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June 1, 2011
File: 175649008

Mr. Dan Shaver
Brown County Hills Project Director
Acting Forest Bank Manager
The Nature Conservancy
PO Box 1092, 1156 Old State Road 46, Suite A
Brown County, Indiana 47448

**Reference: Stream Restoration Master Plan for the Yellowwood Lake Watershed
Brown County, Indiana**

Dear Mr. Shaver:

Stantec Consulting Services Inc. (Stantec) is pleased to submit the Stream Restoration Master Plan (SRMP) for the Yellowwood Lake Watershed and referenced project. The SRMP presents stream assessment data and site-specific recommendations for stream restoration and enhancement including two conceptual restoration plans. We would like to thank the Indiana Department of Environmental Management (IDEM) for the opportunity to develop a restoration plan for the Yellowwood Lake Watershed. We have enjoyed working with you on this project. If you should have any questions or comments, please feel free to contact our office.

Sincerely,

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Stream Restoration Master Plan

For the Yellowwood Lake Watershed
Brown County, Indiana

June 1, 2011

Executive Summary

At the request of the Brown County Soil and Water Conservation District on behalf of the Yellowwood Lake Watershed Planning Group (YLWPG), Stantec Consulting Services Inc. (Stantec) has prepared this addendum to the Yellowwood Lake Watershed Management Plan. This project has been paid for by the Indiana Department of Environmental Management (IDEM) via funding from the 319 Grants Program (ARN 9-180).

The Stream Restoration Master Plan presents assessment data for streams within the Yellowwood Lake Watershed, site-specific recommendations for stream restoration and enhancement, and information prepared in support of developing a demonstration workshop. This report has been preceded by the *Yellowwood Lake Watershed Management Plan (YLWMP)*, which was prepared by the YLWPG and may be consulted for more extensive data regarding the overall watershed characteristics and goals of the YLWPG.

Sediment sources within the Yellowwood Lake Watershed include impacts from land–use practices including the main access road and various stream impairments throughout the watershed, in addition to the other sources mentioned in the YLWMP. The major sources of sediment from streams observed in the watershed include headcuts, avulsions, lateral migration, streambank erosion, and overland erosion from roadways and crossings. Conceptual restoration plans and preliminary construction cost estimates are presented in Section 3.3. Conceptual Plan 1 is a potential demonstration project that involves approximately 1700 linear feet located on the downstream end of Reach 7. Option 1 of Conceptual Plan 1 involves a Priority III restoration of Reach 7a, while Option 2 of Conceptual Plan 1 involves a Priority I restoration of Reach 7a. Conceptual Plan 1 includes various treatments at different locations including shifting the channel away from the hillside, installing in-stream structures to provide bank protection, grade-control and maintain habitat, and establishing native vegetation to stabilize streambanks and enhance in-stream and floodplain habitat. Conceptual Plan 2 involves improving one of the main Yellowwood Lake Road crossings in the watershed along Reach 6. Option 1 of Conceptual Plan 2 involves replacing the existing low water crossing with a clear span bridge while Option 2 of Conceptual Plan 2 involves improving the existing low water crossing. Additional field data and construction plans will be required to implement all solutions and conceptual restoration plans presented in this report.

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Glossary of Terminology

Bank Stabilization	Hardening the bed and banks of a river in place using a variety of materials and methods including bio-engineering, check dams, concrete lined channels, gabions, rip rap, bin-walls, log crib walls, weirs, willow post planting, etc.
Bankfull Discharge	The discharge and corresponding stage at the incipient point of flooding. It is often associated with a return period between 1 and 1.5 years. It is expressed as the momentary maximum or instantaneous peak flows rather than the mean daily discharge.
Bankfull Stage	The elevation of the water surface associated with the bankfull discharge.
Bankfull Width	The surface width of the stream measured at the bankfull stage.
Bankfull Mean Depth	The mean depth of flow at the bankfull stage, determined as the cross sectional area (sum of the products of unit width times depth) divided by the bankfull surface width.
Channel Incision	The degree to which the stream has abandoned its floodplain as determined by Bank-Height Ratio (lowest bank height divided by bankfull height).
Channelization	The re-alignment of rivers involving straightening, widening, reshaping, entrenching and altering the slope of rivers. Often this work is accompanied by streambank stabilization, grade control and levee construction.
Confinement	The lateral containment of rivers as quantitatively determined by meander width ratio (meander width ratio is determined by dividing belt width by bankfull width).
Entrenchment Ratio	The quantitative index of the vertical containment of rivers as determined by dividing the flood-prone area width by the bankfull width (The flood-prone area width is measured at twice the maximum bankfull depth).
Floodplain	The floodplain of a river is the flat adjacent to the bankfull channel, which is constructed by the river in the modern climate. It is available to the river to accommodate flows greater than the bankfull discharge. There is not a constant frequency of occurrence of flood discharge associated with the floodplain, as the depth of flow over the flood plain is a function of the width of the floodplain and the magnitude of the flood peak.

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Flood-prone Area Width	The width associated with a value of twice the bankfull depth. It is the area including the flooplain of the river and often the low terrace of alluvial streams. This value when divided by the bankfull width is used to determine entrenchment ratio.
Grade Control Structure	A structure designed to maintain the local base level of a stream and/or to influence the grade of the stream either upstream and/or downstream. It can be constructed from a variety of materials including logs, boulders, loose rock, concrete and gabion baskets.
Mannings n	The resistance of the bed of a channel to the flow of water in it. Representative values of the coefficient are from 0.010 to 0.1 for alluvial channels.
Natural Channel (Stream) Stability	The ability of a stream, over time, to transport the flow and sediment of its watershed without aggrading nor degrading while maintaining its dimensions, pattern and profile.
Restoration	The creation of a stable dimension, pattern and profile for a stream type and channel morphology appropriate to its landform and valley, designed such that over time it is self-maintaining. Native materials common to the river are used to obtain natural stability including streambank and streambeds.
Riffle Pool Channel	Generally associated with alluvial channels on slopes less than 0.02 whose bed features are composed of a series of pools (deep and flat water surface features) and riffles (shallow and steep water surface features). The pool-to-pool sequence is related to the meander geometry of rivers.
Step Pool Channel	The type of bed features associated with the slope and bankfull width of the stream. The bed features are generally chutes and scour pools, whose pool-to-pool spacing is inversely related to the stream slope and is proportional to the bankfull width.
Stream Slope	Determined by the change in elevation of the bed surface over a measured length of channel. It is expressed as the ratio of elevation (rise) over distance (run) in ft/ft.

Glossary of Terminology

Terrace	A flat adjacent to the river in alluvial valleys created by the abandonment of the floodplain. Other than the low terrace, it is rare that terraces are flooded in the modern climate. Many of the higher terraces are related to elevations associated with the Holocene period.
Width to Depth Ratio	Determined by the ratio of bankfull surface width to bankfull mean depth.

1.0 Introduction

The Yellowwood Lake Watershed Planning Group (YLWPG) was formed in 2000 to develop a long-term management plan for the Yellowwood Lake Watershed (YLW). In 2004, the group launched an extensive study of the watershed, along with research and discussion aimed at maintaining and improving the quality of water within the watershed, as well as preventing future problems. The group published the finished product of this effort in 2006 as the *The Yellowwood Lake Watershed Management Plan: Protecting, Enhancing, and Conserving Yellowwood Lake and Its Tributaries* (YLWMP). Problems, goals, and action plans were identified for each of the four main topics addressed in the report:

1. Group Sustainability;
2. Sedimentation;
3. Nuisance and Invasive Species; and
4. Biological and Chemical Contamination.

While this report focuses on the problem of sedimentation, it also possesses implications for Topics 3 and 4. The YLWMP noted an influx of sediment to Yellowwood Lake, which has led to adverse conditions for ecology and recreation within the lake. Research of the watershed indicated a major contributor to the sedimentation problem was widespread erosion of stream banks. As a result of land use stressors earlier in the 20th century, massive changes in drainage patterns and characteristics led to instability in the streams to which they have not yet recovered. Without restoration and enhancement within the stream corridors, full recovery of the watershed to its potential could take an extensive amount of time. The YLWPG understands that improving the streams within the watershed will address specific sedimentation problems, as well as enhance the aesthetics and overall attraction of the watershed. Stream restoration initiatives encourage the planting of native vegetation species as well as aid in reducing biological and chemical contamination through decreasing bank erosion, which acts as a transportation device for contaminated sediments.

The Stream Restoration Master Plan for the Yellowwood Lake Watershed (SRMP) identifies the origins and causes of increased sedimentation, as well as characterizes and prioritizes problem areas and solutions for the stream corridors within the watershed. The SRMP is intended for use in conjunction with other watershed level efforts to meet the goals of the YLWPG. The objectives of the report are to provide data, information, and conceptual designs to help guide restoration/enhancement activities within the YLW and establish their viability. In this report, Stantec will present a brief summary of watershed and geomorphologic information, detailed assessments and analyses of the streams within the watershed, potential restoration opportunities throughout the watershed, and two conceptual designs for top priority sites. The conceptual designs were formed with the goal of providing sustainable solutions with the highest degree of potential success in such a way that this watershed and its improvements may offer educational value in future watershed restoration endeavors. Through implementation of the conceptual designs, the third concern of the YLWPG, nuisance and invasive species, can also be addressed. Standard recommendations during stream construction include removal or eradication of invasive and nuisance species, as well as seed and establishment of native stream-side vegetation.

An extensive description of the watershed and its physiographic, geologic, and ecologic settings can be found within the YLWMP. Section 2 presents observations and data collected during the streams assessment. Section 3 describes general guidelines for watershed management and the development of reach prioritization. Two conceptual enhancement plans are also presented. Conclusions and recommendations for implementing conceptual plans are summarized in Section 4. References cited in this report are documented in Section 5. Maps of the site and the results of the study are located in the Appendices.

2.0 Streams Assessment

2.1 WATERSHED DESCRIPTION

The YLW, located in Southern Indiana, drains approximately 7 square miles via Jackson Creek and its tributaries and contains approximately 18 miles of perennial and intermittent streams. The landscape of the watershed includes pine and hardwood forests of varying age, few open fields, abandoned logging roads, several hiking and horse trails, Yellowwood Lake Road bisecting the watershed, private gravel/dirt driveways, and two gravel roads bordering the watershed. The forest is home to very diverse wildlife with numerous recreational opportunities. The topography is generally steep with a flat valley floor which ranges largely in width. A significant portion of the watershed has historical and/or current anthropogenic impacts, primarily historical clear-cutting, which has degraded the conditions of many of the streams. A map of the watershed and the inventoried stream reaches is included in Appendix A. A much more detailed description and further detailed mapping of the watershed may be found in the YLWMP.

2.2 HYDROLOGY

The majority of channel length in the watershed is classified as intermittent. Storm flow in the watershed is flashy. Rain events within the contained stream corridors cause the water levels to rise rapidly throughout the watershed, as observed during field investigations, with enough power to move significant bed load in the channels. However, nearly all of the tributaries and some portions of Jackson Creek are almost completely dry during summer months, leaving only infrequent pools fed by subsurface flow (See YLWMP for further discussion).

Figure 1: Dry weather creek bed (Reach 17) typical of watershed.

2.3 GEOMORPHOLOGY

2.3.1 Valley Type

Broad, alluvial valleys with wide floodplains and gentle relief are the dominant valley type in the lower portion of the YLW. Smaller streams located in the upper portion of the watershed flow through moderately steep, colluvial valleys with gentle side slopes.

Valley type information can be used to help predict stream type because erosional and depositional processes that influence morphological characteristics of dimension, pattern, profile, and channel materials are typical to certain valley types. For example, "C" stream type channels are wide, meandering, gently sloping channels typically found in broad valleys with wide floodplains and gentle relief. Stable Rosgen "E" and "C" stream types (Rosgen, 1994) with meandering, gently sloping channels are typically found in broad alluvial valleys. Stable "B" stream types, often described as "rapids" or "step pools", are typically found in the moderately steep, colluvial valleys with gentle side slopes. Steep, narrow, confined "G" stream type channels can be found in V-shaped, confined valleys with high elevation relief.

Valley type information can also be used to assess stream stability. For instance, gullies found in broad, alluvial valleys are usually highly unstable streams that have evolved from the stable "C" stream type to the "G" stream type due to changes in dimension, pattern, profile, slope, sediment supply, flow, or vegetation. Valley type is also a consideration in river restoration as a reference reach of the same stream type and valley type is typically used as a "blueprint" for natural channel design.

2.3.2 Stream Classification

The Rosgen Classification of Natural Rivers (Rosgen, 1994) is used to stratify streams and rivers by stream type using geomorphic parameters such as slope, width-to-depth ratio, entrenchment ratio, sinuosity, and the particle size distribution of the channel materials. The classification system groups streams into eight broad-level categories (A, B, C, D, DA, E, F, and G) based on the number of channels, entrenchment ratio, width-to-depth ratio; and six channel material categories [1 (bedrock), 2 (boulder), 3 (cobble), 4 (gravel), 5 (sand), and 6 (silt/clay)] based on the mean channel material size (D_{50}) calculated from the representative pebble count. Streams may be further stratified into slope range categories (a+, a, b, c, and c-) based on the average bankfull slope. A copy of the Key to the Rosgen Classification of Natural Rivers (Wildland Hydrology, 2006) is provided in Appendix B.

Entrenchment ratio is an important parameter to consider when assessing the stability of a stream. Entrenchment is the vertical containment of a stream and is qualitatively defined by the entrenchment ratio: the width of the flood prone area (measured at an elevation equal to twice the maximum bankfull depth) divided by the bankfull surface width. A stream with a high entrenchment ratio has access to a wide floodplain and uses it to dissipate energy when conveying discharges greater than the bankfull discharge. A stream with a low entrenchment ratio approaching a value of 1, which is typical of F and G stream types, has limited access to a wide floodplain; therefore, stream flow is contained within the channel and excess flow energy produces streambank and bed erosion. Bank and bed erosion lead to lateral migration of streambanks, stream down cutting, vegetation loss, increased sediment yields, higher water temperatures, impaired water quality, and poor stream habitat. Streams are considered highly entrenched if the entrenchment ratio is less than 1.4, moderately entrenched if the entrenchment ratio is between 1.4 and 2.2, and slightly entrenched if the entrenchment ratio is greater than 2.2.

Another important parameter to consider when assessing the stability of a stream is width-to-depth ratio: the bankfull width divided by the bankfull mean depth. Width-to-depth ratio is used to determine the sediment carrying capacity of a stream. As the width-to-depth ratio increases, the sediment carrying capacity of a stream decreases. As the width-to-depth ratio decreases, the sediment carrying capacity of a stream increases. Stream types are defined as having the following width-to-depth values: A (<12), B(>12), C(>12), D(>40), E(<12), F(>12), and G(<12). Refer to Appendix B for graphics regarding stream characteristics for classifications.

Stream types identified in the YLW include A1, B4c, B4/1c, C1, C4/1, C4, F1, F4, and F4/1. Stable Bc and C stream types were expected to dominate given that the dominant valley types in the watershed is a broad alluvial valley with a wide floodplain and moderately steep, colluvial valleys with gentle side slopes. In an undisturbed watershed, F stream types typically do not exist in broad alluvial valleys; therefore, the presence of F stream types in the YLW is likely the result of impacts from anthropogenic influences (historical clear cutting and hillside farming) and resulting natural processes (vertical and lateral erosion).

The bed material in the majority of channel length assessed had high gravel content, with particle sizes ranging from sand to cobble. Based on field observation, the current bed composition appears to be made up of materials eroded from the stream bed and banks throughout the watershed, with some road gravel where the stream is in close proximity. There were frequent bedrock controlled sections of channel and local instances of vertical and lateral bedrock control. Many segments were observed, predominantly in the tributaries and headwaters of Jackson Creek, which tended to be cobble dominated. Several of the larger pool facets in the lower half of Jackson Creek were composed primarily of sand, which would be expected with the lower gradient of the valley.

2.3.3 Methodology

The Bank Assessment for Non-Point Source Consequences of Sediment (BANCS; Rosgen 2006) method is a tool adopted by the USEPA to predict streambank erosion rates. The BANCS method provides an estimate of the rate of erosion and the amount of bank material being released from streambanks into the stream system. It is a visual assessment tool that, when combined with more quantitative studies completed in other states, can provide a reasonable estimate of erosion rates. The BANCS method uses two bank erodibility estimation tools: the Bank Erosion Hazard Index (BEHI) and Near Bank Stress (NBS). BEHI provides an indication of a streambank's susceptibility to erosion, while NBS provides an indication of the erosive forces acting on the streambank. Refer to Appendix B to view streambank erodibility criteria used for BEHI ratings. The bank characteristics assessed in the development of BEHI ratings are:

(1) Study bank height ratio (study bank height divided by bankfull height)

(2) Root depth ratio (root depth divided by study bank height)

(3) Weighted root density (root density multiplied by root depth ratio)

(4) Bank angle

(5) Surface protection

(6) Bank material

(7) Stratification of bank material

There are seven methods that can be used to assess energy distribution on streambanks, which is referred to as NBS. Method 1, which is completed in the field, was used during this survey to estimate NBS. This method involves observing the channel patterns that are occurring locally such as transverse or mid-channel bars, chute cut offs, converging flows, down-valley migration, or extensive deposition that create NBS. A hand held geographic positioning system (GPS) unit, along with aerial mapping, was used to verify some of the lengths of bank segments and determine periodic reach locations along the streams.

The application of the BANCS model involves evaluating the bank characteristics and flow distribution along stream reaches, mapping the location and extent of each bank feature, and developing BEHI and NBS ratings for each feature. Curves relating BEHI and NBS ratings to bank erosion rates are then used to predict annual streambank erosion rates of a study reach. In each reach an overall estimate of erosion is made by multiplying the length and height of each rated bank by the estimated erosion rate from the curve, and then summing the estimates for each bank. This provides an estimate of cubic yards and/or tons of sediment that erodes per reach per year.

During the week of July 20, 2009, bank erosion surveys and qualitative surveys were performed on Jackson Creek and related tributaries in the YLW. Data were collected from approximately 146,800 linear feet of streambank and 73,400 feet of stream channel (i.e., both banks were surveyed). Field surveys of bank erosion were stopped near the upstream ends of the defined channels in the watershed.

During field surveys, the left and right banks of the stream reaches were classified based on both the BEHI and NBS. As part of the classification, banks were divided into segments and inventoried based on the changes of physical bank characteristics and the applied shear stress. The lengths and heights of assessed bank segments were recorded on field data sheets that referenced each tributary in the watershed. Tributaries were defined according to the National Hydrography Dataset, topographic data, and aerial imagery. Later the segments and related characteristics were mapped in GIS where additional data and attributes could be assigned. Photographs of each bank segment were taken to visually document BEHI conditions and factors contributing to NBS.


(a) BEHI: Low, NBS: Low


(b) BEHI: Low, NBS: High

(c) BEHI: Moderate, NBS: Low

(d) BEHI: Moderate, NBS: Low

(e) BEHI: High, NBS: Low

(f) BEHI: High, NBS: High

(g) BEHI: Extreme, NBS: High

(h) BEHI: Extreme, NBS: Very High

Figure 2: Various BEHI and NBS conditions.

The BEHI and NBS ratings for each of the bank segments of the watershed were converted to bank erosion rates (ft/yr) using models for the North Carolina Piedmont Region (North Carolina State University Stream Restoration Program, 1989) and the South Central Colorado Region

(USEPA, 1989) (Figures 3 and 4, respectively). The erosion rates were converted to sediment in tons/year/foot (ton/yr/ft) by multiplying bank erosion rates (North Carolina and Colorado) by the bank height and the length of bank assessed. The volume of material (cubic feet) lost from the streambank each year was converted to pounds based on a density of 124 lbs/ft^3 (Jury and Horton, 2004). The values were then normalized to reflect the weight of sediment eroding for each foot of streambank. It should be noted that, based on soil cohesion, vegetation type, and humidity, it is expected that the South Central Colorado Region curve will over-predict bank erosion and the North Carolina Piedmont Region curve will under-predict bank erosion for the YLW.

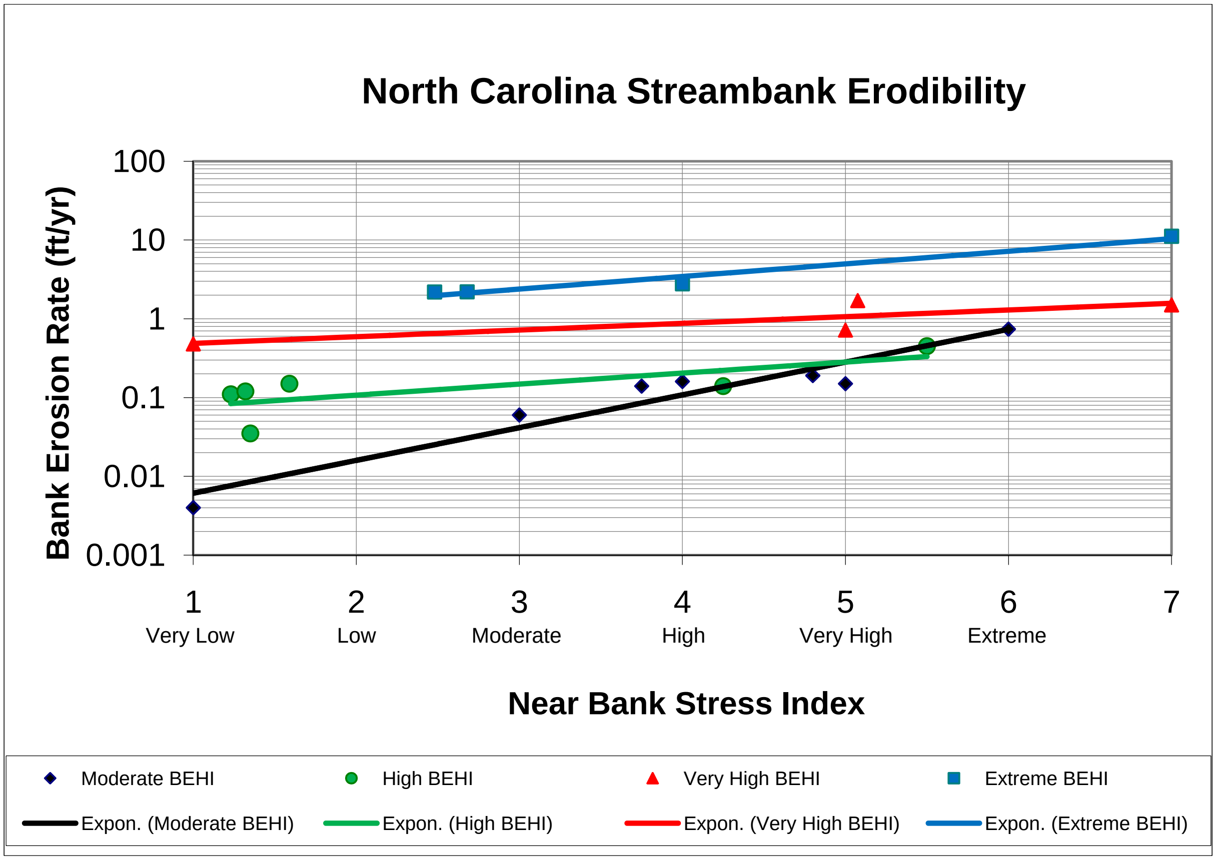

Figure 3: North Carolina Piedmont Region Bank Erosion Prediction Curve (Courtesy of North Carolina State Stream Restoration Program).

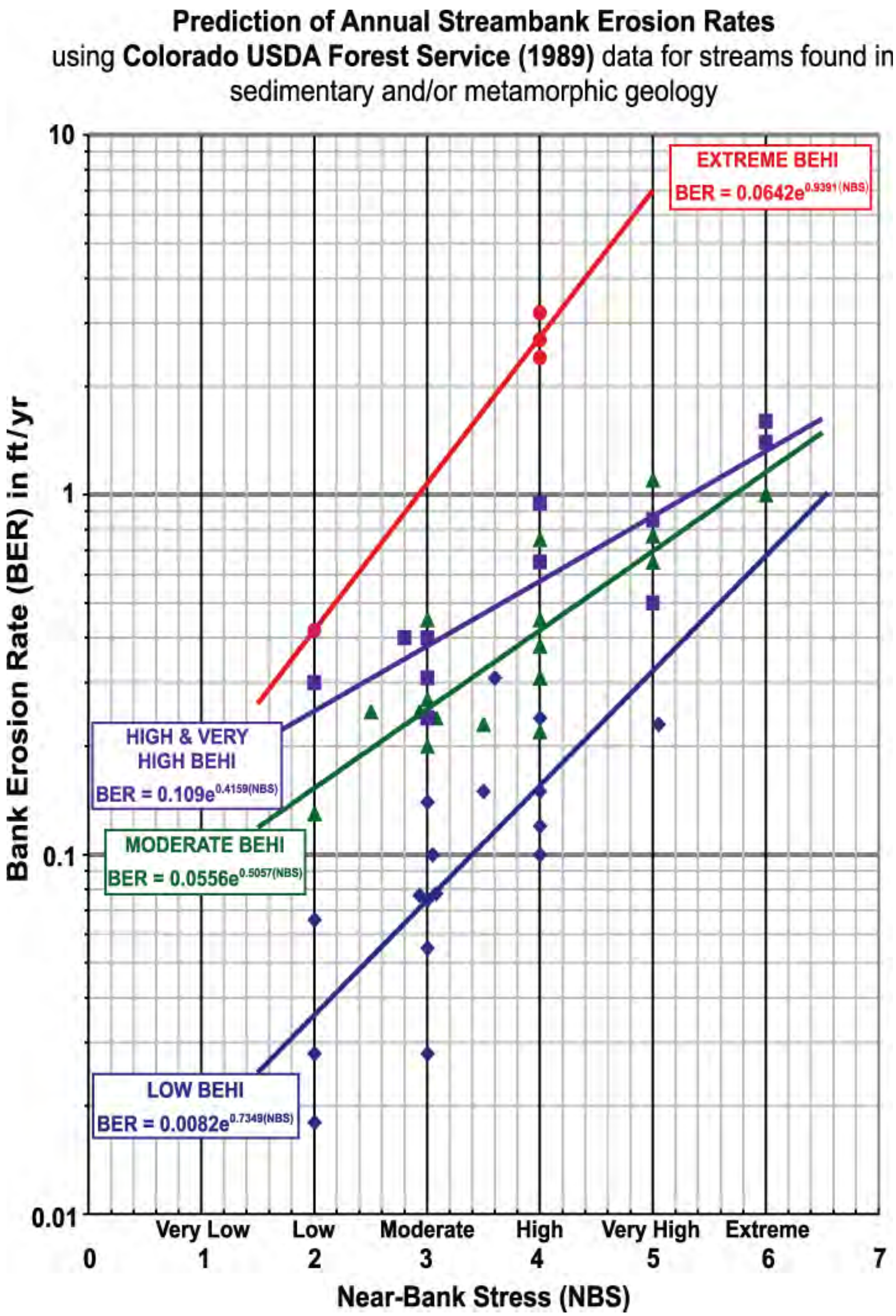

Figure 4: South Central Colorado Region Bank Erosion Prediction Curve (Rosgen, 1996, 2001a).

