Upper Rattlesnake Creek
Aquatic Habitat Enhancement Project
Elk Mountain Ranch
Carbon County, WY

Prepared by

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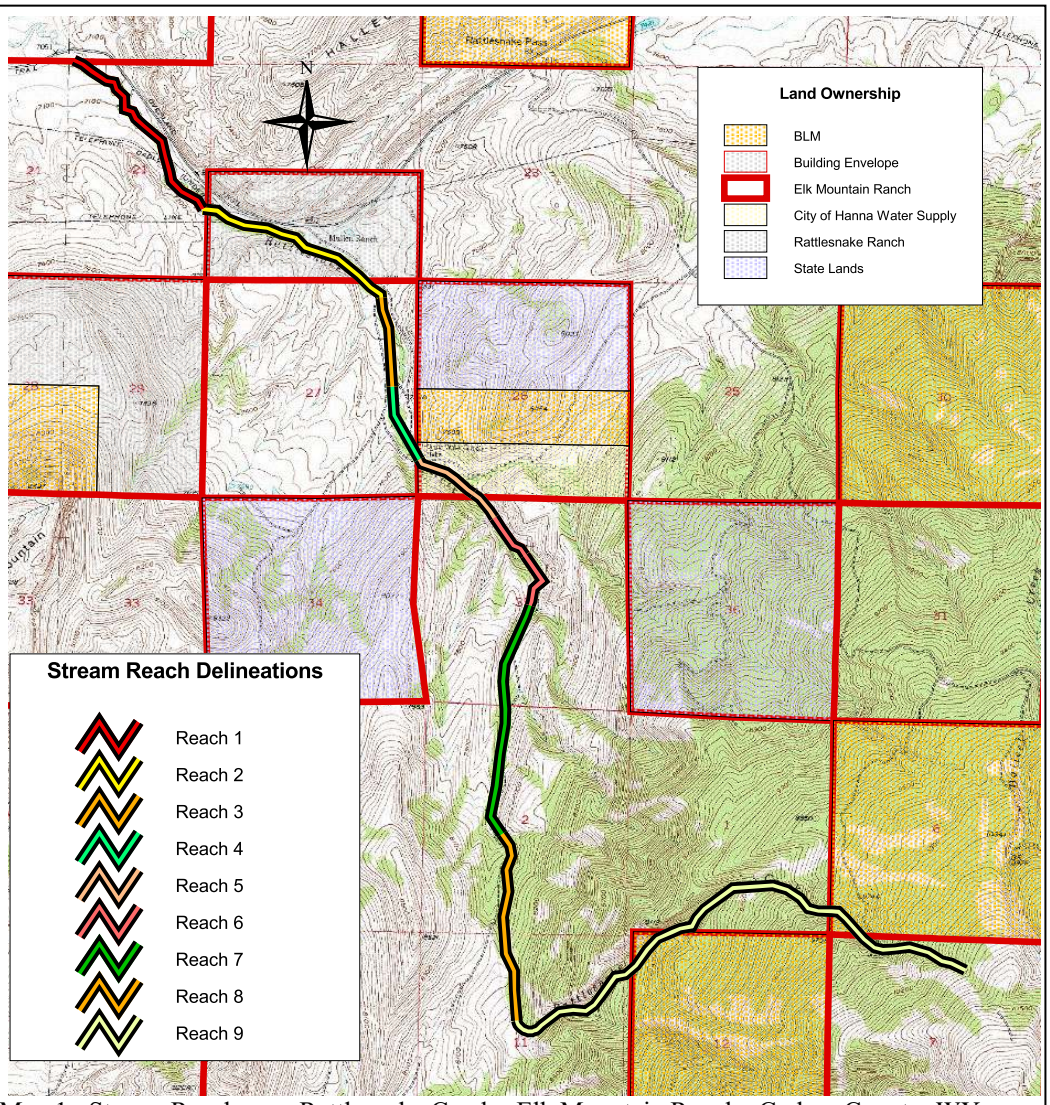
Elk Mountain lies on the watershed divide between the Medicine Bow River and Pass Creek watersheds, two major tributaries of the North Platte River in south central Wyoming. Within the Elk Mountain Ranch there are four perennial streams and over 25 ponds and lakes. The headwaters of two major streams, 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. During the course of this assessment, Rattlesnake Creek Reaches 5 and 6 were identified as presenting the best opportunities in the drainage for aquatic habitat manipulation and enhancement to dramatically improve the fishery.

In May and July, 2007, FIN-UP, Inc. returned to the Elk Mountain Ranch to collect additional data to develop a detailed habitat enhancement plan for the upper reaches of Rattlesnake Creek, with the primary goal of increasing pool depth and complexity, stabilizing the actively eroding banks, providing enhanced "pocket water" cover habitats in the riffles, and addressing the road/stream interactions in the project area. In addition to the stream enhancements considered above, the large beaver pond upstream of the road crossing in Reach 6 was evaluated for possible enhancement to provide for additional pool habitat and over-wintering capacity in the reach. This document will describe the recommended treatment plan for addressing the habitat and bank stability issues in the upper reaches of the creek.

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 4 extends from the Hanna Water Intake fore-bay upstream the Sec.26/Sec.35 boundary. Reach 5 continues from this point upstream to the first road crossing. Reach 6 extends from the first road crossing upstream to the large spring on the east side of the stream. This spring is the primary source of late summer flows in Rattlesnake Creek, and the stream is virtually dry upstream of this point. Both reaches exhibit



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

similar morphological and habitat characteristics. Initial reconnaissance indicated that Reaches 4, 5 and 6 represent some of the best potential on the ranch for a quality fishery, and appeared to be a good representation of habitat conditions in higher gradient B type channels found in the higher elevation reaches of Rattlesnake Creek.

Rattlesnake Creek flows down through a relatively straight and narrow valley throughout this segment. The channel was classified as Rosgen B3, exhibiting less sinuosity than the C channels downstream, slightly greater gradient, and slightly more entrenchment of the channel. The adjacent riparian areas are not as broad as downstream, and are composed of aspen, alder, willow, and some larger mixed conifers. Riparian vegetation in the reach exhibited good vigor with adequate regeneration, and was determined to be in properly functioning condition, although noxious weeds (Canada thistle) were present along the stream throughout the reach. The road parallels the stream throughout Reach 5, and influences the stream in at least two areas. One of these areas is the

road crossing at the boundary between Reach 5 and Reach 6. This crossing is a low water ford, and is actively contributing sediment to Reach 5 immediately downstream. This crossing may also present a barrier to fish passage during extreme low flows, due to the wideness of the channel and lack of depth through the crossing.

Water temperature in the reach during the 2006 assessment was measured at 50˚ f., and pH was measured at 8.58. Measured stream flow at the upstream boundary of the reach, using a Marsh-McBirney Flow-Mate 2000 flow meter, was calculated to be 2.25 cubic feet per second (cfs) in August 2006, and 3.75 cfs in July 2007. Fish were observed throughout the reach, and most likely were brook trout. An electrofishing sample was collected by the Wyoming Fish and Game Dept. (WFGD) in July 1985, and found Brook trout present in the stream at densities of 1,560 individuals/acre with an estimated biomass of 124 lbs/acre. Density and biomass estimates indicate that the population is viable and sustainable, but not robust. Other fish species found in the reach in 1985 included native species such as Creek Chub, Longnose Dace, and Longnose Sucker. The average length of brook trout sampled in the reach in 1985 was 5.5 inches, and no fish larger than this were observed during the 2006 assessment.

Aquatic Habitat Inventory:
A detailed aquatic habitat analysis was conducted along a representative 1,000 foot long segment located near the upstream boundary of Reach 5 in August 2006, using a US Forest Service developed protocol, the Basin-Wide Stream Habitat Inventory (BWSHI)(D. Winters & P. Gallagher, 1997) to quantify aquatic habitat in the reach. The inventory was expanded in 2007 to include all of the Reach 5 downstream to the boundary with the Hanna Watershed property. A summary of the BWSHI assessment is presented here. Detailed habitat metrics for the study segment can be found in the appendix.

For the purposes of the stream aquatic habitat assessment, individual meso-habitat features were identified and numbered consecutively beginning at the downstream boundary of the reach and continuing upstream. All directional references to stream banks other features are from a fisheries biologist's perspective, with left and right banks determined looking upstream along the channel.

A total of seventy-two separate meso-habitats were identified in the study segment. These were composed of thirty-one pools, thirty-four riffles, and seven glide habitats (Chart 1). The average width of the stream was 8.2 feet, and the average depth was 0.4 feet. Channel substrate was predominately gravel, with considerable accumulations of cobble and a few boulders. Sand and silt was present in all habitat types, filling the interstitial spaces between the gravels and cobble, and was significant in depositional areas such as the bottom of pools and in the glides. Large wood was present but somewhat limited in the study segment, with 70 individual pieces counted during the survey. Large wood provided important velocity shelter and cover, and was a significant contributor to habitat creation and scour. Stream banks were mostly vegetated

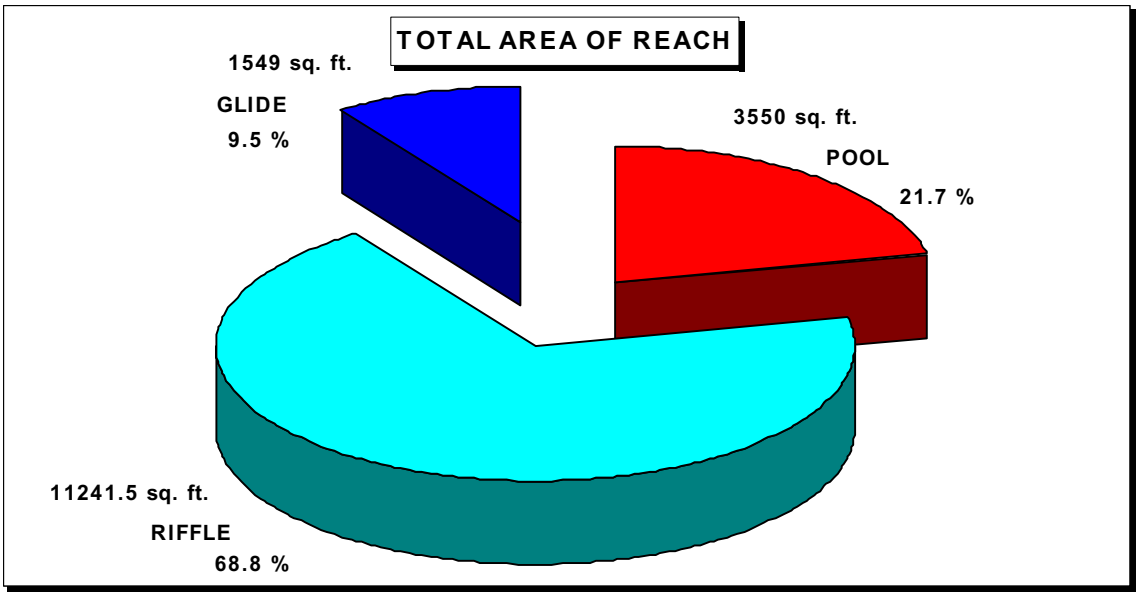


Chart 1: Distribution of Pool, Riffle, & Glide Habitats in Reach 5 on Rattlesnake Creek.

and stable throughout the reach, and the bank rock particle size (BRC) ranged from <1/8" up 6". While not significantly armoring the banks, BRC was largeenough to adequately strengthen banks with robust riparian vegetation. Three hundred and seventy-two feet of active eroding banks were measured in the study segment, and appeared to be a significant source of fine sediment in the reach. These actively eroding banks were primarily associated with the adjacent road and the road crossing.

Pools in this segment were principally associated with scouring of the channel due to root-wad obstructions, large wood and woody debris. A few of the pools were formed by boulders or the natural meander pattern of the river. Pool habitats comprised approximately 22% of the total wetted area of the study segment. The average depth of all of the pools measured was only 0.75 ft., with maximum pool depths ranging from 0.9 to 1.8 feet. Residual pool depth (RPD) was found to range from 0.4 to 1.3 feet, with an average of 0.8 feet throughout the reach. RPD in the reach was considered a significant limiting factor, and appeared to be marginally adequate to provide for over-wintering of salmonids and other native species in this reach.

Low gradient gravel and cobble riffles were the most dominant habitat type, in terms of both numbers and area, in the study segment, comprising more than 69% of the wetted area (Chart 2). These riffles typically dominate B channel types, and depending on depth and substrate structure, may provide important holding and feeding habitats for trout, as well as critical habitat for benthic macro-invertebrates and other aquatic organisms. The average depth of these riffles was 0.25 feet in the study segment and there was only minimal (<50ft^2) holding cover. Most of the riffle holding cover was found in the less disturbed lower portion of the reach. Riffles in the study segment did appear to provide adequate spawning habitat for salmonids and other native fish species, and several year classes of brook trout were observed.

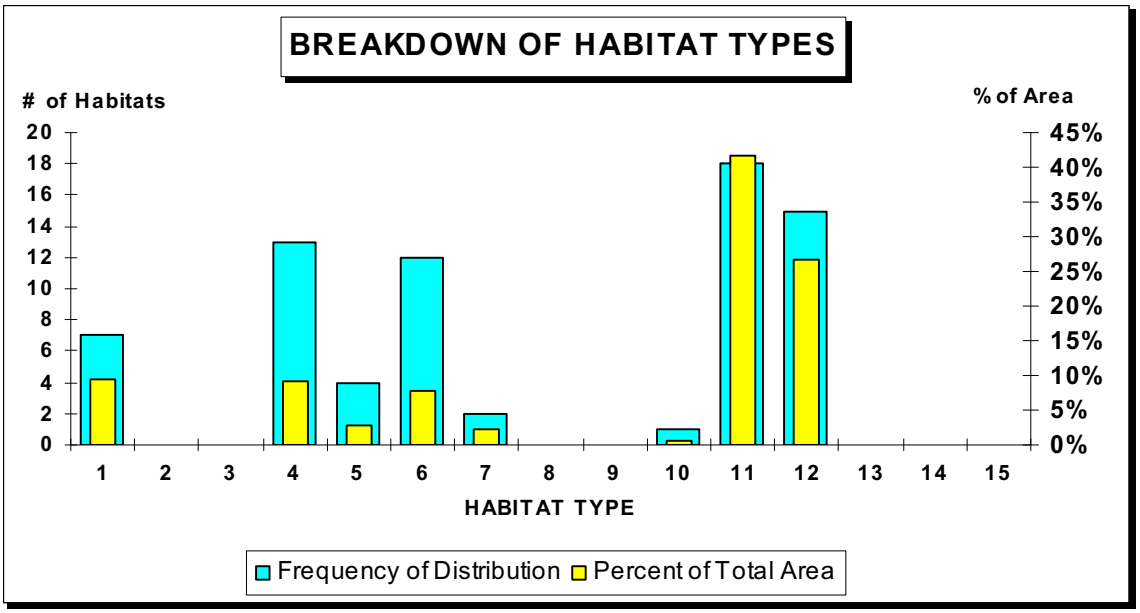


Chart 2: Percentage distribution of Pool, Riffle, & Glide Habitat forms in Reach 5.

Seven glides were observed in the reach, and were principally associated with pools that had been filled with sediments from adjacent eroding banks and the road crossing. Glide habitats accounted for <10% of the total area of the study segment. Cover in the glides was limited to overhanging streamside vegetation, which provided no velocity shelter.

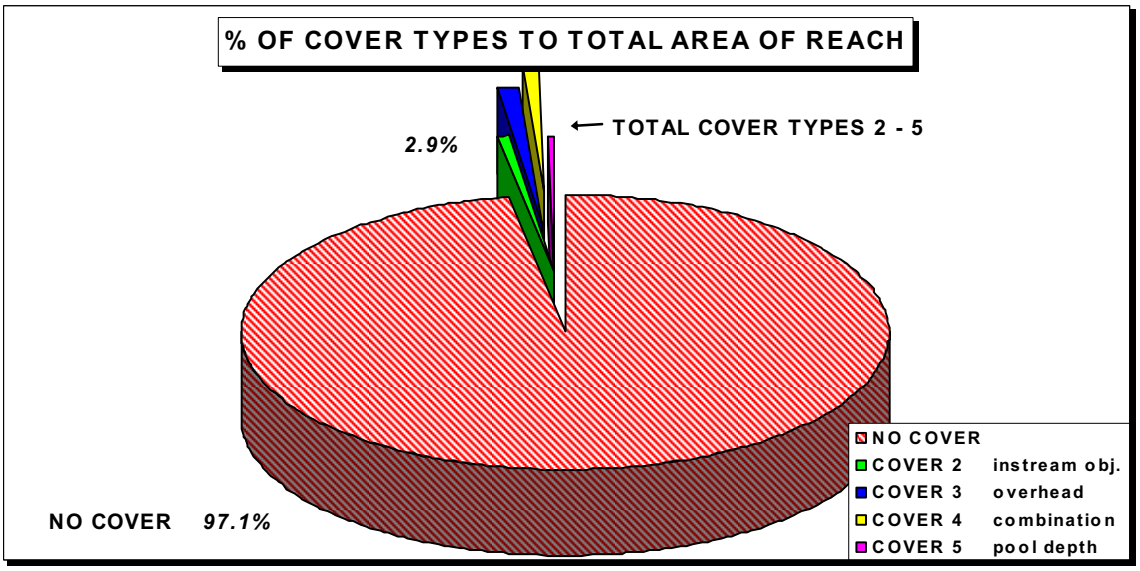
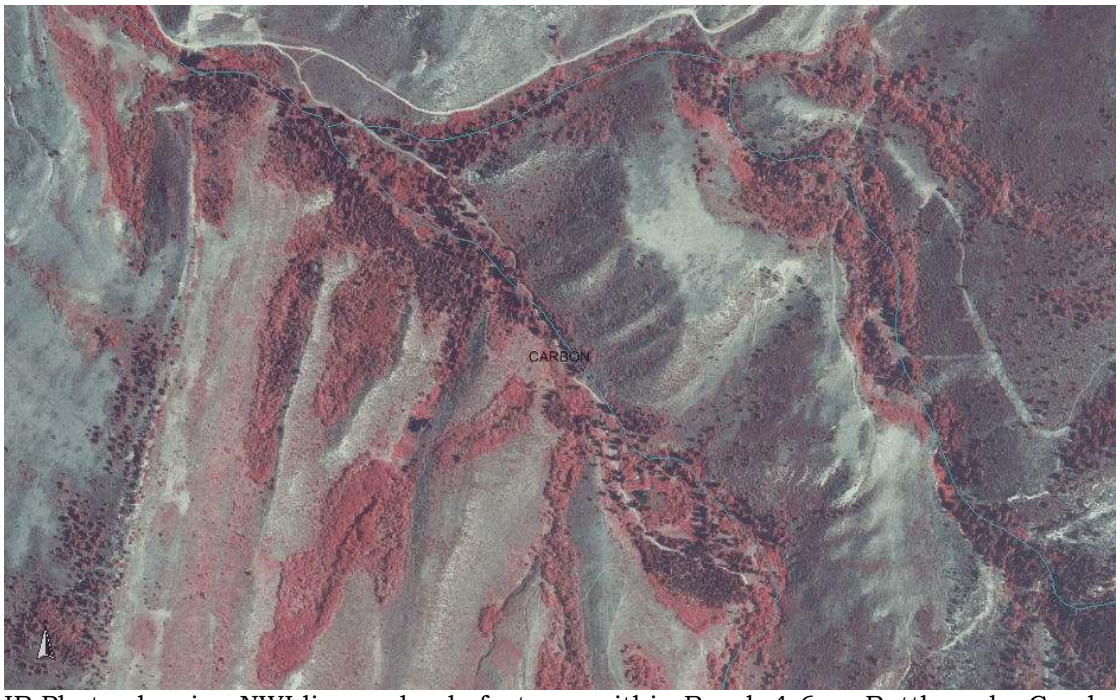


Chart 3: Percentage of Cover Types within Reach 5 on Rattlesnake Creek.

The quantity of suitable cover for salmonids in the Reach 5 study segment was very limited (Chart 3), accounting for less than 3% of the total wetted area of the channel. Suitable cover was more abundant in the less disturbed downstream segment of the reach. Less cover is expected in higher gradient B type channels, particularly those with larger stream channel substrates that

armor the channel against pool scour. In undisturbed B channels, cover values of 5% - 8% would be expected. Cover was principally composed of overhead vegetation cover. Pool cover, an important metric for determining over-wintering capacity in the study segment, was virtually non-existent in the study segment.

Aquatic habitat conditions in Reach 5 and 6 were found to be fair, with several limiting factors potentially affecting the sustainability of the trout fishery in the reach. Currently, the principal limiting factors to the fishery are the lack of over-wintering deep water habitat and limited cover in the reach. These problems are being compounded by actively eroding banks continuing to contribute sediment to the system and filling in the remaining deep water pockets.



IR Photo showing NWI line and poly features within Reach 4-6 on Rattlesnake Creek.

National Wetlands Inventory data and IR color photographs (2000) from the WyGISC Data Server (http://partners.wygisc.uwyo.edu) were used to identify important wetland and riparian features within Reach4, 5 and 6 on Rattlesnake Creek. A composite photograph showing the NWI line and polygon features superimposed over the color IR photo is shown above, and at a larger scale in the appendix. In addition to the NWI line features expected to be present in the study area, one important palustrine habitat polygon is identified in the NWI. This feature is attributed in the NWI as **PAB**Gb - Aquatic Bed, and likely is associated with the off-channel beaver pond and adjacent carex wetlands between the road and the stream in Reach 6. The IR photos also indicate a well developed riparian/water influence zone surrounding the stream throughout all three reaches. Stream channel work within these reaches of Rattlesnake Creek will avoid impacting any critical riparian or other wetland resources.

The off-channel beaver pond between the road and the stream in Reach 6 was identified in the 2006 Rapid Landscape Assessment as a critical feature in the watershed, and the ranch has expressed a keen interest in enhancing this feature and stocking it with trout. In May 2007, FIN-UP, Inc. collected data on the bathymetric profile of the pond, and mapped the pond's outlet and feeder streams, and the source of water feeding the pond.

The pond is fed from a natural spring emerging from the western hill slope of the valley, immediately below the Rattlesnake Creek road, approximately 360 ft. upstream of the impoundment. Flow from the spring was measured, using a Marsh-McBirney FlowMate 2000 flow meter and English top-set wading rod, at mid-day on July 12, 2007, and was calculated to be running at 0.5 cfs. The measurement cross-section was approximately 75 ft downstream of the source, at the first definable single-thread channel.

The outlet stream flows from the west side of the beaver pond, down through several old beaver pond remnants, for 230 ft to the confluence with Rattlesnake Creek, just upstream of the Reach 5 / Reach 6 boundary. The beaver pond consists of 0.25 surface acres at full-pool stage, and is estimated to contain a volume of just under 0.5 acre/ft at that stage. During the May 2007 survey, the pond was down 0,5 feet from full-pool stage, with a resulting wetted perimeter of just under 0.08 surface acre, and an estimated volume of 0.15 acre/ft. The average depth of the pond, at full-pool stage is 1.9 ft. and there is considerable aquatic vegetation and weed growth established in the feature.

The pond is surrounded along the eastern and southern shorelines, and along the first 75 ft of the feeder channel, by relatively extensive wetland/riparian plant communities, consisting primarily of carex and willow. Riparian vegetation is limited to a narrow green-line along the western shore of the feature, due to the steep topography and encroachment by the Rattlesnake Creek Road. The beaver pond, and the remnants downstream no longer appear to be inhabited by beaver, although there is evidence of several colonies downstream in Reach 2, 3, and 4.

Off-Channel Beaver Pond looking South East adjacent to Reach 6 on Rattlesnake Creek.

Stream Channel Morphology:

For the purposes of the stream channel morphology study, cross-sections were established and numbered consecutively beginning at the top of the reach and continuing downstream. All directional references to stream banks and cross-sectional head pins are for the channel morphology study are from a hydrologist's perspective, with left and right banks determined looking downstream along the channel.

A longitudinal profile (Chart 4) of the stream channel and several representative cross-sections were established in July 2007 in the upstream segment of Reach 5. This segment of the reach exhibits the most disturbance to the channel, poorest quality habitat, and will be the principal focus area for restoration efforts. The longitudinal profile shows that although there has been some historic down-cutting of the channel throughout the reach, as evidenced by the "top of bank" features present in the profile, the stream channel currently appears to be vertically stable, with minimal active head-cutting observed. Historic down-cutting appears to have likely been the result of inundation by beaver ponds and subsequent failure of these habitats.