2.3.4 Results

Significant erosion was observed throughout the watershed. Based on observation, the majority of erosion within the YLW streams originated from the streambanks. Localized degradation of the bed was noted, but the presence of bedrock throughout the watershed limits vertical migration. Most of the more intense erosion points were a function of local watershed disturbances, with some concentrated in specific sub-catchments. Both BEHI and NBS ratings varied from very low to extreme. Bank segments ranged in length from 5 to 270 feet, and totaled approximately 146,800 linear feet (73,400 feet of stream channel). The total bank erosion was estimated to be 3,635 tons/year using the South Central Colorado Region curve and 2,287 tons/year using the North Carolina Piedmont Region curve. The boundary conditions and controlling environmental factors found in the YLW are estimated to be bounded in severity by the conditions found in North Carolina and Colorado, leading to the conclusion that actual erosion rates would be between the predicted rates for similar BEHI/NBS conditions in North Carolina and Colorado. The average lateral erosion rate for the entire watershed was 0.16/0.32 (ft/yr) (NC/CO). The data from this assessment clearly indicate that the reaches are in a state of accelerated bank erosion, regardless of the calibration used for the BANCS model.

Once the erosion data for each reach was completed, the reaches were ranked based on “tons/yr/ft” to determine the severity of erosion for each reach. Analysis showed that seven reaches, including the main stem, contribute 83 to 90% (CO and NC, respectively) of the total watershed erosion, with three of those seven contributing 67 to 72% of the total. Both predictive models indicated the same seven most erosive reaches in varying order, with Reaches 1 and 7 occupying the top two positions. During field data collection, Reaches 1, 6, and 7 were selected as having the most restoration potential based on severity of erosion as well as access and location. The analysis of the data confirmed the initial field selection. The seven reaches are spread across the watershed and range from headwaters to the main stem. Table 1 summarizes the results of each reach. Graphs of the results for each segment are presented in tons/yr/ft in Appendix C.

Table 1: Bank Erosion Summary by Reach

Reach # *	Colorado Curve Estimate			North Carolina Curve Estimate		
	tons/yr	tons/yr/ft	ft/yr	tons/yr	tons/yr/ft	ft/yr
1	1453	0.10	0.41	798	0.05	0.22
2	13	0.03	0.31	4	0.01	0.10
3	16	0.01	0.36	4	0.00	0.10
4	21	0.02	0.41	7	0.01	0.14
5	17	0.03	0.42	12	0.02	0.30
6	206	0.04	0.22	141	0.03	0.12
7	761	0.08	0.43	707	0.07	0.32
8	18	0.02	0.29	4	0.01	0.06
9	125	0.04	0.36	59	0.02	0.14
10	19	0.01	0.30	5	0.00	0.07
11	33	0.02	0.22	5	0.00	0.03
12	120	0.02	0.24	37	0.01	0.07
14	18	0.02	0.15	13	0.02	0.07
16	1	0.00	0.04	0	0.00	0.00
17	164	0.02	0.21	54	0.01	0.06
18	30	0.02	0.30	6	0.00	0.07
19	106	0.02	0.21	66	0.01	0.10
20	39	0.02	0.22	13	0.01	0.07
21	350	0.04	0.22	312	0.04	0.13
23	105	0.05	0.38	36	0.02	0.12
25	20	0.02	0.29	5	0.00	0.07
TOTAL	**3635**			**2287**		

Shaded reaches account for 83% of total tons/yr according to Colorado estimates and 90% according to North Carolina estimates

The main stem of Jackson Creek was one of the two reaches most susceptible to erosion. Predicted erosion rates within this reach vary from nearly 0 to 0.56/0.49 ton/yr/ft (NC/CO), with an average rate of 0.054/0.098 (NC/CO) ton/yr/ft. Predicted rates for all of Jackson Creek are displayed in Figure 5. The average lateral bank erosion rate of Jackson Creek was estimated at 0.22/0.41 ft/yr (NC/CO).

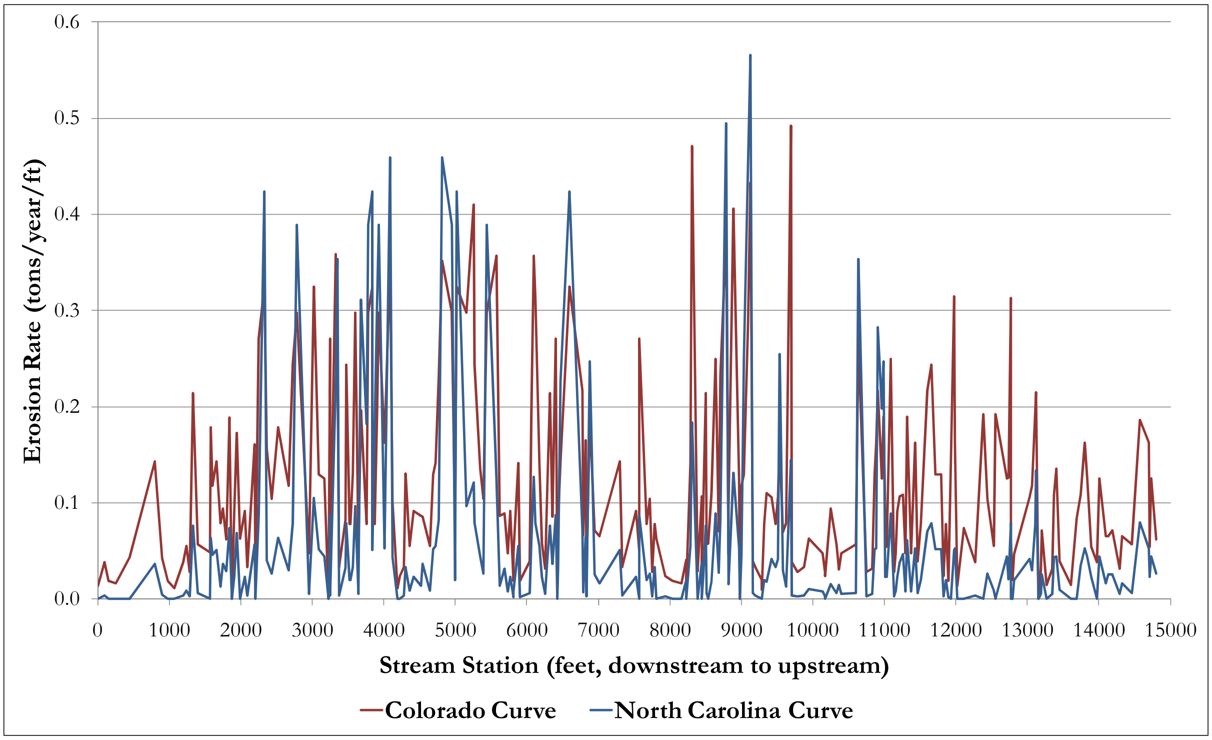

Figure 5: Bank erosion rate predictions for Jackson Creek

2.4 STREAMS ASSESSMENT SUMMARY

Despite its relative seclusion and densely forested landscape, historic and current anthropogenic disturbances are evident in the YLW. These disturbances have led to stream instabilities throughout the watershed (e.g. headcuts and avulsions) and facilitated an increased rate of bank erosion in the streams. Streambank erosion rates for 25 different reaches were assessed in July 2009, using the BANCS model. The assessed streambanks were divided into segments based on their BEHI and NBS scores. Using quantitative studies from North Carolina and Colorado, the BEHI and NBS scores were converted to lateral erosion rates that averaged 0.16/0.32 (ft/yr) (NC/CO) over all the reaches surveyed. The rates of erosion can be converted into a volume or weight of sediment reaching the lake. The total bank erosion was estimated to be 3,635 tons/year (2171 yd^3/yr) using the South Central Colorado Region curve and 2,287 tons/year (1366 yd^3/yr) using the North Carolina Piedmont Region curve. Bank erosion and lateral migration are expected to continue in most of the channels in the YLW. Streams in varying stages of stream type succession were observed throughout the watershed, with few indicating imminent or quick recovery to their potential (See Appendix B for illustrations of stream type succession).

3.0 Streams Master Plan

3.1 GENERAL RECOMMENDATIONS

Sediment sources within the YLW include impacts from land use practices and stream impairments. Land management practices directly impact watershed characteristics including infiltration rates, peak flows, sediment supplies, and riparian buffer zones. These watershed characteristics affect the ability of streams to convey flows, transport sediment, provide habitat, and resist excessive streambank erosion. Therefore, an effective watershed management plan must address sediment sources from land uses as well as sediment sources contributed from the stream channel itself. The natural channel design method involves sediment capacity modeling to determine if a design stream can adequately convey the sediment supply from its watershed; therefore, sediment sources related to land use should be addressed first in areas where impaired streams will be restored using natural channel design.

A variety of methods can mitigate various sediment sources from land-use impacts and stream impairments. Stream reaches with poor plan form, profile and/or cross sections typically result in excessive erosion of the stream banks due to natural adjustments of the stream system to restore appropriate dimensions. Reaches that are impaired due to inappropriate dimensions and/or slope, should be restored using natural channel design methods for sustainable solutions. Full restoration of a reach provides the highest degree of potential success. The degree of impairment with resulting earth movement and structure frequency determines how expensive or cost effective a stream restoration project can be.

Isolated headcuts in the watershed should be addressed to prevent the upstream advancement of bed and bank erosion. Isolated headcuts can be stabilized with the construction of step-pool systems or a B-type stream channel that provide energy dissipation and grade-control. Natural channel design components would still need to be analyzed when considering this method and it is often a viable solution for directly mitigating major sediment sources in the watershed. Stabilization of isolated headcuts may require less earthmoving, land disturbance, and construction cost than a full stream restoration design of an entire reach.

Locations where the stream has begun to move into historic roadbeds or old alignments can be restored by diverting or maintaining the channel in the natural flowpath, cutting a localized floodplain, and constructing in-stream structures that provide grade-control, energy dissipation, and habitat. This method would also employ natural channel design techniques and directly mitigate a major sediment source by stabilizing the stream and preventing erosion. Reaches where this method of restoration is necessary could be expensive if significant avulsions or erosion has occurred outside of the natural alignment that would require a large amount of earthmoving and land disturbance to restore the channel.

Streambank erosion in several study reaches that have evolved to unstable F or G stream types cannot be addressed with isolated bank treatments or structures. Stabilization of some of these reaches is reasonable if the channel depth is not excessive and the stream has maintained appropriate plan form dimensions. The reaches that will require significant earthmoving, land disturbance, and funding are typically those that are more incised and also have poor plan form and cross sections.

Streambank erosion in C stream types can usually be addressed with minimized disturbance through reduced plan form adjustments and the use of in-stream structures since these reaches have often maintained the approximate dimensions of a stable stream type.

Land use impacts such as sediment from eroded, historic roadbeds; forest facilities and recreation areas; and any temporary construction areas can be mitigated using erosion and sediment–control best management practices (BMPs), as well as storm water BMPs. Further discussion on storm water control and BMPs is included in the YLWMP. Streams that have been straightened and relocated against the valley wall during road construction typically have steep slopes. These streams should be restored as B stream types with constructed riffles and log and rock steps to provide energy dissipation and grade-control.

Crossings over streams should be installed to control roadway erosion, prevent gravel addition to streams and provide adequate flow conveyance and fish passage. Changes to the natural stream channel, such as the alignment, excess cut, or fill should be minimized when a crossing is installed. Vegetated buffers and/or other BMPs should be implemented where roads and streams are in close proximity to limit the amount of sediment and pollutants entering the streams from local roads.

The following sections present site-specific solutions for stream stabilization and restoration along with watershed management recommendations to mitigate sources of sediment from stream impairments in the watershed. Section 3.2 presents Stream Master Plan Prioritizations for the YLW. Section 3.3 presents two conceptual restoration plans. Potential future projects for the watershed are discussed in Section 3.4. Permitting requirements for restoration projects are discussed in Section 3.5 and recommendations for construction and post-restoration monitoring are discussed in Section 3.6.

3.2 STREAM MASTER PLAN PRIORITIZATIONS

Several reaches within the YLW were considered for immediate or future restoration opportunities. Six of the top seven reaches shown in Table 1 were prioritized according to rankings based upon their characteristics. Reach 5 was not included because it was such a short reach and contributed the least amount of sediment. The Master Plan Map (Appendix D) shows the locations of reaches where conceptual restoration designs and potential future restoration projects were evaluated. The prioritization of the reaches allows one to determine what reaches would likely be lower risk, more cost effective, and meet primary goals of the YLWMP. The characteristics and prioritization are located in Table 2. Potential solutions for each reach vary and require further investigation to formulate appropriate conceptual designs/solutions.

Table 2: Yellowwood Lake Watershed Reach Prioritization

Reach	Stream Type*	Drainage Area (acres)	# of Mapped Tributaries	CO Sediment Loading (tons/yr/ft)	NC Sediment Loading (tons/yr/ft)	Degree of Road & Utility Impacts	Landowners	Accessibility	Notes
1a	C/F4	3020	2	0.086	0.037	Moderate	Public	road 200 to 550 ft away	from Trib 17 to mouth
1b	F/C4	2063	6	0.116	0.077	High	Public & Private	road 100 to 600 ft away	between Trib 6 and 17
1c	F/Bc4	587.2	2	0.071	0.019	Low	Public & Private	no current access	upstream Trib 6
6a	C/F4	174.7	0	0.043	0.027	Very High	Public & Private	road	downstream half
6b	Bc/F4	104.1	0	0.030	0.023	Very High	Private	road	upstream half
7a	C/F4	445.2	2	0.120	0.116	Low	Public & Private	road on landowner property	downstream Trib 3
7b	C/F4	176.8	0	0.041	0.038	Very Low/None	Public	no current access	upstream Trib 3
9	C/F4	107.6	0	0.041	0.020	Moderate	Public & Private	driveway	
21a	F/C4	693.6	2	0.020	0.005	Low	Public	road at d/s. couple trails	downstream Trib 15
21b	F/C4	253.9	1	0.098	0.115	Very Low/None	Public	no current access	upstream Trib 15
23	C/F4	178.9	0	0.051	0.017	Very Low/None	Public	only a trail	

Reach	Stream Type*	Drainage Area (acres)	# of Mapped Tributaries	CO Sediment Loading (tons/yr/ft)	NC Sediment Loading (tons/yr/ft)	Degree of Road & Utility Impacts	Landowners	Accessibility	Total Points
1a	6	0	6	8	4	6	10	10	50
1b	2	1	0	10	8	4	5	10	40
1c	4	5	6	7	2	8	5	5	42
6a	6	8	10	4	3	2	5	10	48
6b	8	10	10	3	3	2	10	10	56
7a	6	6	6	10	10	8	7	8	61
7b	6	8	10	4	4	10	10	5	57
9	6	10	10	4	2	6	5	8	51
21a	2	4	6	2	0	8	10	8	40
21b	2	7	8	9	10	10	10	5	61
23	10	8	10	5	2	10	10	0	55

Ranking note: 10 = most desirable reach/project, 0 = least desirable reach/project

****Stream types based on visual assessments***

3.3 CONCEPTUAL RESTORATION PLANS

Two conceptual plans with two options each are provided for two stream reaches in the YLW. Each conceptual design was developed with the goal of providing sustainable solutions with the highest degree of potential success so that the watershed and its improvements may offer educational value in future watershed restoration endeavors. Streambank erosion in C stream types that are evolving to G or F stream types are a major source of sediment for the watershed such as Reach 7. Conceptual Plan 1 is comprised of two different restoration options for Reach 7a. Each Reach 7 design option can also address nuisance and invasive species within a specified stream riparian zone. Planting Plans for each option would be developed during the final design phase. Conceptual Plan 2 provides two different options for improving a low water crossing on Reach 6. The conceptual design plans are provided in Appendix E.

3.3.1 Conceptual Plan 1 – Option 1 (Priority III Restoration of Reach 7a)

Conceptual Plan 1 is focused on approximately 1700 to 2000 linear feet of stream on Reach 7a. The design reach is located on the most downstream end of Reach 7, from the confluence to approximately 500 feet upstream of a stream crossing for a private road. Figure 6 is a photograph of one of the eroded banks along Reach 7 where the stream is migrating laterally to develop a bend.

Figure 6: Reach 7

Priority III restoration (Rosgen, 1997) involves converting an existing stream to a new stream type that has a floodprone area rather than an active floodplain. Refer to Appendix B for a table of priorities, descriptions and summary for incised river restoration (Rosgen, 1997). Priority III restoration efforts minimize the amount of land disturbance to return the stream to stable form, improve aquatic habitat, and potentially decrease the flood stage for the same magnitude flood or the overall flooding potential. Priority III restoration of Reach 7 involves excavation to lay back the banks and installation of appropriate stream structures for grade control and habitat to convert the incised C and F to a Bc stream type. The new Bc stream type will have an increased entrenchment ratio and a decreased width/depth ratio. The width/depth ratio is a comparison of the bankfull width to the bankfull mean depth. In areas where the stream is classified as an F, it is over-widened and shallow resulting in poor sediment transport for the bankfull channel. The new Bc stream type with a decreased width/depth ratio will have a narrower low flow channel for appropriate sediment transport and in-stream habitat. By laying back the banks and establishing vegetation to the water's edge, shear stresses on the banks will be reduced. Structures involved in the Priority III restoration include toe wood/sod mat, constructed riffles, log vanes, log drops, and log j-hooks. The various structures are designed to decrease near-bank shear stress, provide occasional grade control, and provide woody habitat for aquatic species. Native vegetation will also be established to stabilize streambanks and enhance in-stream and floodplain habitat. This project could be an excellent demonstration project because of its proximity to Jackson Creek Road. Final design of the project will require a field survey to develop an accurate basemap, cross sections, and a longitudinal survey. A preliminary cost estimate for the design, construction oversight, and construction to implement Conceptual Plan 1 - Option 1 are presented in Table 3. Costs for the monitoring of the project are not included in the cost estimate.

Table 3: Conceptual Plan 1 – Option 1 (Priority III Restoration of Reach 7a)

Opinion of Probable Cost for Stream Enhancements					
No.	Item	Unit	Quantity	Unit Price	Item Cost
1	Topographic Surveying, Environmental Permitting (Section 404 and Section 401), and Stream Restoration Design	Lump Sum	1	$40,000.00	$40,000.00
2	Construction Oversight – 8 weeks with 2 days/week on site	Lump Sum	1	$25,000.00	$25,000.00
3	Mobilization/Demobilization	Lump Sum	1	$10,000.00	$10,000.00
4	Construction Entrance	Each	1	$2,000.00	$2,000.00
5	Pump-Around System	Lump Sum	1	$5,000.00	$5,000.00
6	Erosion & Sediment Control (w/silt fence)	Lump Sum	1	$2,000.00	$2,000.00
7	Earthwork/Excavation	CY	1500	$10.00	$15,000.00
8	Log J-Hooks	Each	4	$2,000.00	$8,000.00
9	Log/Boulder Steps	Each	3	$1500.00	$4,500.00
10	Log Vane/Root Wad Combinations	Each	9	$1500.00	$13,500.00
11	Woody Toe Sod Mat	LF	440	$40.00	$17,600.00
12	Constructed Riffles (with native material)	Each	5	$1500.00	$7,500.00
13	Erosion Control Blanket	Sq. Yd.	3910	$4.00	$15,640.00
14	Temporary Native Seed Mix (assumes 80 Lbs/acre)	Acre	5	$350.00	$1,750.00
15	Native Riparian Seed Mix (assumes 60 Lbs/acre)	Acre	4.25	$6000.00	$25,500.00
16	Straw Mulch	Acre	5	$500.00	$2,500.00
17	Native Live Stakes (assumes 1/Sq. Yard)	Each	2600	$3.50	$9,100.00
18	Native Trees (assumes 400 bare root trees/acre)	Each	1700	$4.00	$6800.00
19	Native Shrubs (assumes 200 bare root shrubs/acre)	Each	850	$4.00	$3400.00
				SUBTOTAL	$ 214,790.00
				CONTINGENCY (20%)	$ 42,958.00
				TOTAL	$ 257,748.00

Note: Monitoring costs are not included in this cost estimate.

3.3.2 Conceptual Plan 1 – Option 2 (Priority I restoration of Reach 7a)

Option 2 is focused on the same approximate stream reach and length as Option 1 on the most downstream end of Reach 7. Figure 7 is a photograph of one of the most downstream eroded banks along Reach 7 where the stream is migrating laterally in an existing bend.

Figure 7: Reach 7 Bend

Priority I restoration (Rosgen, 1997) involves converting an existing stream to a new stream type at the previous floodplain elevation. Priority I restorations are used to establish a stable stream, improve aquatic and terrestrial habitat, and raise the local water table. However, this method could increase the floodprone width for the same magnitude flood. Priority I restoration of the Reach 7 involves excavation of a new channel in many locations and raising the profile of the stream to re-connect the floodplain and convert the incised C and F to a C stream type. The old existing stream channel will be filled with cut material in various locations as well as discontinuous oxbows or vernal pools level with the new floodplain elevation. The new C stream type will have an increased entrenchment ratio and a decreased width/depth ratio. The Priority I restoration efforts will reduce bank height and streambank erosion (land loss), decrease sedimentation, raise the local water table, and improve aquatic and terrestrial habitat. Structures involved in the Priority I restoration include toe wood/sod mat, log vanes, log j-hooks, and constructed riffles. The various structures are designed to decrease near-bank shear stress, provide occasional grade control, and provide woody habitat for aquatic species. Native vegetation will also be established to stabilize streambanks and enhance in-stream and floodplain habitat. This project could be an excellent demonstration project because of its proximity to Jackson Creek Road. Improvements to the streams within the watershed also provide educational value in future watershed restoration endeavors. Final design of the project will require a field survey to develop an accurate basemap, cross sections, and a longitudinal survey. Preliminary construction costs to implement Option 2 are presented in Table 4. Costs for the monitoring of the project are not included in the estimate.

Table 4: Conceptual Plan 1 – Option 2 (Priority I Restoration of Reach 7a)

Opinion of Probable Cost for Stream Restoration					
No.	Item	Unit	Quantity	Unit Price	Item Cost
1	Topographic Surveying, Environmental Permitting (Section 404 and Section 401), and Stream Restoration Design	Lump Sum	1	$50,000.00	$50,000.00
2	Construction Oversight – 9 weeks with 2 days/week on site	Lump Sum	1	$28,500.00	$28,500.00
3	Mobilization/Demobilization	Lump Sum	1	$10,000.00	$10,000.00
4	Construction Entrance	Each	1	$2,000.00	$2,000.00
5	Pump-Around System	Each	1	$2,000.00	$2,000.00
6	Erosion & Sediment Control (w/silt fence)	Lump Sum	1	$3,000.00	$3,000.00
7	Earthwork/Excavation	CY	2500	$10.00	$25,000.00
8	Log J-Hooks	Each	9	$2,000.00	$18,000.00
10	Log Vane/Root Wad Combinations	Each	2	$1500.00	$3,000.00
11	Woody Toe Sod Mat	LF	540	$40.00	$21,600.00
12	Constructed Riffles (with native material)	Each	8	$1500.00	$12,000.00
13	Erosion Control Blanket	Sq. Yd.	4000	$4.00	$16,000.00
14	Temporary Native Seed Mix (assumes 80 Lbs/acre)	Acre	8	$350.00	$2,800.00
15	Native Riparian Seed Mix (assumes 60 Lbs/acre	Acre	4.25	$6000.00	$25,500.00
16	Straw Mulch	Acre	8	$500.00	$4,000.00
17	Native Live Stakes (assumes 1/Sq. Yard)	Each	2600	$3.50	$9,100.00
18	Native Trees (assumes 400 bare root trees/acre)	Each	1700	$4.00	$6800.00
19	Native Shrubs (assumes 200 bare root shrubs/acre)	Each	850	$4.00	$3400.00
				SUBTOTAL	$ 242,700.00
				CONTINGENCY (20%)	$ 48,540.00
				TOTAL	$ 291,240.00

Note: Monitoring costs are not included in this cost estimate

The benefits of implementing Conceptual Plan 1, Options 1 or 2 include a reduction in sediment load by minimizing lateral migration and stream bank erosion with improved floodplain access, lateral stability and in-stream habitat. The completion of a final design for Conceptual Plan 1, Options 1 or 2 will require topographic surveys of the project reach and additional geomorphic surveying. A reference reach of a B4c or C4 stream type will also need to be located and surveyed to obtain dimensionless ratios for one of the natural channel design options.

3.3.3 Conceptual Plan 2 – Option 1 (Clear Span Crossing on Reach 6)

Conceptual Plan 2 is focused on approximately 100 linear feet of stream where Yellowwood Lake Road crosses Reach 6. The crossing is located approximately 1150 linear feet upstream from the Reach 6 confluence. Figure 8 is a photograph of the existing crossing.

Figure 8: Reach 6 Crossing

Option 1 of Conceptual Plan 2 involves the installation of a 12-foot steel, clear span bridge across Reach 6. This option also includes headwalls and the installation of two, 18 inch culverts for floodplain drainage. The installation of a clear span bridge and floodplain culverts would provide appropriate flow conveyance, a natural channel bottom for sediment transport and fish passage, and an appropriate crossing without disturbing the stream. The clear span bridge would minimize the amount of disturbance to the stream and improve aquatic habitat. This project could be an excellent demonstration project since it is located on Jackson Creek Road with easy access. Final design of the project will require a field survey to develop an accurate basemap, cross sections, and a longitudinal survey. A preliminary cost estimate for the design, construction oversight, and construction to implement Conceptual Plan 2 - Option 1 are presented in Table 5.

Table 5: Conceptual Plan 2 – Option 1 (Clear Span Crossing on Reach 6)

Opinion of Probable Cost for Stream Crossing					
No.	Item	Unit	Quantity	Unit Price	Item Cost
1	Topographic Surveying, Permitting (Regional General Permit), and Pre-fabricated Bridge Design (span bridge)	Lump Sum	1	$20,000.00	$20,000.00
2	Construction Oversight – 2 days on site	Lump Sum	1	$2,700.00	$2,700.00
3	Mobilization/Demobilization	Lump Sum	1	$8,000.00	$8,000.00
4	Pump-Around System	Each	1	$1,000.00	$1,000.00
5	Earthwork/Excavation	CY	100	$10.00	$1,000.00
6	Erosion & Sediment Control (w/silt fence)	Lump Sum	1	$3,000.00	$3,000.00
7	12 foot steel arch w/footer and bedding (20 feet long)	Each	1	$27,000.00	$27,000.00
8	18 inch CMP (floodplain drainage)	LF	48	$25.00	$1200.00
				SUBTOTAL	$ 63,900.00
				CONTINGENCY (15%)	$ 9,585.00
				TOTAL	$ 73,485

3.3.4 Conceptual Plan 2 – Option 2 (Improvements to Low Water Crossing on Reach 6)

Option 2 of Conceptual Plan 2 is focused on improving the existing low water crossing where Yellowwood Lake Road crosses Reach 6. Figure 9 is a second photograph of the existing crossing.

Figure 9: Looking Downstream at Reach 6 Crossing

Option 2 involves the installation of a rock cross vane downstream of the crossing and larger rock as the base material for the low water crossing. The installation of a cross vane and larger rock for base material would provide more stability and protection for the crossing. The improvements would reduce the amount of material being washed downstream, which would also reduce the amount of maintenance on the crossing and impacts to the stream. The low water crossing would still allow appropriate flow conveyance and a natural channel bottom for sediment transport and fish passage. This project could still be a good demonstration project because of it is located on Jackson Creek Road. Final design of the project will require a field survey to develop an accurate basemap, cross sections, and a longitudinal survey. A preliminary cost estimate for the design, construction oversight, and construction to implement Conceptual Plan 2 - Option 2 are presented in Table 6.

Table 6: Conceptual Plan 2 – Option 2
(Improvements to Low Water Crossing on Reach 6)

Opinion of Probable Cost for Stream Crossing					
No.	Item	Unit	Quantity	Unit Price	Item Cost
1	Topographic Surveying, Permitting (Regional General Permit), and Low Water Crossing Design	Lump Sum	1	$15,000.00	$15,000.00
2	Construction Oversight – 2 days on site	Lump Sum	1	$2,600.00	$2,600.00
3	Mobilization/Demobilization	Lump Sum	1	$8,000.00	$8,000.00
4	Pump-Around System	Each	1	$1,000.00	$1,000.00
5	Low Water Crossing	Each	1	$3,000.00	$3,000.00
6	Rock Cross Vane with Step	Each	1	$5,000.00	$5,000.00
7	Erosion & Sediment Control	Lump Sum	1	$1,000.00	$1,000.00
				SUBTOTAL	$ 35,600.00
				CONTINGENCY (15%)	$ 5,340.00
				TOTAL	$ 40,940.00

3.4 POTENTIAL FUTURE PROJECTS

The Yellowwood Lake Watershed contains several miles of streams with various different characteristics and features. In order to achieve goals set by the YLWPG most efficiently, it is logical to prioritize the different reaches to determine what reaches would likely be lower risk, more cost effective, as well as meet the primary goals of the YLWMP. Overall, the reaches that are contributing large amounts of sediment and have a smaller watershed should be higher priority, leaving downstream reaches as a lower priority until the tributaries have been addressed. Stream restoration on a watershed level is most successful when strategic. It is recommended to have an engineer trained in geomorphology to provide conceptual or final design plans for natural channel design stream restoration techniques. Additional field data and construction plans would be required to implement restoration solutions.

3.5 PERMITTING

The following applicable permits must be obtained prior to the construction of a stream restoration project in the YLW:

- Clean Water Act (CWA) Section 404 permit issued by the US Army Corps of Engineers (USACE);
    - Section 106 Review from the State Historic Preservation Office (SHPO), administered by the IDNR Division of Historic Preservation and Archaeology (Typically required for projects involving Federal grants or loans or issuance of a Federal permit)
    - Clearance from US Fish and Wildlife Service (USFWS) in relation to endangered species
- CWA Section 401 Water Quality Certification from the Indiana Department of Environmental Management (IDEM);
- State of Indiana Department of Natural Resources (IDNR) Division of Water (DOW) Permit for Construction in the Floodway;
- Approval from IDNR DOW for work within a state forest.
- National Pollutant Discharge Elimination System (NPDES) General Permit Rule for Storm Water Discharges Associated with Construction Activity [Rule 5 (Construction/Land Disturbance Storm Water) Permit] submitted to the Brown County Soil and Water Conservation District as designated by IDEM.
    - Notice of Intent (NOI)
    - Notice of Termination (NOT)

3.6 CONSTRUCTION AND POST RESTORATION MONITORING

It is recommended that an engineer trained in geomorphology be present on site to assist the contractor on natural channel design construction and structure placement techniques. Because of unexpected conditions that may occur in the field, a field engineer may need to make adjustments to the design.

If the success of the project needs to be evaluated and depending on the state requirements or permits, an As-Built survey and post-construction monitoring may be required. Permanent monitoring locations should be established during the As-Built survey. Measurable performance standards for geomorphic, vegetative, and habitat criteria should be established for post construction monitoring. The duration of post construction monitoring and variation in monitored characteristics will depend upon the content within the approved monitoring plan, which is typically developed and submitted with the permit applications. Annual monitoring activities may include habitat assessments, cross section and longitudinal profile surveys, vegetation surveys, and photo documentation. Sediment sampling should include pebble counts and the collection of bar samples for sieve analyses. Vegetation monitoring should be performed annually after the first growing season. Permitting agencies may require a monitoring report that documents the results of each monitoring effort. The monitoring report should include a site location map, a comparison of measurable performance standards to monitoring data, and a general assessment of hydrologic and vegetative conditions observed at the site.

3.7 POTENTIAL PROJECT FUNDING

There are many different funding sources that are available to YLW for implementation of best management practices that may or may not be directly related to stream restoration, but are beneficial to the water quality and/or overall ecosystem of the watershed. Refer to Appendix F - Funding Sources to view a list of various funding sources potentially available to YLW.

There are also multiple funding opportunities to consider for streams within the YLW, depending on the type of project and the specific approach taken to accomplish the project. One strong potential funding source for stream enhancement or restoration projects within YLW is Section 319(h) Grants, which are specifically for projects that reduce nonpoint source water quality impairments. The funds from the 319(h) grants may be used to conduct assessments, develop and implement watershed and surface water monitoring plans, provide technical assistance, demonstrate new technology and provide education and outreach. The goals and desires of the YLWPG match up well with the criteria and goals of the 319(h) grant program.

Another promising funding source for stream projects within YLW and throughout Indiana is through stream mitigation funding. The Indiana Departments of Environmental Management, Natural Resources, and Transportation all sponsor a website that provides a pipeline for professionals to share information regarding potential mitigation sites for streams, wetlands, lakes, or other water features. The Mitigation Volunteer link listed below allows people looking for a site for a mitigation project to connect with people that have proposed sites for restoration or enhancement work and vice versa.

http://idemmaps.idem.in.gov/apps/MitigationVolunteer/

4.0 Conclusions

The SRMP presents assessment data that documents the condition of streams along with significant sources of sediment within the YLW. Sediment sources within the YLW include impacts from land–use practices and stream impairments. The major sources of sediment observed in the watershed include headcuts, avulsions, clearcuts, streambank erosion, and overland erosion from abandoned roadbeds. The SRMP provides site-specific recommendations for stream restoration and enhancement projects to reduce sediment loads and improve floodplain and in-stream habitat. The YLWMP also provides general guidelines for watershed management. Conceptual restoration plans and preliminary construction cost estimates were prepared for Options 1 and 2 of Conceptual Plans 1 and 2. Conceptual Plan 1 is a potential demonstration project that involves approximately 1700 linear feet of stream on Reach 7. Option 1 of Conceptual Plan 1 involves a Priority III restoration of Reach 7a while Option 2 of Conceptual Plan 1 involves a Priority I restoration of Reach 7a. The options include various treatments at different locations including shifting the channel away from the hillside, installing in-stream structures to provide bank protection, grade-control and maintain habitat, and establishing native vegetation to stabilize streambanks and enhance in-stream and floodplain habitat. Conceptual Plan 2 involves improving one of the main Yellowwood Lake Road crossings in the watershed along Reach 6. Option 1 of Conceptual Plan 2 involves replacing the existing low water crossing with a clear span bridge while Option 2 of Conceptual Plan 2 involves improving the existing low water crossing. Additional field data and construction plans will be required to implement all solutions and conceptual restoration plans presented in the SRMP. General guidelines for the management of the YLW presented in the YLWMP include land use management, the application of erosion and sediment control BMPs, stormwater management, and natural channel design techniques.

5.0 References

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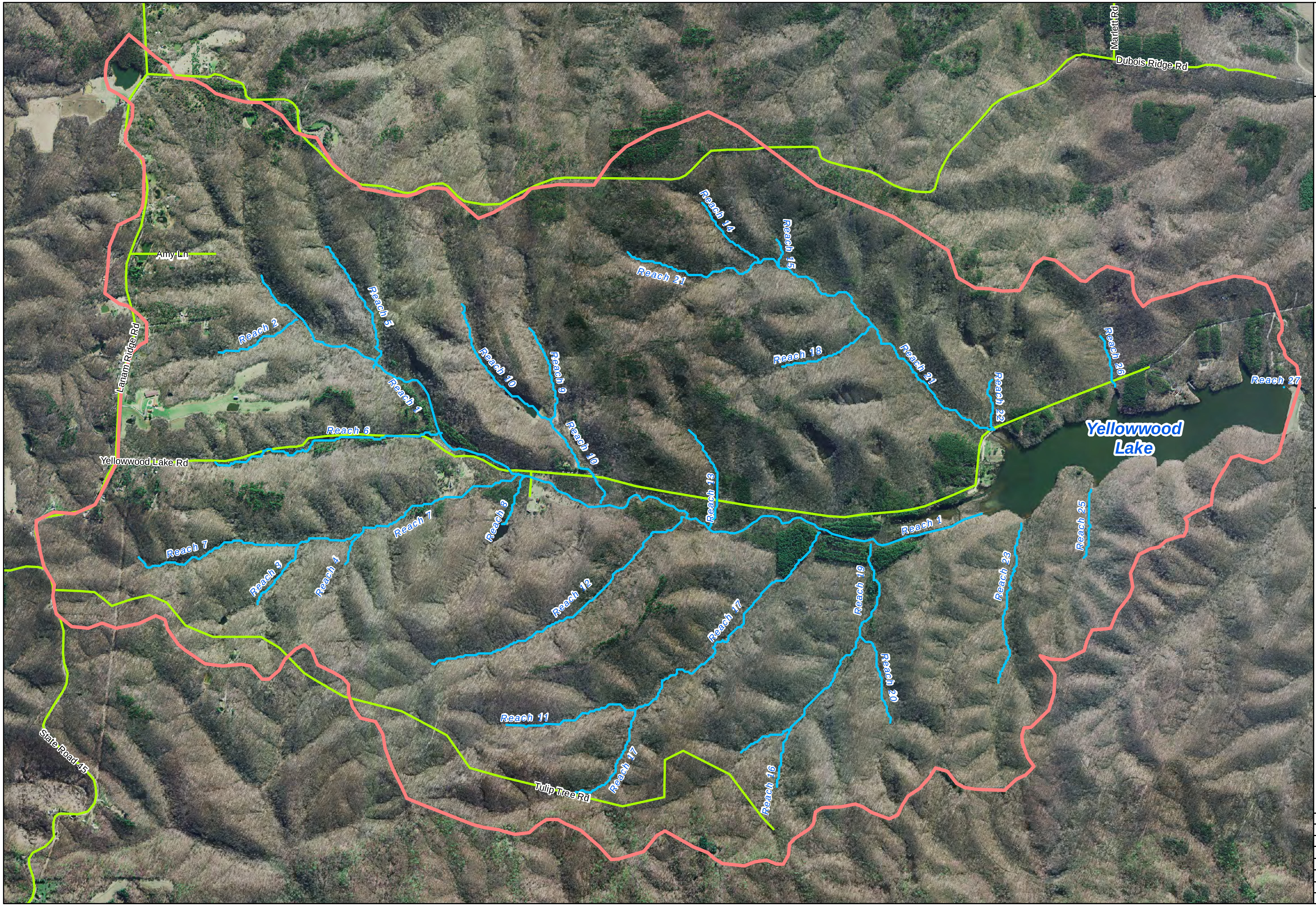
Appendix A
Watershed and Stream Map



Map 1: Yellowwood Lake Watershed and Assessed Stream Reaches

Brown County, Indiana

Legend

- Stream
- Watershed Boundary
- Road

0 750 1,500 3,000 Feet

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Stantec

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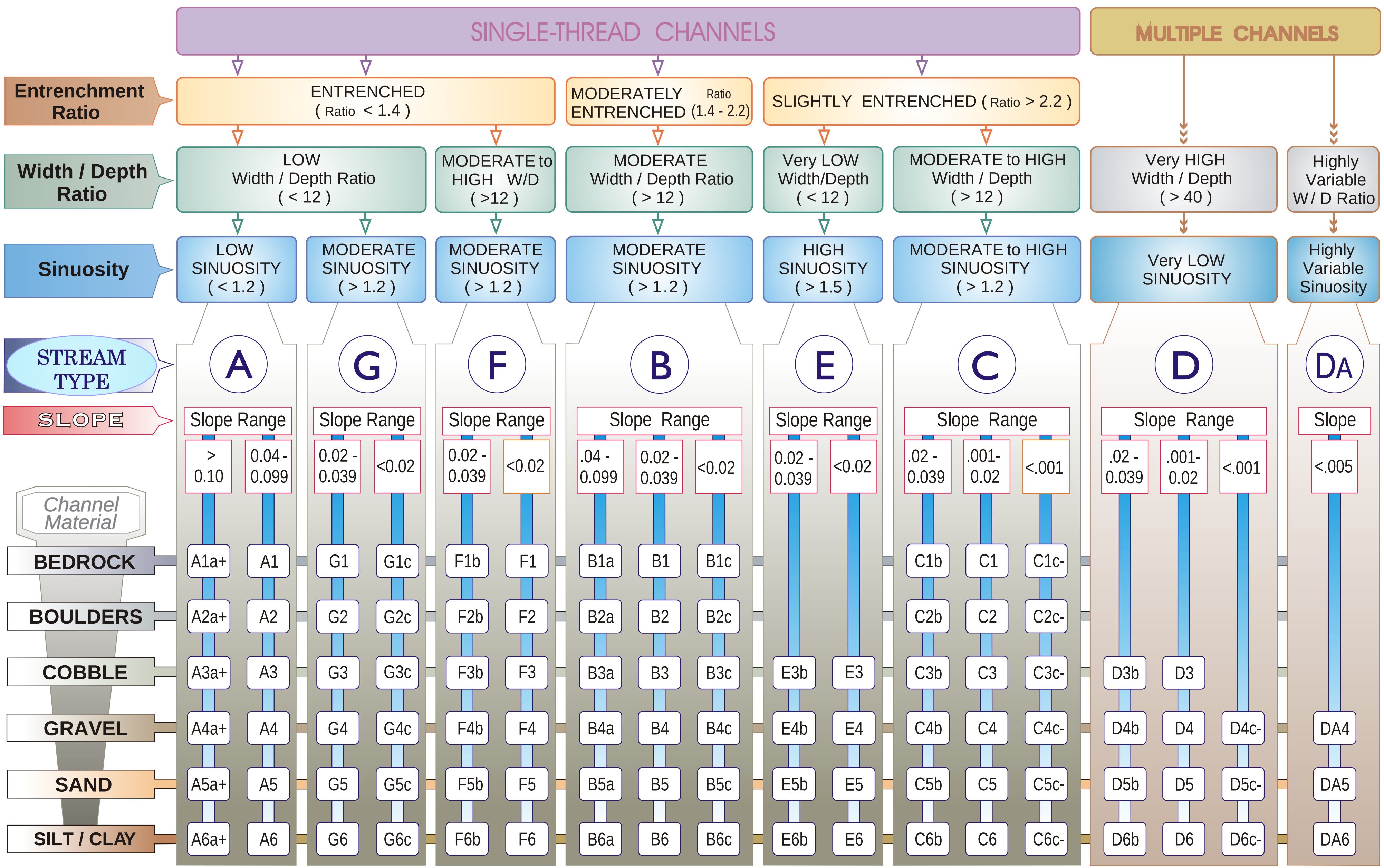
Appendix B
Assessment and Restoration Tools

The Key to the Rosgen Classification of Natural Rivers



KEY to the *ROSGEN* CLASSIFICATION of NATURAL RIVERS. As a function of the "*continuum of physical variables*" within stream reaches, values of ***Entrenchment*** and ***Sinuosity*** ratios can vary by +/- 0.2 units; while values for ***Width / Depth*** ratios can vary by +/- 2.0 units.

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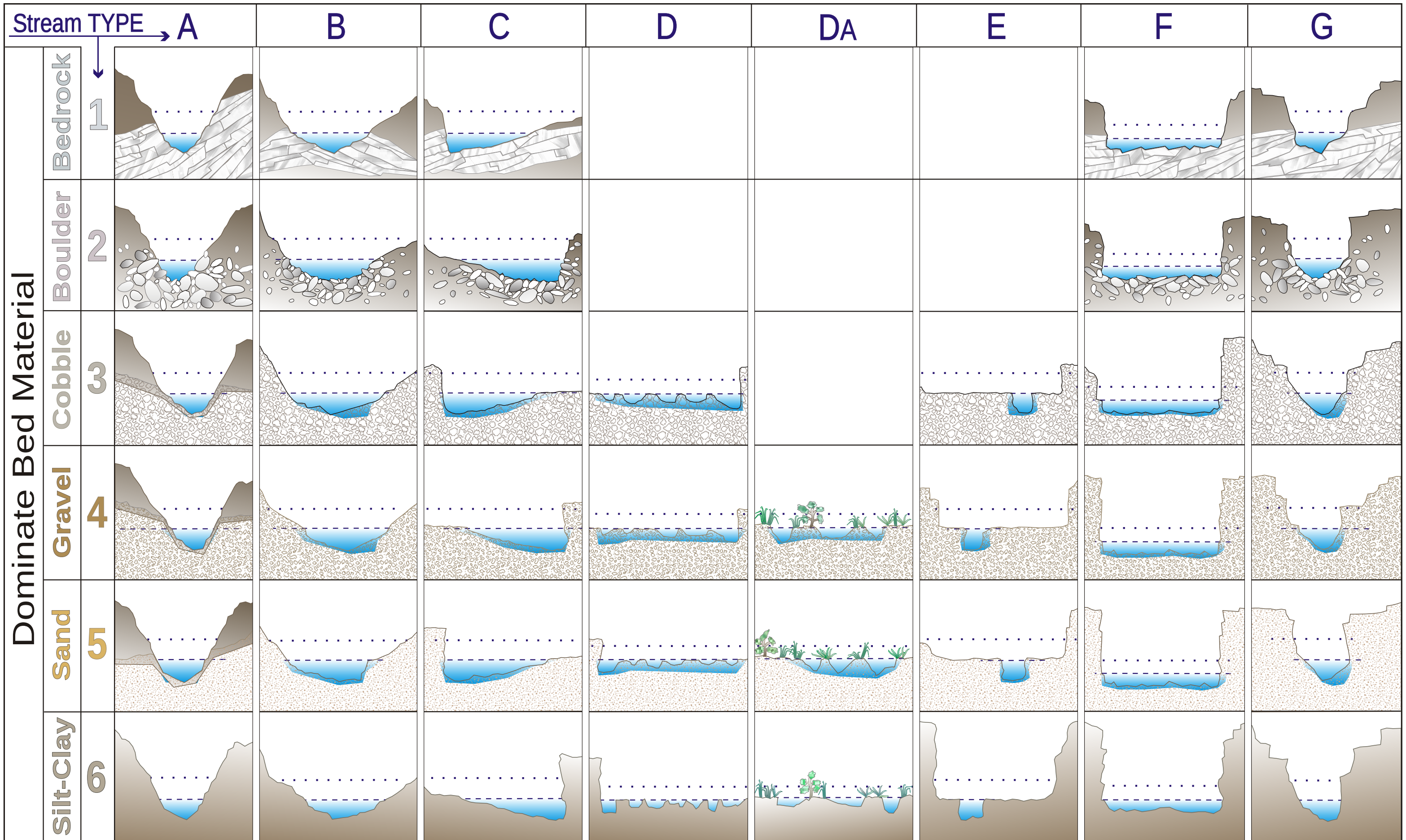

	A	B	C	D	DA	E	F	G
Entrchmnt.	< 1.4	1.4 - 2.2	> 2.2	n/a	> 4.0	> 2.2	< 1.4	< 1.4
W/D Ratio	< 12	> 12	> 12	> 40	< 40	< 12	> 12	< 12
Sinuosity	1 - 1.2	> 1.2	> 1.2	n/a	variable	> 1.5	> 1.2	> 1.2
H_2O Slope	.04-.099	.02-.039	< .02	< .04	<.005	< .02	< .02	.02-.039