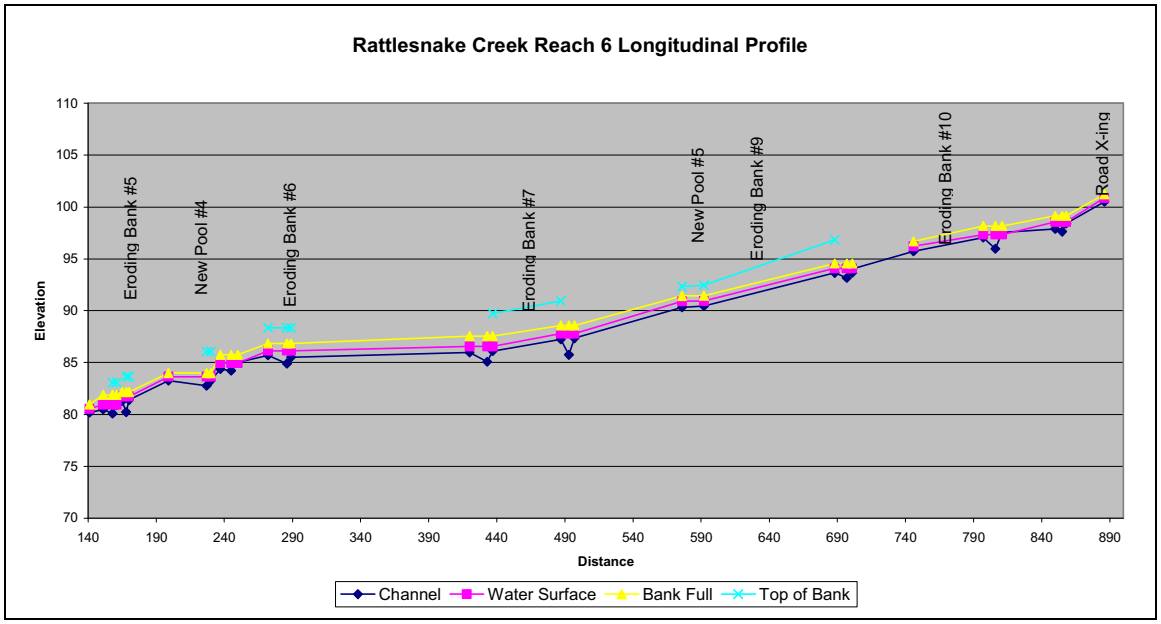


Chart 4: Longitudinal Profile of the upper segment of Reach 5 on Rattlesnake Creek.

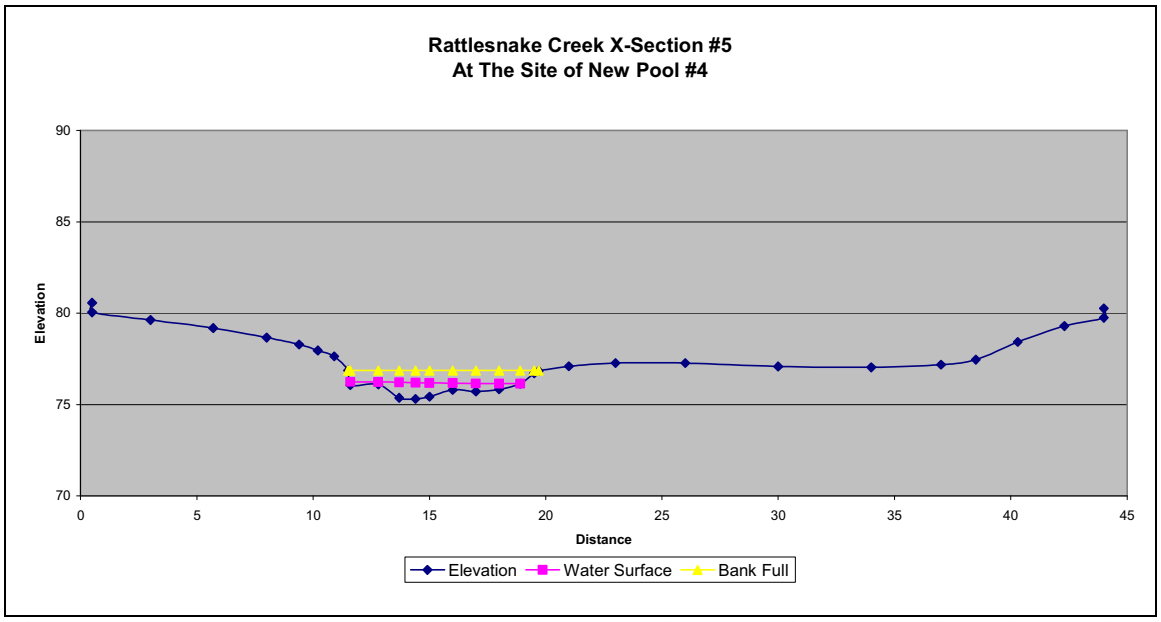


Chart 5: A representative reference cross-section along Reach 5 on Rattlesnake Creek.

Cross-section #5 depicts a reference channel within the reach, with a width to depth ratio near the optimal value for this channel type (B3 Channel - W/D ratio = 9.75). There is a well developed flood-plain on the east side of the creek, and the stream banks are stable and well vegetated. The cross-section bisects the creek at the transition between Pool 18 and Riffle 18, described in the BWSHI assessment in the previous section, and is also the location for planned pool enhancement described later in this document. The composite photo to the right shows the cross-section, looking from RHP5 toward LHP5, and from downstream of the cross-section.

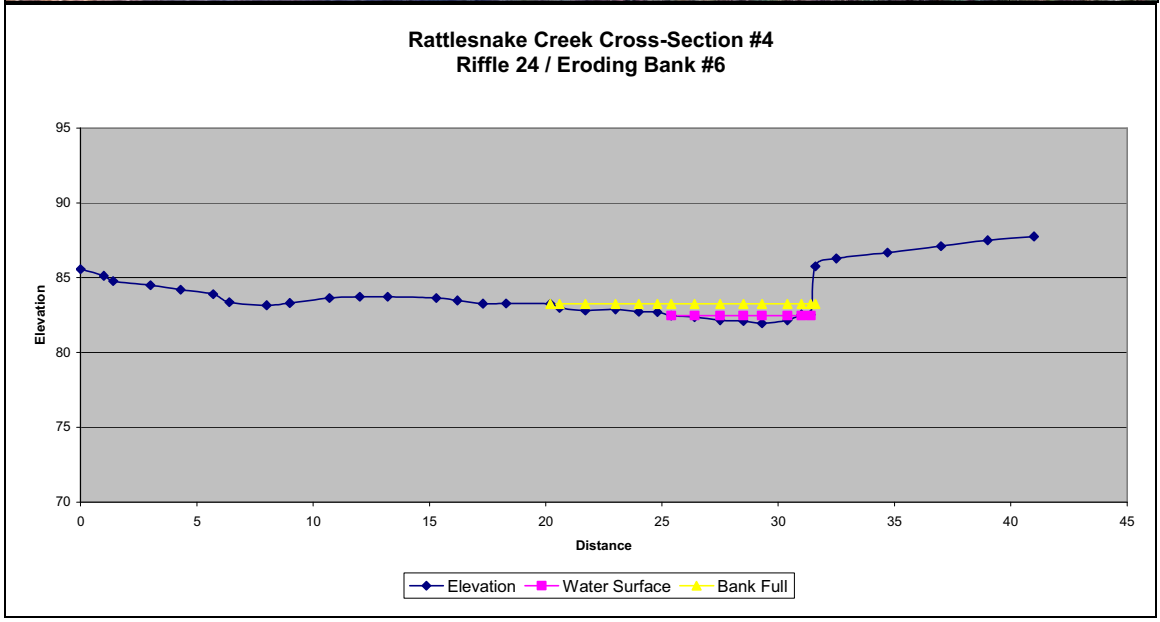


Chart 6: Cross-Section #4 @ R5-EB6 along Reach 5 on Rattlesnake Creek.

The other channel cross-sections indicate that there may be some lateral instability of the reach, with frequent vertical, poorly vegetated stream banks subject to considerable shear stress on the outside of the meander bends (Cross Sections #4 and #6). Cross-Section #4 (Chart 6) is a good example of lateral instability and bank failure occurring in the reach. The stream, though this cross-section, exhibits a tight meander bend, and is rapidly eroding the right bank, which is failing at several points. The width/depth ratio of the channel is currently 15.8 and appears to be gradually increasing. The point bar on the inside of the meander is stable however, and is well vegetated. The vegetation on the right bank however, consists of mostly shallow rooted upland grasses. Left untreated, the stream will continue to erode into the right bank, increasing sedimentation downstream. The photo in the chart above shows the cross-section from upstream, looking downstream at the site.

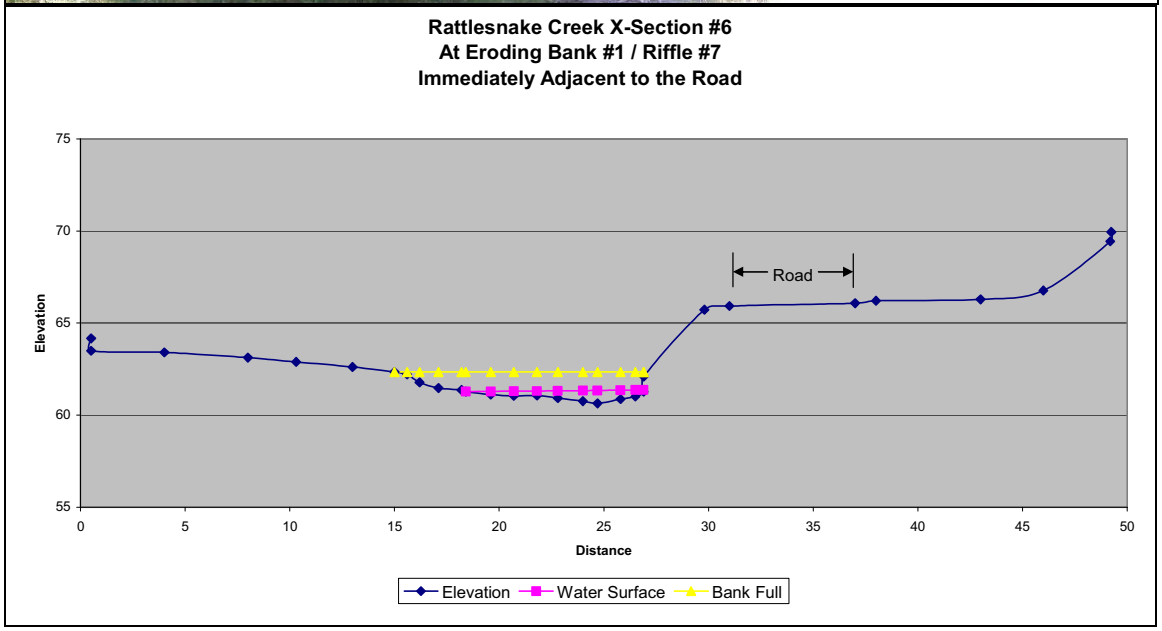


Chart 7: Cross-Section #6 @ R5-EB1 along Reach 5 on Rattlesnake Creek.

Cross-Section #6 is an example of the road/stream interactions occurring within the reach (Chart 7). As is the case with Cross-Section #4, the stream exhibits an extremely tight meander bend at the point where it is immediately adjacent to the road. The road-side stream bank vegetation is shallow rooted and very sparse, and the bank has failed at several points. Left untreated, the stream will eventually erode the bank to the point where the road will be cut-off. The photo in Chart 7 shows the cross-section from upstream of the site, looking downstream.

Additionally, there are several segments of the reach that exhibit channel width/depth ratios greater than would be expected or desirable in this channel type. Over-wide channels are a significant problem at the Reach 5/Reach 6 road crossing, and immediately downstream of this point (Cross-Section #3, Chart 9), where width/depth ratios range from 13 to over 31. The road crossing (Cross-Section #1, Chart 8) is likely a barrier to fish migration through the reach during the low flows found in late summer and fall, due to lack of depth or defined channel through the crossing. The photographs in each of these charts are taken from downstream of the cross-sections, looking upstream.

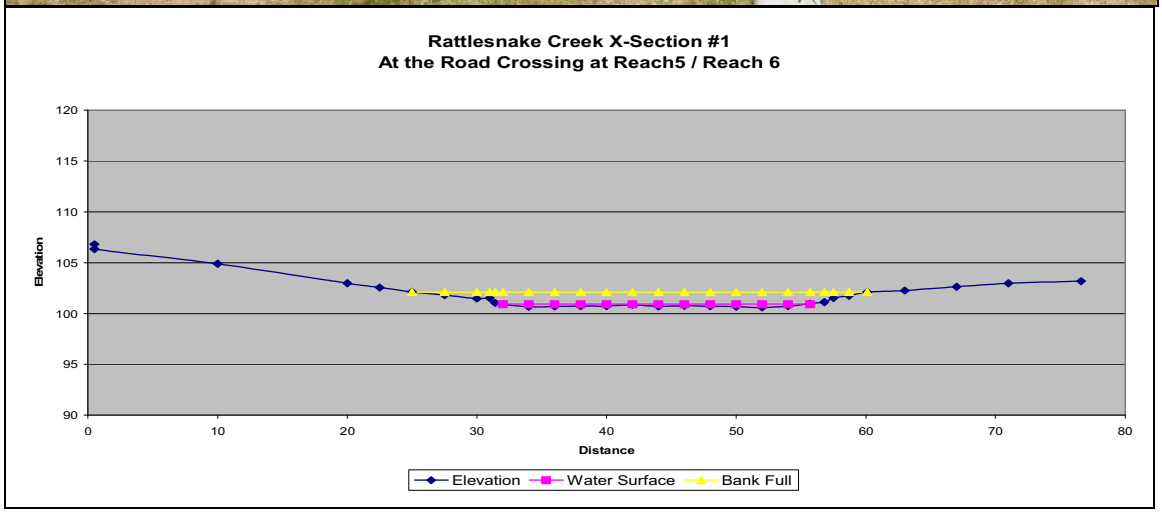


Chart 8: Cross-Section #1 @ the R5/R6 Reach Boundary on Rattlesnake Creek.

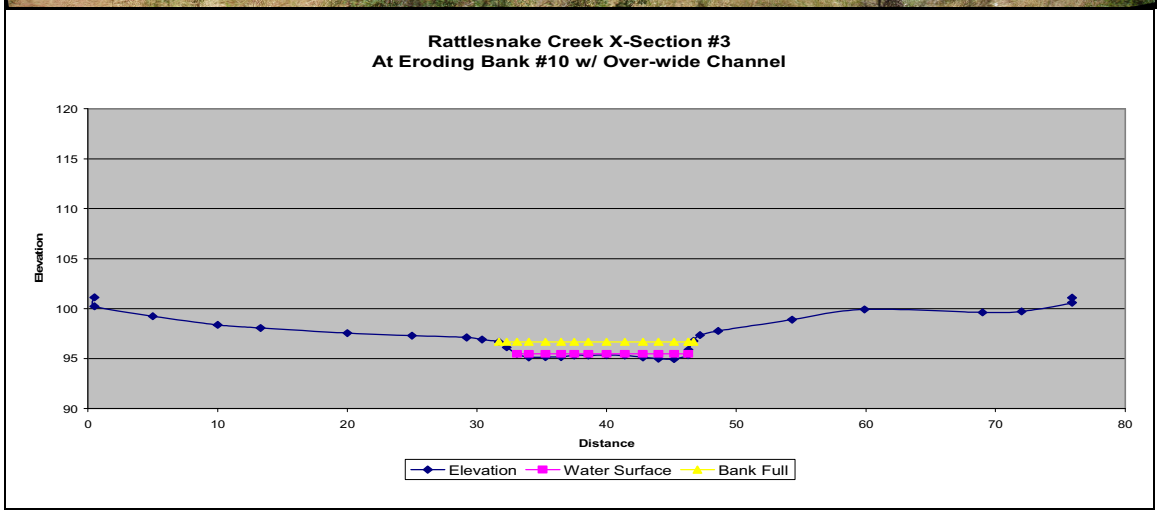


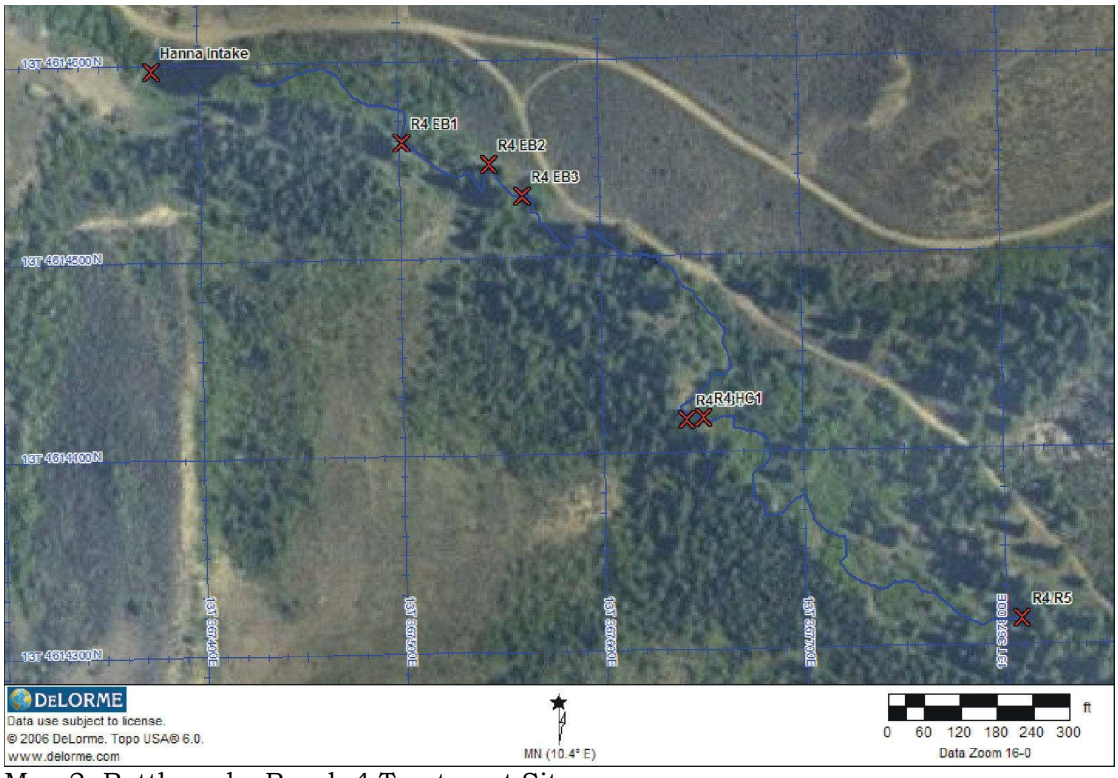
Chart 9: Cross-Section #3 @ R5-EB10 along Reach 5 on Rattlesnake Creek.

Rattlesnake Creek Reach 4/5/6 Aquatic Habitat Enhancement Plan

The aquatic assessment indicates that poor pool development, insufficient residual pool depth, and lack of cover are significant limits to the health of the fishery in Rattlesnake Creek. Additionally, lateral instability in the upstream half of Reach 5, and interactions between the road and the creek, have resulted over-wide channels, with actively eroding stream banks contributing excess sediment to the system, and further degrading available pool habitat and spawning redds. The following chapter will describe the specific treatments recommended to address limiting factors to salmonid habitat and stream channel stability issues identified in the aquatic habitat assessment and inventory. Treatments are grouped by individual reach, and each treatment site will be described in detail. Technical drawings of the specific treatment types may be found in the appendix of this document.

For the purposes of the stream aquatic habitat enhancement plan, treatment sites were identified and numbered consecutively beginning at the downstream boundary of the reach and continuing upstream. All directional references to stream banks and other features are from a fisheries biologist's perspective, with left and right banks determined looking upstream along the channel.

Reach 4:
Reach 4 extends from the upstream boundary of the Hanna Water Supply intake to the Section boundary between R.82 W., T.20 N., Sec. 26 and Sec. 35. Most of the stream throughout this segment is inaccessible, and much of the habitat consists of active beaver ponds. Three sites were identified within the reach where bank stabilization treatments may be utilized to treat actively eroding stream banks and enhance existing pool habitat. Additionally, one small head-cut was identified in the reach. The locations of these sites are shown in the map below.



Map 2: Rattlesnake Reach 4 Treatment Sites.

Photo 7 - Site R4-EB1 Downstream

Photo 8 - Site R4-EB1 Upstream

Photo 9 - Site R4-EB2 Left Bank

Photo 10 - Site R4-EB3 From Right Bank

The first treatment site on Reach 4 is designated as GPS point R4-EB1 on the map, and consists of 75 ft. of actively eroding stream bank on the right side of the channel. This segment of the stream lies along a corridor frequently utilized by elk, which has resulted in severe hoof-shear and collapse of the bank. Additional pressure from grazing cattle has resulted in banks that are nearly devoid of vegetation and actively contributing sediment to habitats downstream. Two pools exist along the 75 ft length, and could be further enhanced at the same time as the bank stabilization. The segment is shown in Photos 7 and 8, looking downstream and upstream respectively. Recommended treatment includes installing 3 log toe-slope structures along the right bank, and transplanting willow behind these structures. The channel throughout this segment is not overly wide, therefore the logs will be installed flush against the existing stream bank, creating a bench on which to transplant willow harvested from the riparian area beyond the left bank. A short segment of the right and left banks immediately downstream of Pool 3 will be armored with small cobble in order to provide a hardened crossing for elk. Two log/boulder J-hook vanes will be installed on the right bank adjacent to the existing pool habitats, to further protect the right bank and to enhance scour in these habitats. A total of 5 pieces of large wood, 8 to 10 boulders (0.5 yd^3 each), and 1.5 yd^3 of cobble will be required for this site. Fill below the ordinary high water mark of the stream for the log/boulder J-hook vane structures is estimated to be approximately 2.5 to 3.5 yd^3 for each structure. Bank stabilization fill below the ordinary high water mark is expected to be approximately 0.1 yd^3 per linear foot of bank for the log-toe-slope structures, and 0.2 yd^3 per linear foot for the cobble hardened crossing. Total fill for the site is estimated not to exceed 15.5 yd^3. Good access is available to the site along the elk / cattle path leading to the stream, therefore no wetlands will be effected in the course of this work.

The next treatment site is designated as R4-EB2, and consists of a short segment of collapsing stream bank that can be easily treated with a single log toe-slope structure and willow transplant (Photo 9). The log will be installed flush with the existing bank, and anchored with two small boulders and willow transplants. Total fill below the ordinary high watermark of the stream channel should not exceed 0.2 yd^3/linear foot of stream bank treated. Total fill is expected to be less than 3 yd^3. The site is easily accessible from the Rattlesnake Creek road, and no wetlands will be affected.

Treatment site R4-EB3 is immediately adjacent to the Rattlesnake Creek road and consists of approximately 15 feet of eroding left bank with a very shallow pool near the upper end of the site (Photo 10). The eroding stream bank will be treated using a single log toe-slope structure (0.2 yd^3/linear foot - 3 yd^3 cumulative). The pool may be enhanced by removing some of the larger cobble and small boulders that are limiting scour in this feature. Any large rock removed from the pool will be used to anchor the ends of the log toe-slope structure on the left bank.

The eroding bank at R4-EB4 is not easily accessible to equipment, and therefore will not be treated under this project. The unstable bank is approximately 70 ft long, and appears to be gradually healing, as evidenced by the line of riparian sedges that have become established along the toe-slope of

the stream bank (Photo 11). This bank should continue to be monitored to ensure that it continues this trend.

The small head-cut observed in Reach 4 is designated on the map as R4-HC1, and can barely be seen in Photo 12. This site is also inaccessible to equipment, therefore, the usual treatment of installing a grade controlling structure such as a cross vane will not be practical here. In lieu of a cross-vane, it may be desirable to create a woody debris dam pool immediately downstream of this feature by dropping two or three small tree-tops into the channel. The tree-tops will capture smaller woody debris moving through the stream and form a dam pool at the head-cut, reducing the downward erosional pressure on the channel. This work can be accomplished without the use of heavy equipment.

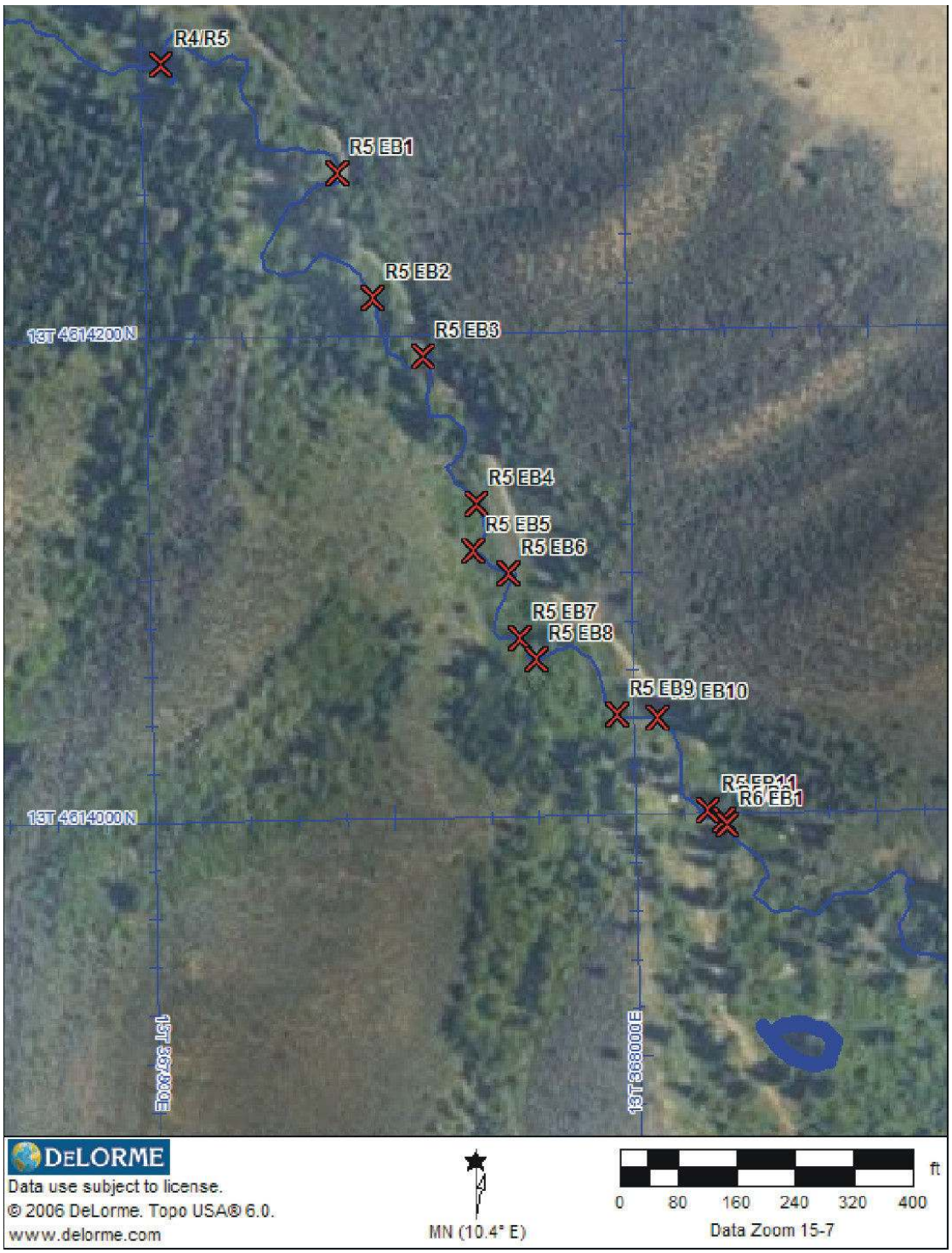
Photo 11 - Site R4-EB4 Downstream

Photo 12 - Site R4-HC1 Looking Upstream

REACH 6		
Site	**Treatment Type**	**Estimated Fill**
R4-EB1	Log Toe-Slope Stabilization - Log/Bldr J-Hooks	15.5 yd^3
R4 EB2	Log Toe-Slope Stabilization	3 yd^3
R4-EB3	Log Toe-Slope Stabilization - Remove Armor	3 yd^3
R4-EB4	No Treatment - Monitor	N/A
R4-HC1	Create Debris Dam Pool Using Small Tree Tops	<2 yd^3

Reach 5:
Reach 5 extends from the Section boundary between R.82 W., T.20 N., Sec. 26 and Sec. 35., upstream to the first crossing of the road with Rattlesnake Creek. The road parallels the creek throughout this reach, with good access to the creek for equipment in many locations. A significant number of the treatment areas under this project are found in Reach 5. Much of the enhancement activity will focus on stabilizing eroding stream banks, enhancing pool depth and scour, and addressing excessive width/depth ratios in the stream channel near the upstream boundary of the reach. Two of the treatment sites will address undesirable road/stream interactions occurring where the road is immediately adjacent or crosses the creek. The locations of these treatment areas are shown in the map on the right. Additionally, several new pool

habitats will be developed at suitable sites along the stream channel within the reach. The locations and construction details of these new pools are described in the *New Pool Habitat Development* section following the *Eroding Stream Banks* descriptions.



Map 3: Rattlesnake Reach 5 Eroding Bank Sites.

Photo 14 - Site R5-EB2 Looking Downstream

Photo 15 - Site R5-EB3 From the Right Bank

Photo 16 - Site R5-EB1 From the Right Bank

Photo 13 - Site R5-EB1 Looking U/S.

Eroding Stream Banks:
The first eroding stream bank treatment site on Reach 5 is designated as GPS point R5-EB1 on the map, and corresponds with Riffle 7 in the BWSHI and Cross-Section # 6 described in the previous chapter. The site consists of 35 ft. of actively eroding stream bank on the left side of the channel. The road is immediately adjacent to the stream channel at this site, and is at risk of collapsing into the stream (Photo 13). The road will need to be moved approximately 8 ft to the east, away from the stream. There is adequate width between the stream and the steep hill slope to allow for this re-location. The collapsing left bank will be stabilized using two log toe-slope bank structures placed flush against the existing stream bank. These toe-slope structures will be anchored using small boulder vanes extending 1/3 of the distance into the channel, at an angle not to exceed 30^{o} from the bank. These structures will further reduce the sheer stress along the outside of this meander bend, as well as providing additional in-stream cover within Riffle 7. The existing vertical bank will be sloped back to the edge of the newly relocated road and will be re-vegetated using native willow and sedges transplanted from the point bar on the inside of the meander bend. A total of 2 pieces of large wood, and 12 to 14 boulders (0.5 yd^3 each) will be required for this site. Fill below the ordinary high water mark of the stream for the boulder vanes is estimated to be approximately 2.5 to 3.5 yd^3 for each structure. Bank stabilization fill below the ordinary high water mark is expected to be approximately 0.1 yd^3 per linear foot of bank for the log-toe-slope structures. Total fill for the site is estimated not to exceed 10 yd^3.

Treatment site R5-EB2 (Photo 14) corresponds with Riffle 10 in the BWSHI, and consists of 40 ft of unstable left stream bank, and a somewhat over-wide stream channel due to the formation of a mid-channel bar in the upstream boundary of the site. Treatments will include installing a large tree along the left stream bank, and revegetating the bank with sedges harvested from the mid-channel bar. A small log/boulder vane will be installed at the downstream boundary of this site to enhance scour and cover in Pool 8. Two pieces of large wood, and 4 - 5 boulders (0.5 yd^3 each) will be required for this site. Fill below the ordinary high water mark of the stream for the log/boulder vane is estimated to be approximately 2.5 to 3.5 yd^3. Bank stabilization fill below the ordinary high water mark is expected to be approximately 0.2 yd^3 per linear foot of bank for the log-toe-slope structure. Total fill for the site is estimated not to exceed 10.5 yd^3.

Site R5-EB3 (Photos 15 & 16) corresponds with Riffle 16 in the BWSHI and consists of 35 ft of actively eroding bank on the left side of the channel adjacent to the road. A log toe-slope structure will be installed flush with the left bank, and revegetated using native willow available on the other side of the stream. Additionally, a poorly developed pool (Pool 16) exists immediately below the actively eroding stream bank. This pool will be enhanced by installing a boulder cross vane to improve scour and depth of the pool, as well as anchoring the toe-slope structure above. One piece of large wood, and 13 -15 boulders (0.5 yd^3 each) will be required for this site. Fill below the ordinary high water mark of the stream for the cross-vane is estimated to be approximately 7 yd^3. Bank stabilization fill below the ordinary high water mark is expected to be

Photo 17 - Site R5-EB4 Looking Downstream at left bank.

Photo 18 - Site R5-EB5 Looking Downstream at left bank.

Photo 19 - Site R5-EB6 Looking Upstream

Photo 20 - Site R5-EB6 Looking Downstream

approximately 0.1 yd^3 per linear foot of bank for the log-toe-slope structure. Total fill for the site is estimated not to exceed 10.5 yd^3.

Site R5-EB4 (Photo 17) corresponds with Riffle 21 in the BWSHI and consists of 120 ft of relatively unstable and steep stream bank on the left side of the channel, including 25 ft of actively eroding stream bank contributing sediment to the channel. Three logs will be installed flush with the left bank, and revegetated using native willow available on the other side of the stream. Additionally, two pools (Pool 21 and 22) will be enhanced by installing log/boulder vanes to improve scour and depth, as well as reducing sheer on the unstable left bank between the pools. Five pieces of large wood, and 8 boulders (0.5 yd^3 each) will be required for this site. Fill below the ordinary high water mark of the stream for the log/boulder vanes is estimated to be approximately 2.5 to 3.5 yd^3 per structure. Bank stabilization fill below the ordinary high water mark is expected to be approximately 0.1 yd^3 per linear foot of bank for the log-toe-slope structure. Total fill for the site is estimated not to exceed 19 yd^3.

Site R5-EB5 (Photos 18) corresponds with Pool 24 and Riffle 23 in the BWSHI and consists of 20 ft of actively eroding stream bank contributing sediment to the channel. Treatment will include installing a tree along the right stream bank, and revegetating the bank with willow harvested from the point bar on the inside of the meander bend. A small log/boulder vane will be installed at the downstream boundary of the toe slope structure to enhance scour and cover in Pool 24. Two pieces of large wood, and 4 - 5 boulders (0.5 yd^3 each) will be required for this site. Fill below the ordinary high water mark of the stream for the log/boulder vane is estimated to be approximately 2.5 to 3.5 yd^3. Bank stabilization fill below the ordinary high water mark is expected to be approximately 0.1 yd^3 per linear foot of bank for the log-toe-slope structure. Total fill for the site is estimated not to exceed 5.5 yd^3.

Site R5-EB6 corresponds with Riffle 24 in the BWSHI and Cross-Section # 4 described in the previous chapter. The site consists of 40 ft. of actively eroding stream bank on the left side of the tightly meandering stream channel (Photos 19 and 20). Enlarging the stream meander radius of curvature, lengthening the channel and reducing the water surface slope will reduce the sheer on this extremely unstable bank. The left bank of the stream will be excavated approximately 3 feet in order to increase the radius of curvature of the meander bend. Material from this excavation will be used to augment the point bar on the inside of the meander bend in order to maintain the existing channel width/depth ratio and cross-sectional bank-full dimension. The new stream bank will be stabilized using two log toe-slope bank structures placed flush against the bank, with the slope above pulled back to an angle of repose of 3:1 or less. These toe-slope structures will be anchored on the downstream side and middle of the bank by installing two small boulder vanes extending 1/3 of the distance into the channel, at an angle not to exceed 30o from the bank. A full channel cross-vane will be installed at the upstream boundary of the site to anchor the toe slope treatments, as well as creating additional pool habitat. The left stream bank and augmented point bar will be re-vegetated using native willow and sedges transplanted from behind the point bar on the inside of the

Photo 21 - Site R5-EB7 Looking Downstream

Photo 22 - Site R5-EB8 Looking Across the Channel at Right Bank.

Photo 23 - Site R5-EB9 Looking Across the Channel at the Right Bank.

meander bend. Two pieces of large wood, and 18 - 20 boulders (0.5 yd^3 each) will be required for this site. Fill below the ordinary high water mark of the stream for the cross-vane is estimated to be approximately 6 yd^3., and 3 yd^3 for each rock vane. Bank stabilization fill below the ordinary high water mark is expected to be approximately 0.1 yd^3 per linear foot of bank for the log-toe-slope structure. Total fill for the site is estimated not to exceed 16 yd^3.

Site R5-EB7 (Photo 21) corresponds with Pool 26 in the BWSHI and consists of 17 ft of generally unstable stream bank on the left side of the channel. Treatment will include installing a tree flush along the left stream bank, and revegetating the bank with willow harvested from the point bar on the inside of the meander bend. A small log/boulder vane will be installed at the upstream boundary of the toe slope structure to enhance scour and cover in Pool 26. Two pieces of large wood, and 4 - 5 boulders (0.5 yd^3 each) will be required for this site. Fill below the ordinary high water mark of the stream for the log/boulder vane is estimated to be approximately 2.5 to 3.5 yd^3. Bank stabilization fill below the ordinary high water mark is expected to be approximately 0.1 yd^3 per linear foot of bank for the log-toe-slope structure. Total fill for the site is estimated not to exceed 5.5 yd^3.

Site R5-EB8 (Photo 22) corresponds with Pool 27 in the BWSHI and consists of 13 ft of generally unstable stream bank on the left side of the channel, with 7 linear feet of the bank actively contributing sediment to the system. Treatment will include installing a tree flush along the right stream bank, and revegetating the bank with willow and sedge harvested from near the site. A small log/boulder vane will be installed at the upstream boundary of the toe slope structure to enhance scour and cover in Pool 27. Additionally, some accumulated sediment will be excavated from the pool and removed from the site. Two pieces of large wood, and 4 - 5 boulders (0.5 yd^3 each) will be required for this site. Fill below the ordinary high water mark of the stream for the log/boulder vane is estimated to be approximately 2.5 to 3.5 yd^3. Bank stabilization fill below the ordinary high water mark is expected to be approximately 0.1 yd^3 per linear foot of bank for the log-toe-slope structure. Total fill for the site is estimated not to exceed 5.5 yd^3.

Site R5-EB9 (Photo 23) corresponds with Riffle 28 and Pool29 in the BWSHI and is characterized by unstable and poorly vegetated stream banks on the right stream bank. The site is approximately 30ft long. Treatments will include installing a tree flush along thirty feet of the right stream bank, and revegetating the bank with willow and sedge harvested from near the site. A small log/boulder vane will be installed at the tail of Pool 28 in order to increase residual pool depth and cover within this feature. Two pieces of large wood, and 5 - 6 boulders (0.5 yd^3 each) will be required for this site. Fill below the ordinary high water mark of the stream for the log/boulder vane is estimated to be approximately 2.5 to 3.5 yd^3. Bank stabilization fill below the ordinary high water mark is expected to be approximately 0.1 yd^3 per linear foot of bank for the log-toe-slope structure. Total fill for the site is estimated not to exceed 6 yd^3.

Photo 20/24 pan - Site R5-EB10 Left Bank Along the Site.

Photo 25 - Site R5-EB10 Looking Downstream

Photo 28 - Site R5-EB11/R6EB1 Looking Across the Channel at the Right Bank.

Photo 26 - Site R5-EB11 Looking D/S.

Photo 27 - Site R5-EB11 Left Bank

Site R5-EB10 (Photos 24 & 25) corresponds with Riffle 29 in the BWSHI and Cross-Section #3 in the preceding chapter. The channel throughout this site is characterized by high width/depth ratios, unstable and poorly vegetated stream banks, and generally limited habitat for trout. The site is approximately 66 ft long, with 45 ft of eroding banks actively contributing sediment to the channel. Forty-five feet of unstable bank on the left side of the channel will be stabilized using large wood toe-slope structures and transplanted willow. These structures will be installed so as to reduce the width/depth ratio of the channel along Cross-Section to a W/D of 10 from the current W/D of 13. Additionally, a cross vane will be installed at the upstream boundary of the site to create a new pool, as well as anchor the tree toe-slope treatments. Two pieces of large wood, and 14 -16 boulders (0.5 yd^3 each) will be required for this site. Fill below the ordinary high water mark of the stream for the cross-vane is estimated to be approximately 7 yd^3. Bank stabilization fill below the ordinary high water mark is expected to be approximately 0.25 yd^3 per linear foot of bank for the log-toe-slope structure. Total fill for the site is estimated not to exceed 17 yd^3.

Site R5-EB11 and R6-EB1 (Photos 26, 27 and 28) correspond with the low water road crossing at the upstream Reach 5/Reach 6 boundary, and Cross-Sections #1 and #2 in the preceding chapter. R5-EB11 and R6-EB 1 are immediately adjacent, and have been combined into one project site for the purposes of this description. The channel throughout this site is characterized by high width/depth ratios, unstable and poorly vegetated stream banks, and severely limited habitat for trout. During low flows in the late summer and fall, the site is likely a barrier to migration of fall spawning brown trout. The site is approximately 100 ft long, with most of the banks actively contributing sediment to the channel. A schematic of the proposed work is shown in Diagram 1 and in the appendix.

Large wood toe-slope structures and transplanted willow will be utilized to define the stream banks throughout the site. These structures will be installed so as to reduce the width/depth ratio of the channel along Cross-Section to a W/D of 12 - 15 from the current W/D of 31. The areas behind these bank structures will be filled with transplanted willow and sedge mats harvested from areas nearby the site. A boulder cross vane will be installed immediately downstream of the low water crossing, in order to maintain the grade at the crossing, as well as to providing additional pool habitat and depth necessary for trout to maximize burst speed necessary to pass the low water crossing during low flows. Additionally, another cross vane will be installed at the upstream boundary of the site to create an additional new pool in Reach 6, as well as anchor the tree toe-slope treatments. This pool will provide additional velocity shelter and refugia for trout migrating upstream through the crossing during spawning. The road approaches to the low water crossing will be hardened using large gravel and cobble imported to the site. The gravel/cobble armoring of the approaches will extend down to the ordinary high water mark of the channel, but not below this elevation. Additionally, water-bars will be constructed on the southern approach to the crossing in order to deflect run-off from the road away from the creek. Benefits of this work will include eliminating the hydrologic connection between the road and the stream, eliminating a potential barrier to migration, and providing the ranch with a

potential hardened watering site for cattle when the pasture is grazed., Seven pieces of large wood, and 30 - 32 boulders (0.5 yd^3 each) and approximately 22 yd^3 of cobble will be required for this site. Fill below the ordinary high water mark of the stream for each cross-vane is estimated to be approximately 8 yd^3. Bank stabilization fill below the ordinary high water mark is expected to be approximately 0.1 yd^3 per linear foot of bank for the log-toe-slope structure. Additionally, up to 7 yd^3 of transplanted willow and sedge mats may be used to re-vegetate the areas behind the log toe-slope structures. Total fill, including boulder, willow/sedge transplants and large wood for the site is estimated not to exceed 43 yd^3.

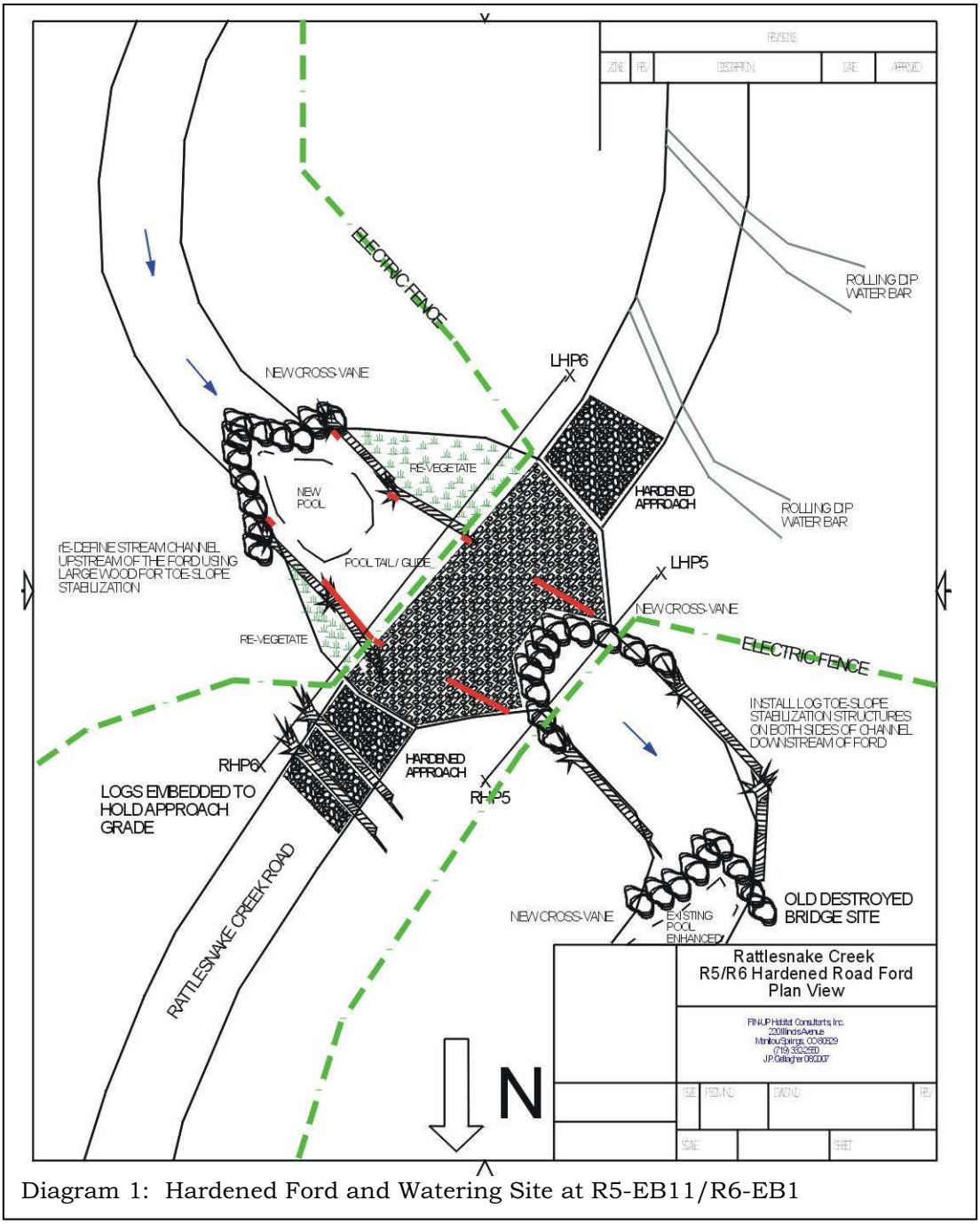


Diagram 1: Hardened Ford and Watering Site at R5-EB11/R6-EB1

New Pool Habitat Development:
The first new pool development site on Reach 5 is designated as GPS point R5-NP1 on the map, and corresponds with Riffle 5 in the BWSHI described in the previous chapter (Photo 29). The proposed work here is to install a log/boulder-vane above a brief low-gradient transition within the riffle habitat to create a new pool. One piece of large wood, and 3- 4 boulders (0.5 yd^3 each)

Map 4: Rattlesnake Reach 5 New Pool Development Sites.

Photo 29 - Site R5-NP1 From Left Bank

Photo 30 - Site R5-NP2 From Right Bank

Photo 31 - Site R5-NP3 From Left Bank

Photo 32 - Site R5-NP5 Looking Upstream

Photo 33 - Site R5-NP6 Looking Upstream

will be required for this site. Fill below the ordinary high water mark of the stream for the log/boulder vane is estimated to be approximately 3 yd^3. Larger cobbles/boulder armoring the channel within the pool may be removed to enhance scour. These materials will be placed outside the water influence zone of the stream.

Site R5-NP2 (Photo 30) is 26 ft. upstream of the previous new pool site, and corresponds with Glide 2 in the BWSHI. This habitat is well suited for conversion to a plunge pool by installing a double-log cross-vane at the upstream boundary of the feature to enhance scour. Two pieces of large wood, and 5- 6 boulders (0.5 yd^3 each) will be required for this site. Fill below the ordinary high water mark of the stream for the log/boulder vane is estimated to be approximately 5 yd^3.

Site R5-NP3 (Photo 31) corresponds with Pool 18 in the BWSHI, and Cross-Section #5 discussed in the previous chapter. This habitat is characterized by a well armored substrate, allowing little scour and poor residual pool depth in the feature. Larger cobbles/boulder armoring the channel within the pool will be removed to enhance scour. Large cobble and boulders removed from the pool and existing boulders immediately upstream of the pool will be re-configured as a cross-vane to enhance scour through the habitat. Any excess materials will be removed from the site and placed outside the water influence zone of the stream.

Site R5-NP4 (no photo) corresponds with Riffle 24 in the BWSHI. Riffle 24 is particularly long and homogeneous habitat, with poor depth and no cover. Some additional pool habitat within this feature has been described in R5-EB6 previously. Additional pool habitat may be created in this feature by installing a log/boulder-vane above a brief low-gradient transition within the riffle habitat approximately 50 feet upstream of the R5-EB6 site. One piece of large wood, and 3- 4 boulders (0.5 yd^3 each) will be required for this work. Fill below the ordinary high water mark of the stream for the log/boulder vane is estimated to be approximately 3 yd^3. Larger cobbles/boulder armoring the channel within the pool may be removed to enhance scour. Larger cobbles/boulder armoring the channel within the pool may be removed to enhance scour. These materials will be placed outside the water influence zone of the stream.

Site R5-NP5 (Photo 32) corresponds with Glide 6 in the BWSHI. There is a remnant of a beaver dam near this feature. This habitat is a natural low-gradient transition between two cobble riffles, and is well suited for conversion to a plunge pool by installing a double-log cross-vane at site of the beaver dam remnant. Two pieces of large wood, and 5- 6 boulders (0.5 yd^3 each) will be required for this site. Fill below the ordinary high water mark of the stream for the log/boulder vane is estimated to be approximately 5 yd^3.