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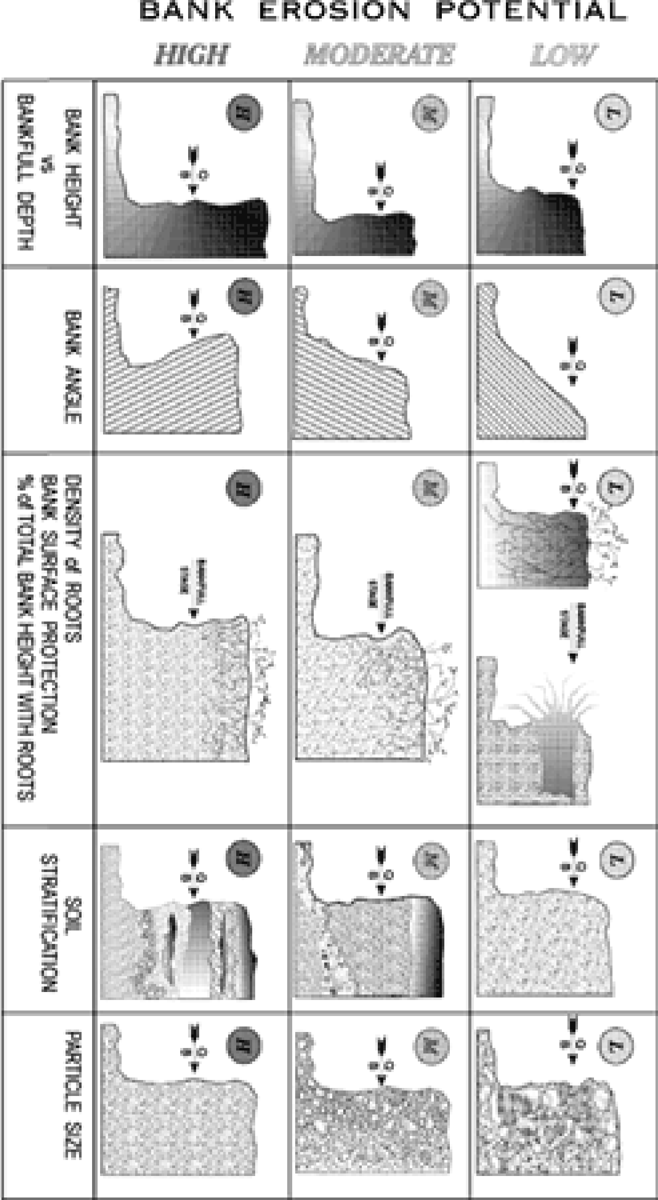
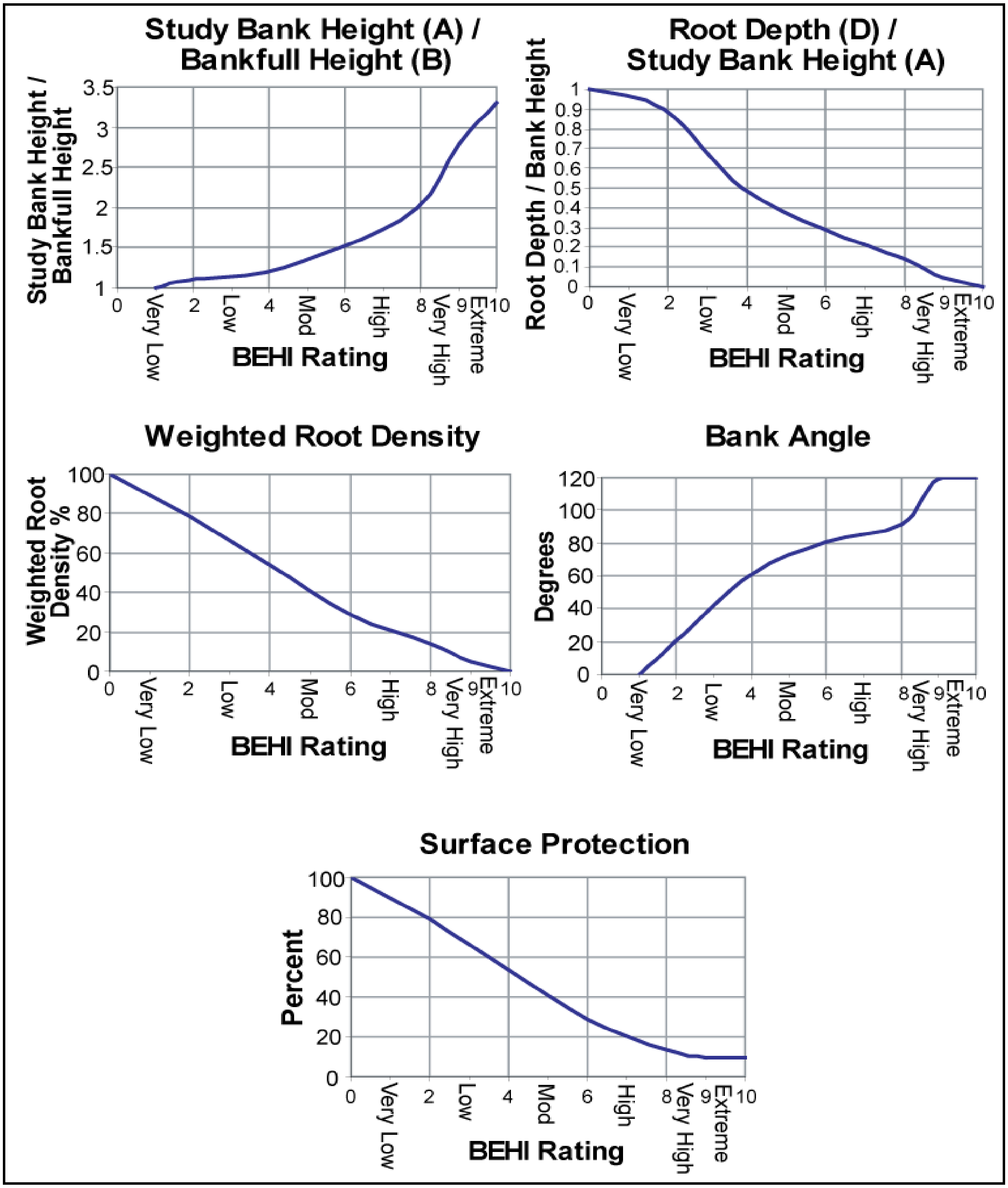
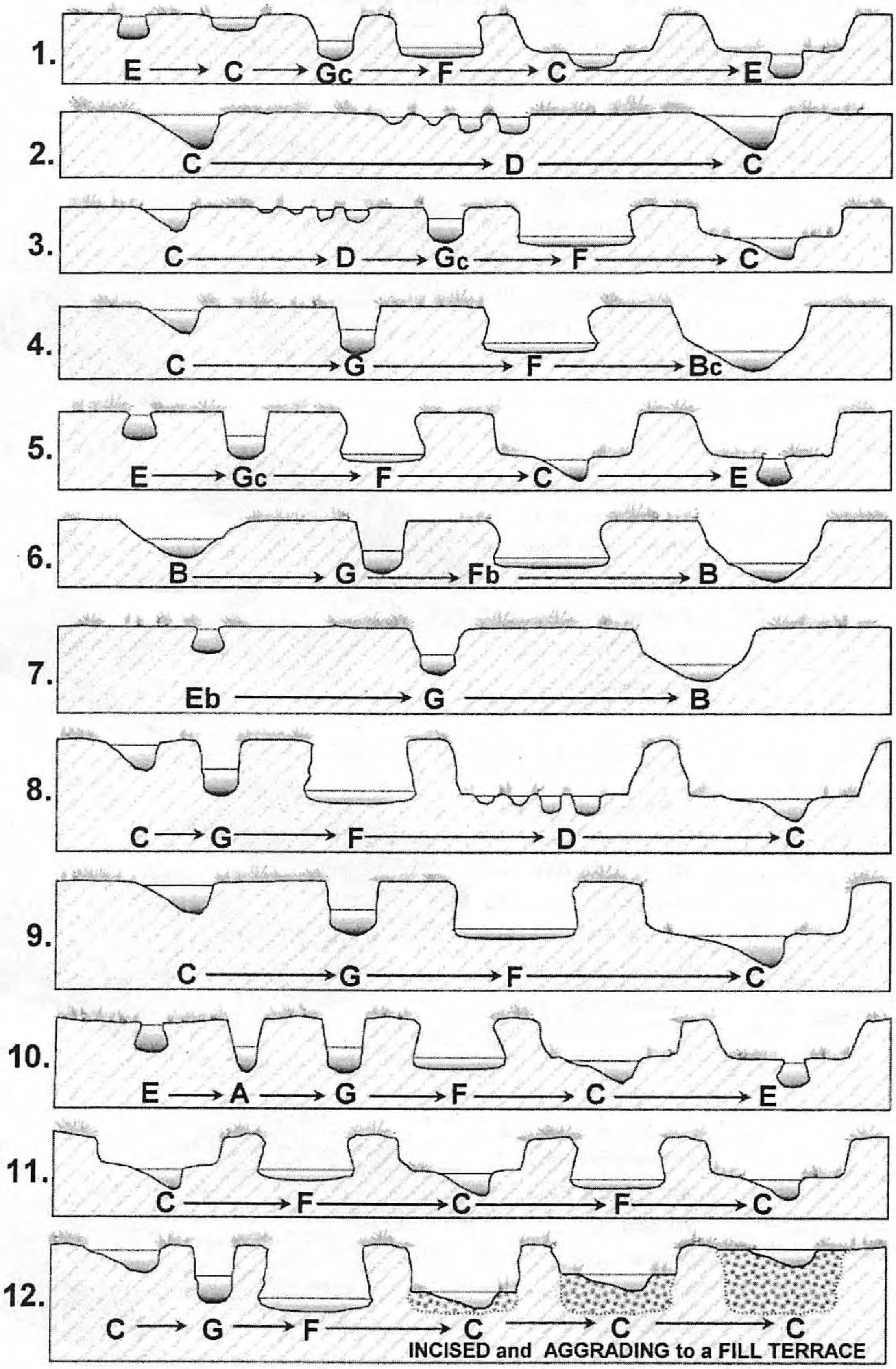

BANK EROSION POTENTIAL
HIGH
MODERATE
LOW
BANK HEIGHT vs BANKFULL DEPTH
BANK ANGLE
DENSITY of ROOTS
BANK SURFACE PROTECTION
% of TOTAL BANK HEIGHT WITH ROOTS
SOIL STRATIFICATION
PARTICLE SIZE

Figure 5-15. Streambank erodibility criteria showing conversion of measured ratios and bank variables to a BEHI rating. Use **Worksheet 5-16** variables to determine BEHI score.



Various *Stream Type Succession* Scenarios



Stream Channel Succession

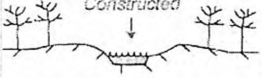
Sequence of Stream Type Occurrence Due to Morphological Change. (Rosgen, 1996)

ALLUVIAL VALLEY — Gravel Bed — Valley Slope .009

Channel Evolution Model
(Simon and Hupp, 1986)

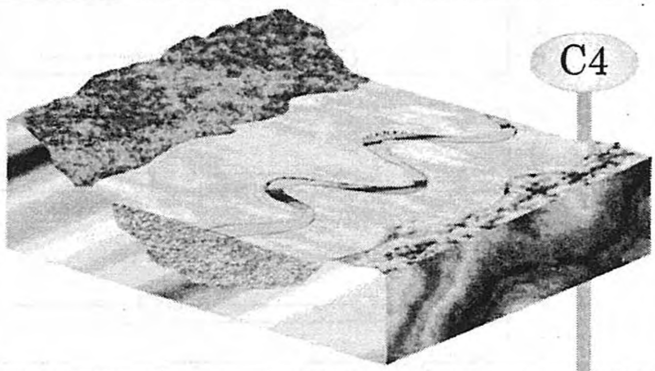
Stage 1:
PreModified

Stage 2:
Constructed

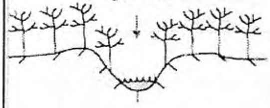


Stream Type C4

Entrenchment Ratio... 20
Width / Depth Ratio... 18
Sinuosity 1.8
Channel Slope ...... .005
Meander Width Ratio ... 8
Simon & Hupp
Evolutionary Stage ....1 & 2

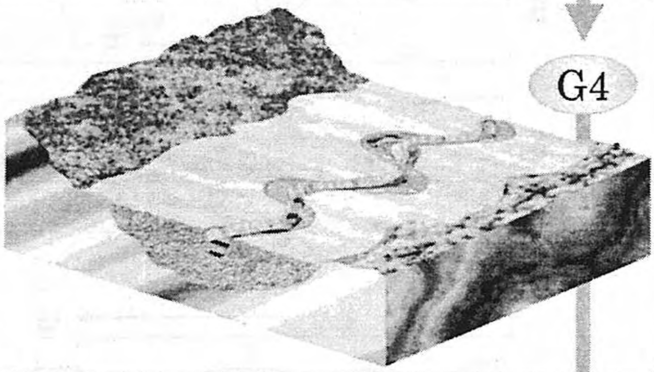


Stage 3:
Degradation

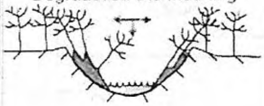


Stream Type G4

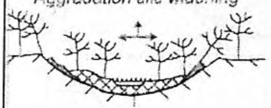
Entrenchment Ratio... 1.1
Width / Depth Ratio.......5
Sinuosity 1.3
Channel Slope ...... .007
Meander Width Ratio ... 4
Simon & Hupp
Evolutionary Stage 3



Stage 4:
Degradation and widening

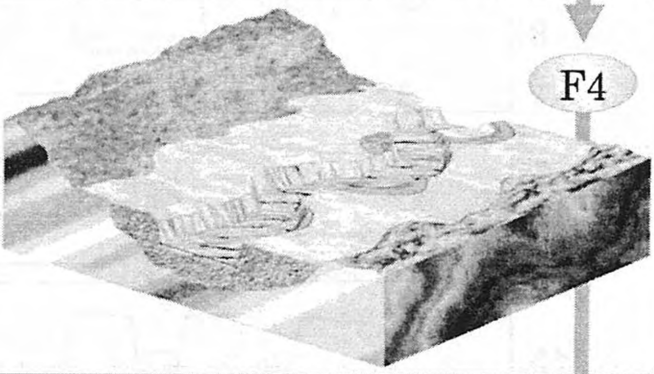


Stage 5:
Aggradation and widening

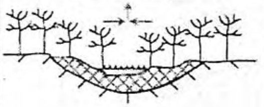


Stream Type F4

Entrenchment Ratio...1.0
Width / Depth Ratio...150
Sinuosity 1.8
Channel Slope ...... .008
Meander Width Ratio..1.5
Simon & Hupp
Evolutionary Stage ....4 & 5



Stage 6:
Quasi equilibrium



Stream Type C4

Entrenchment Ratio... 20
Width / Depth Ratio... 20
Sinuosity 1.6
Channel Slope ...... .006
Meander Width Ratio ... 6
Simon & Hupp
Evolutionary Stage ...6

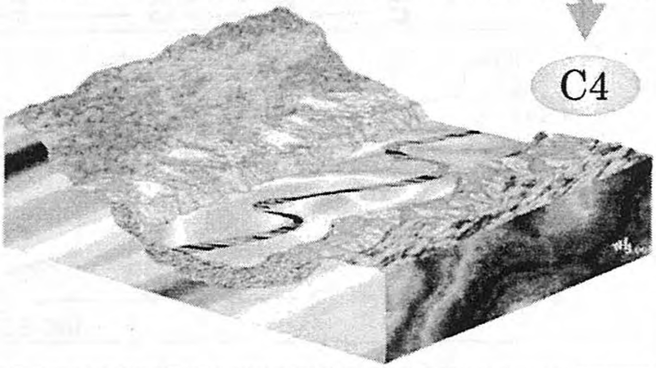
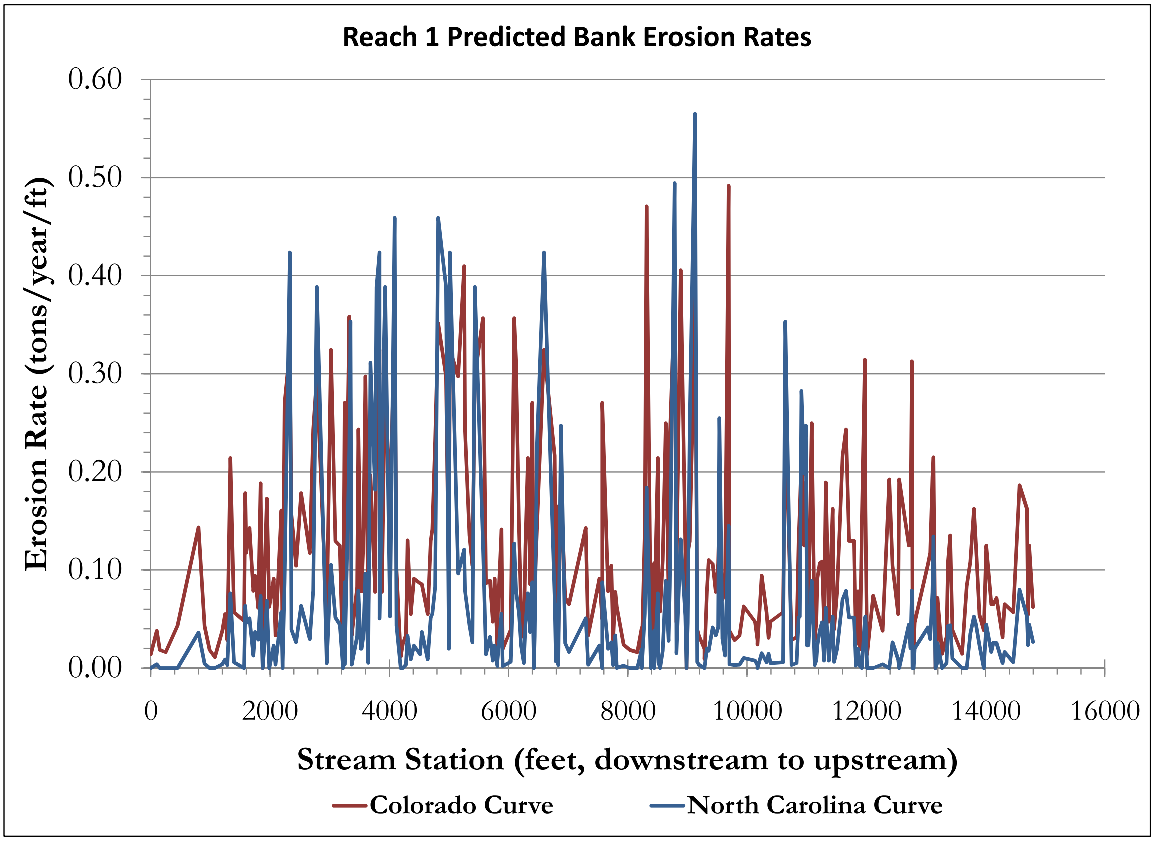
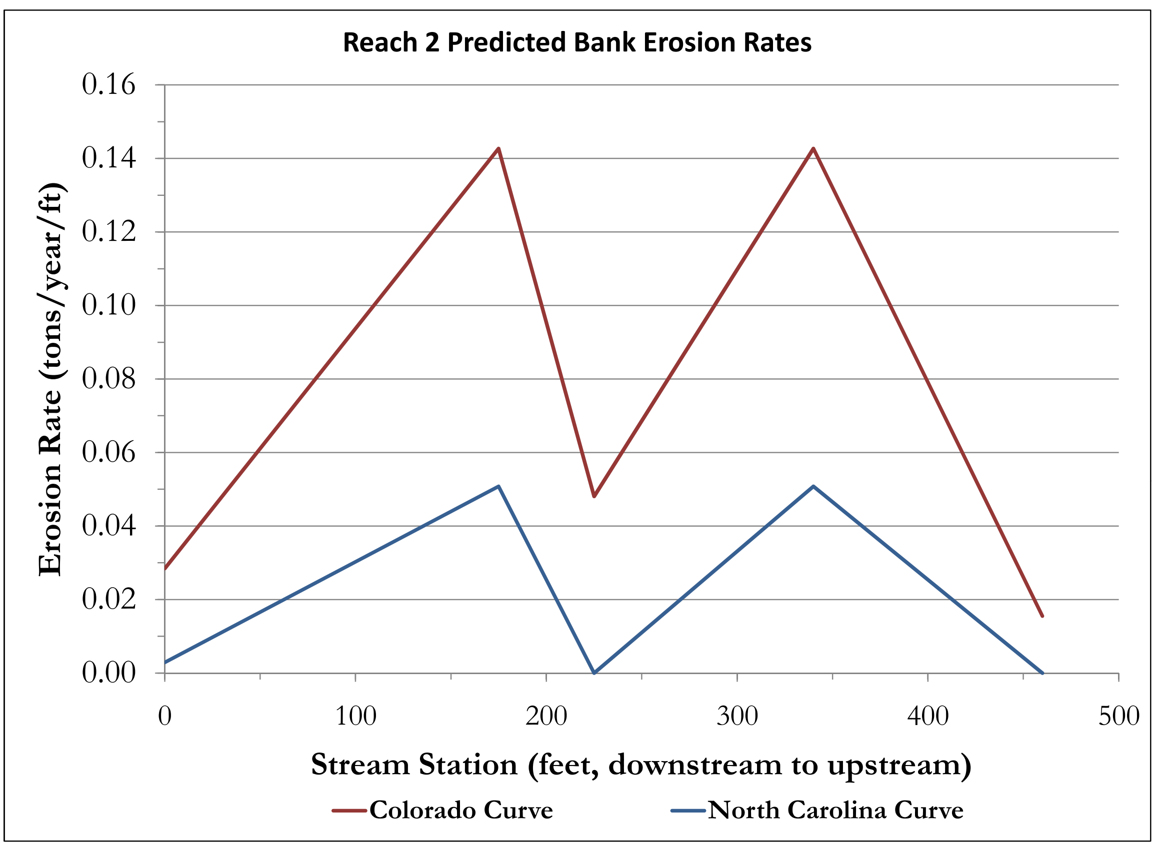


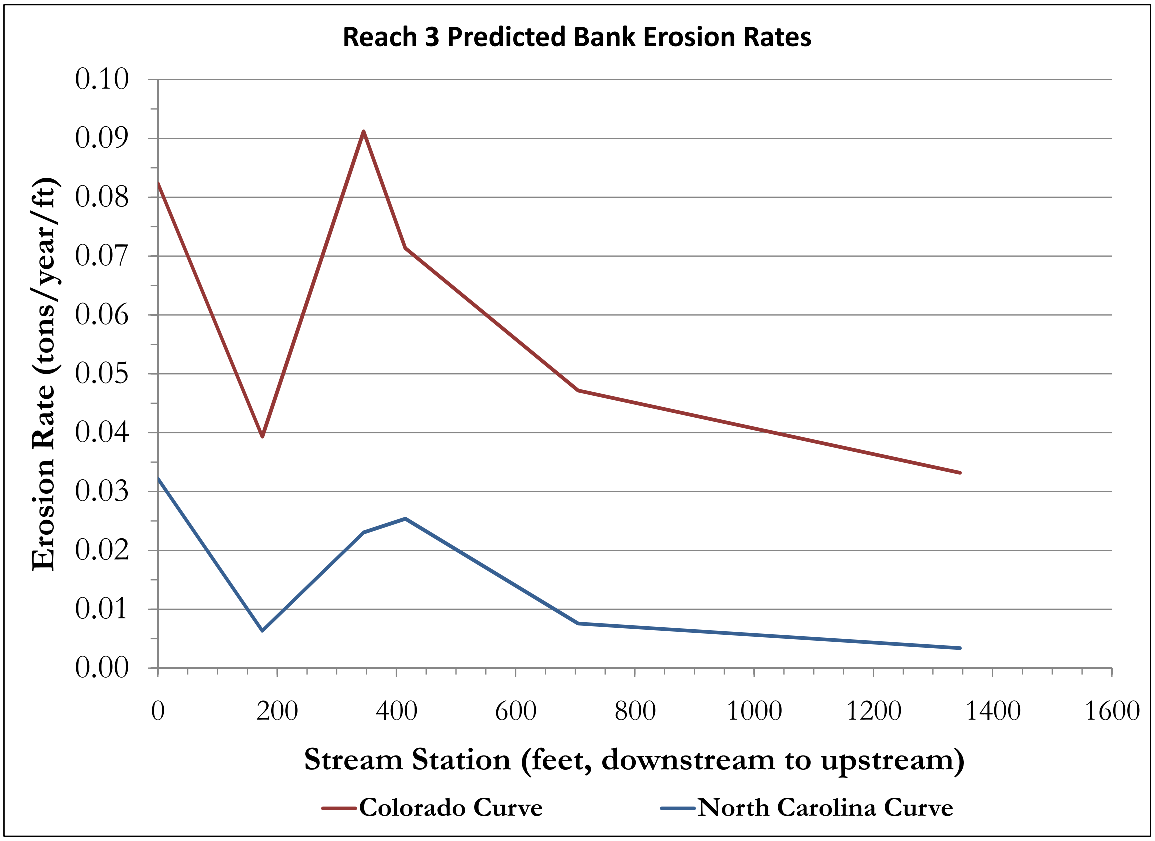
Table 1. Priorities, descriptions and summary for incised river restoration