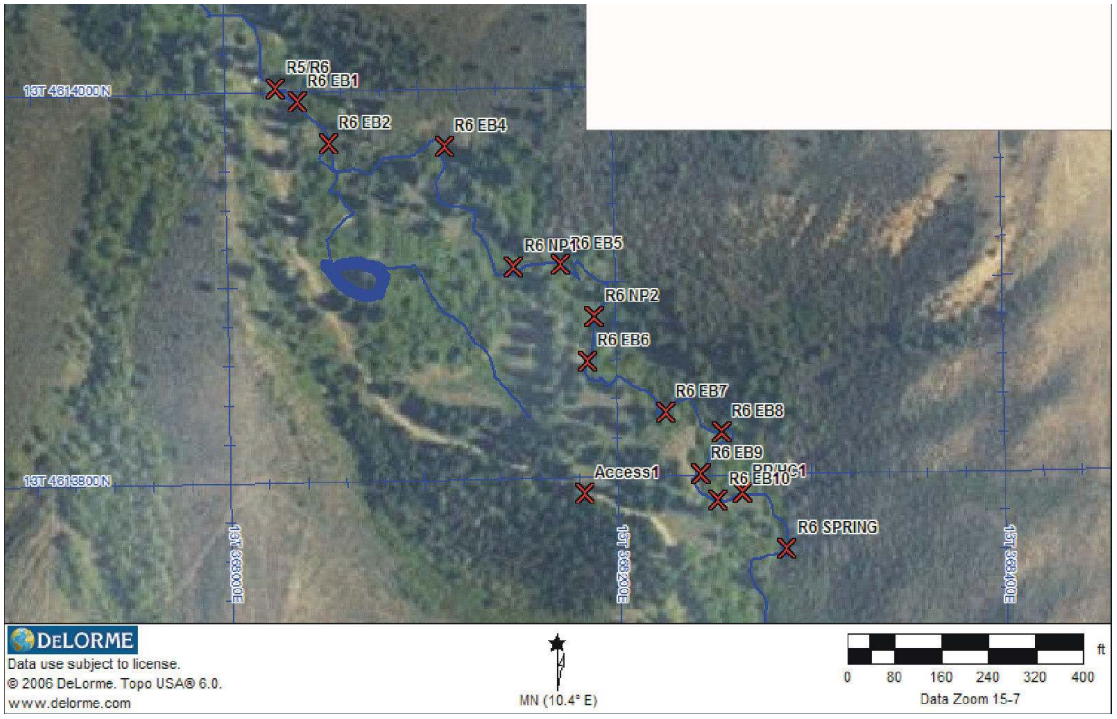
Site R5-NP5 (Photo 33) corresponds with Pool 31 in the BWSHI. There is a collapsed bridge fragment along the right bank of this feature that is providing some overhead cover. The pool itself is poorly functioning, exhibiting limited residual pool depth and cover. This habitat may be enhanced by removing larger cobbles/boulder armoring the channel within the pool and re-configuring

boulders at the riffle pool transition of Riffle 33 and Pool 21 as a cross-vane to enhance scour through the habitat. Any excess materials will be removed from the site and placed outside the water influence zone of the stream.

REACH 5		
Site	**Treatment Type**	**Estimated Fill**
Eroding Steam Bank Sites		
R5-EB1	Log Toe-Slope Stabilization - 2 Bldr Vanes	10 yd^3
R5-EB2	Log Toe-Slope Stabilization - 1 Log/Bldr Vane	10.5 yd^3
R5-EB3	Log Toe-Slope Stab. - 1 Bldr Cross-Vane	10.5 yd^3
R5-EB4	Log Toe-Slope Stab. - 2 Log/Bldr Vanes	19 yd^3
R5-EB5	Log Toe-Slope Stabilization - 1 Log/Bldr Vane	5.5 yd^3
R5-EB6	Log Toe-Slope Stab. - 2 Log/Bldr Vanes - 1 CV	16 yd^3
R5-EB7	Log Toe-Slope Stabilization - 1 Log/Bldr Vane	5.5 yd^3
R5-EB8	Log Toe-Slope Stabilization - 1 Log/Bldr Vane	5.5 yd^3
R5-EB9	Log Toe-Slope Stabilization - 1 Log/Bldr Vane	6 yd^3
R5-EB10	Log Toe-Slope Stab. - 1 Bldr Cross-Vane	17 yd^3
R5-EB10/ R6-EB1	Log Toe-Slope Stab. - 2 Bldr Cross-Vane	43 yd^3
New Pool / Pool Enhancement Sites		
R5-NP1	New Pool - Log/Boulder Vane	3 yd^3
R5-NP2	New Pool - 2X Log Cross-Vane	5 yd^3
R5-NP3	New Pool - Remove Armor / Reconfigure Bldrs	<2 yd^3
R5-NP4	New Pool - Log/Boulder Vane	3 yd^3
R5-NP5	New Pool - 2X Log Cross-Vane	5 yd^3
R5-NP6	New Pool - Remove Armor / Reconfigure Bldrs	<2 yd^3

Reach 6:
Reach 6 extends from the first crossing of the road with Rattlesnake Creek upstream to the spring (GPS = R6 SPRING) which perennially feeds the stream. The road is removed from the stream throughout most of this reach, and the quality of aquatic habitat in the reach is notably better than in Reach 5., There is good access to the creek for equipment near the downstream boundary of the reach, and from several openings in the forest upstream of the off-channel beaver pond. Habitat problems in this reach consist mostly of a few failing stream banks and a few over-wide channels resulting from grazing and elk impacts to the reach. Enhancement activity will focus on stabilizing eroding stream banks, improving existing pool depth and scour, and addressing excessive width/depth ratios in the stream channel. The locations of these treatment areas are shown in the map on the right. Additionally, four new pool habitats will be developed at suitable sites along the stream channel within the reach.

R6-EB1 has already been described as part of the low water road crossing work described in the previous section. R6-EB2 is located approximately 95 ft upstream, near the confluence of the off-channel beaver pond outflow channel



Map 5: Rattlesnake Reach 6 Treatment Sites.

and Rattlesnake Creek (Photo 34). The site consists of 75 ft. of actively eroding stream bank on the right side of the channel, extending upstream past the confluence and up along the Beaver Pond outflow channel. The channel is over-wide throughout the upstream half of this site, due to the collapsing banks. There is good access to the site from the road immediately to the west. The collapsing right bank will be stabilized using three log toe-slope bank structures. The downstream log will be placed flush against the bank since W/D ratios are not an issue along this portion of the channel. The other two log toe-slope structures will be installed so as to reduce the width/depth ratio of the channel to a W/D of 10-11. Additionally, a cross vane will be installed at the downstream boundary of the site to enhance an existing pool, as well as anchor the tree toe-slope treatments. Three pieces of large wood, and 12 - 14 boulders (0.5 yd^3 each) will be required for this site. Fill below the ordinary high water mark of the stream for the cross-vane is estimated to be approximately 6 yd^3. Bank stabilization fill below the ordinary high water mark is expected to be approximately 0.1 - 0.25 yd^3 per linear foot of bank for the log-toe-slope structure, depending on whether the structure is used to reduce W/D ratios in addition to bank stabilization and revegetation. Total fill for the site is estimated not to exceed 21 yd^3.


Photo 34 - Site R6-EB2 Left Bank

Photo 35 - Site R6-EB4 Looking Downstream

Photo 36 - Site R6-NP1 Looking Upstream

Photo 37 - Site R6-EB5 From the Right Bank

Photo 38 - Site R6-NP2 Looking Upstream

Photo 39 - Site R6-EB6 Looking Downstream

Photo 40 - Site R6-NP6 Looking Upstream

Site R6-EB3 is a small eroding stream bank on the left side of the channel. This site has been dropped from the project, due to inaccessibility of equipment getting to the site.

Site R6-EB4 (Photos 35) consists of 60 ft of actively eroding stream bank on the left side of the stream channel. Care will need to be taken to access this site, as it is the farthest site from the road that has been identified for treatment. A path that crosses no wet areas or important riparian/water influence zones has been identified that begins upstream of the off channel beaver pond and follow a bench above the right bank of the stream downstream to the site. Minimal existing vegetation (one or two small alder/aspen saplings) will need to be removed to use this path. Three toe-slope structures will be installed, placing the trees flush along the left stream bank, and revegetating the bank with willow and sedge harvested from the point bar beyond the right bank of the stream. Three pieces of large wood, available at the site, and 4 boulders (0.5 yd^3 each) will be required for this site. Bank stabilization fill below the ordinary high water mark is expected to be approximately 0.1 yd^3 per linear foot of bank for the log-toe-slope structure. Total fill for the site is estimated not to exceed 6 yd^3.

Site R6-NP1 is located approximately 325 ft upstream of R6-EB4, and can be accessed along the same route as that site (Photo 36). There is a natural constriction in the channel at this point where a large woody debris dam pool can be created by dropping two tree-tops into the channel. The trees will capture smaller woody debris moving through the stream and gradually form a dam pool. Suitable trees are available at the site. Total fill for the site is estimated not to exceed 3 yd^3.

Site R6-EB5 (Photos 37) is approximately 80 ft upstream of R6-NP1, and consists of 20 ft of actively eroding stream bank on the left side of the stream channel. A single tree toe-slope structure will be installed, placing the tree flush along the left stream bank, and revegetating the bank with willow and sedge harvested from the point bar beyond the right bank of the stream. Additionally, there is a natural constriction in the channel immediately downstream of the site where a large woody debris dam pool can be created by dropping two tree-tops into the channel. Suitable trees are available at the site Three pieces of large wood, and 2 boulders (0.5 yd^3 each) will be required for this site. Bank stabilization fill below the ordinary high water mark is expected to be approximately 0.1 yd^3 per linear foot of bank for the log-toe-slope structure. Total fill for the site is estimated not to exceed 5 yd^3.

Site R6-NP2 is located approximately 165 ft upstream of R6-EB5, and can be accessed along the same route as that site (Photo 38). The site is characterized by a brief low-gradient transition within a long high gradient boulder/cobble riffle. A new plunge pool will be constructed at this site by installing a boulder cross vane in the channel. Eight to ten boulders (0.5 yd^3 each) will be required for the cross-vane. Total fill for the site is estimated not to exceed 5 yd^3.

Site R6-EB6 (Photos 39 & 40) is 80 ft upstream of R6-NP2, and consists of 20 ft of generally unstable stream bank on the right side of the channel. Treatment

Photo 41 - Site R6-EB7 Looking Downstream

Photo 42 - Site R6-EB8 Looking Downstream

Photo 43 - Site R6-EB9 Looking Upstream

Photo 44 - Site R6-EB10 Looking Downstream

Photo 45 - Site R6-HC1 Looking Upstream

will include installing a tree flush along the right stream bank, and revegetating the bank with willow and sedge harvested from near the site. A small log/boulder vane will be installed at the upstream boundary of the toe slope structure to enhance scour and cover in an existing pool. Two pieces of large wood, and 4 - 5 boulders (0.5 yd^3 each) will be required for this site. Fill below the ordinary high water mark of the stream for the log/boulder vane is estimated to be approximately 2.5 to 3.5 yd^3. Bank stabilization fill below the ordinary high water mark is expected to be approximately 0.1 yd^3 per linear foot of bank for the log-toe-slope structure. Total fill for the site is estimated not to exceed 5.5 yd^3.

The remaining sites on Rattlesnake Creek Reach 6 may be easily accessed from the forest opening noted as ACCESS1 on the map, upstream of the off-channel beaver pond. Site R6-EB7 (Photo 41) is 200 ft upstream of R6-EB6, and appears to be a cattle watering and crossing area. The site is generally over-wide, with 40 ft of unstable stream bank on the right side of the channel. Treatment will include installing two logs along the right stream bank, and revegetating the bank with willow and sedge harvested from near the site. Accumulated sediments from the existing scour pool immediately downstream will be excavated and removed from the site and placed outside the water influence zone of the stream. Two pieces of large wood, and 3-4 boulders (0.5 yd^3 each) will be required for this site. Bank stabilization fill below the ordinary high water mark is expected to be approximately 0.2 yd^3 per linear foot of bank for the log-toe-slope structures. Total fill for the site is estimated not to exceed 8 yd^3.

Site R6-EB8 (Photo 42) is 135 ft upstream of R6-EB7, and appears to be another cattle watering and crossing area. The site is also somewhat over-wide, with 20 ft of unstable stream bank on the left side of the channel. Treatment will include installing a log toe-slope structure along the left stream bank, and revegetating the bank with willow and sedge harvested from near the site. A small log/boulder vane will be installed at the downstream boundary of the toe slope structure to enhance scour and cover in an existing pool. Accumulated sediments from the existing pool will be excavated and removed from the site and placed outside the water influence zone of the stream. Two pieces of large wood, and 3-4 boulders (0.5 yd^3 each) will be required for this site. Bank stabilization fill below the ordinary high water mark is expected to be approximately 0.2 yd^3 per linear foot of bank for the log-toe-slope structures. Total fill for the site is estimated not to exceed 6 yd^3.

Site R6-EB9 (Photo 43) is 135 ft upstream of R6-EB8, and appears to be yet another cattle watering area. The site appears to be healing on it's own, with riparian sedge becoming established along the toe slope of the unstable right bank. This bank should continue to be monitored to ensure that it continues an upward trend.

Site R6-EB10 and R6-HC1 are 75 ft and 120 ft upstream of R6-EB9, and are combined into one treatment site, due to the influence that R6-HC1 has on the eroding banks of R6-EB10. Site R6-EB10 consists of approximately 20 ft of unstable eroding right bank (Photo 44) on the outside bend a meander bend,

due in part to down-cutting of the channel as a result of the minor head-cut at R6-HC1. The eroding bank will be treated with a log toe-slope structure flush along the right stream bank, revegetating the bank with willow and sedge harvested from near the site. The head-cut threatens an important large woody debris pool habitat immediately upstream (Photo 45), and will be treated by creating an additional woody debris obstruction by dropping two or three small tree-tops into the channel below the head-cut. The tree-tops will capture smaller woody debris moving through the stream and form a dam pool at the head-cut, reducing the downward erosional pressure on the channel. Two or three pieces of large wood, and 3-4 boulders (0.5 yd^3 each) will be required for this site. Bank stabilization fill below the ordinary high water mark is expected to be approximately 0.1 yd^3 per linear foot of bank for the log-toe-slope structures. Total fill for the site is estimated not to exceed 4 yd^3.

REACH 6		
Site	**Treatment Type**	**Estimated Fill**
R6-EB1	Log Toe-Slope Stab. - 1 Bldr Cross-Vane	21 yd^3
R6-EB2	Log Toe-Slope Stabilization	6 yd^3
R6-EB3	Dropped from the Project	N/A
R6-EB4	Log Toe-Slope Stab. - 2 Log/Bldr Vanes	19 yd^3
R6-NP1	New Woody Debris Pool	3 yd^3
R6-EB5	Log Toe-Slope Stab. - New Woody Debris Pool	5 yd^3
R6-NP2	New Plunge Pool - Boulder Cross Vane	5 yd^3
R6-EB6	Log Toe-Slope Stab. - 1 Log/Bldr Vane	5.5 yd^3
R6-EB7	Log Toe-Slope Stab. - Pool Excavation	8 yd^3
R6-EB8	Log Toe-Slope Stab. - 1 Log Vane - Pool Exc.	6 yd^3
R6-EB9	No work - Continue to monitor trend	N/A
R6-EB10/ R6-HC1	Log Toe-Slope Stabilization Create Debris Dam Pool Using Small Tree Tops	2 yd^3 <2 yd^3

Off-Channel Beaver Pond Adjacent to Reach 6:
The off-channel beaver pond between the road and the stream in Reach 6 was identified in the 2006 Rapid Landscape Assessment as a critical feature in the watershed, and the ranch has expressed an interest in enhancing this feature. The pond will be dredged to provide for additional pool habitat and over-wintering capacity in the reach. This work will entail a certain greater risk than the stream enhancement project, due to the fragile nature of the old beaver dam forming the pond. Deeping the pond will be done in a manner that will not disturb the dam face or the surrounding carex wetland features, and the pond will not be deepened to a level lower than the surrounding valley profile.

A sediment deposition depth profile, using a graduated wading staff, indicates that 1 to 3 feet of depositional sediment and detritus may be excavated from the western half of the pond (Diagram 2). It is expected that approximately 300 - 325 yd^3 of material will be dredged from the pond and removed from the site. Average depth of the pond will be increased from 1.8 ft at full-pool stage to 2.6 ft. The maximum depth of the pond will not change, but the area of maximum

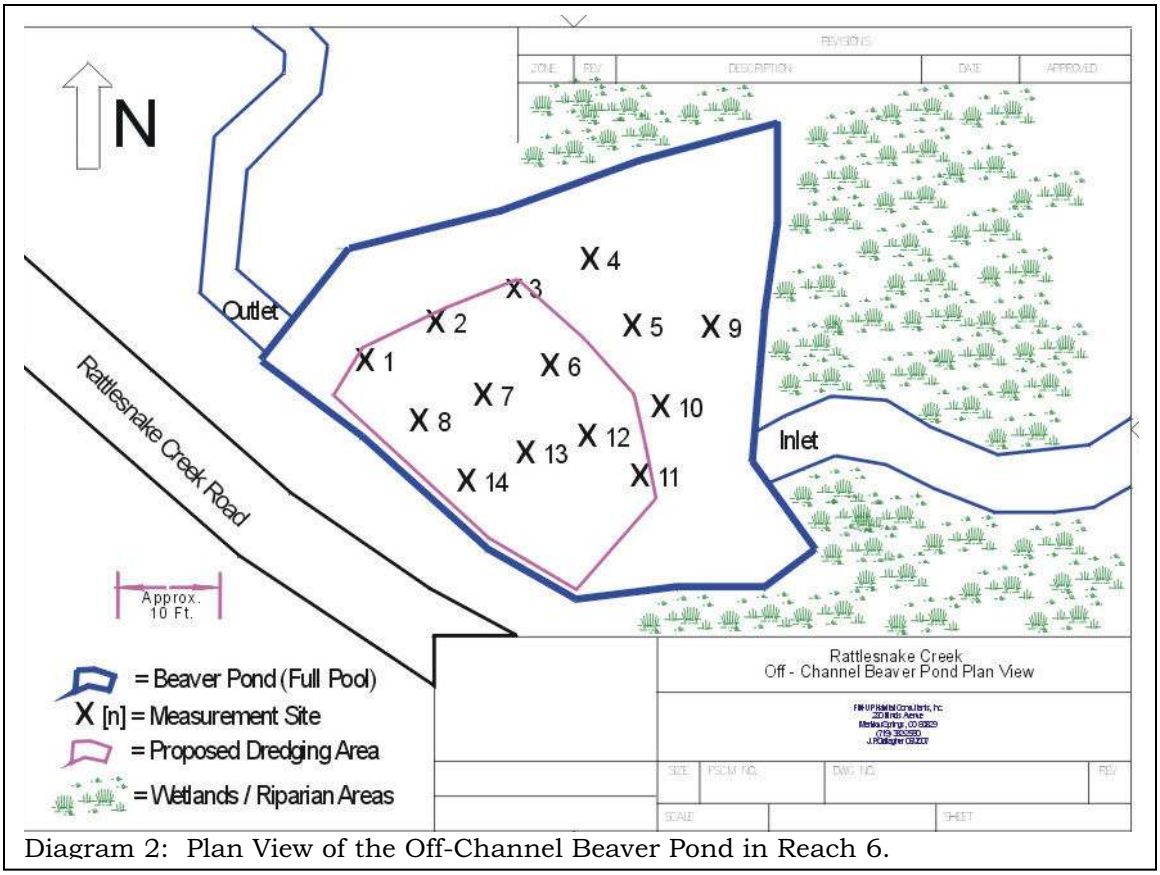


Diagram 2: Plan View of the Off-Channel Beaver Pond in Reach 6.

depth will increase by approximately 20%. While the surface acreage of the pond will remain the same, the volume of the pond will increase to 0.7 acre/ft.

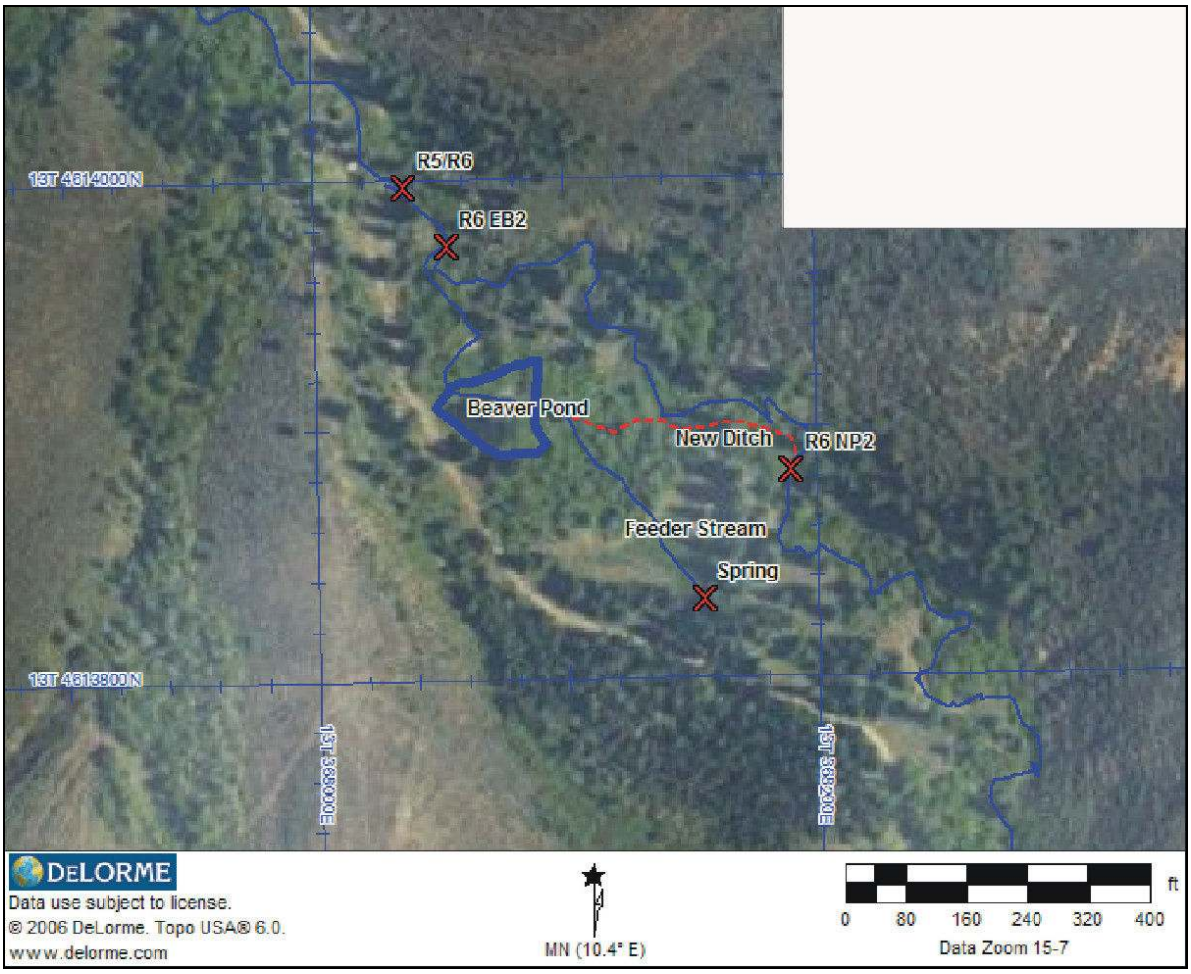
The preferred method for accomplishing this dredging is to use a long-reach excavator (72 ft boom) to dredge the lake from the Rattlesnake Creek Road, hauling the dredged spoils 1.5 miles downstream to an identified upland storage site on the Rattlesnake Ranch (Photo 46). This type of excavator will provide approximately a 45 ft reach into the pond. If this method is used, the work can be accomplished in a non-jurisdictional manner, and will require no temporary fills or crossing of riparian or wetland areas.


Photo 46 - Upland Storage site on Rattlesnake Ranch

If a long reach excavator is not available, or if the equipment is unable to access the site, the work may require the installation of a temporary fill pad on the southwestern quadrant of the pond. We estimate that a temporary fill to

support a PC150 or similar excavator will require approximately 25-30 yd^3 of fill material. Any temporary fills required to accomplish the work will be removed immediately upon completion of the dredging, and will be hauled to the Rattlesnake Ranch storage site. If the work cannot be accomplished with the long reach excavator, the US ACE District Engineer will be notified before any temporary fills are installed.

In order to improve water quality and maintain optimal temperatures in the pond during the late summer and fall, the ranch may wish to consider utilizing part of their existing water rights on Rattlesnake Creek to divert water from the creek into the off-channel pond. In order to proceed with this work, a change in use of the existing decree will likely need to be filed with the State Engineer. If this change of use is approved, it may be possible to install a head-gate at the new cross-vane pool at R6-NP2, and construct a new 360 ft long diversion ditch that would tie into the existing feeder channel to the beaver pond, upstream of the wetlands surrounding the lake. During the 2007 field survey, a route for this diversion ditch was identified (see Map below) that avoids wetlands and riparian/water influence zones, and is shown in the map below. A quick survey with a hand level indicated that there was adequate slope (1%) along the route to allow proper flow from the head-gate to the lake.



Map 6: Proposed New Diversion Ditch to the Off Channel Beaver Pond on Reach 6

APPENDIX

Location Maps

NWI/Color IR Photo of Project Site

Stream Channel Structure and Treatment Drawings

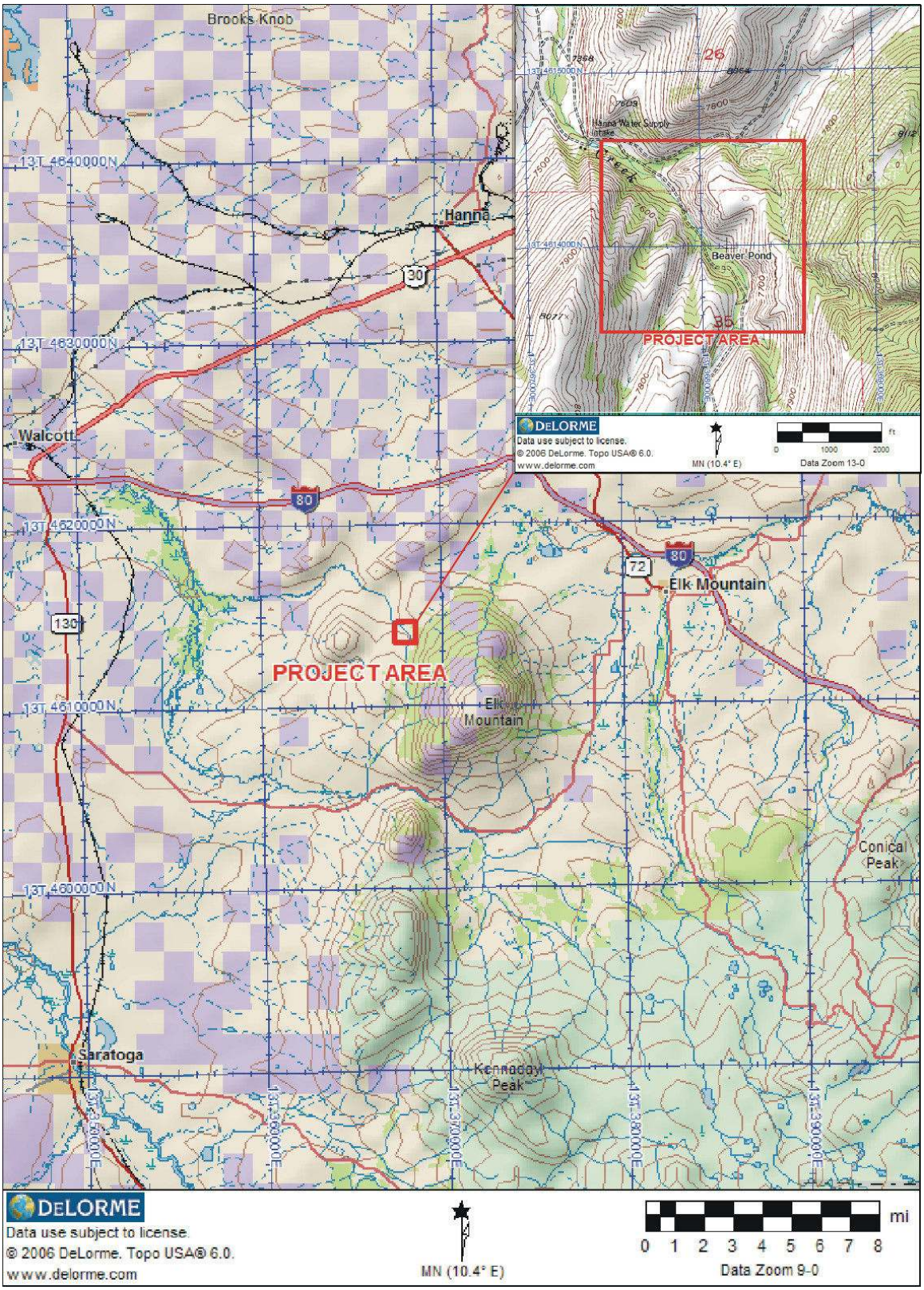
Photographic Representations of Treatment Types

Longitudinal Profile & Cross Section Plots

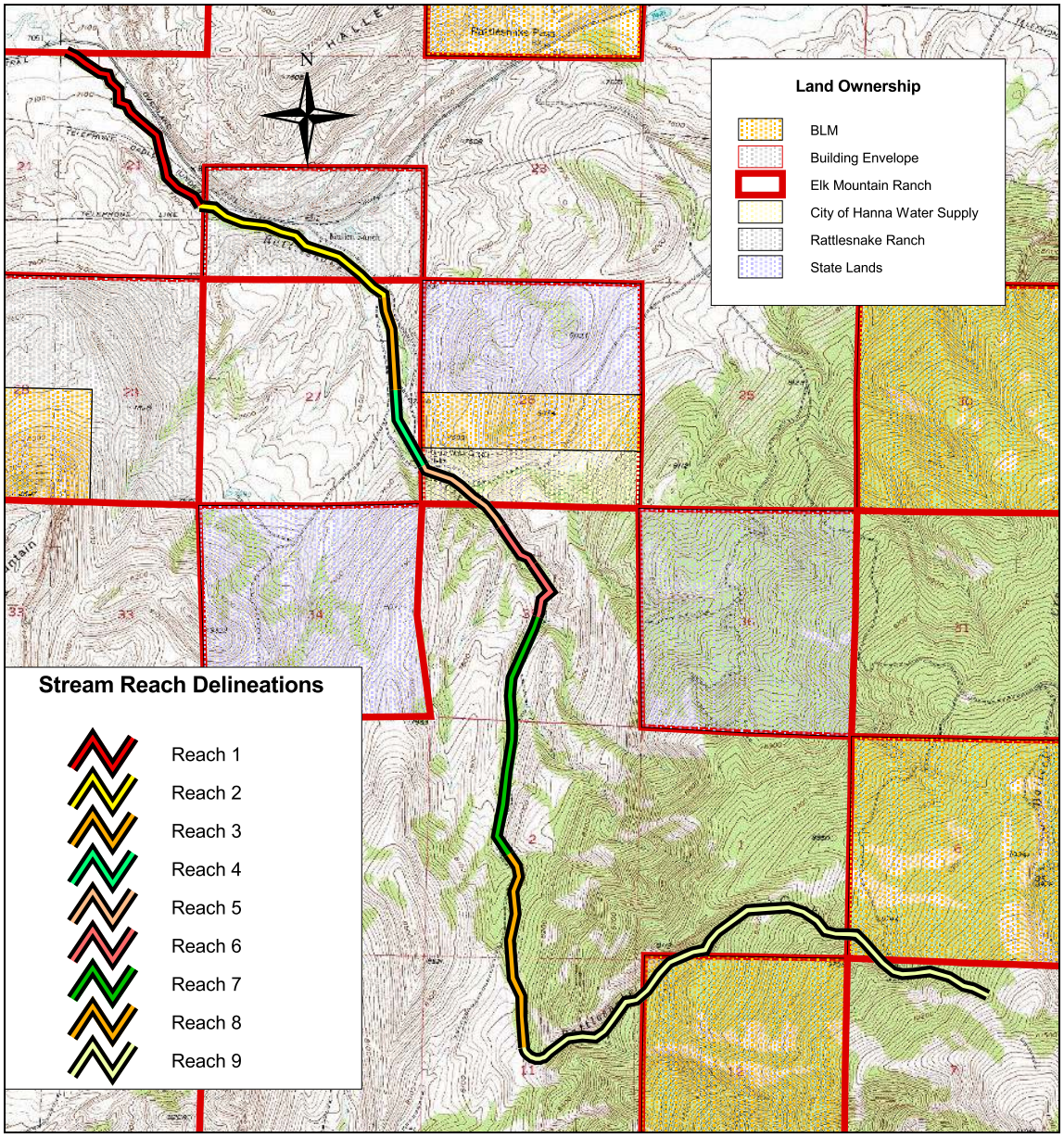
Basin-wide Stream Survey (BWSHI) Data

References

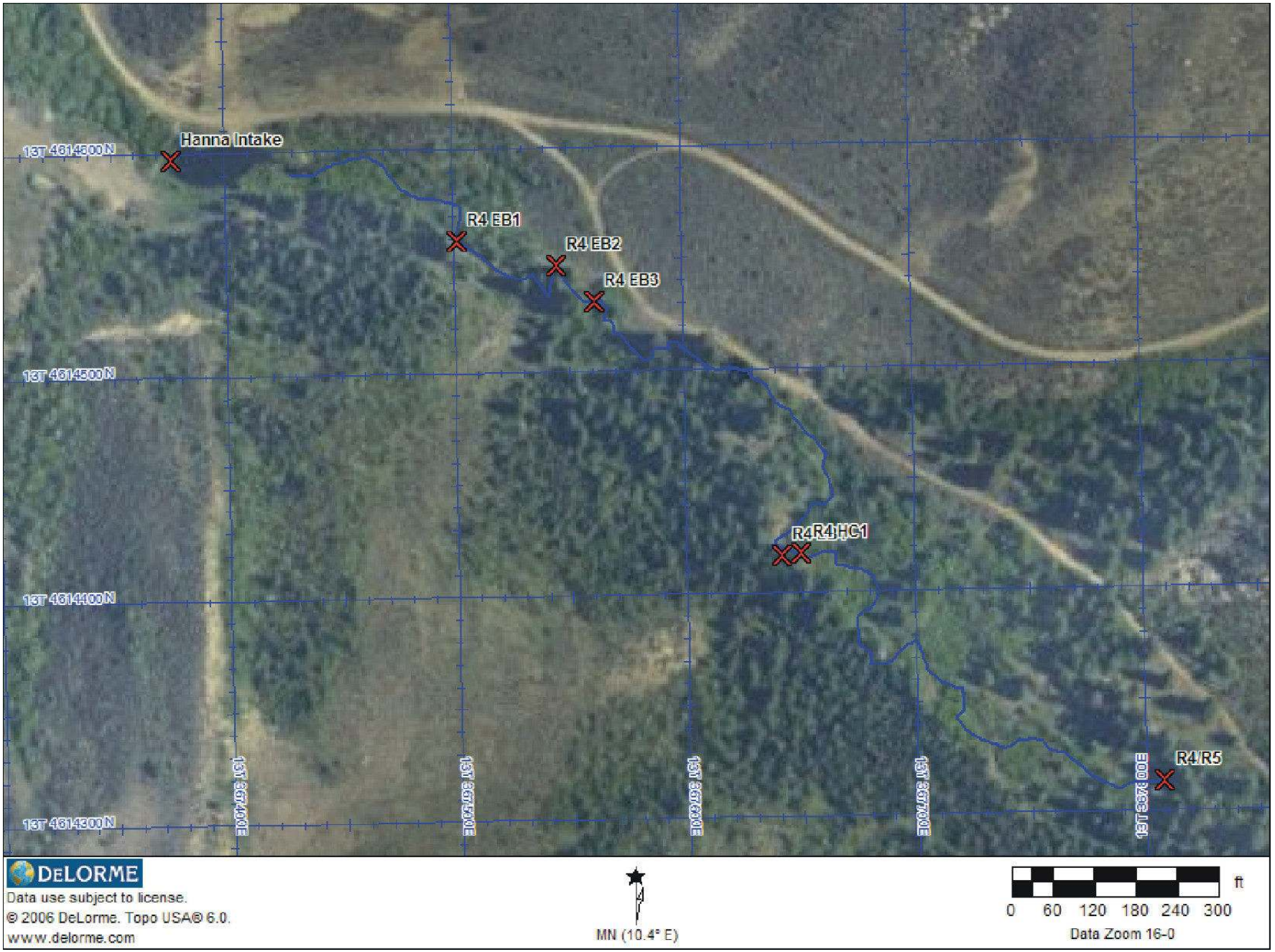
Location Maps



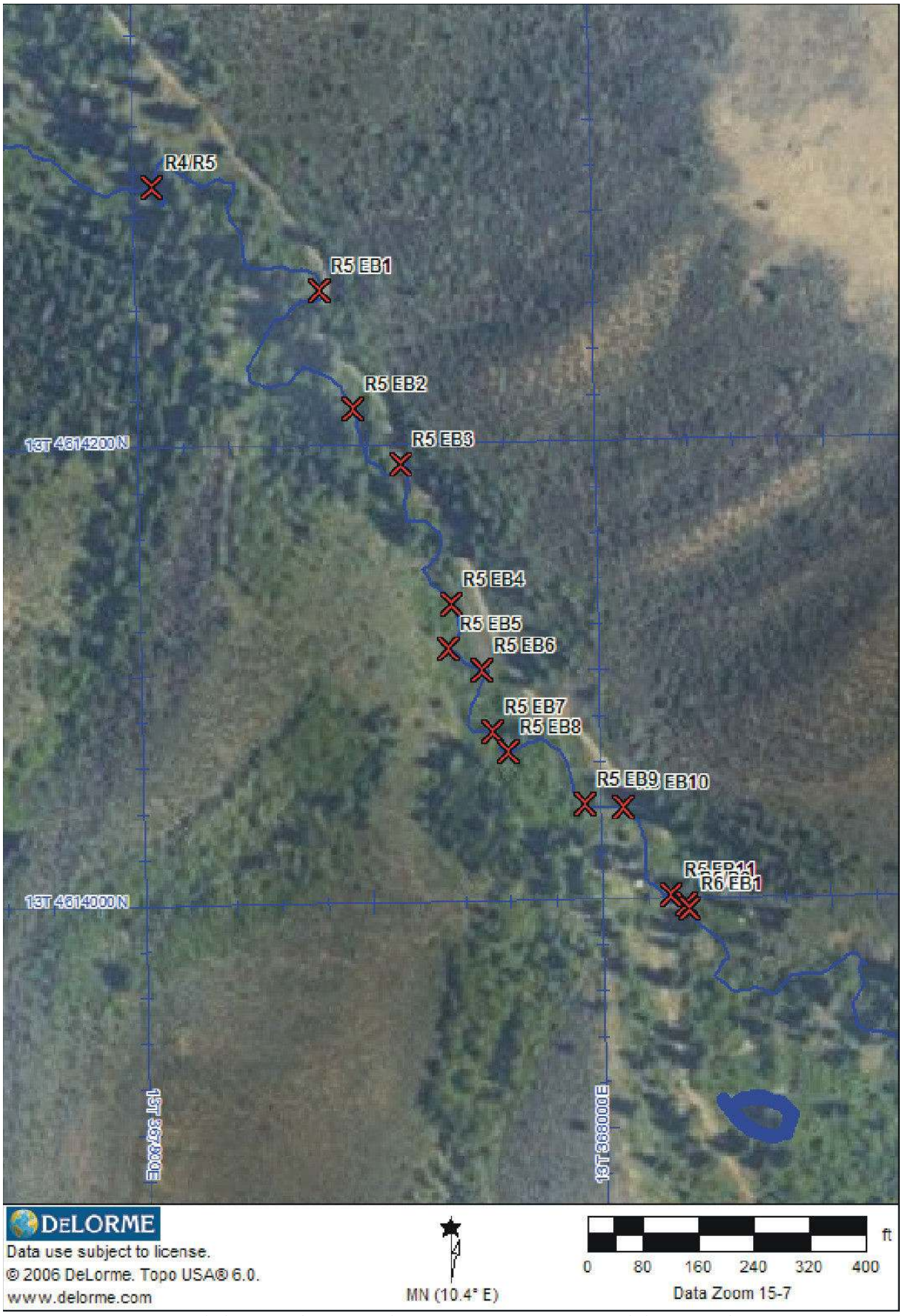
Vicinity Map Showing the Location of the Upper Rattlesnake Creek Project



Upper Rattlesnake Creek Watershed showing reach delineations and land Ownership

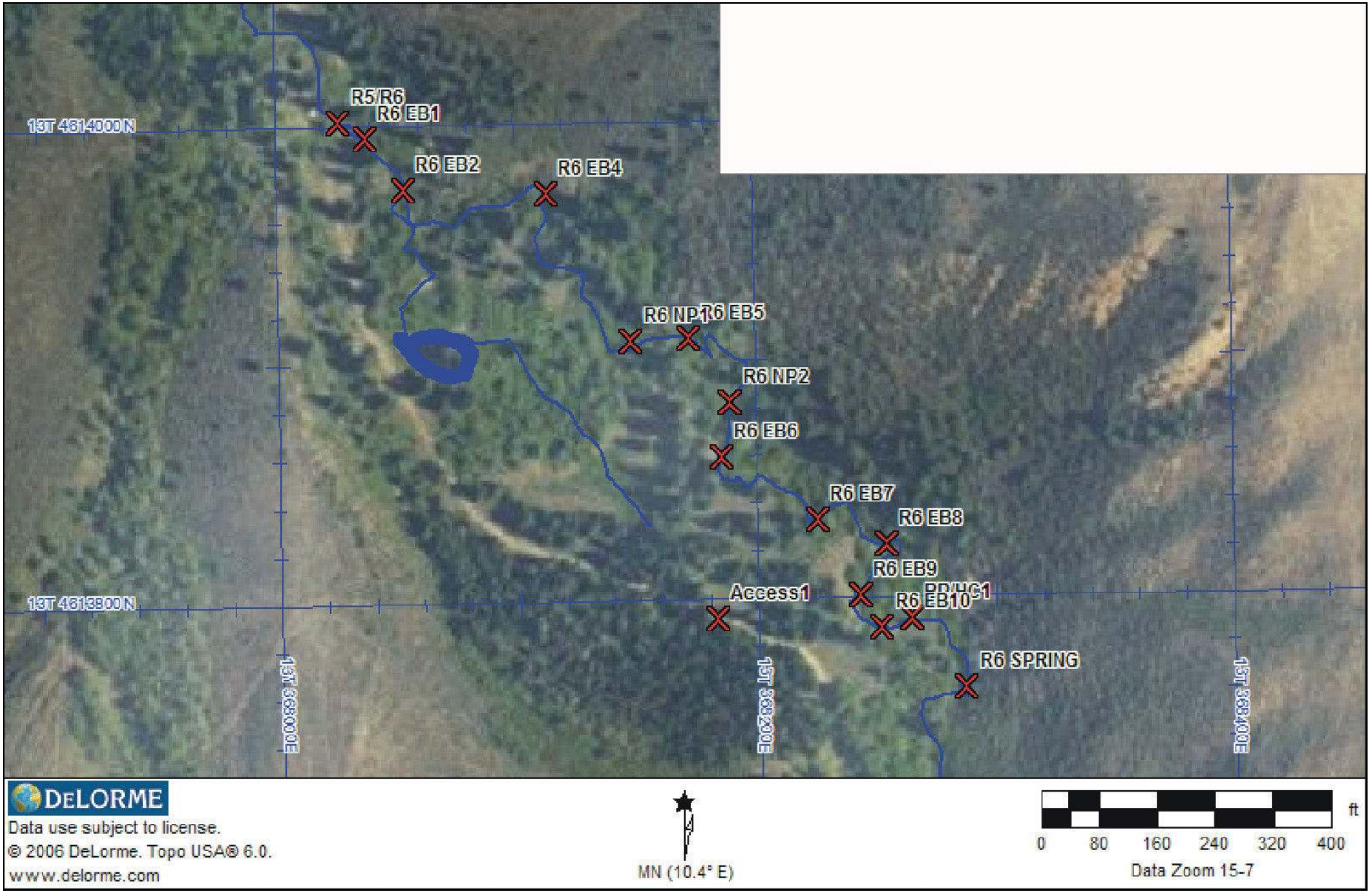


Map 2: Location of the Treatments Proposed for Reach 4 on Rattlesnake Creek.

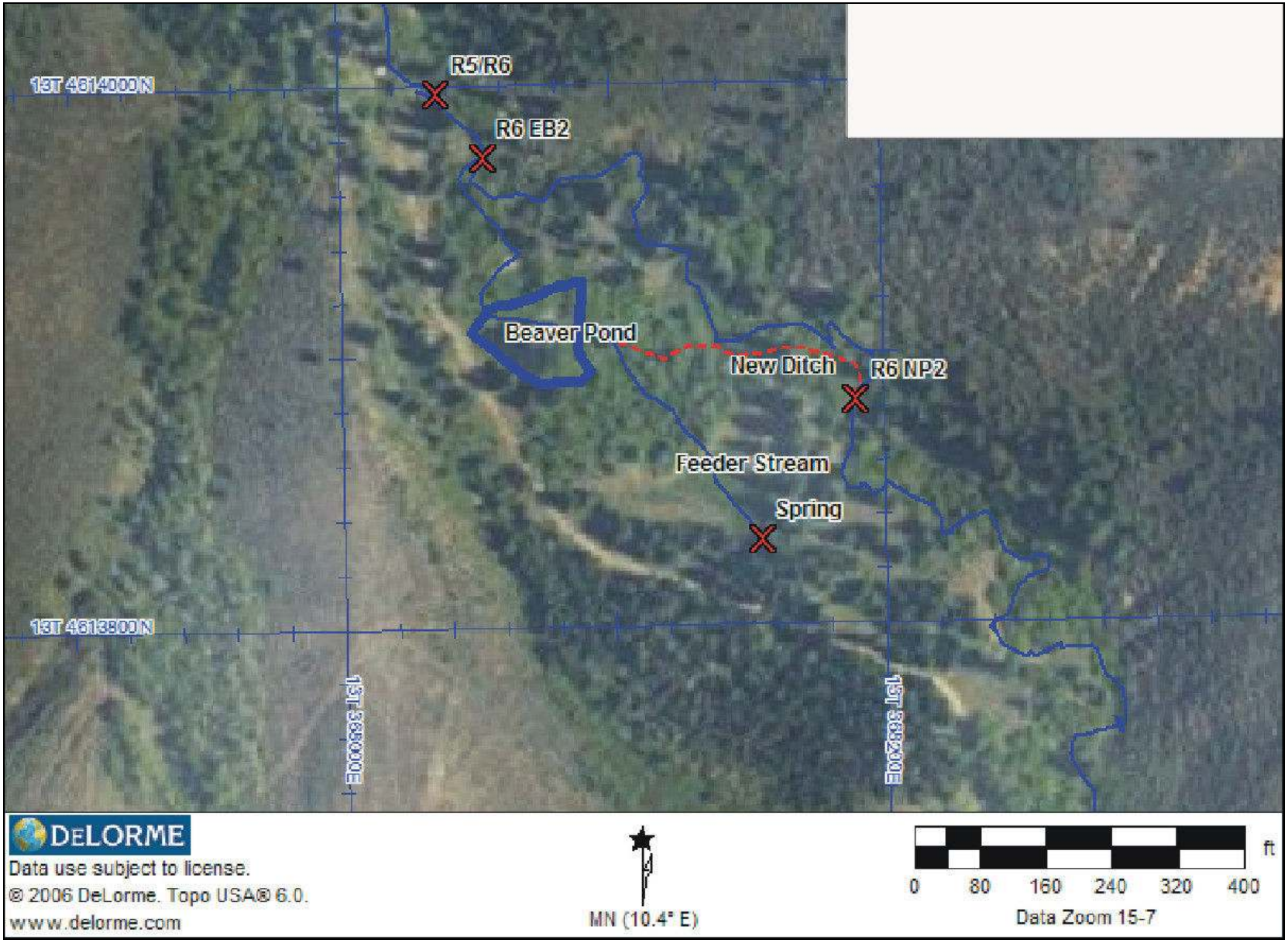


Map 3: Location of the Eroding Bank Treatments Proposed for Reach 5 on Rattlesnake Creek.

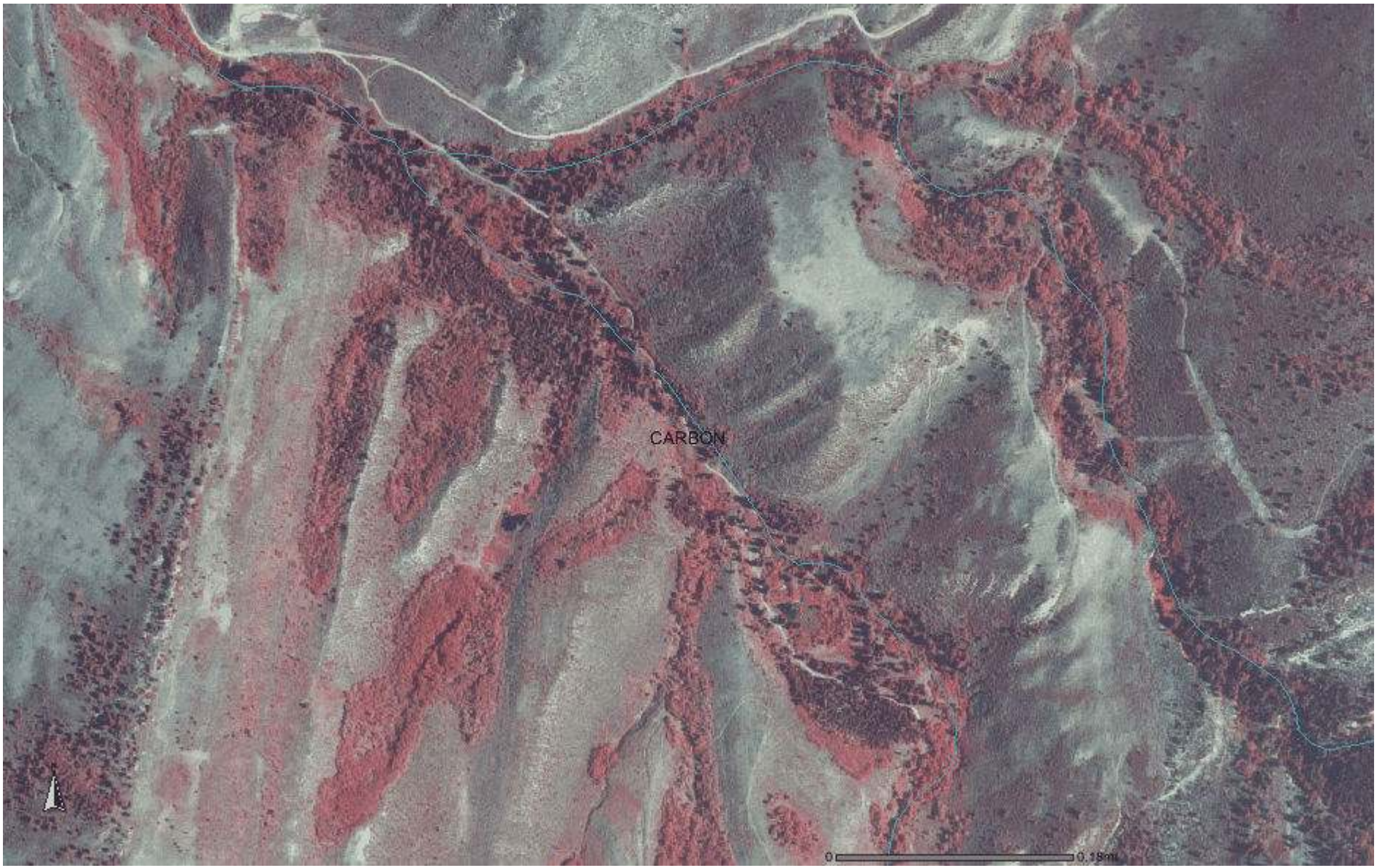
Map 4: Location of the New Pools and Pool Enhancements Proposed for Reach 5 on Rattlesnake Creek.