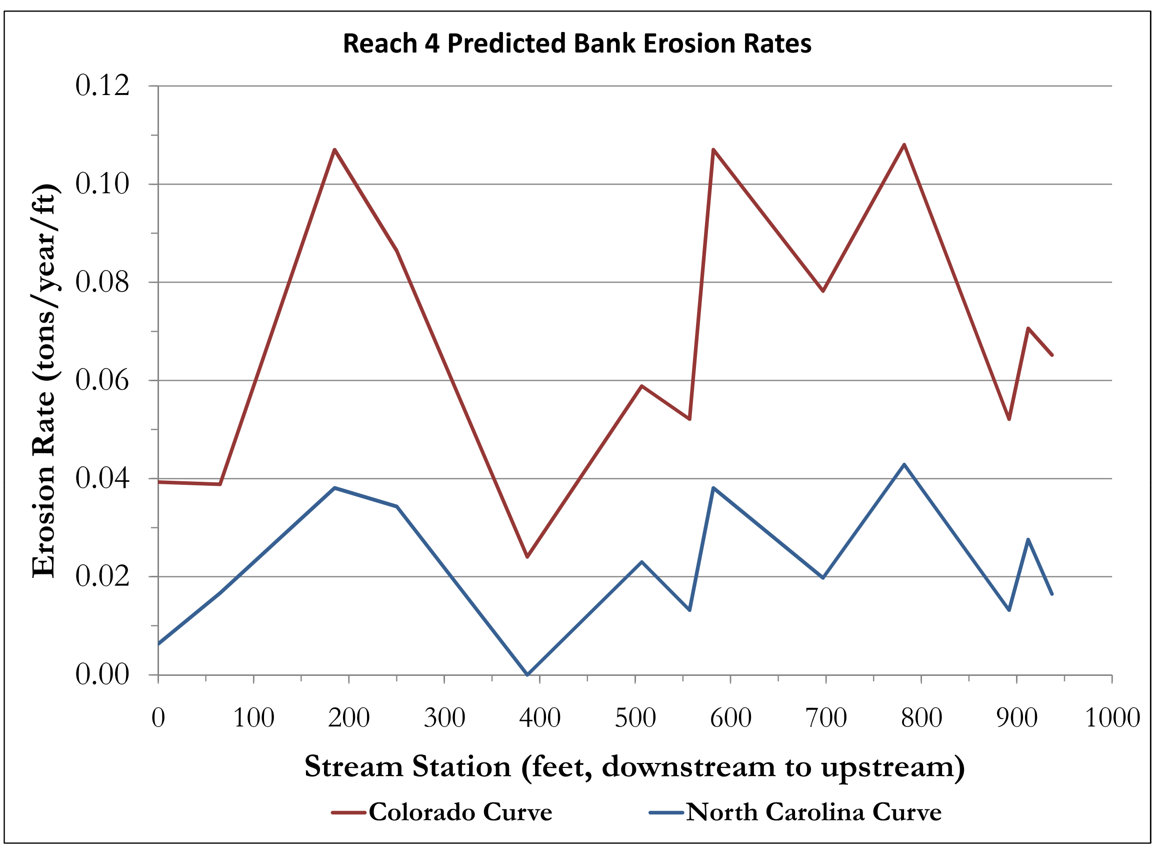
DESCRIPTION	*METHODS*	*ADVANTAGES*	*DISADVANTAGES*
Priority 1 Convert G and/or F stream types to C or E at previous elevation w/floodplain (example shown in figure 5a)	Re-establish channel on previous floodplain using relic channel or construction of new bankfull discharge channel. Design new channel for dimension, pattern and profile characteristic of stable form. Fill in existing incised channel or with discontinuous oxbow lakes level with new floodplain elevation.	Re-establishment of floodplain and stable channel: 1) reduces bank height and streambank erosion, 2) reduces land loss, 3) raises water table, 4) decreases sediment, 5) improves aquatic and terrestrial habitats, 6) improves land productivity, and 7) improves aesthetics.	1. Floodplain reestablishment could cause flood damage to urban agricultural and industrial development. 2. Downstream end of project could require grade control from new to previous channel to prevent headcutting.
Priority 2 Convert F and/or G stream types to C or E. Reestablishment of floodplain at existing level or higher but not at original level (examples shown in Figures 5b and 5c).	If belt width provides for the minimum meander width ratio for C or # stream types, construct channel in bed of existing channel, convert existing bed to new floodplain. If belt width is too narrow, excavate streambank walls. End-haul material or place in streambed to raise bed elevation and create new floodplain in the deposition.	1. Decreases bank height and stream bank erosion. 2. Allows for riparian vegetation to help stabilize banks. 3. Establishes floodplain to help take stress off of channel during lood. 4. Improves aquatic habitat. 5. Prevents wide-scale flooding of original land surface. 6. Reduces sediment. 7. Downstream grade control is easier.	1. Does not raise water table back to previous elevation. 2. Shear stress and velocity higher during flood due to narrower floodplain. 3. Upper banks need to be sloped and stabilized to reduce erosion during flood.
Priority 3 Convert to a new stream type without an active floodplain, but containing a floodprone area. Convert G to B stream type or F to Bc. (Examples shown in Figures 5d and 5e).	Excavation of channel to change stream type involves establishing proper dimension, pattern and profile. To convert a G to B stream involves an increase in width/depth and entrenchment ratio. Shaping upper slopes and stabilizing both bed and banks. A conversion from F to Bc stream type involves a decrease in width/depth ratio and an increase in entrenchment ratio.	1. Reduces the amount of land needed to return the river to a stable form. 2. Developments next to river need not be re-located due to flooding potential. 3. Decreases flood stage for the same magnitude flood. 4. Improves aquatic habitat.	1. High cost of materials for bed and streambank stabilization. 2. Does not create the diversity of aquatic habitat. 3. Does not raise water table to previous levels.
Priority 4 Stabilize channel in place (examples shown in Figure 5f).	A long list of stabilization materials and methods have been used to decrease stream bed and stream bank erosion including concrete, gabions, boulders, and bio-engineering methods.	1. Excavation volumes are reduced. 2. Land needed for restoration is minimal.	1. High cost for stabilization. 2. High risk due to excessive shear stress and velocity. 3. Limited aquatic habitat depending on nature of stabilization methods used.

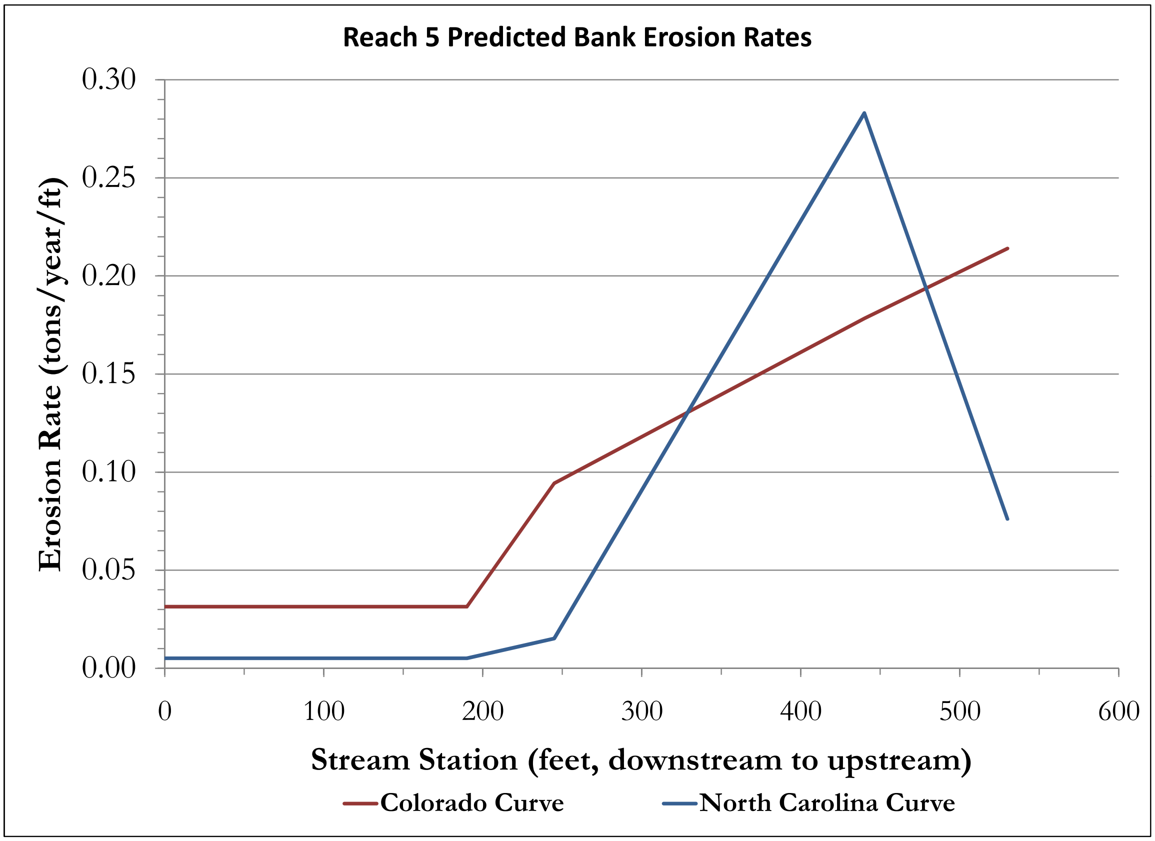
Appendix C
Stream Assessment Results

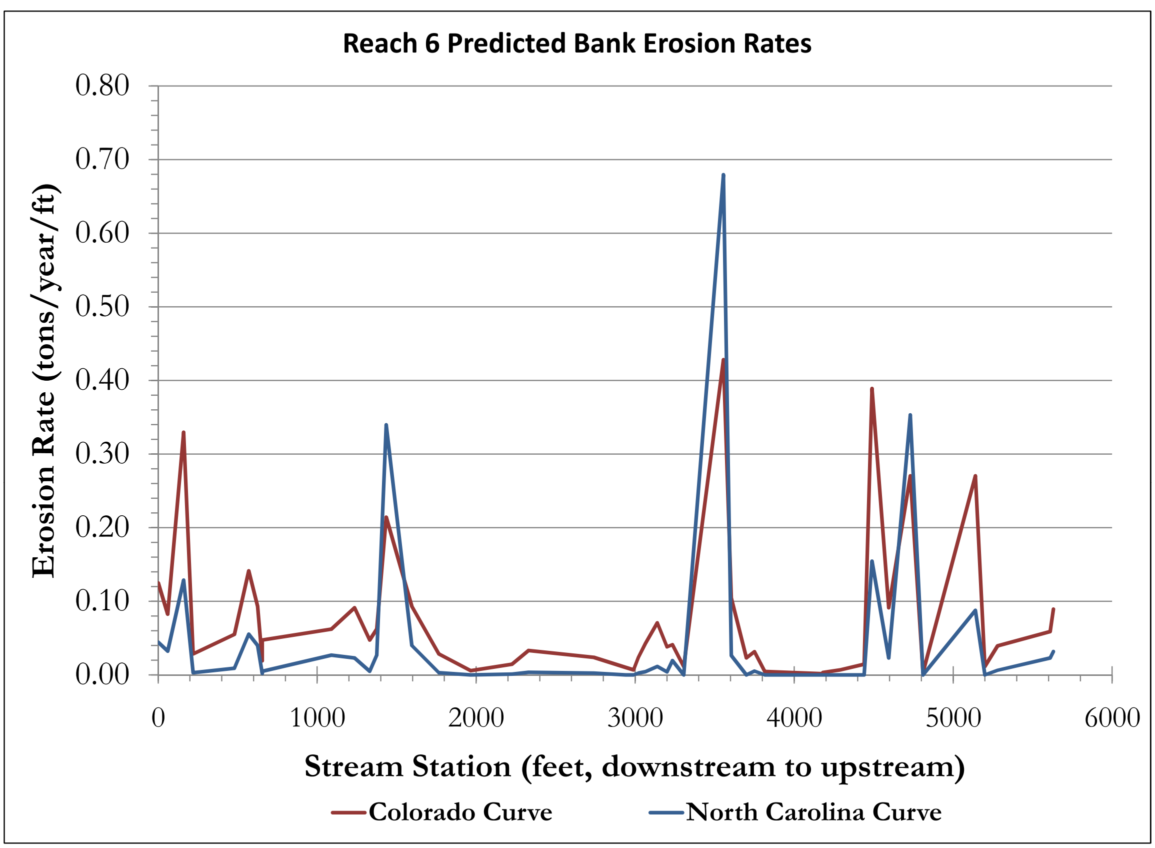

Reach 1 Predicted Bank Erosion Rates
Erosion Rate (tons/year/ft)
0.60
0.50
0.40
0.30
0.20
0.10
0.00
0
2000
4000
6000
8000
10000
12000
14000
16000
Stream Station (feet, downstream to upstream)
Colorado Curve
North Carolina Curve

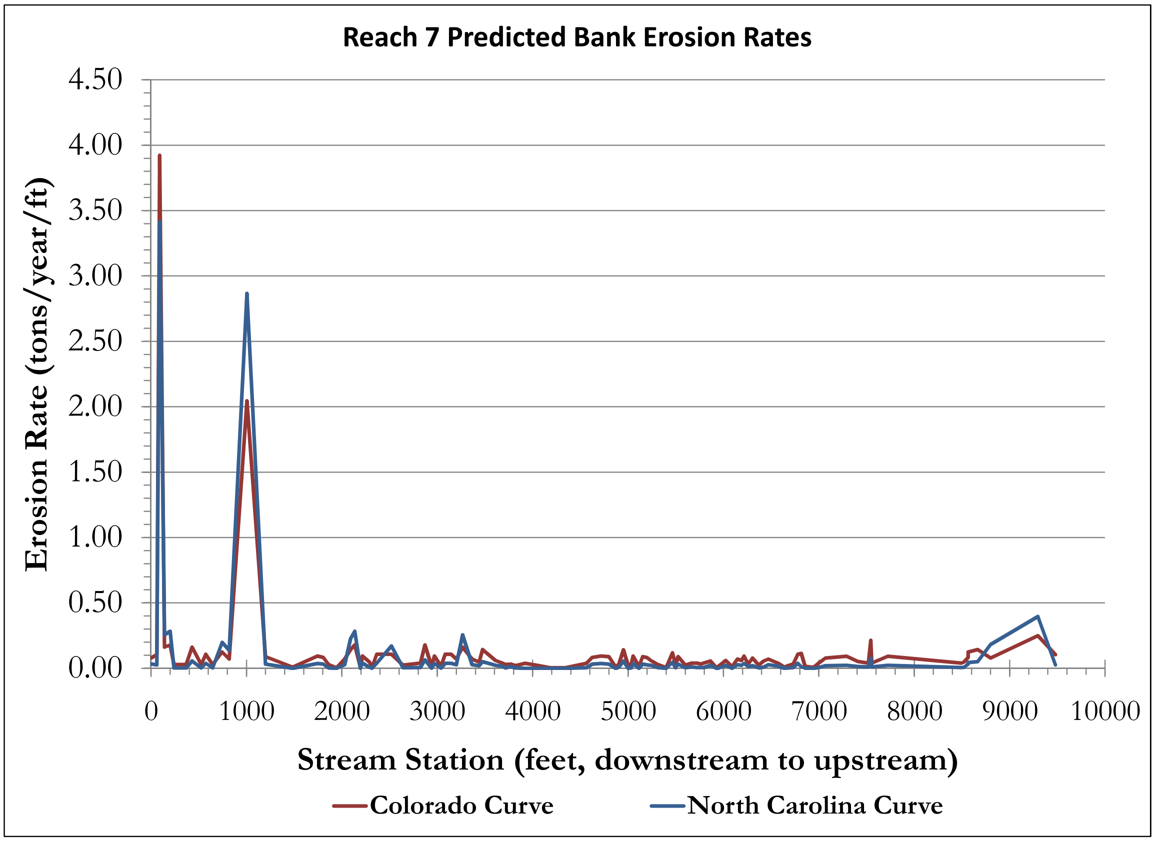

Reach 2 Predicted Bank Erosion Rates
Erosion Rate (tons/year/ft)
0.16
0.14
0.12
0.10
0.08
0.06
0.04
0.02
0.00
0
100
200
300
400
500
Stream Station (feet, downstream to upstream)
Colorado Curve
North Carolina Curve

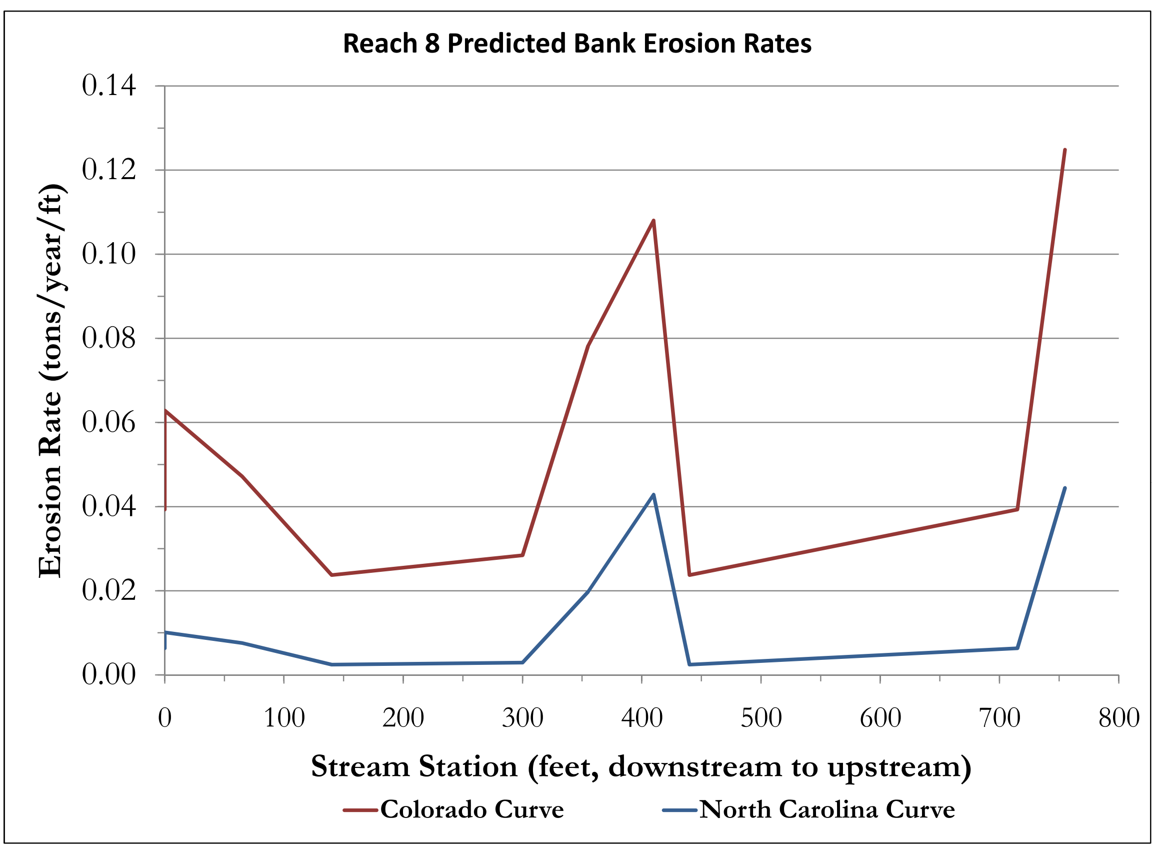

Reach 3 Predicted Bank Erosion Rates
Erosion Rate (tons/year/ft)
0.10
0.09
0.08
0.07
0.06
0.05
0.04
0.03
0.02
0.01
0.00
0
200
400
600
800
1000
1200
1400
1600
Stream Station (feet, downstream to upstream)
Colorado Curve
North Carolina Curve

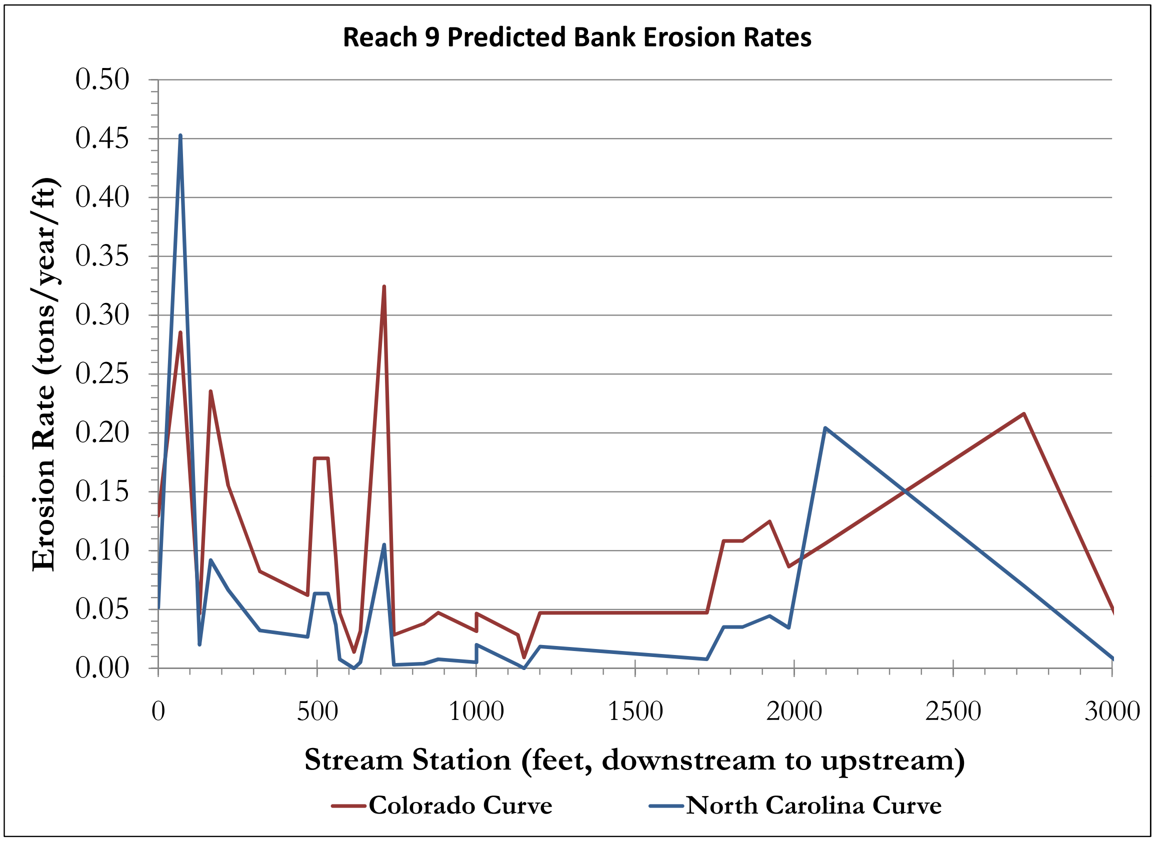

Reach 4 Predicted Bank Erosion Rates
Erosion Rate (tons/year/ft)
0.12
0.10
0.08
0.06
0.04
0.02
0.00
0
100
200
300
400
500
600
700
800
900
1000
Stream Station (feet, downstream to upstream)
Colorado Curve
North Carolina Curve


Reach 5 Predicted Bank Erosion Rates
Erosion Rate (tons/year/ft)
0.00
0.05
0.10
0.15
0.20
0.25
0.30
0
100
200
300
400
500
600
Stream Station (feet, downstream to upstream)
Colorado Curve
North Carolina Curve

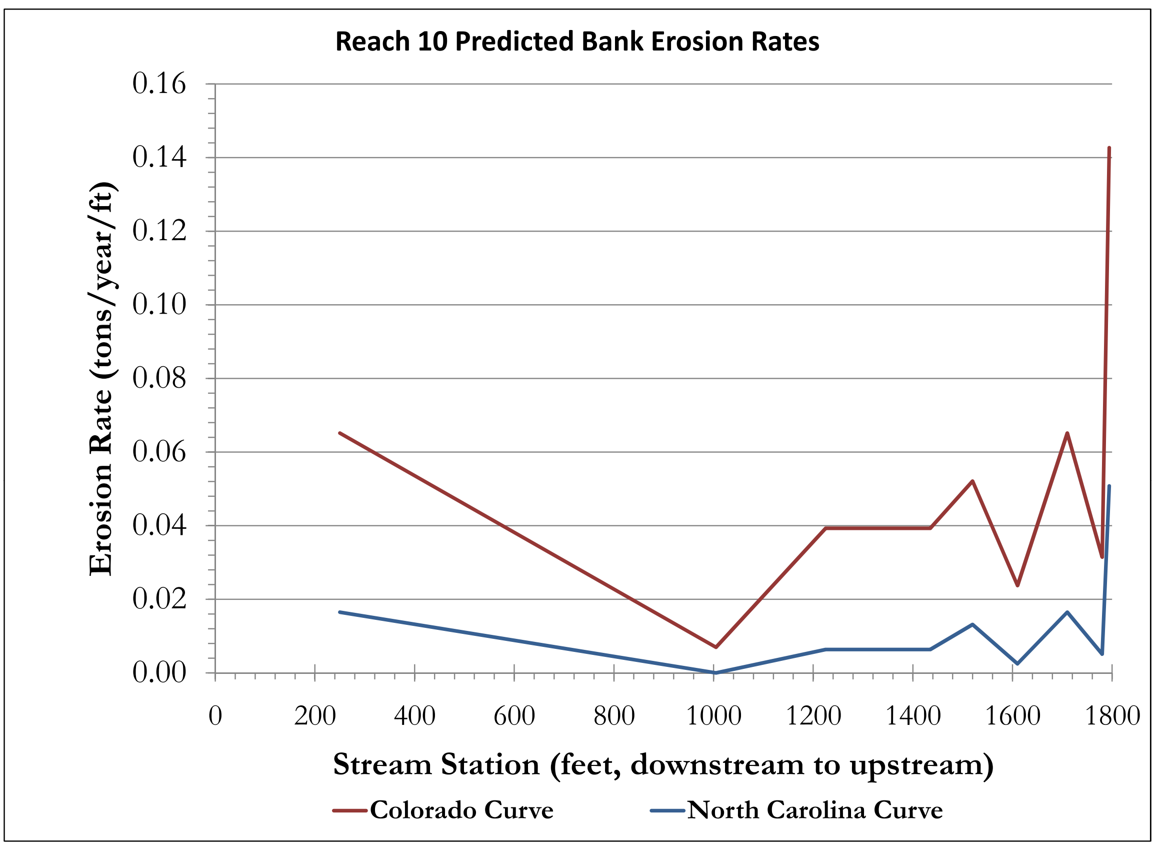

Reach 6 Predicted Bank Erosion Rates
Erosion Rate (tons/year/ft)
0.00
0.10
0.20
0.30
0.40
0.50
0.60
0.70
0.80
0
1000
2000
3000
4000
5000
6000
Stream Station (feet, downstream to upstream)
Colorado Curve
North Carolina Curve


Reach 7 Predicted Bank Erosion Rates
Erosion Rate (tons/year/ft)
4.50
4.00
3.50
3.00
2.50
2.00
1.50
1.00
0.50
0.00
0
1000
2000
3000
4000
5000
6000
7000
8000
9000
10000
Stream Station (feet, downstream to upstream)
Colorado Curve
North Carolina Curve