Map 5: Location of the Treatments Proposed for Reach 6 on Rattlesnake Creek.

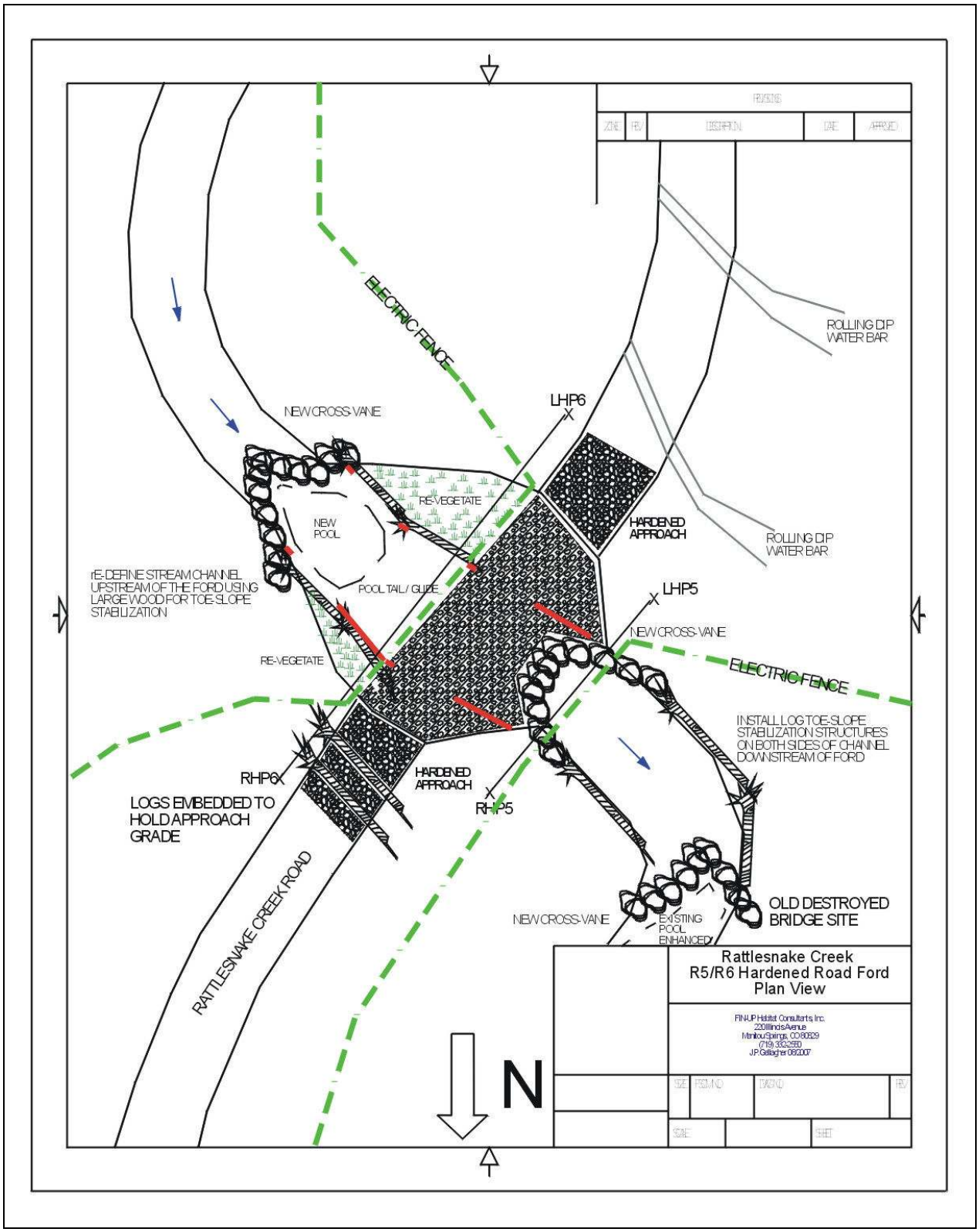


Map 6: Location of the Proposed Ditch from R6-NP2 along Reach 6 on Rattlesnake Creek to the Off-Channel Beaver Pond.

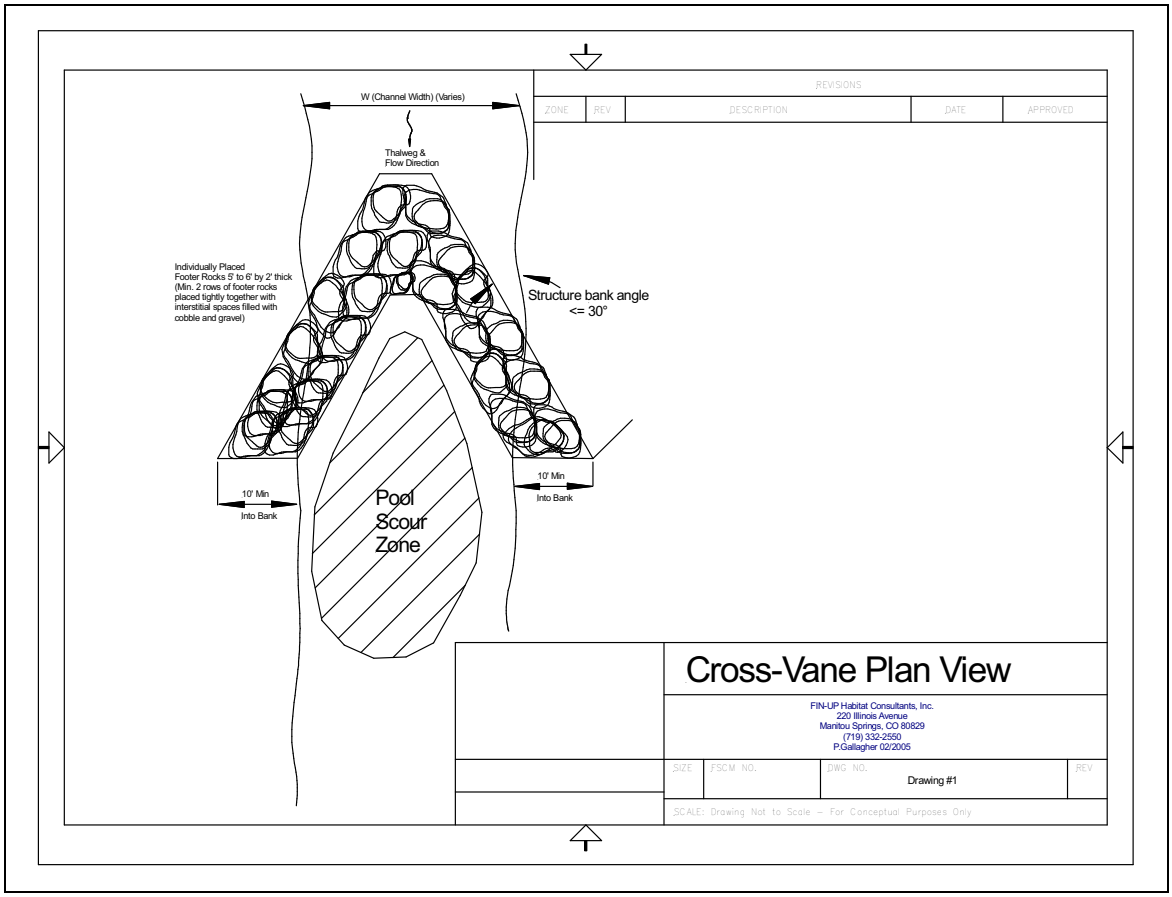


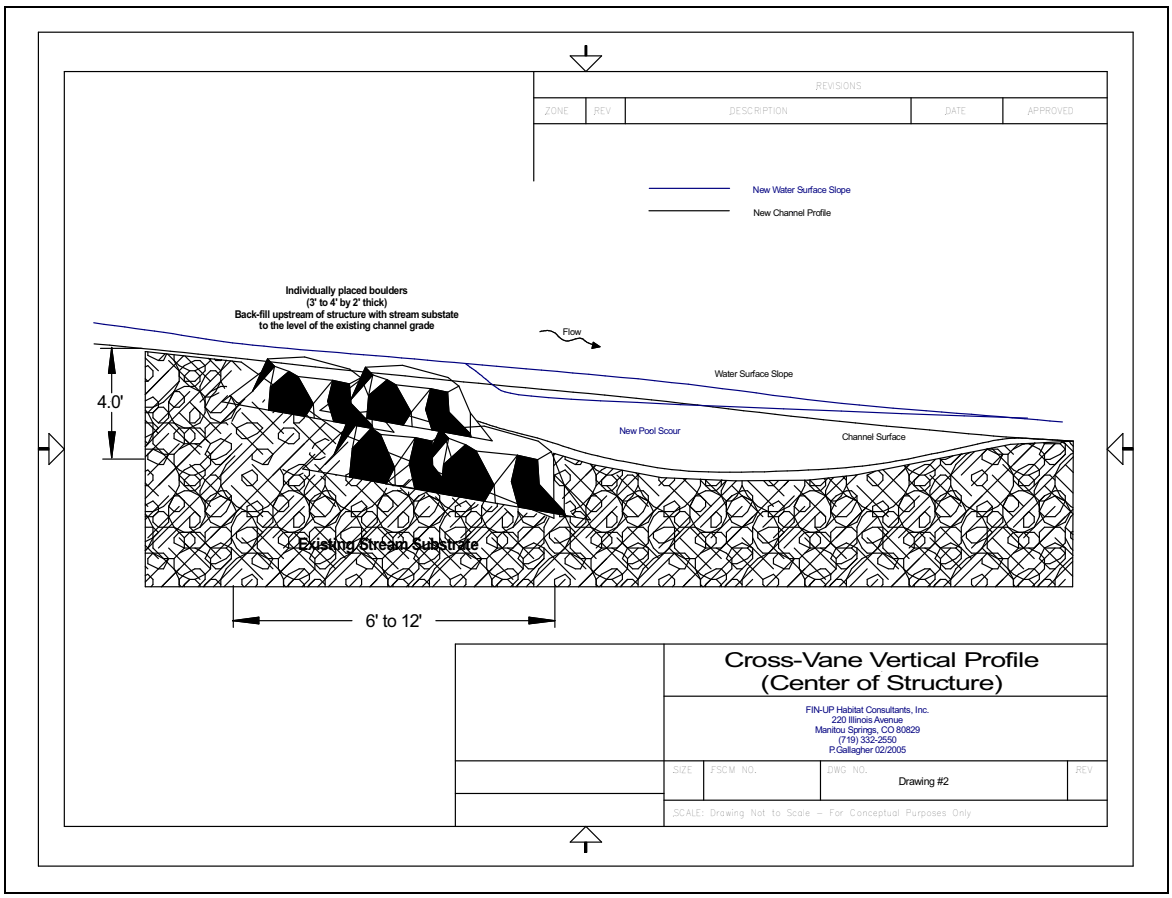
NWI/Color IR Photo of Project Site

Stream Channel Structure and Treatment Drawings



Site Drawing for the Hardened Low Water Crossing and Cattle Watering Site at the Reach 5/6 Boundary on Rattlesnake Creek


REVISIONS
ZONE
REV
DESCRIPTION
DATE
APPROVED
W (Channel Width) (Varies)
Thalweg &
Flow Direction
Individually Placed
Footer Rocks 5' to 6' by 2' thick
(Min. 2 rows of footer rocks
placed tightly together with
interstitial spaces filled with
cobble and gravel)
Structure bank angle
<= 30°
10' Min
Into Bank
10' Min
Into Bank
Pool
Scour
Zone
Cross-Vane Plan View
FIN-UP Habitat Consultants, Inc.
220 Illinois Avenue
Manitou Springs, CO 80829
(719) 332-2550
P.Gallagher 02/2005
SIZE
FSCM NO.
DWG NO.
Drawing #1
REV
SCALE: Drawing Not to Scale – For Conceptual Purposes Only


REVISIONS
ZONE
REV
DESCRIPTION
DATE
APPROVED
New Water Surface Slope
New Channel Profile
Individually placed boulders
(3' to 4' by 2' thick)
Back-fill upstream of structure with stream substate
to the level of the existing channel grade
Flow
Water Surface Slope
4.0'
New Pool Scour
Channel Surface
Existing Stream Substrate
6' to 12'
Cross-Vane Vertical Profile
(Center of Structure)
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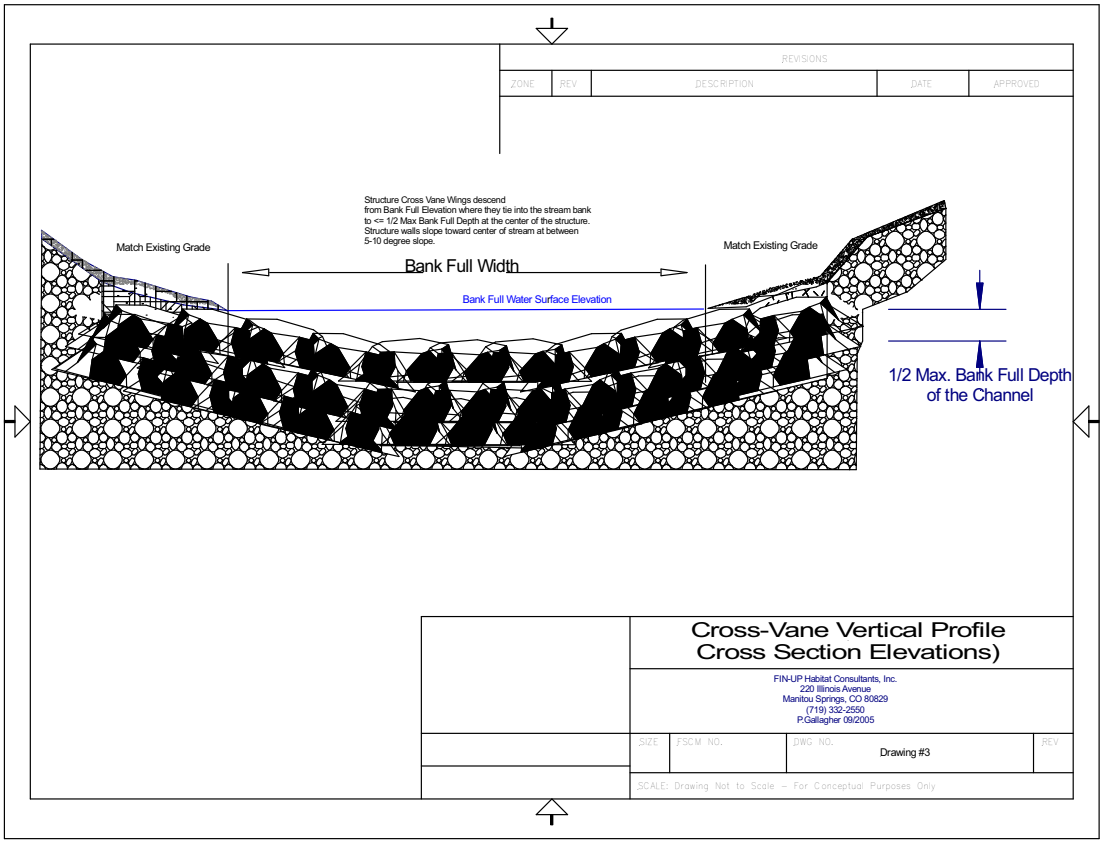
SIZE
FSCM NO.
DWG NO.
Drawing #2
REV
SCALE: Drawing Not to Scale – For Conceptual Purposes Only


REVISIONS
ZONE
REV
DESCRIPTION
DATE
APPROVED
Structure Cross Vane Wings descend from Bank Full Elevation where they tie into the stream bank to <= 1/2 Max Bank Full Depth at the center of the structure. Structure walls slope toward center of stream at between 5-10 degree slope.
Match Existing Grade
Bank Full Width
Match Existing Grade
Bank Full Water Surface Elevation
1/2 Max. Bank Full Depth of the Channel
Cross-Vane Vertical Profile
Cross Section Elevations)
FIN-UP Habitat Consultants, Inc.
220 Illinois Avenue
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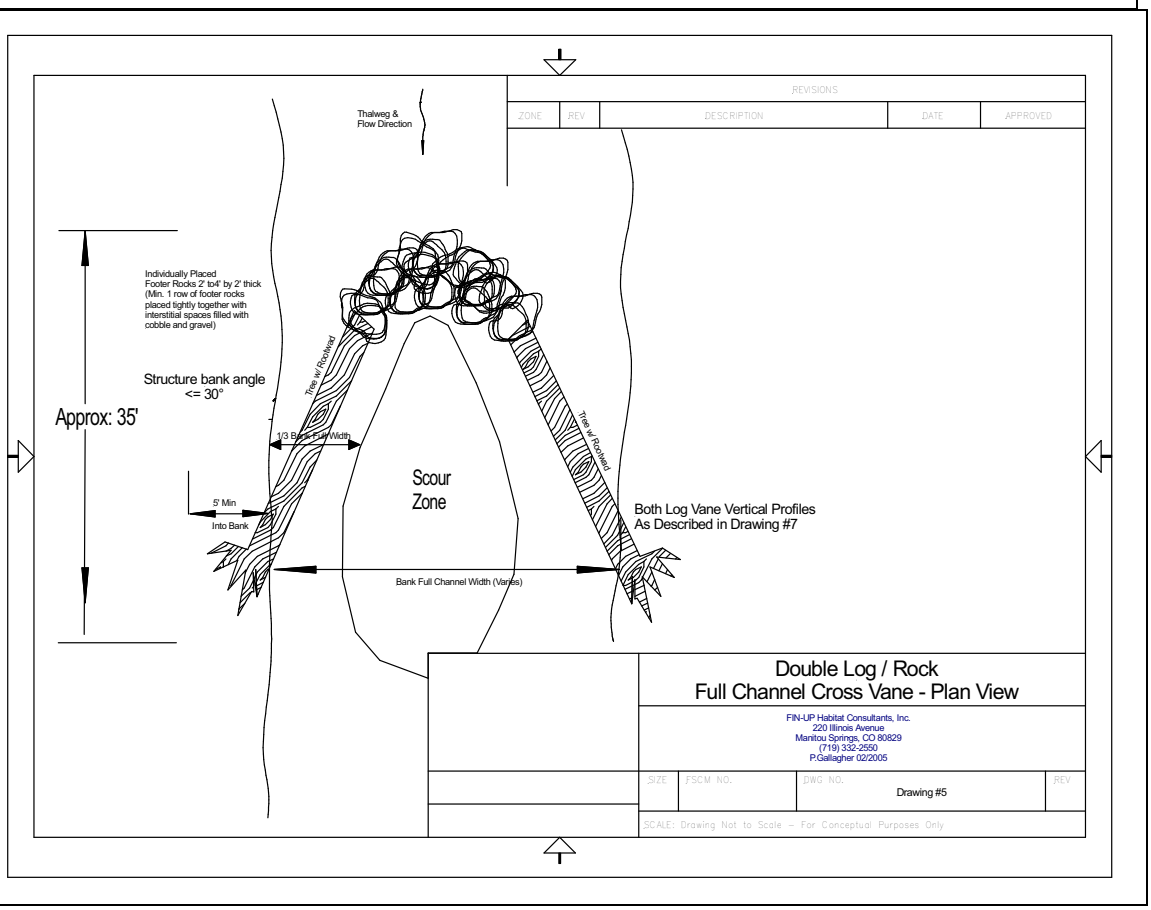
P.Gallagher 09/2005
SIZE
FSCM NO.
DWG NO.
Drawing #3
REV
SCALE: Drawing Not to Scale – For Conceptual Purposes Only


REVISIONS
ZONE
REV
DESCRIPTION
DATE
APPROVED
Thalweg & Flow Direction
Individually Placed Footer Rocks 2' to4' by 2' thick (Min. 1 row of footer rocks placed tightly together with interstitial spaces filled with cobble and gravel)
Structure bank angle <= 30°
Approx: 35'
Tree w/ Rootwad
1/3 Bank Full Width
Tree w/ Rootwad
5' Min Into Bank
Scour Zone
Both Log Vane Vertical Profiles As Described in Drawing #7
Bank Full Channel Width (Varies)
Double Log / Rock
Full Channel Cross Vane - Plan View
FIN-UP Habitat Consultants, Inc.
220 Illinois Avenue
Manitou Springs, CO 80829
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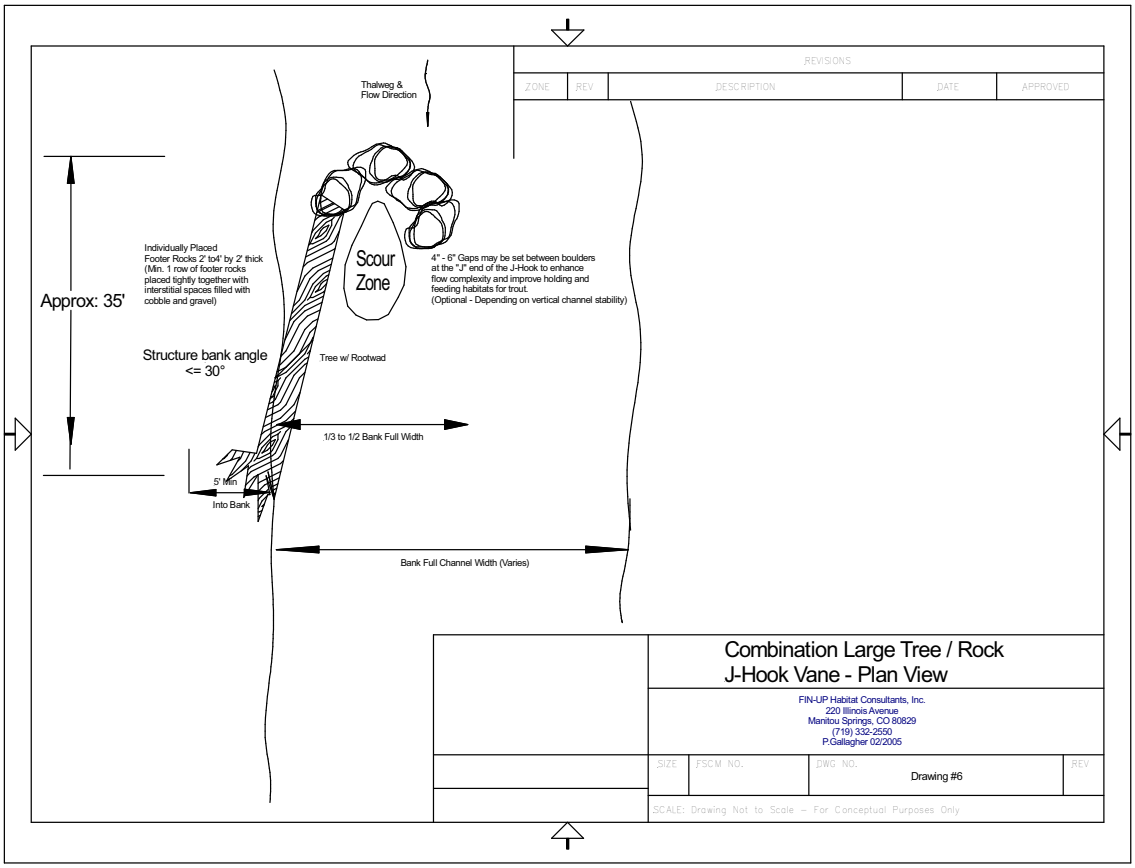
SIZE
FSCM NO.
DWG NO.
Drawing #5
REV
SCALE: Drawing Not to Scale – For Conceptual Purposes Only


REVISIONS
ZONE
REV
DESCRIPTION
DATE
APPROVED
Thalweg &
Flow Direction
Scour
Zone
Individually Placed
Footer Rocks 2' to4' by 2' thick
(Min. 1 row of footer rocks
placed tightly together with
interstitial spaces filled with
cobble and gravel)
4" - 6" Gaps may be set between boulders
at the "J" end of the J-Hook to enhance
flow complexity and improve holding and
feeding habitats for trout.
(Optional - Depending on vertical channel stability)
Approx: 35'
Structure bank angle
<= 30°
Tree w/ Rootwad
1/3 to 1/2 Bank Full Width
5' Min
Into Bank
Bank Full Channel Width (Varies)
Combination Large Tree / Rock
J-Hook Vane - Plan View
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220 Illinois Avenue
Manitou Springs, CO 80829
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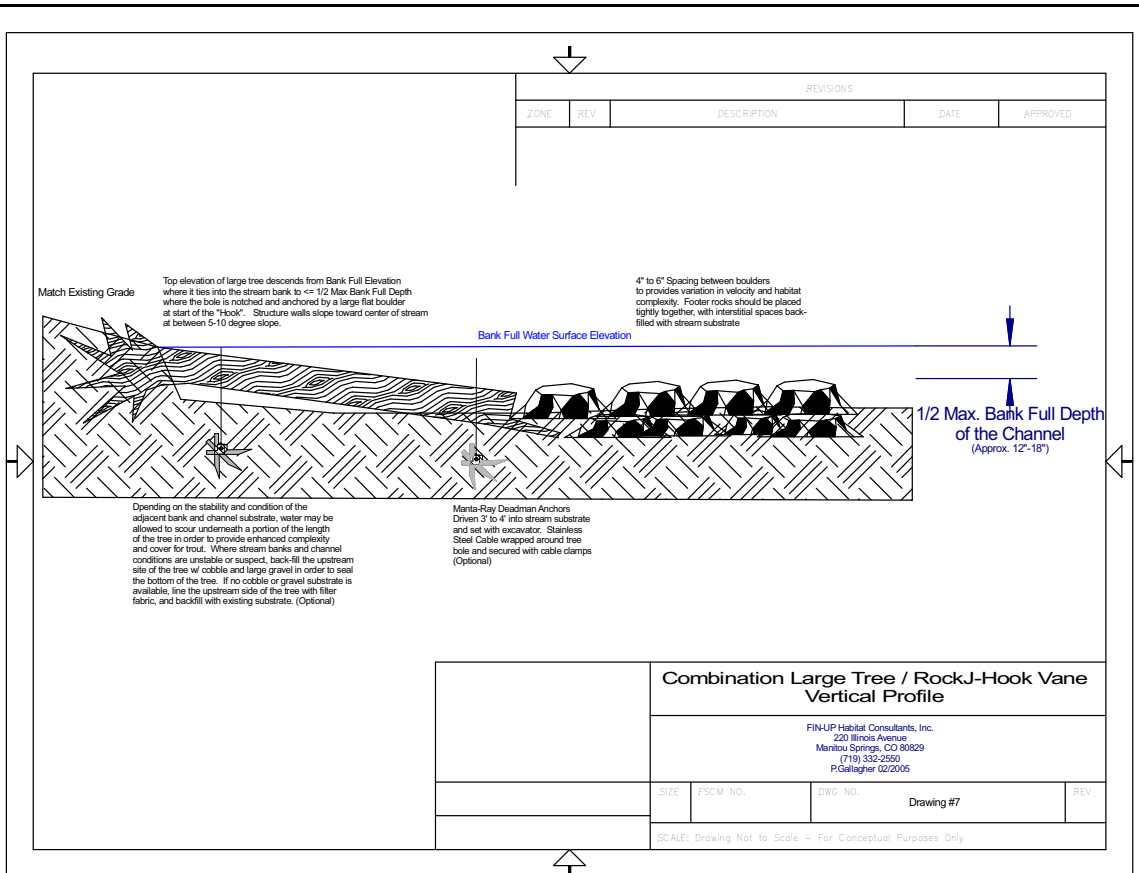
SIZE
FSCM NO.
DWG NO.
Drawing #6
REV
SCALE: Drawing Not to Scale – For Conceptual Purposes Only


REVISIONS
ZONE
REV
DESCRIPTION
DATE
APPROVED
Match Existing Grade
Top elevation of large tree descends from Bank Full Elevation
where it ties into the stream bank to <= 1/2 Max Bank Full Depth
where the bole is notched and anchored by a large flat boulder
at start of the "Hook". Structure walls slope toward center of stream
at between 5-10 degree slope.
4" to 6" Spacing between boulders
to provides variation in velocity and habitat
complexity. Footer rocks should be placed
tightly together, with interstitial spaces back-
filled with stream substrate
Bank Full Water Surface Elevation
1/2 Max. Bank Full Depth
of the Channel
(Approx. 12"-18")
Dpending on the stability and condition of the
adjacent bank and channel substrate, water may be
allowed to scour underneath a portion of the length
of the tree in order to provide enhanced complexity
and cover for trout. Where stream banks and channel
conditions are unstable or suspect, back-fill the upstream
site of the tree w/ cobble and large gravel in order to seal
the bottom of the tree. If no cobble or gravel substrate is
available, line the upstream side of the tree with filter
fabric, and backfill with existing substrate. (Optional)
Manta-Ray Deadman Anchors
Driven 3' to 4' into stream substrate
and set with excavator. Stainless
Steel Cable wrapped around tree
bole and secured with cable clamps
(Optional)
Combination Large Tree / RockJ-Hook Vane
Vertical Profile
FIN-UP Habitat Consultants, Inc.
220 Illinois Avenue
Manitou Springs, CO 80829
(719) 332-2550
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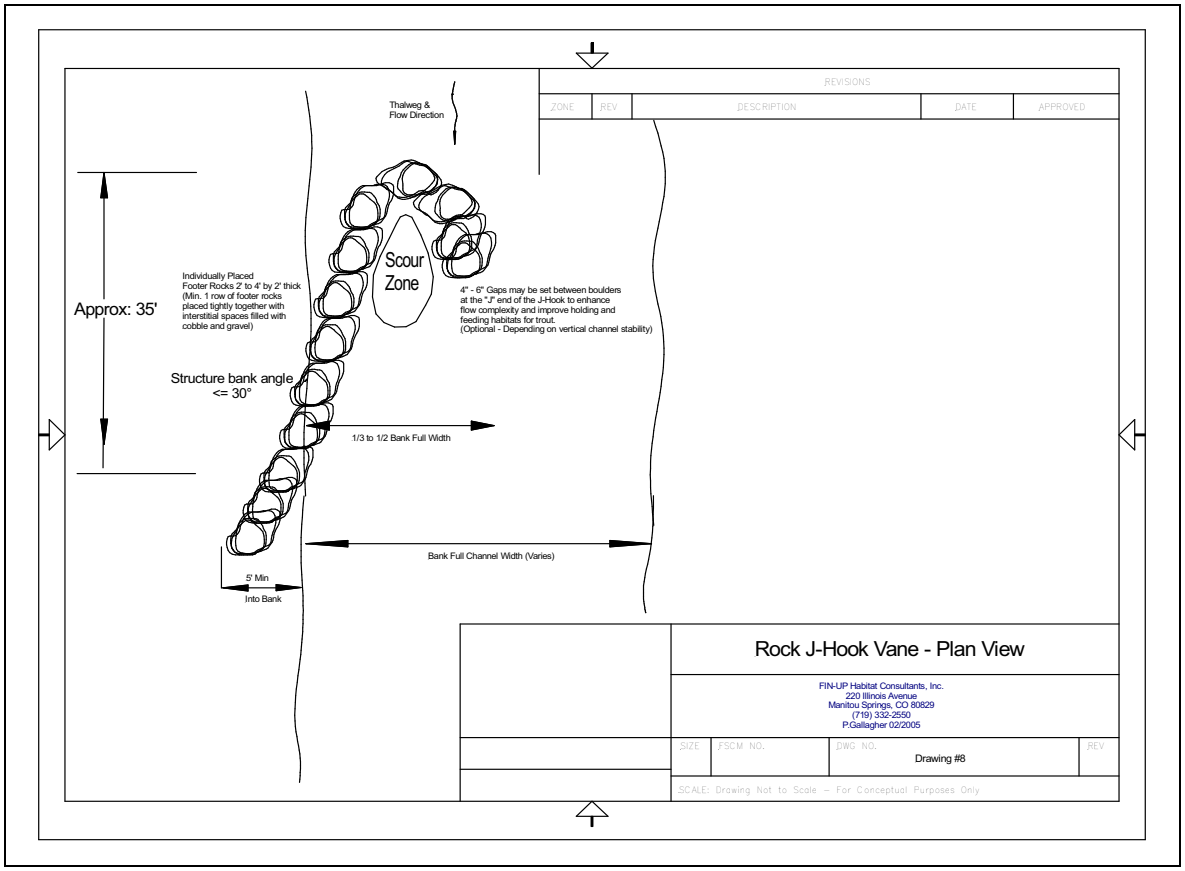
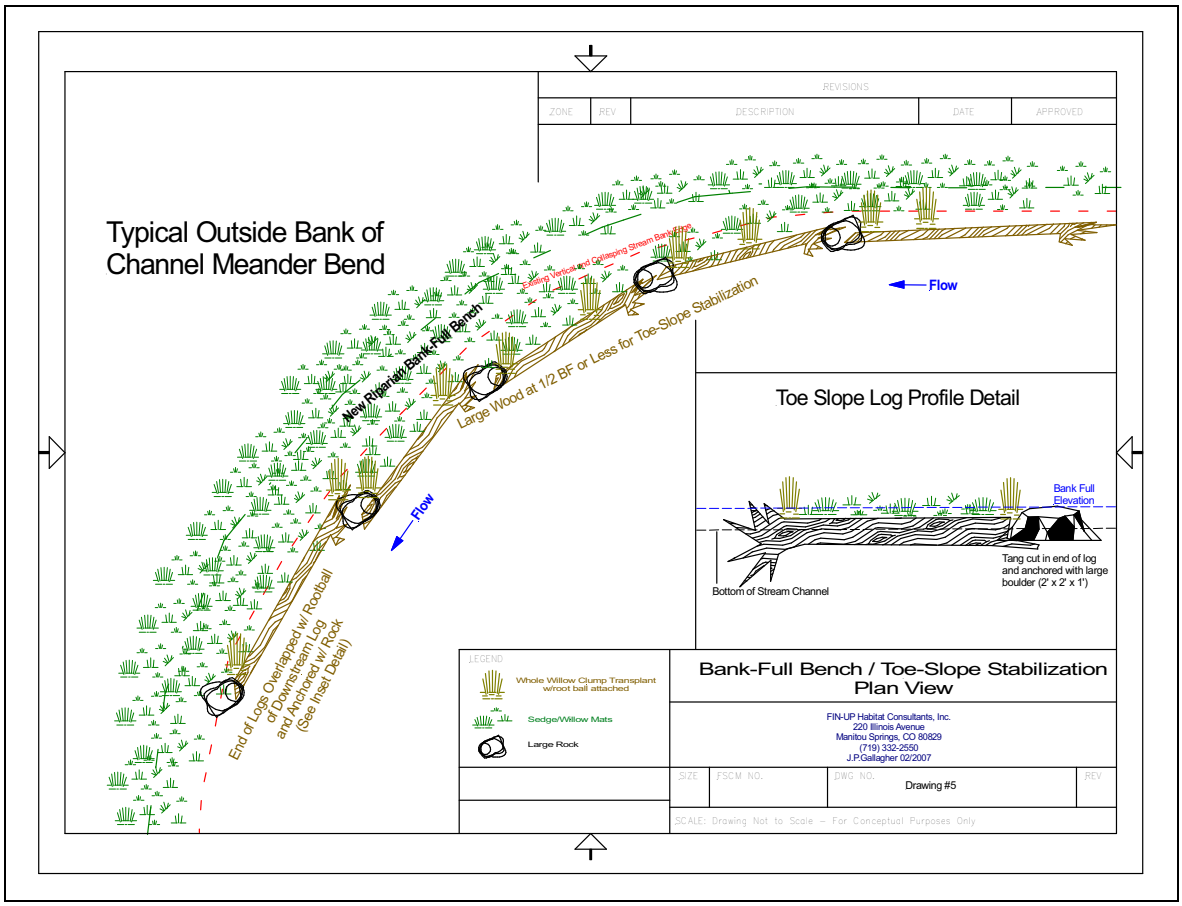
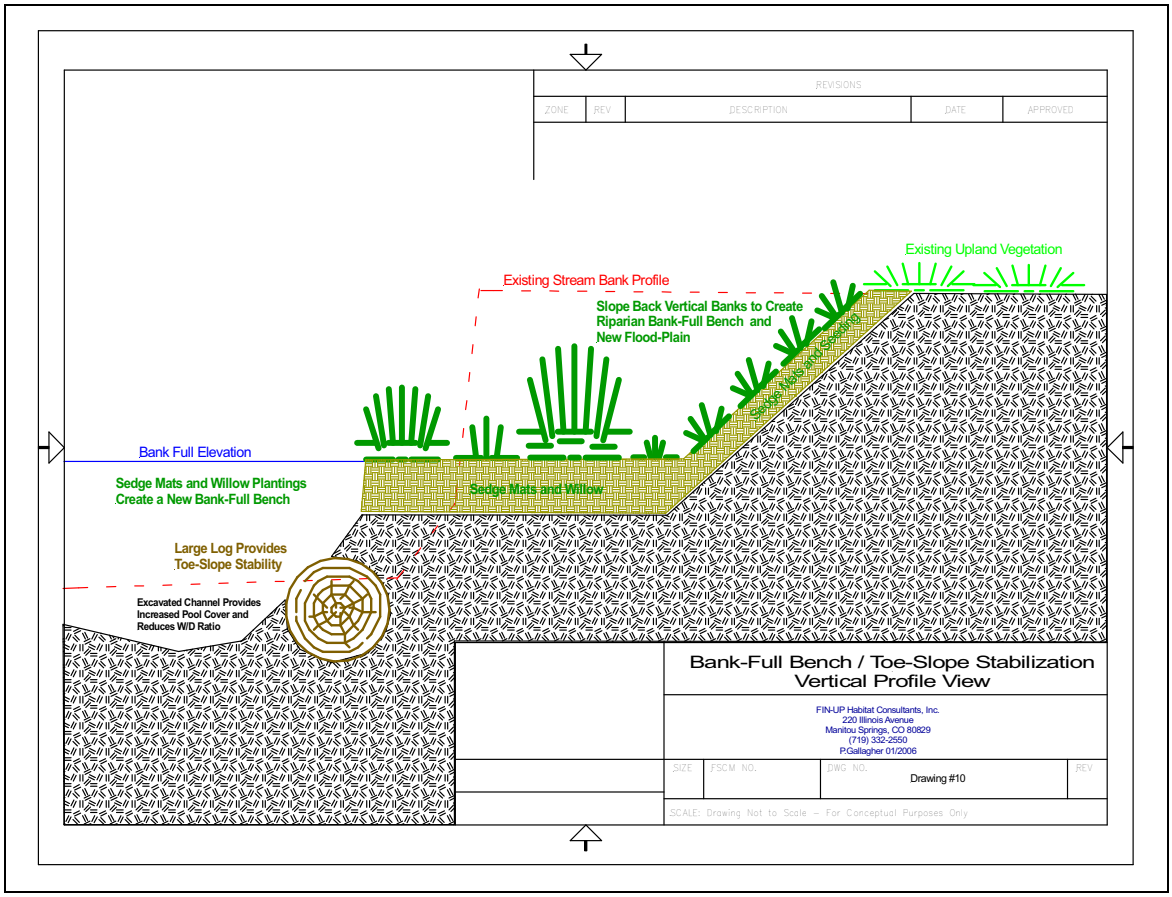
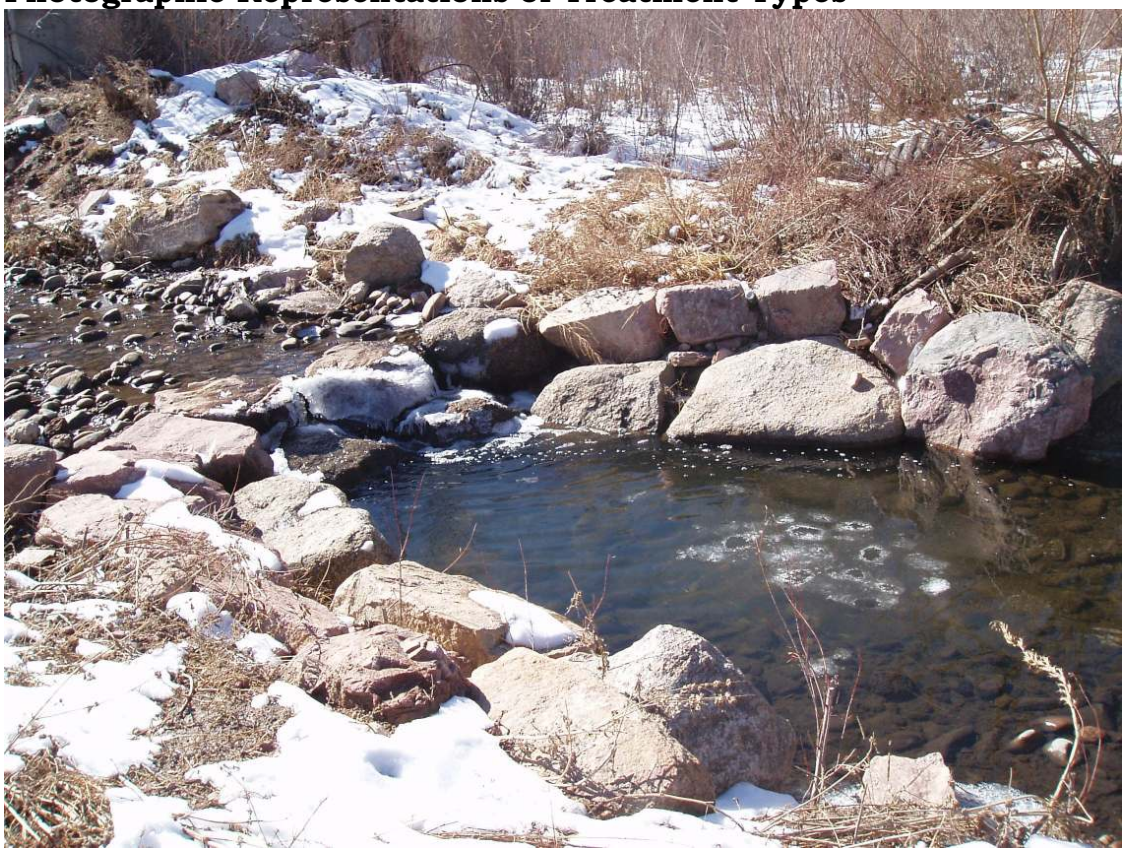
SIZE
FSCM NO.
DWG NO.
Drawing #7
REV
SCALE: Drawing Not to Scale – For Conceptual Purposes Only


REVISIONS
ZONE
REV
DESCRIPTION
DATE
APPROVED
Thalweg &
Flow Direction
Scour
Zone
Approx: 35'
Individually Placed
Footer Rocks 2' to 4' by 2' thick
(Min. 1 row of footer rocks
placed tightly together with
interstitial spaces filled with
cobble and gravel)
4" - 6" Gaps may be set between boulders
at the "J" end of the J-Hook to enhance
flow complexity and improve holding and
feeding habitats for trout.
(Optional - Depending on vertical channel stability)
Structure bank angle
<= 30°
1/3 to 1/2 Bank Full Width
Bank Full Channel Width (Varies)
5' Min
Into Bank
Rock J-Hook Vane - Plan View
FIN-UP Habitat Consultants, Inc.
220 Illinois Avenue
Manitou Springs, CO 80829
(719) 332-2550
P.Gallagher 02/2005
SIZE
FSCM NO.
DWG NO.
Drawing #8
REV
SCALE: Drawing Not to Scale – For Conceptual Purposes Only


REVISIONS
ZONE
REV
DESCRIPTION
DATE
APPROVED
Typical Outside Bank of
Channel Meander Bend
Existing Vertical and Collapsing Stream Bank Edge
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
Bank Full Elevation
Sedge Mats and Willow Plantings
Create a New Bank-Full Bench
Sedge Mats and Willow
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 012206
SIZE
FSCM NO.
DWG NO.
Drawing #10
REV
SCALE: Drawing Not to Scale – For Conceptual Purposes Only

Photographic Representations of Treatment Types

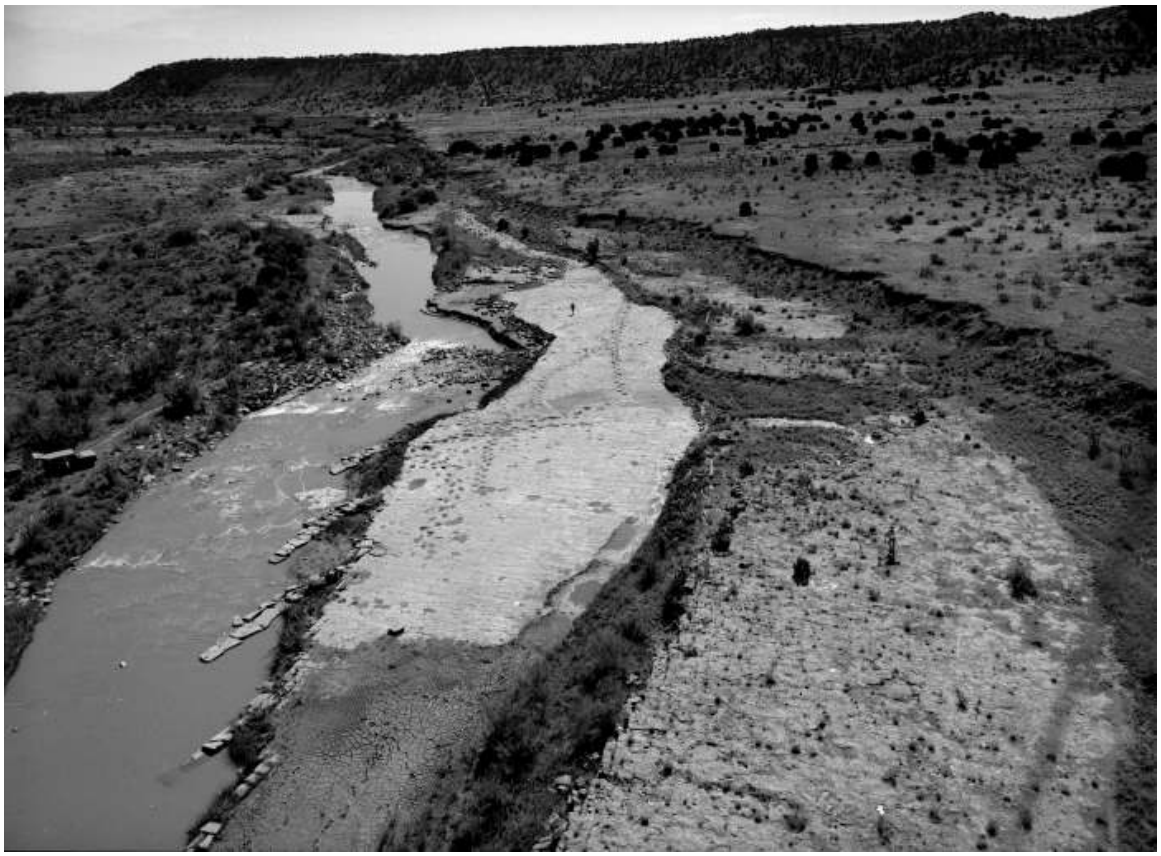


Cross Vane Structure on Cheyenne Creek below I-25 Overpass. Colorado Springs, El Paso County, Colorado

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.