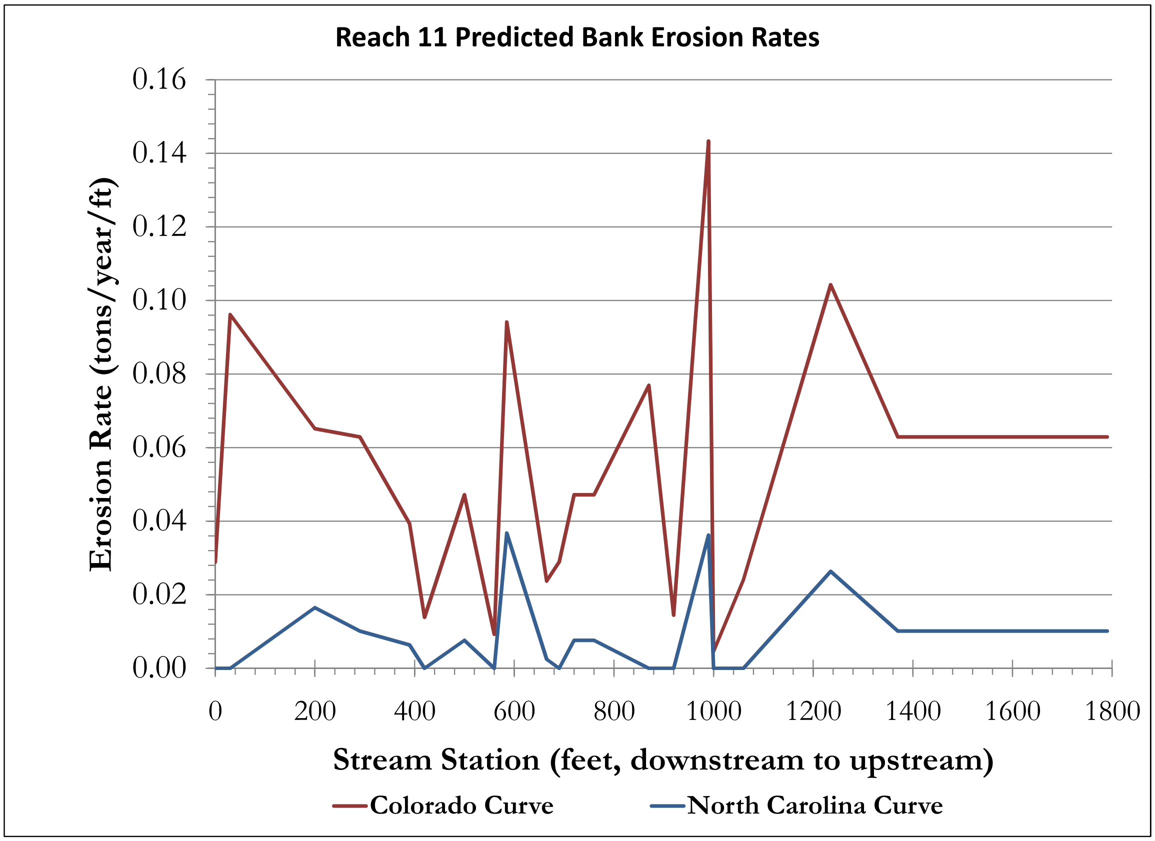

Reach 8 Predicted Bank Erosion Rates
Erosion Rate (tons/year/ft)
0.14
0.12
0.10
0.08
0.06
0.04
0.02
0.00
0
100
200
300
400
500
600
700
800
Stream Station (feet, downstream to upstream)
Colorado Curve
North Carolina Curve



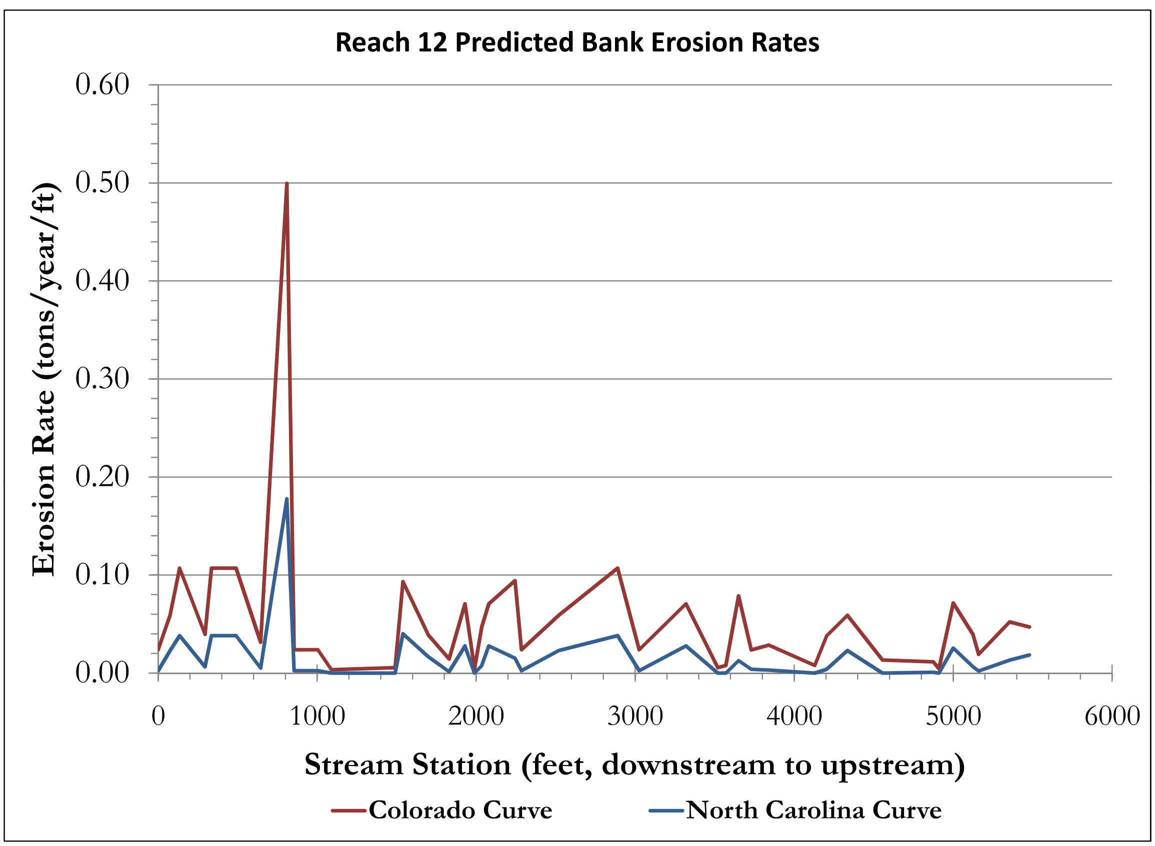
Reach 9 Predicted Bank Erosion Rates
Erosion Rate (tons/year/ft)
0.50
0.45
0.40
0.35
0.30
0.25
0.20
0.15
0.10
0.05
0.00
0
500
1000
1500
2000
2500
3000
Stream Station (feet, downstream to upstream)
Colorado Curve
North Carolina Curve



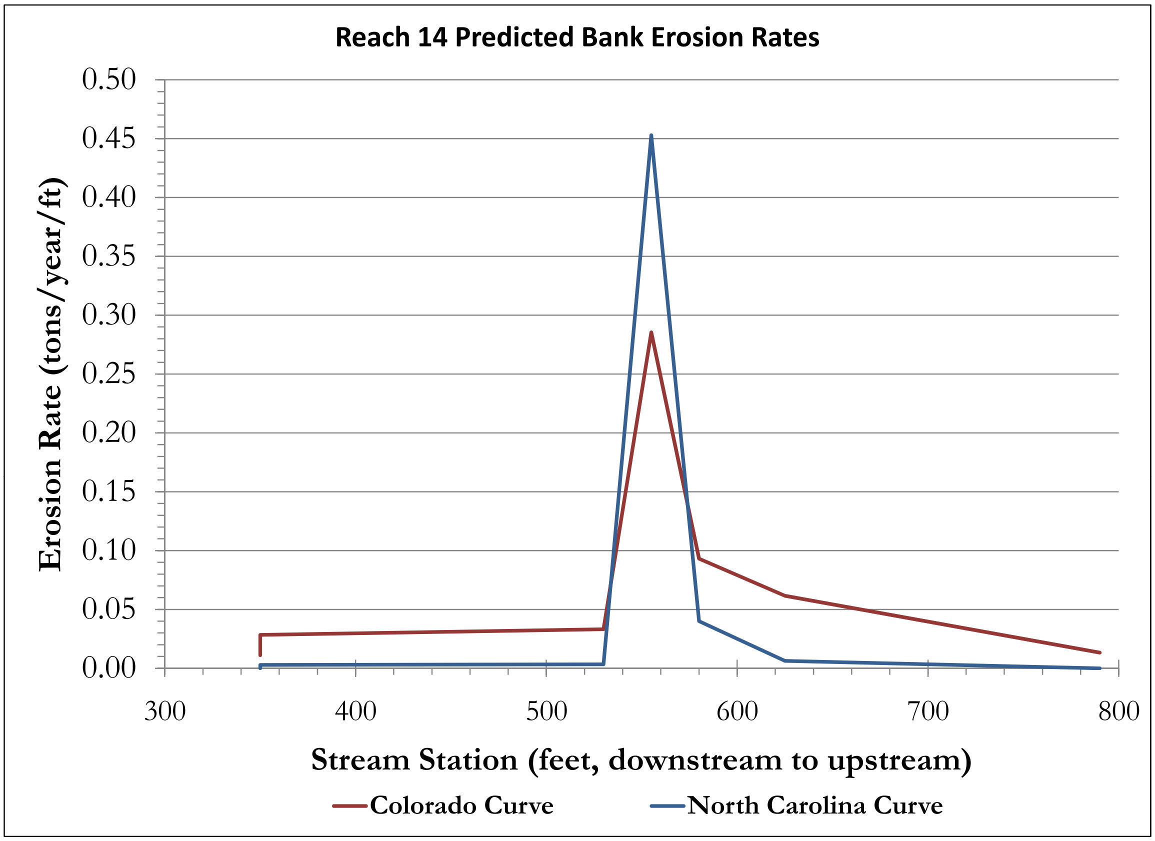
Reach 10 Predicted Bank Erosion Rates
Erosion Rate (tons/year/ft)
0.16
0.14
0.12
0.10
0.08
0.06
0.04
0.02
0.00
0
200
400
600
800
1000
1200
1400
1600
1800
Stream Station (feet, downstream to upstream)
Colorado Curve
North Carolina Curve



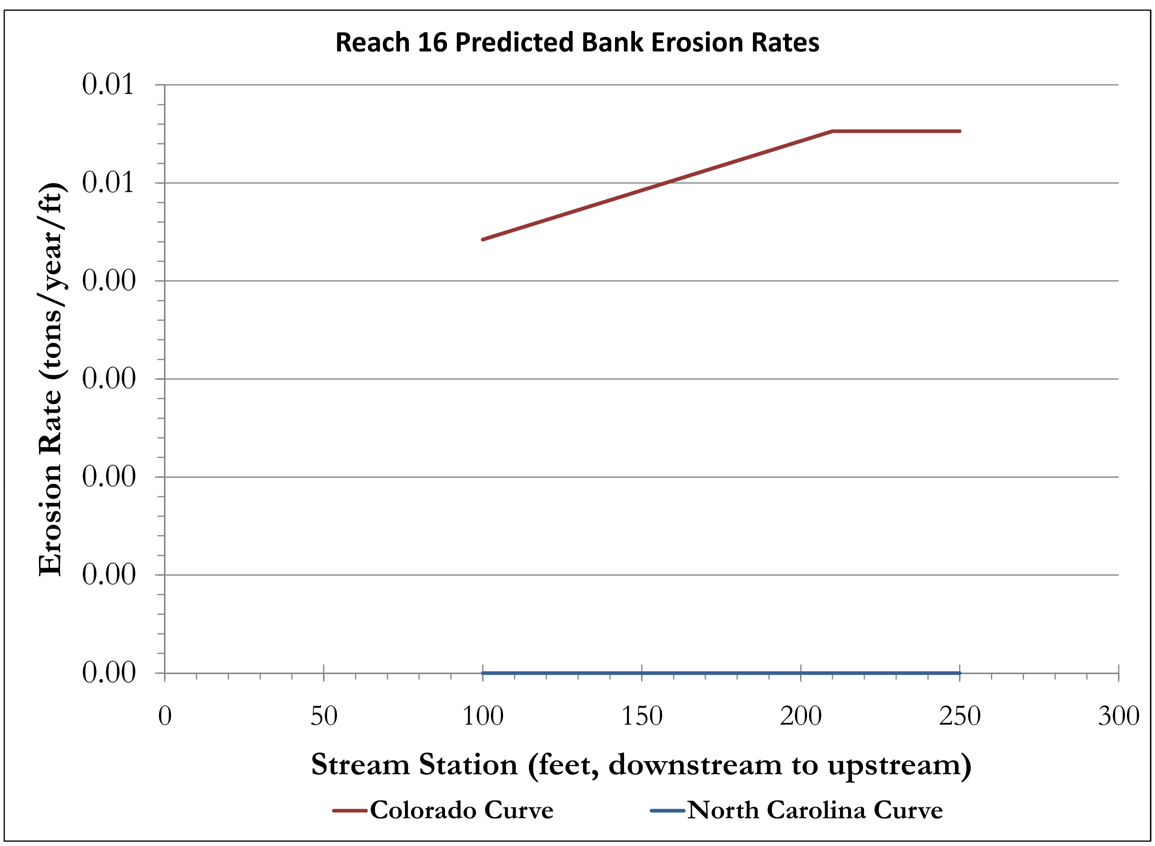
Reach 11 Predicted Bank Erosion Rates
Erosion Rate (tons/year/ft)
0.16
0.14
0.12
0.10
0.08
0.06
0.04
0.02
0.00
0
200
400
600
800
1000
1200
1400
1600
1800
Stream Station (feet, downstream to upstream)
Colorado Curve
North Carolina Curve



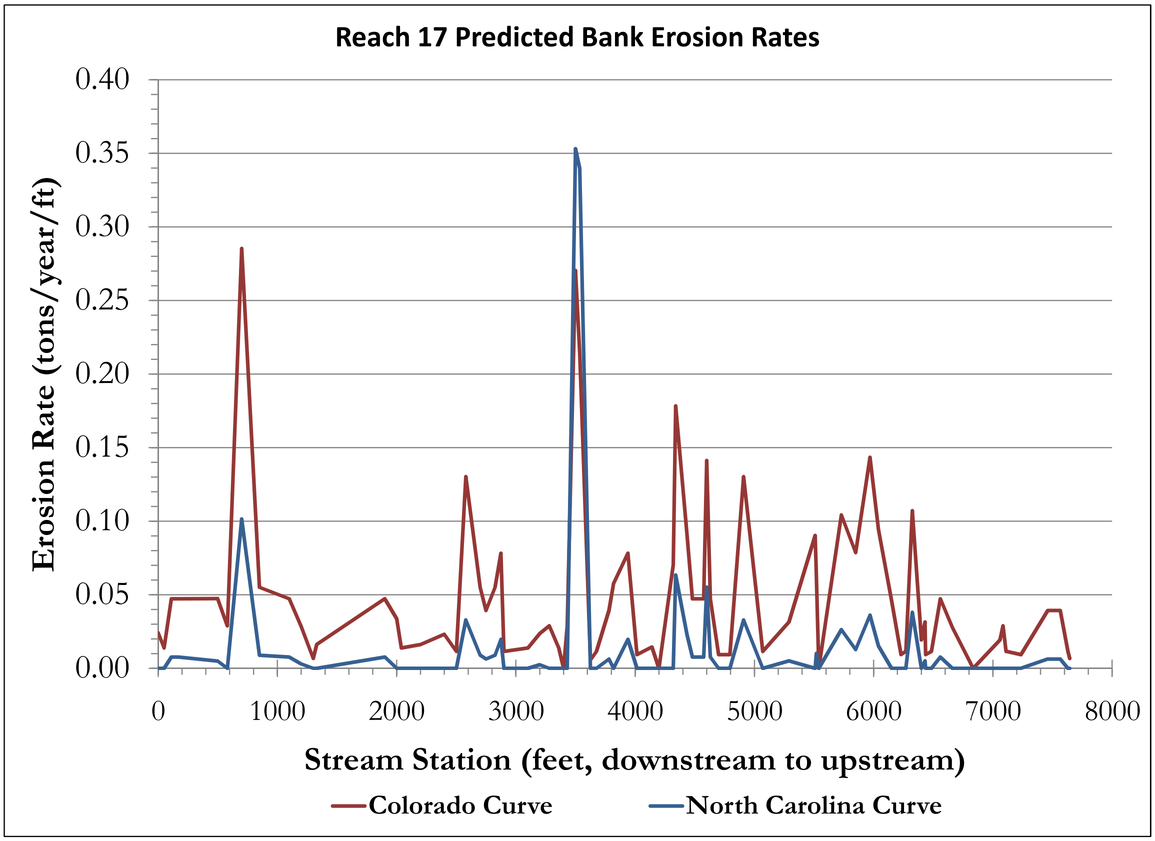
Reach 12 Predicted Bank Erosion Rates
Erosion Rate (tons/year/ft)
0.60
0.50
0.40
0.30
0.20
0.10
0.00
0
1000
2000
3000
4000
5000
6000
Stream Station (feet, downstream to upstream)
Colorado Curve
North Carolina Curve



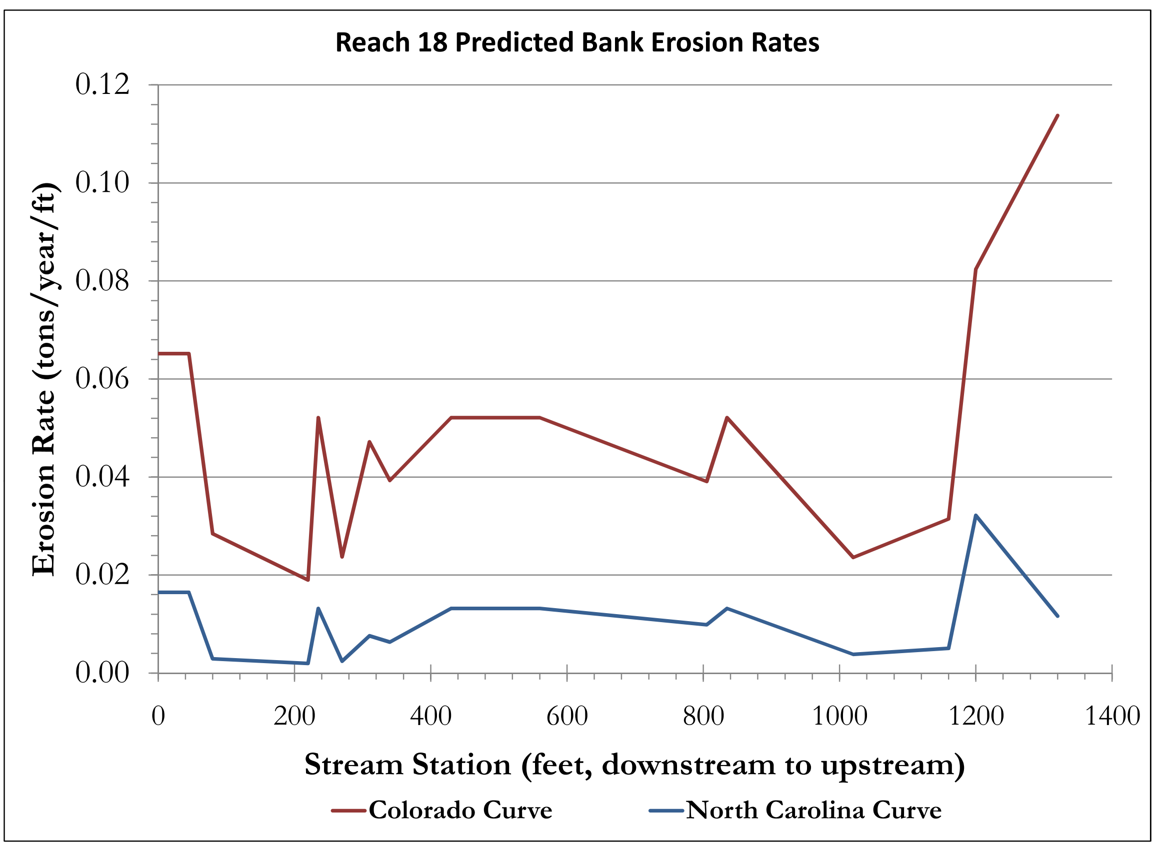
Reach 14 Predicted Bank Erosion Rates
Erosion Rate (tons/year/ft)
0.50
0.45
0.40
0.35
0.30
0.25
0.20
0.15
0.10
0.05
0.00
300
400
500
600
700
800
Stream Station (feet, downstream to upstream)
Colorado Curve
North Carolina Curve



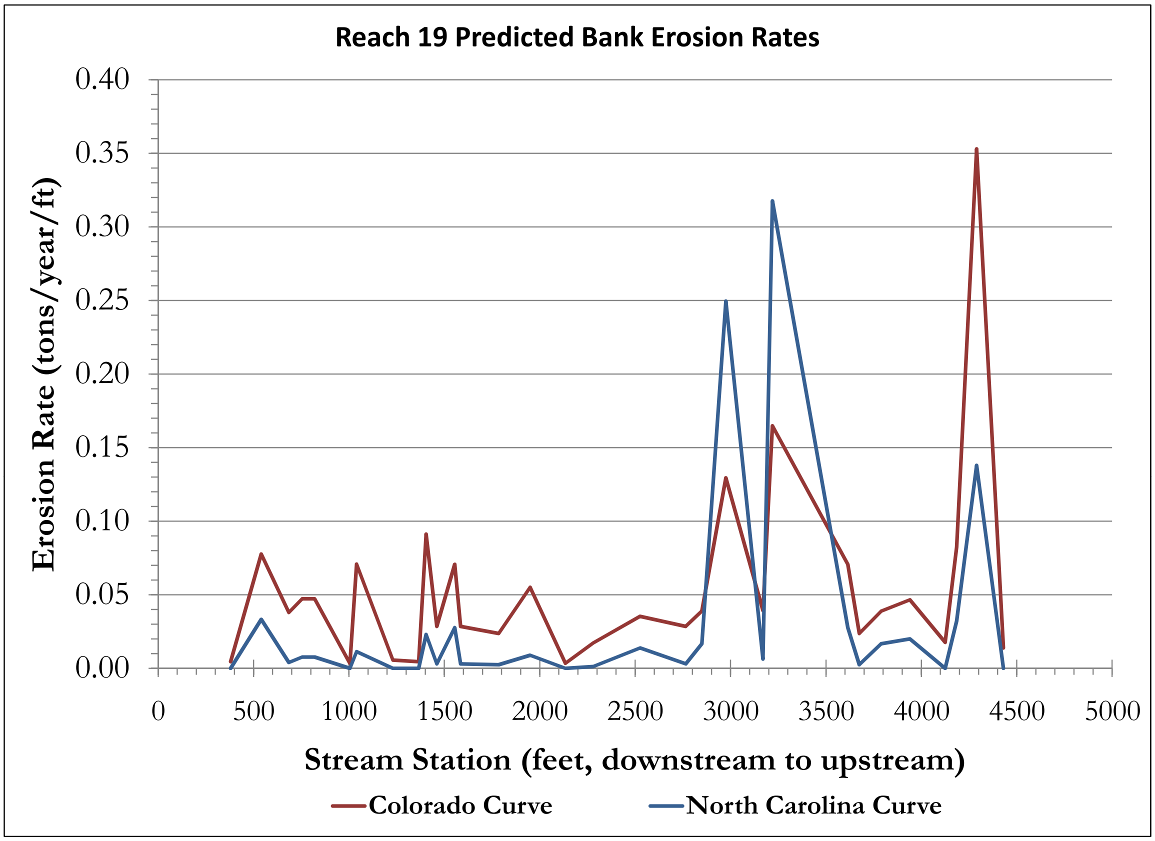
Reach 16 Predicted Bank Erosion Rates
Erosion Rate (tons/year/ft)
0.01
0.01
0.00
0.00
0.00
0.00
0.00
0
50
100
150
200
250
300
Stream Station (feet, downstream to upstream)
Colorado Curve
North Carolina Curve



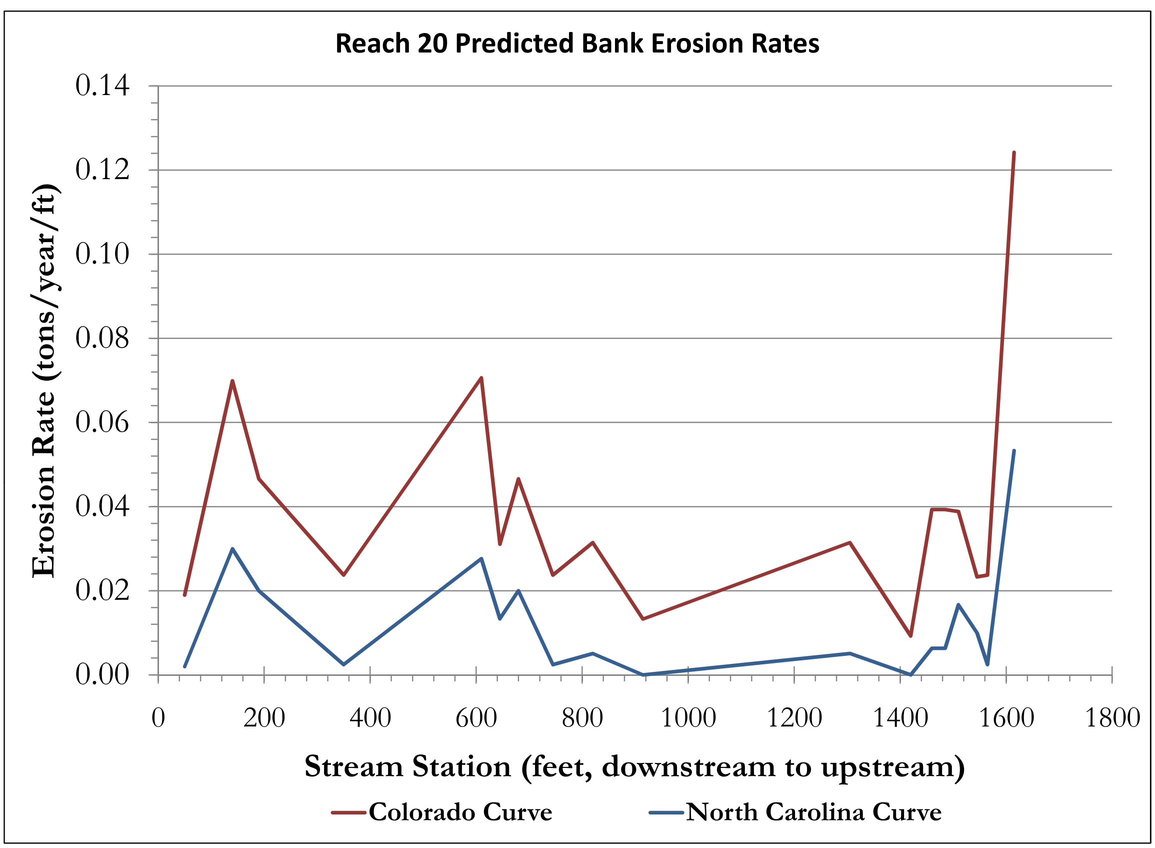
Reach 17 Predicted Bank Erosion Rates
Erosion Rate (tons/year/ft)
0.40
0.35
0.30
0.25
0.20
0.15
0.10
0.05
0.00
0
1000
2000
3000
4000
5000
6000
7000
8000
Stream Station (feet, downstream to upstream)
Colorado Curve
North Carolina Curve



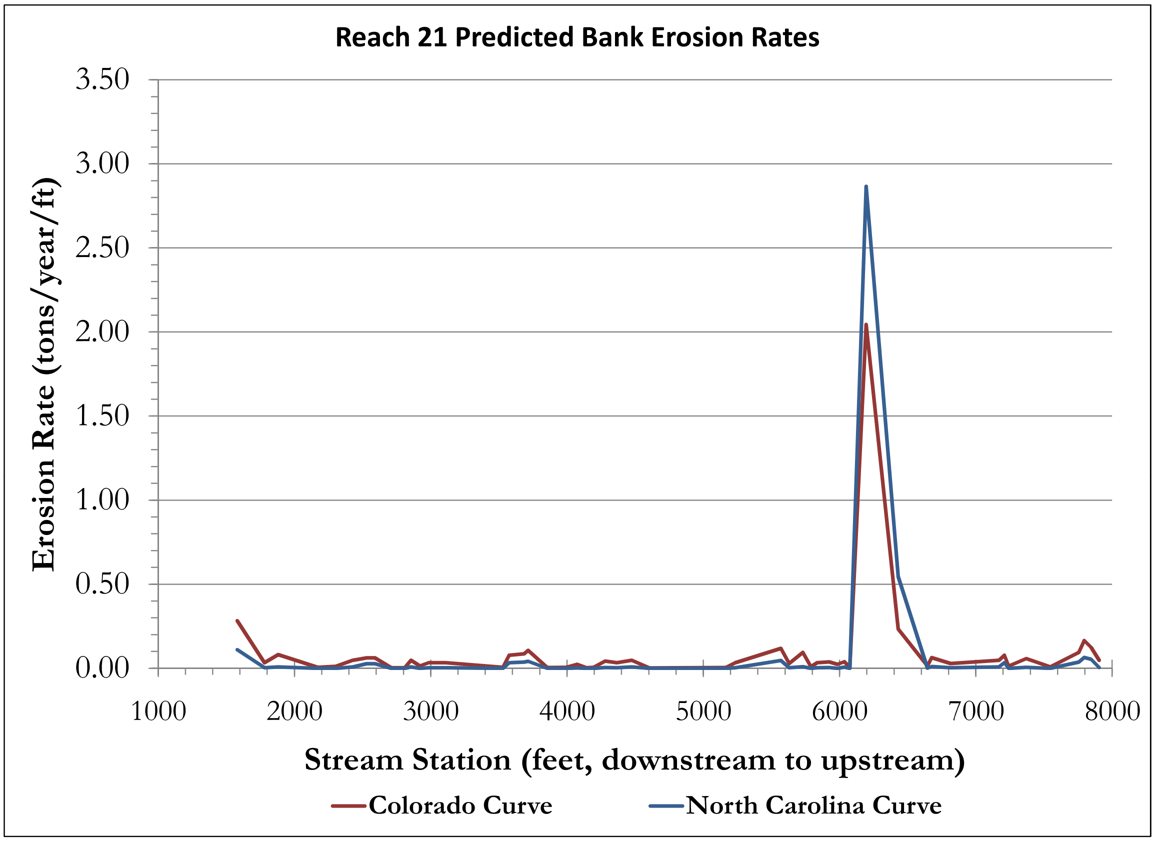
Reach 18 Predicted Bank Erosion Rates
Erosion Rate (tons/year/ft)
0.12
0.10
0.08
0.06
0.04
0.02
0.00
0
200
400
600
800
1000
1200
1400
Stream Station (feet, downstream to upstream)
Colorado Curve
North Carolina Curve

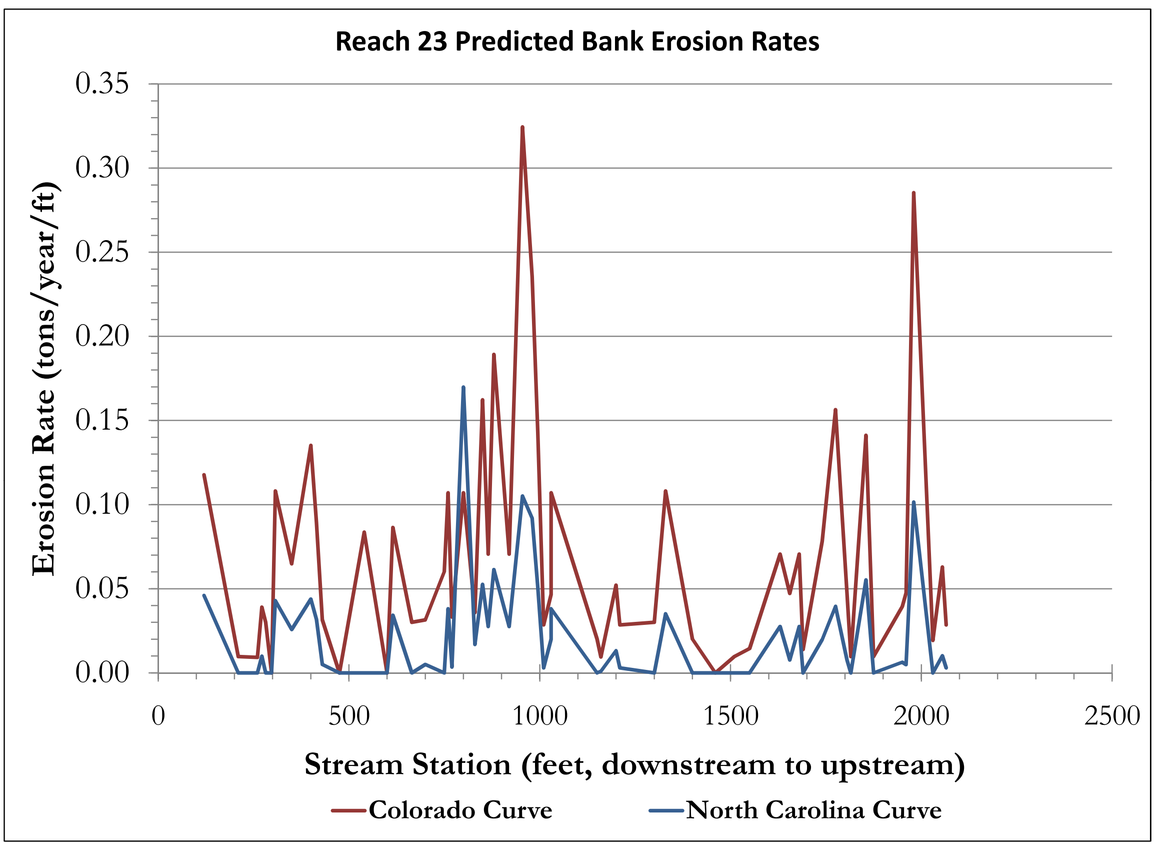


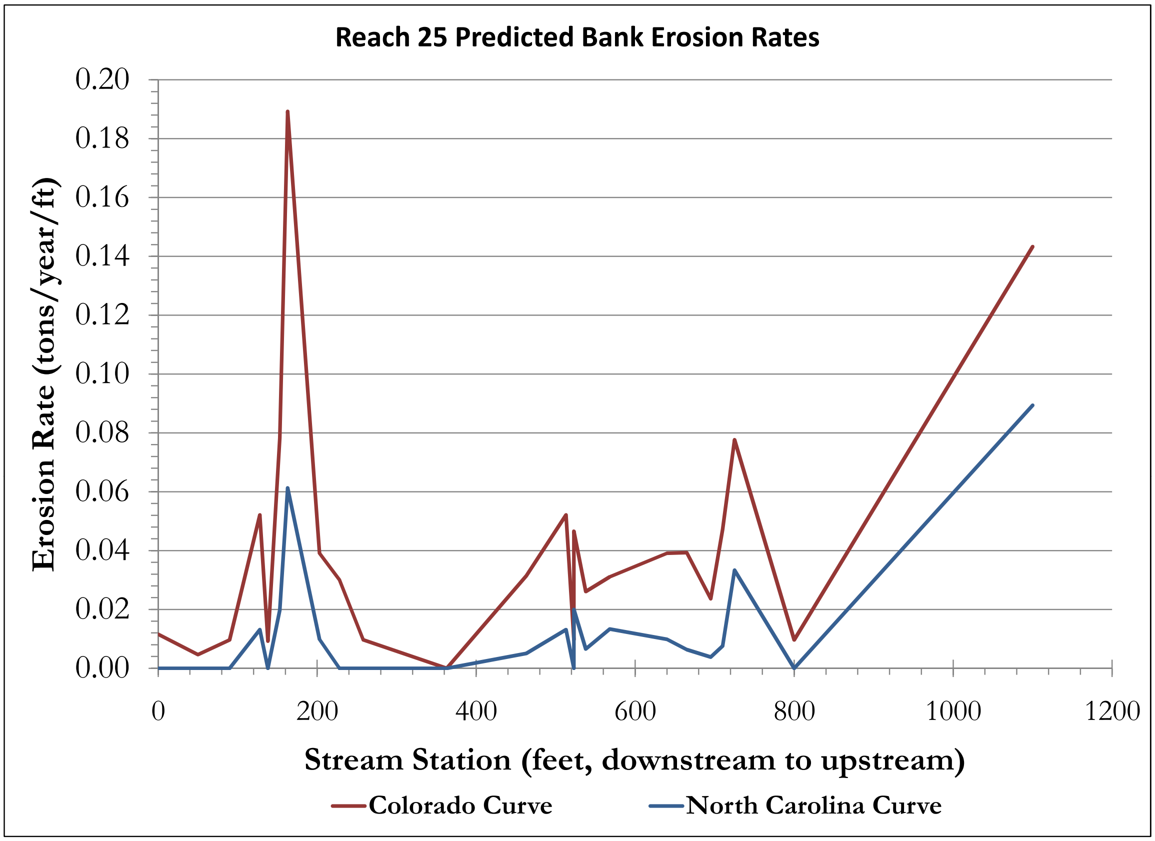
Reach 19 Predicted Bank Erosion Rates
Erosion Rate (tons/year/ft)
0.00
0.05
0.10
0.15
0.20
0.25
0.30
0.35
0.40
0
500
1000
1500
2000
2500
3000
3500
4000
4500
5000
Stream Station (feet, downstream to upstream)
Colorado Curve
North Carolina Curve



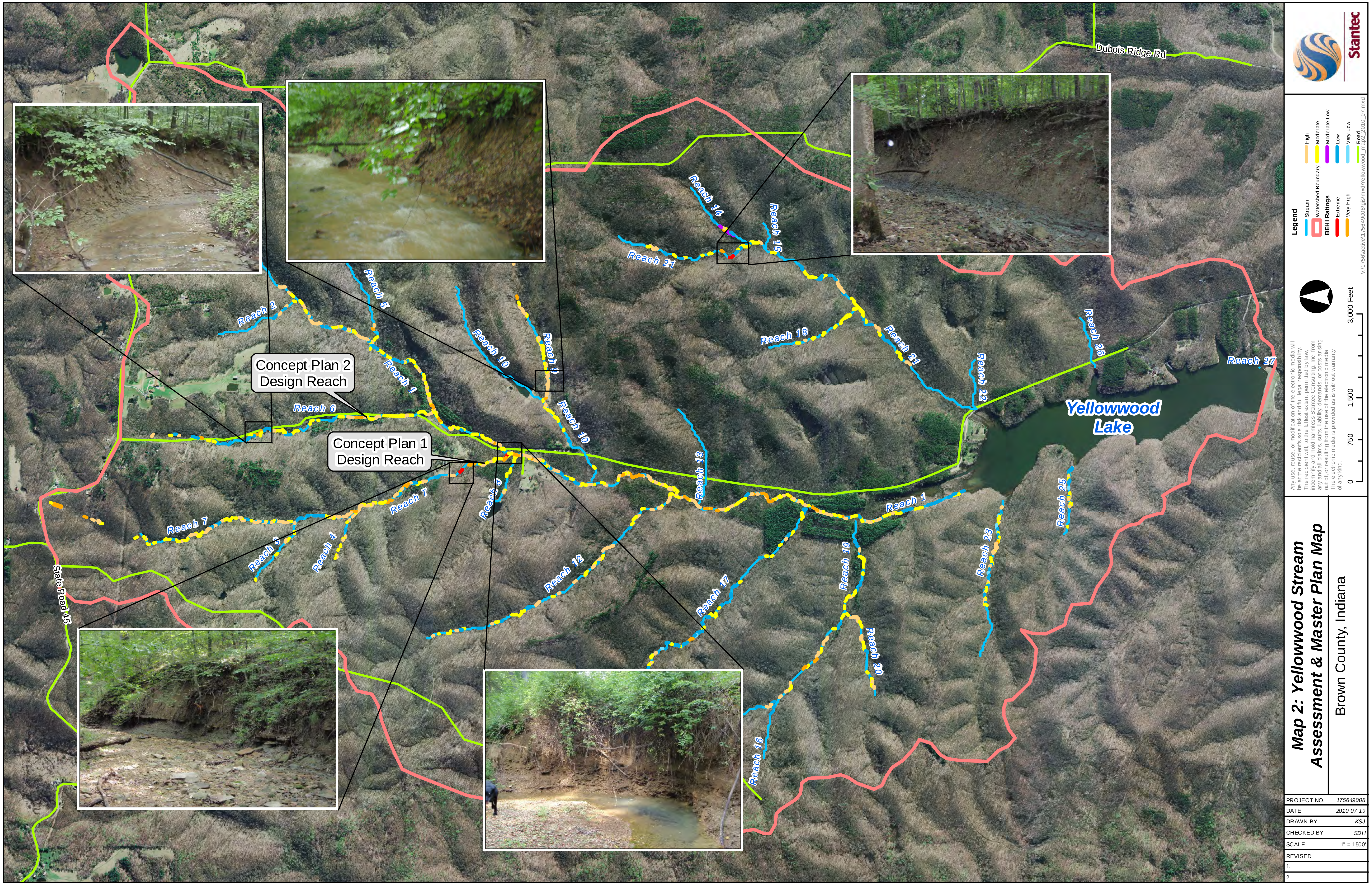
Reach 20 Predicted Bank Erosion Rates
Erosion Rate (tons/year/ft)
0.00
0.02
0.04
0.06
0.08
0.10
0.12
0.14
0
200
400
600
800
1000
1200
1400
1600
1800
Stream Station (feet, downstream to upstream)
Colorado Curve
North Carolina Curve


Reach 21 Predicted Bank Erosion Rates
Erosion Rate (tons/year/ft)
3.50
3.00
2.50
2.00
1.50
1.00
0.50
0.00
1000
2000
3000
4000
5000
6000
7000
8000
Stream Station (feet, downstream to upstream)
Colorado Curve
North Carolina Curve


Reach 23 Predicted Bank Erosion Rates
Erosion Rate (tons/year/ft)
0.35
0.30
0.25
0.20
0.15
0.10
0.05
0.00
0
500
1000
1500
2000
2500
Stream Station (feet, downstream to upstream)
Colorado Curve
North Carolina Curve


Reach 25 Predicted Bank Erosion Rates
Erosion Rate (tons/year/ft)
0.20
0.18
0.16
0.14
0.12
0.10
0.08
0.06
0.04
0.02
0.00
0
200
400
600
800
1000
1200
Stream Station (feet, downstream to upstream)
Colorado Curve
North Carolina Curve

Appendix D
Stream Assessment and Master Plan Map


Dubois Ridge Rd
State Road 45
Yellowwood Lake
Concept Plan 2 Design Reach
Concept Plan 1 Design Reach
Reach 1
Reach 2
Reach 3
Reach 4
Reach 5
Reach 6
Reach 7
Reach 8
Reach 9
Reach 10
Reach 11
Reach 12
Reach 13
Reach 14
Reach 15
Reach 16
Reach 17
Reach 18
Reach 19
Reach 20
Reach 21
Reach 22
Reach 23
Reach 25
Reach 26
Reach 27
Stantec
Legend
Stream
Watershed Boundary
BEHI Ratings
Extreme
Very High
High
Moderate
Moderate Low
Low
Very Low
Road
V:\1756\active\175649008\gis\mxd\Yellowwood_map2_2010_07.mxd
0 750 1,500 3,000 Feet
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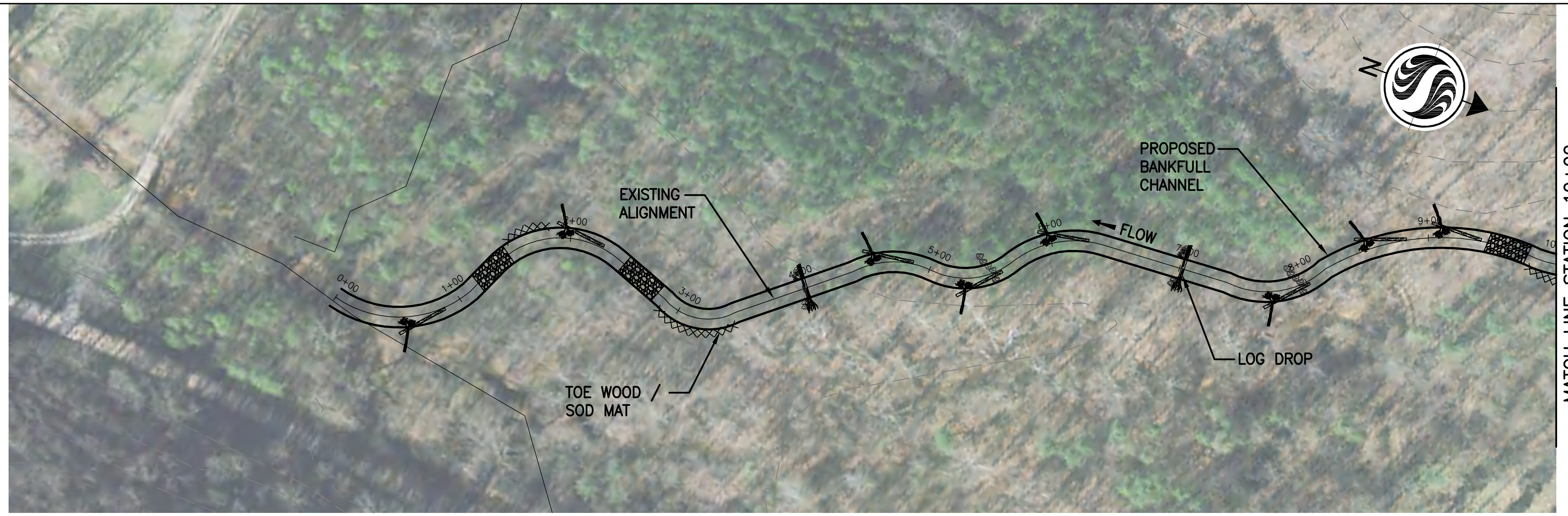
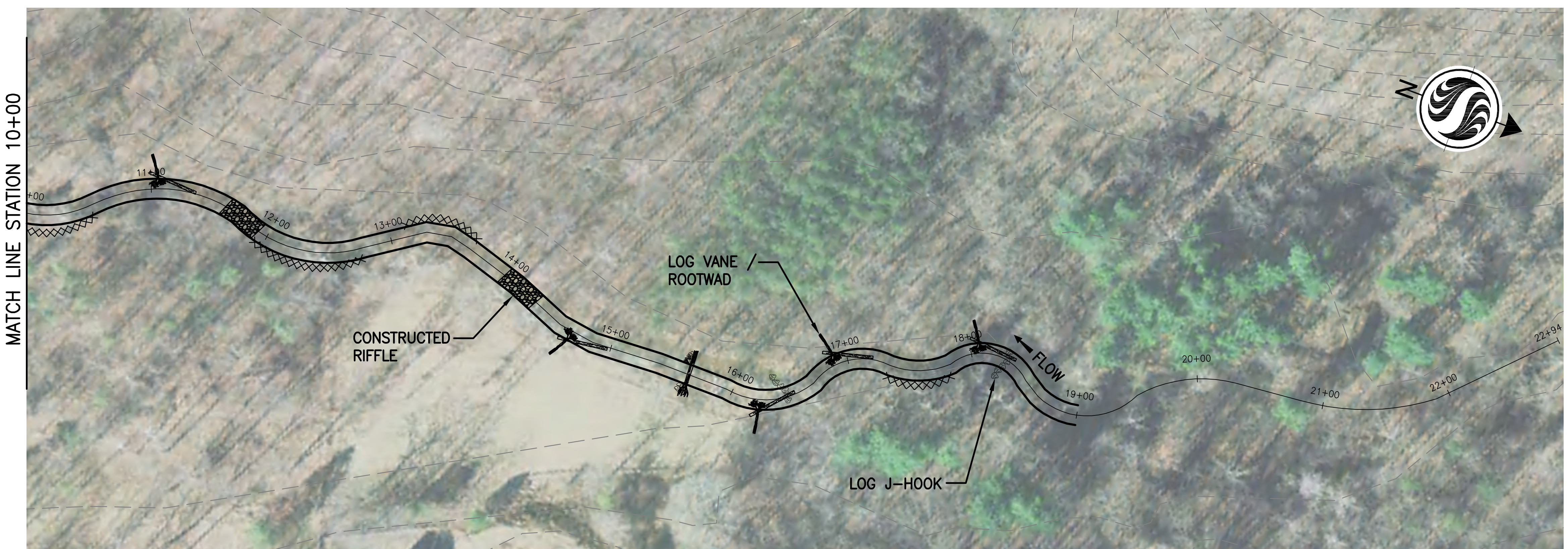
Map 2: Yellowwood Stream Assessment & Master Plan Map
Brown County, Indiana
PROJECT NO. 175649008
DATE 2010-07-19
DRAWN BY KSJ
CHECKED BY SDH
SCALE 1" = 1500'
REVISED
1.
2.