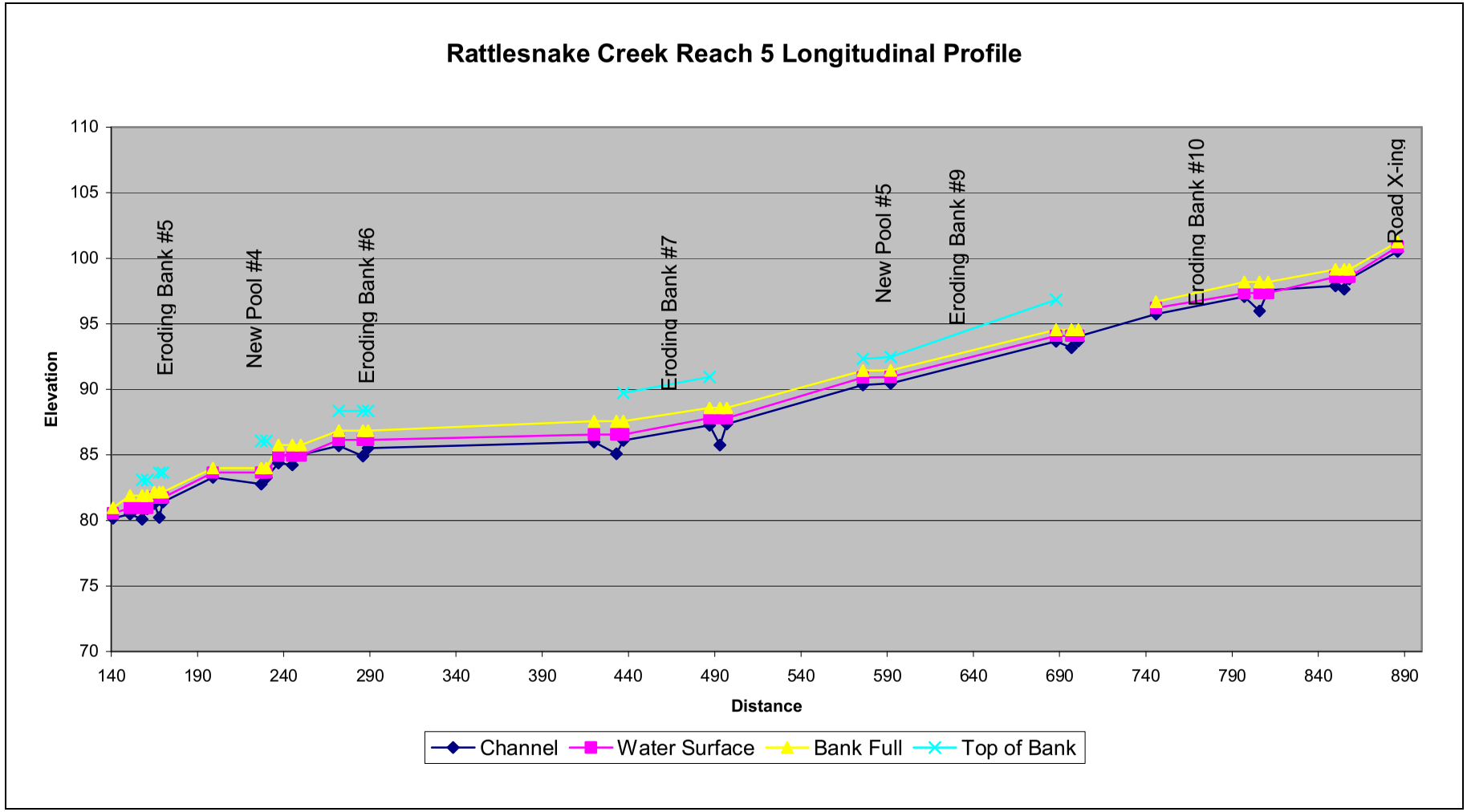
Picketwire Canyonlands, SE Colorado - Rock vanes used to protect dinosaur trackway. These structures were installed in 1998, and survived a 100 year event the following spring. Note the deposition and new willow vegetation taking hold in between the structures. The photo below shows the Project nine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

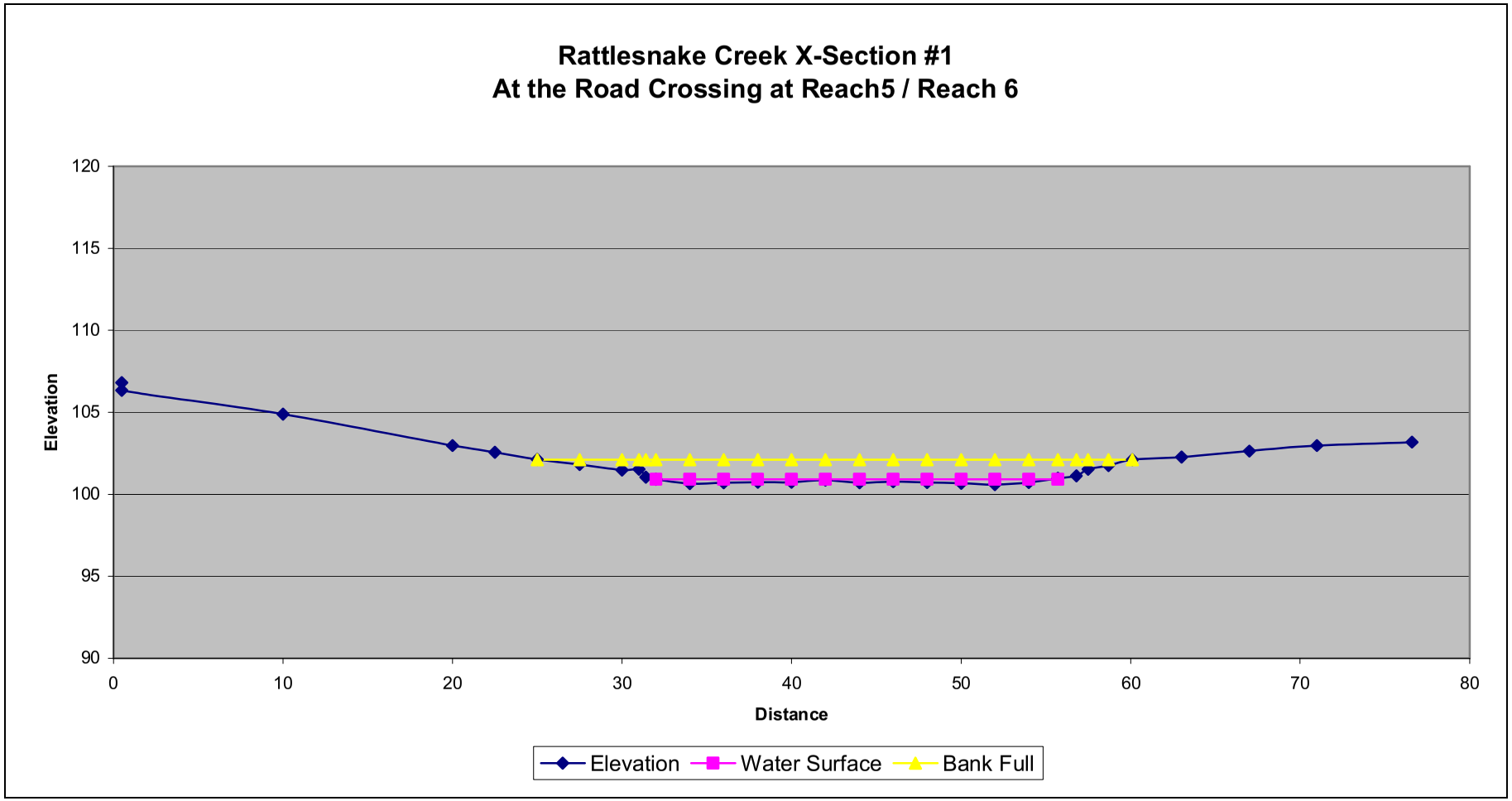
Aerial of Dinosaur Tracks along Purgatoire River
Picket Wire Canyonlands, Comanche National Grassland, southeastern Colorado

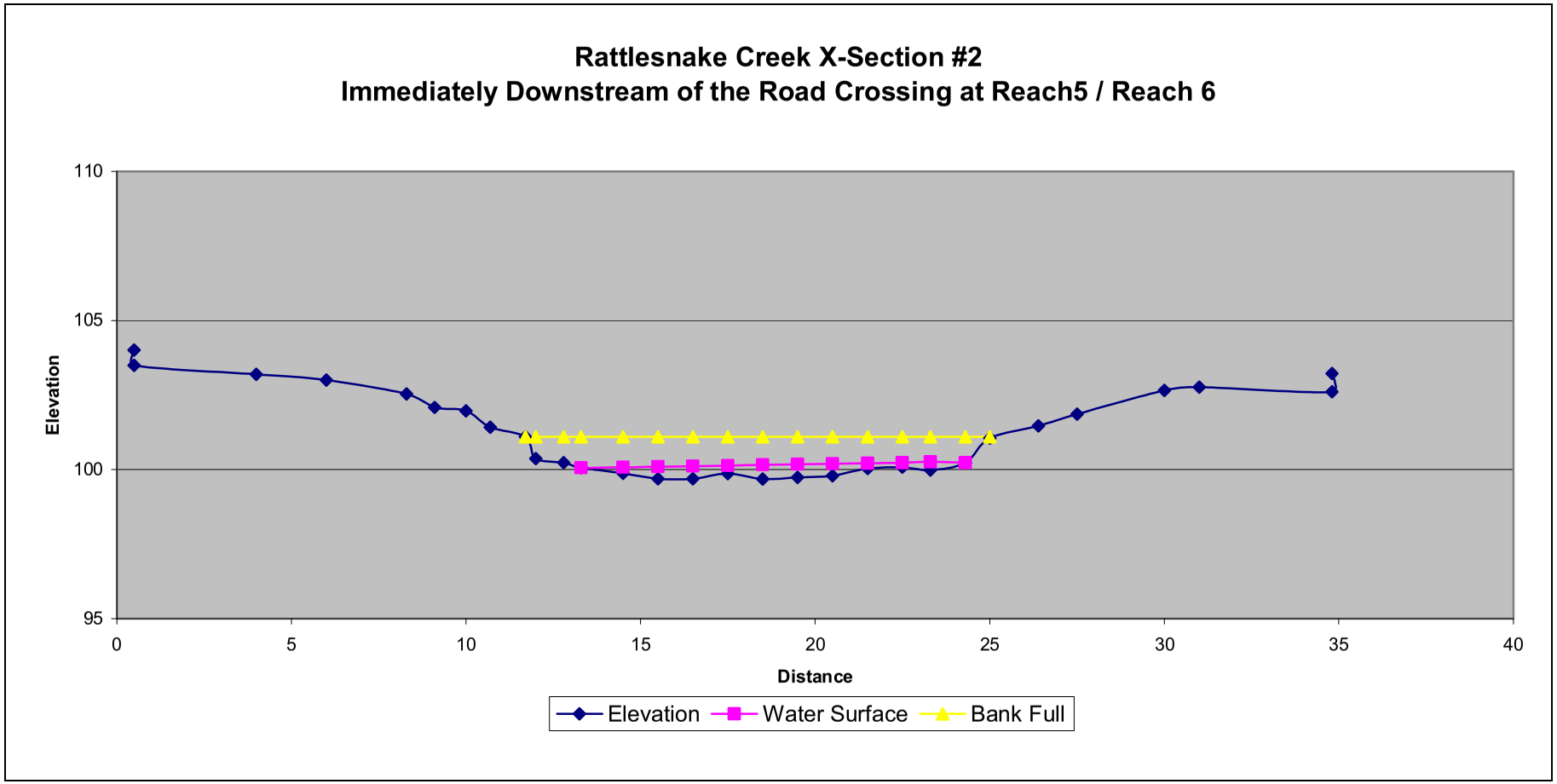
Permission of USDA Forest Service

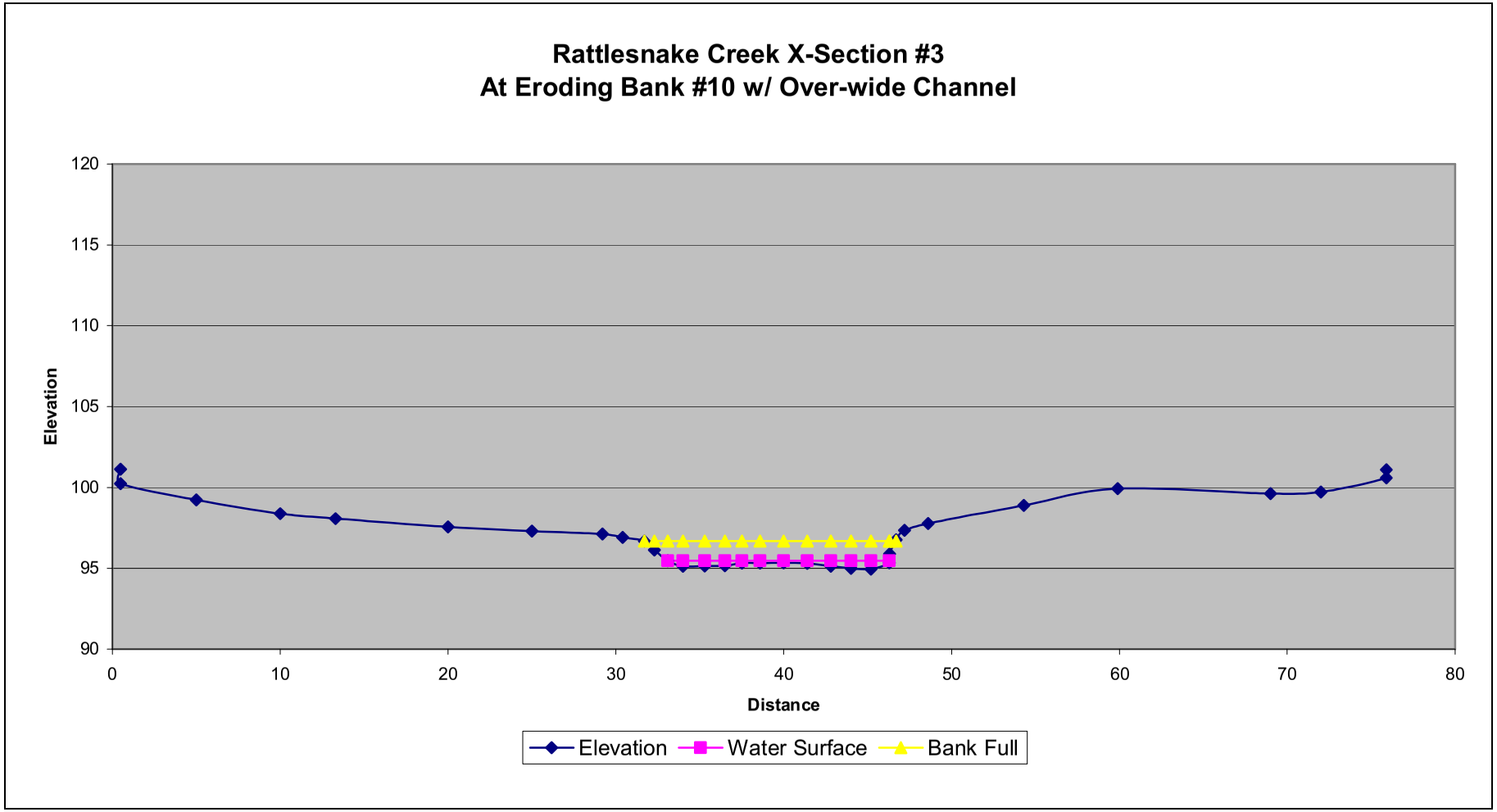
Eagle Rock Ranch - Rock J-Hook Vanes installed to protect stream banks and adjacent road,, 2003.

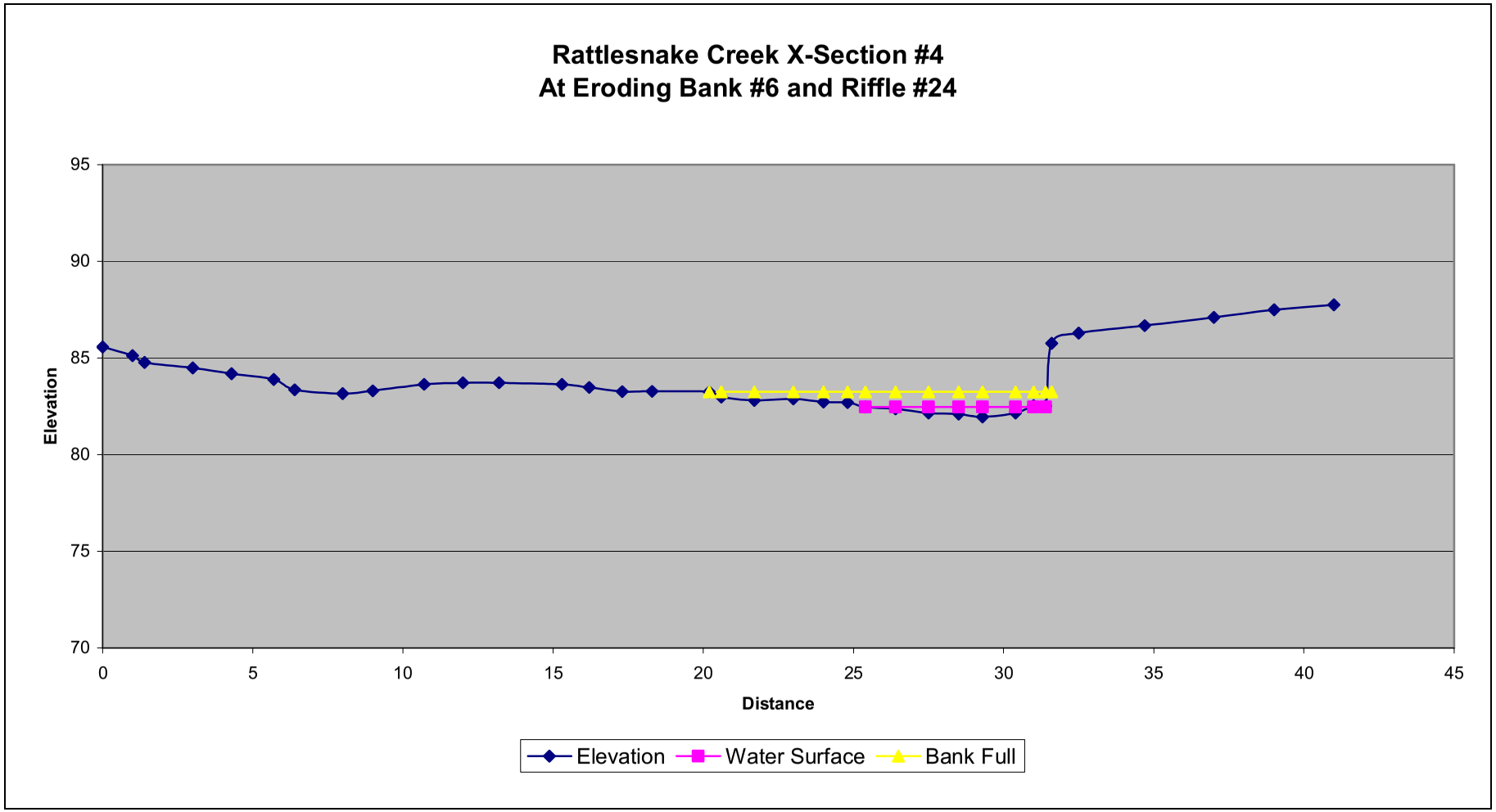
Stream Channel Structure and Treatment Drawings

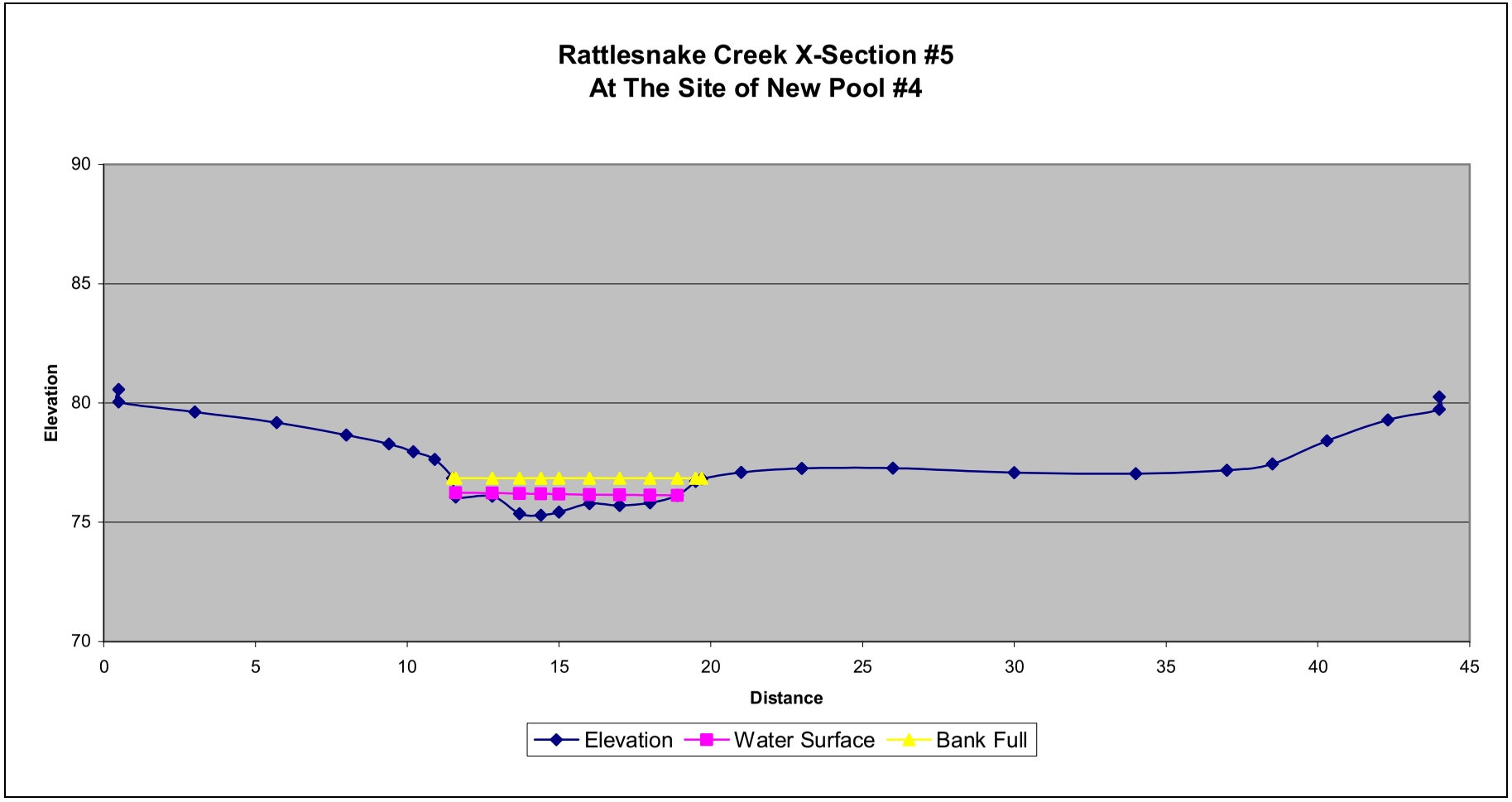


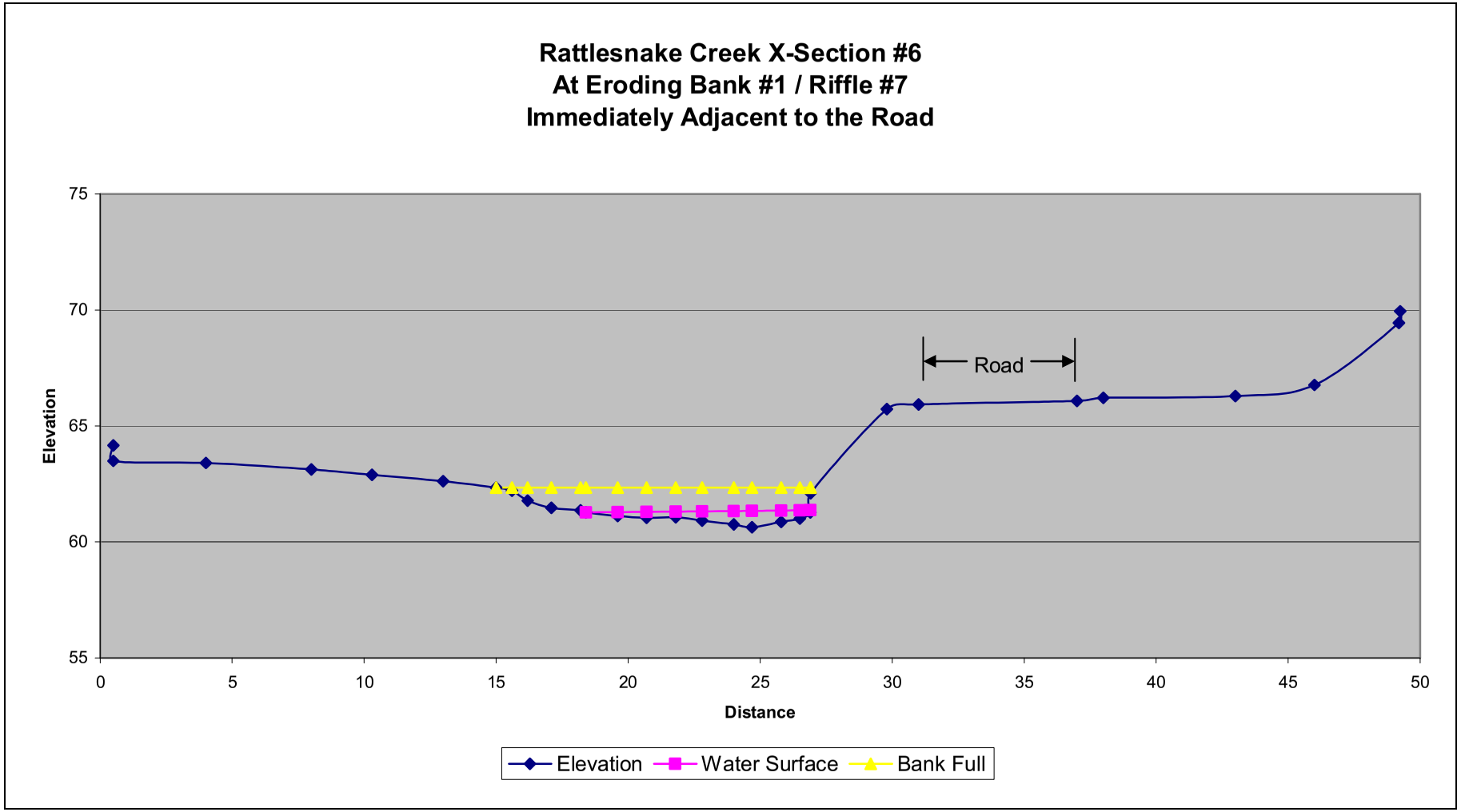

Rattlesnake Creek X-Section #1
At the Road Crossing at Reach5 / Reach 6
Elevation
120
115
110
105
100
95
90
0
10
20
30
40
50
60
70
80
Distance
Elevation
Water Surface
Bank Full


Rattlesnake Creek X-Section #2
Immediately Downstream of the Road Crossing at Reach5 / Reach 6
110
105
100
95
Elevation
0
5
10
15
20
25
30
35
40
Distance
Elevation
Water Surface
Bank Full


Rattlesnake Creek X-Section #3
At Eroding Bank #10 w/ Over-wide Channel
120
115
110
105
100
95
90
Elevation
0
10
20
30
40
50
60
70
80
Distance
Elevation
Water Surface
Bank Full


Rattlesnake Creek X-Section #4
At Eroding Bank #6 and Riffle #24
Elevation
95
90
85
80
75
70
0
5
10
15
20
25
30
35
40
45
Distance
Elevation
Water Surface
Bank Full


Rattlesnake Creek X-Section #5
At The Site of New Pool #4
Elevation
90
85
80
75
70
0
5
10
15
20
25
30
35
40
45
Distance
Elevation
Water Surface
Bank Full


Rattlesnake Creek X-Section #6
At Eroding Bank #1 / Riffle #7
Immediately Adjacent to the Road
Elevation
75
70
65
60
55
0
5
10
15
20
25
30
35
40
45
50
Distance
Road
Elevation
Water Surface
Bank Full

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