Appendix E
Conceptual Design Plans





0 50' 100'
1"=100'

August, 2010
175649008

Stantec

Stantec Consulting Services Inc.
1901 Nelson Miller Pky.
Louisville, Kentucky
40223-2177
Tel. 502.212.5000
Fax. 502.212.5055
www.stantec.com

Notes

CONCEPTUAL DESIGN
NOT FOR CONSTRUCTION

Client/Project

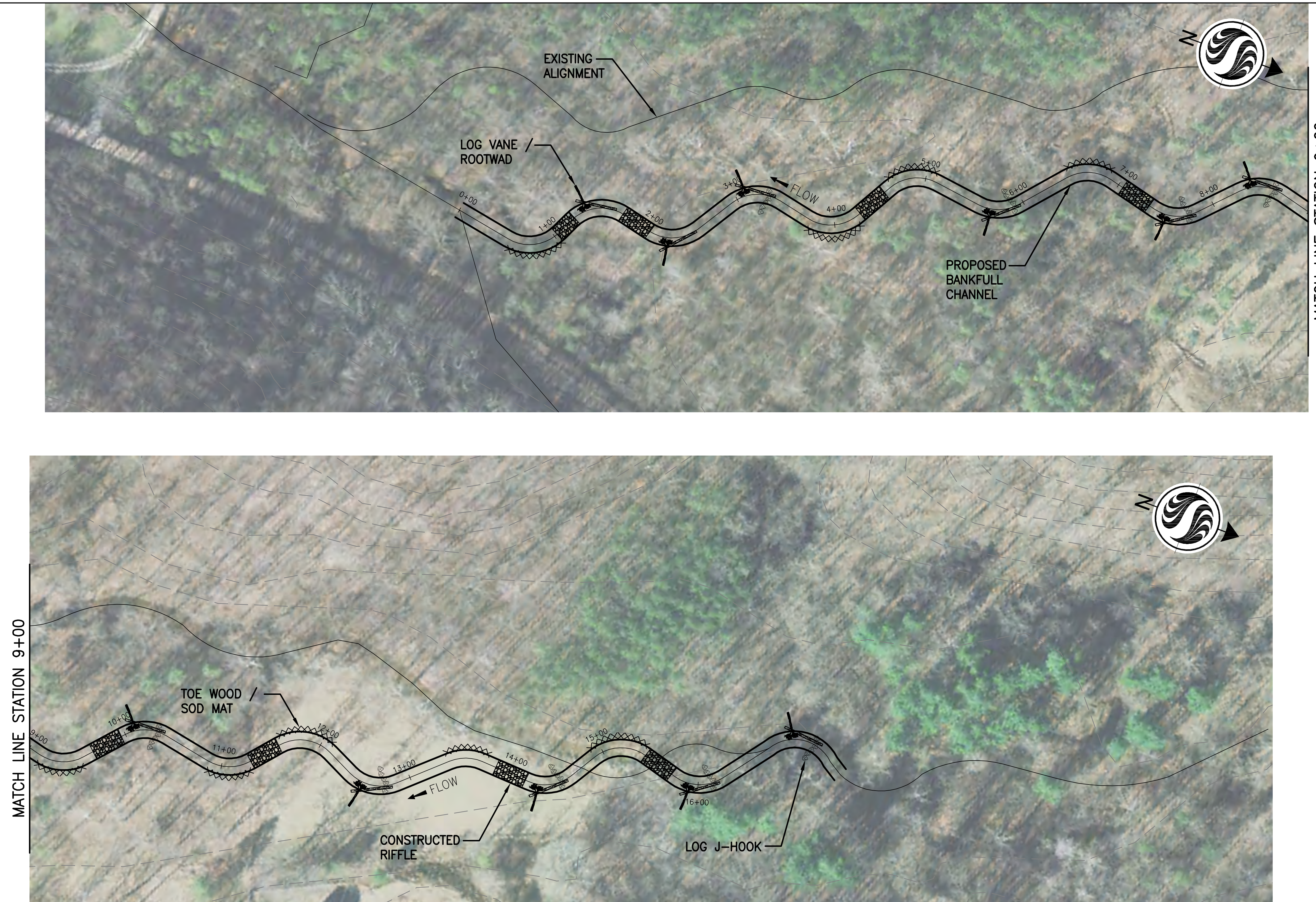
INDIANA DEPARTMENT OF NATURAL RESOURCES
YELLOWWOOD LAKE WATERSHED STREAM RESTORATION MASTER PLAN

Figure No.

1.0

Title

CONCEPTUAL PLAN 1 - OPTION 1
REACH 7A PRIORITY III RESTORATION



August, 2010
175649008

SaveDate: 2010/08/10 4:03 PM Login: Bradshaw, Steven
v:\1756\active\175649008\environmental\drawing\stream-7-opt-2.dwg

Stantec

Stantec Consulting Services Inc.
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40223-2177
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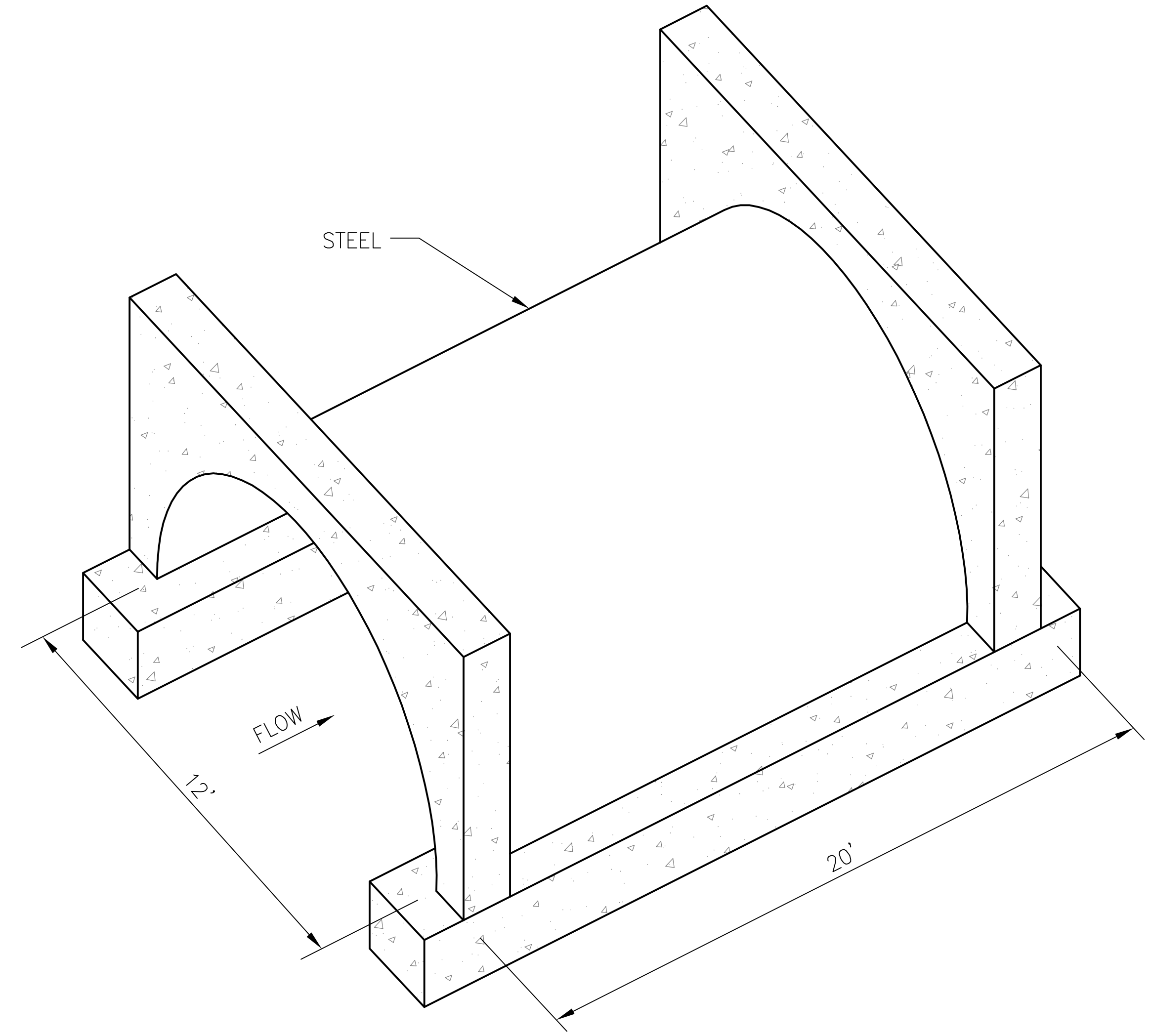
Notes

CONCEPTUAL DESIGN
NOT FOR CONSTRUCTION

Client/Project
INDIANA DEPARTMENT OF NATURAL RESOURCES
YELLOWWOOD LAKE WATERSHED STREAM RESTORATION MASTER PLAN

Figure No.
2.0

Title
CONCEPTUAL PLAN 1 - OPTION 2
REACH 7A PRIORITY I RESTORATION



DETAIL – STEEL ARCH BRIDGE SCHEMATIC
NOT TO SCALE

0 20' 40'
1"=40'

August, 2010
175649008

SaveDate: 2010/08/10 4:58 PM Login: Bradshaw, Steven
v:\1756\active\175649008\environmental\drawing\stream-6-opt-1.dwg

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Legend

CONCRETE

Notes

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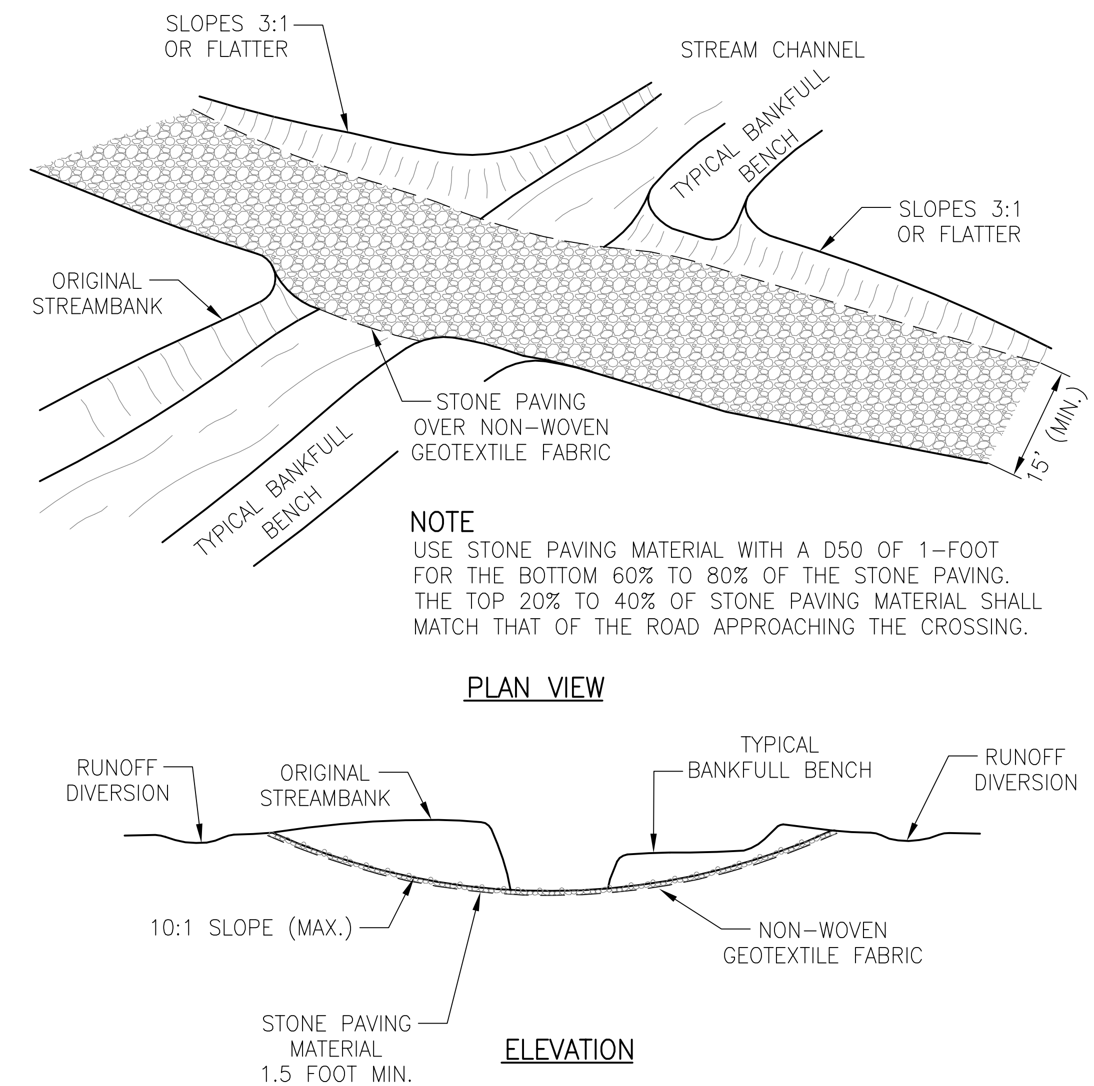
Client/Project
INDIANA DEPARTMENT OF NATURAL RESOURCES
YELLOWWOOD LAKE WATERSHED STREAM
RESTORATION MASTER PLAN

Figure No.
3.0

Title
CONCEPTUAL PLAN 2 - OPTION 1
REACH 6 CLEAR SPAN CROSSING



DETAIL – PERMANENT LOW WATER CROSSING
NOT TO SCALE

0 20' 40'
1"=40'

August, 2010
175649008

SaveDate: 2010/08/10 5:03 PM Login: Bradshaw, Steven
v:\1756\active\175649008\environmental\drawing\stream-6-opt-2.dwg

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Notes

CONCEPTUAL DESIGN
NOT FOR CONSTRUCTION

Client/Project
INDIANA DEPARTMENT OF NATURAL RESOURCES
YELLOWWOOD LAKE WATERSHED STREAM RESTORATION MASTER PLAN

Figure No.
4.0

Title
CONCEPTUAL PLAN 2 - OPTION 2
REACH 6 LOW WATER CROSSING

Appendix F
Funding Sources

Appendix F - Funding Sources

1. Indiana Department of Environmental Management Grants and Loans

1.1. Section 205(j) Grants

These grants are for water quality management planning, and can be used to determine the nature, extent and causes of point and nonpoint source pollution problems as well as develop plans to resolve these problems.

- **Who's Eligible:** Municipal governments, county governments, regional planning commissions, and other public organizations. For-profit entities, nonprofit organizations, private associations, and individuals are not eligible to receive this assistance.
- **Matching Contribution Required:** No match is required.
- **Who to Call:** Doug Campbell, NPS/TMDL Section, (317) 233-8491.
- **More Information:** http://www.in.gov/idem/5226.htm

1.2. Section 319(h) Grants

These grants are for projects that reduce documented nonpoint source water quality impairments.

Funds may be used to conduct assessments, develop and implement watershed and surface water monitoring plans, provide technical assistance, demonstrate new technology and provide education and outreach.

- **Who's Eligible:** Nonprofit organizations, universities, and federal, state, and local governmental units.
- **Matching Contribution Required:** 40% of the total project cost, federal funds cannot be used.
- **Who to Call:** Laura Bieberich, NPS/TMDL Section, (317) 233-1863.
- **More Information:** http://www.in.gov/idem/5225.htm

1.3. Recycling Grants

Each of these grants is intended to create sustainable projects with no state funding for ongoing program costs.

Note: The Recycling Grant Program has been temporarily suspended.

- **Who's Eligible:** Solid waste management districts, counties, municipalities, townships, schools, and nonprofit organizations with 501(c) status.
- **Matching Contribution Required:** 50% of the total project cost. See web site for further information.
- **Who to Call:** Office of Pollution Prevention and Technical Assistance (OPPTA), at (800) 988-7901
- **More Information:** http://www.in.gov/recycle/funding/

1.4. Wastewater (WWSRF) and Drinking Water (DWSRF)

SRF loans are designed to fund projects that improve drinking water and wastewater infrastructure in order to maintain water quality or provide other public health benefits.

Funds are available for improvements to wastewater plants, sewer line extension projects, corrections to sewage overflow problems, water storage facilities, and water line extension projects. Funds are also available for the costs associated with non-point source water pollution abatement projects such as wetland restoration/protection, erosion control measures, stormwater best management practices, and wellhead and source water protection measures.

Contact SRF staff to see if your project is eligible for a Small System Technical Assistance Fund (SSTAF) grant.

- **Who's Eligible:** Political subdivision including incorporated cities, towns, counties, regional sewer/water districts, conservancy districts and water authorities. Private and not-for-profit facilities are eligible only for drinking water SRF loans.
- **Rates:** Below market rates are adjusted quarterly and are based on median household income (2000 census data) and current user rates. Call for current interest rates and additional information.
- **Who to Call:** Sarah Hudson, Drinking Water SRF Administrator, (317) 232-8663 or Shelley Love, Wastewater SRF Administrator, (317) 232-4396
- **More Information:** http://www.in.gov/ifa/srf/

1.5. Boating Infrastructure Grant Program (BIG P)

This program is intended to provide funding (on a reimbursement basis) for the construction of facilities that will enhance boating for non-trailerable, (26 feet or over in length) transient recreational boats. "Transient" is defined as passing through or by a place, and staying 10 days or less.

Funding could be used for such projects as slips for transient boaters, mooring buoys, navigational aids to direct safe entry to facilities, and initial dredging to provide transient vessels with safe channel depths. These funds are subject to certain limitations and requirements. Call for additional information.

Boating facilities constructed under this program must be open to the public, designed to last for at least 20 years, continue to be used for their original stated grant purpose, and be maintained throughout their useful life.

- **Who's eligible:** All public marinas in Indiana which are situated along the shorelines of Lake Michigan and the Ohio River.
- **Matching Contribution Required:** 25% of the project cost, federal funds cannot be used.
- **Who to Call:** Tony Sullivan, Office of Pollution Prevention & Technical Assistance,
(317) 233-6663
- **More Information:**
http://www.in.gov/idem/5223.htm

1.6. Clean Vessel Act Grant Program

The primary goal of the Clean Vessel Act (CVA) is to reduce overboard sewage discharge from recreational boats. Boat sewage dumped into our waters may affect aquatic plants, fish, and other animals. The nutrients, microorganisms, and chemicals contained in human waste discharged from boats have a negative impact on coastal and inland waters, particularly in sheltered or shallow areas not naturally flushed by tide or current.

This program provides funding (on a reimbursement basis) for the construction, renovation, operation and maintenance of pump-out stations for holding tanks and dump stations for portable toilets. These funds are subject to certain limitations and requirements. Call for additional information.

• **Who's eligible:** All public marinas in Indiana which support recreational boats which are 26 feet and over in length and have portable or permanent on-board toilets.
• **Matching Contribution Required:** 25% of the project cost, federal funds cannot be used.
• **Who to Call:** Tony Sullivan, Office of Pollution Prevention & Technical Assistance,
(317) 233-6663
• **More Information:** http://www.in.gov/idem/5222.htm

Clean Vessel Act Public Notices:

- East Chicago Marina located at 3301 Aldis Avenue, East Chicago, Indiana 46312
- Rivercrest Marina located at 1200 W. 2nd Street, Madison, Indiana 47250
- Turtle Creek Harbor located at 206 6th Street, Florence, Indiana 47020

2. Indiana Department of Natural Resources Grants

2.1. Best Management Practices (BMP) Cost-Share Program

Logging operations in the State of Indiana are eligible to apply for cost-share dollars that will help defray the expense of BMP installations on harvest sites, depending on the location and timing of the harvest.

2.2. Community Forestry Grant Programs

Trees make our communities better places to live and work. Cities, towns and non-profit organizations can receive funding to enhance urban trees and forests. The Indiana DNR, Division of Forestry offers four grant programs that help improve, protect, maintain and increase the number of trees in Indiana communities. This federal and state funding is provided on an annual basis by the Indiana Department of Natural Resources and the U.S.D.A.

2.3. Develop a Shooting Range

The Indiana Shooting Range grant program provides assistance with the development of rifle, handgun, shotgun, and archery facilities. The main objective of this program is to provide the citizens of Indiana with additional and safer places to fire their guns, and train hunter education students.

2.4. Development of a New Park or Recreation Area

The Land and Water Conservation Fund grant program is to assist eligible governmental units in the provision of new park areas. Participation in outdoor recreation activities is expanding so rapidly that park agencies often face a real financial burden in attempting to provide enough facilities to keep up with the demand.

2.5. Fire Fighting Assistance for Rural Community Fire Departments

There are a number of programs aimed at assisting rural fire departments with needs ranging from equipment to training. Fire departments may serve either incorporated communities or unincorporated rural areas.

2.6. Forest Management Cost Share Programs

Many landowners may not be reaping their full benefits or providing adequate long term protection of forestlands. Cost share assistance is available to provide maximum watershed protection and erosion control, encourage abundant, healthy populations of wildlife, and maximum yields on timber harvests.

2.7. Historic Preservation and Archaeology

Each year the Division of Historic Preservation and Archaeology receives over $500,000 in federal funding under the Historic Preservation Fund (HPS) Program, which helps promote the U.S. Department of the Interior, National Park Service. The HPF Program helps promote historic preservation and Archaeology in Indiana by providing assistance to projects that will aid the State in meeting its goals for cultural resource management.

2.8. Hoosier Riverwatch

Hoosier Riverwatch has awarded grants to volunteer groups since 1996. These grant recipients form the foundation of the Hoosier Riverwatch volunteer stream monitoring network. Each grant provides up to $500 of water monitoring equipment. In return, grant recipients agree to monitor their selected stream or river segments at least four times per year for two years.

2.9. Lake and River Enhancement

The Lake and River Enhancement Program (LARE) was developed to ensure the continued viability of public-access lakes and streams. The program's goal is to utilize a watershed approach to reduce non-point source sediment and nutrient pollution of Indiana's and adjacent states' surface waters to a level that meets or surpasses state water quality standards. To accomplish this goal, grants are available for technical and financial assistance for qualifying projects.

2.10. Recreational Trails Program (RTP)

The Recreational Trails Program is a matching assistance program that provides funding for the acquisition and/or development of multi-use recreational trail projects. Both motorized and non-motorized projects may qualify for assistance. The assistance program is sponsored by the U.S. Department of Transportation’s Federal Highway Administration (FHWA).

http://www.in.gov/dnr/outdoor/4101.htm

3. Indiana Office of Federal Grants & Procurement

Message from the Governor

I created the Office of Federal Grants and Procurement (OFGP) by Executive Order on my first day in office in order to increase significantly the amount of federal dollars coming to our state. Indiana ranks at or near the bottom among states in terms of our success in bringing federal funds back from Washington, and now the state is determined to move quickly to improve our performance and our ranking.

The OFGP will serve as a valuable resource in helping agencies of state government identify and win competitive federal grants, provide them with training and technical assistance to improve their grant skills, and measure and track federal grant funding to the state. In order to leverage resources and increase Indiana's capacity to pursue and secure federal grants, the Office will also provide grant assistance and support to Hoosier universities, non-forprofits, and the business community.

To ensure that Indiana receives its fair share of federal funding in the future, the OFGP will work closely with the State's Washington D.C. Office and our strong Congressional Delegation to advocate for fair adjustments in federal grant formulas, and to develop strong relationships with key federal agencies that are best able to provide direct grant assistance to the state.

In addition to coordinating federal grant activity, the OFGP is dedicated to keeping Indiana businesses informed of opportunities to sell their products and services to the federal government. The Office will work closely with the business community to find ways for the federal government to "Buy Indiana" whenever possible.

Hoosier taxpayers deserve to know that we are making every effort to ensure that a fair portion of the monies they send to Washington each year come back to Indiana to help us meet the challenges we face in building infrastructure, training workers for new job opportunities, and caring for the sick and disabled. The OFGP will be the central focus of this Administration's efforts to obtain federal support wherever possible to support our goal of improving the lives Hoosier citizens and communities as we "Aim Higher" for Indiana's future.

Sincerely,

Mitch Daniels

http://www.in.gov/ofgp/index.htm

4. Federal Emergency Management Agency (FEMA) Grants

4.1. Buffer Zone Protection Program (BZPP)

Total Funding Available in FY 2010: $48 million

Purpose: BZPP provides grants to build security and risk-management capabilities at the State and local level in order to secure pre-designated Tier I and Tier II critical infrastructure sites, including chemical facilities, financial institutions, nuclear and electric power plants, dams, stadiums, and other high-risk/high-consequence facilities.

Eligible Applicants: Specific BZPP sites within 45 States have been selected based on their level of risk and criticality. Each State with a BZPP site is eligible to submit applications for its local communities to participate in and receive funding under the program. Therefore, BZPP funding allocated to any given State or territory is a function of the number, type, and character of the pre-identified sites within that State or territory.

http://www.fema.gov/government/grant/bzpp/index.shtm

4.2. Emergency Management Performance Grants

(Note: The most current information for this grant program is for FY 2008.)
The principal priority for the FY 2008 EMPG funds is to sustain and enhance catastrophic planning capabilities, to include addressing the findings of the FEMA gap analysis program address national and regional catastrophic planning needs. State and local jurisdictions should also continue to focus on addressing state-specific planning issues identified through the 2006 Nationwide Plan Review. In FY 2008, specific planning focus areas of evacuation planning, logistics and resource management, continuity of operations (COOP) / continuity of government (COG) planning, and recovery planning have been identified as national planning focus areas.

Total Funding Awarded in FY 2008: $291,450,000

http://www.fema.gov/emergency/empg/empg.shtm

4.3. Hazard Mitigation Grant Program

The Hazard Mitigation Grant Program (HMGP) provides grants to States and local governments to implement long-term hazard mitigation measures after a major disaster declaration. The purpose of the HMGP is to reduce the loss of life and property due to natural disasters and to enable mitigation measures to be implemented during the immediate recovery from a disaster. The HMGP is authorized under Section 404 of the Robert T. Stafford Disaster Relief and Emergency Assistance Act.

4.4. Flood Mitigation Assistance (FMA)

Provides funding to assist States and communities in implementing measures to reduce or eliminate the long-term risk of flood damage to buildings, manufactured homes, and other structures insurable under the NFIP.

4.5. Pre-Disaster Mitigation Grant Program (PDM)

Provides funds to states, territories, Indian tribal governments, communities, and universities for hazard mitigation planning and the implementation of mitigation projects prior to a disaster event.

4.6. Repetitive Flood Claims (RFC)

Provides funding to States and communities to reduce or eliminate the long-term risk of flood damage to structures insured under the NFIP that have had one or more claims for flood damages, and that cannot meet the requirements of the Flood Mitigation Assistance (FMA) program for either cost share or capacity to manage the activities.

4.7. Severe Repetitive Loss (SRL)

Provides funding to reduce or eliminate the long-term risk of flood damage to severe repetitive loss (SRL) structures insured under the National Flood Insurance Program (NFIP).

http://www.fema.gov/government/grant/hmgp/index.shtm