319 Nonpoint Source Final Project Proposal

FY2016 Final Proposals are due Monday, September 28, 2015

Section I: General Information

Project Title: Tobacco River Restoration Project - Phase 1 Final Design and Implementation

Project Sponsor Information

Sponsor Name: Lincoln Conservation District

Registered with the Secretary of State? Yes | Registered with SAM? Yes

County: Lincoln | Website: http://lincolncd.org/

Tax Identification # 81-0372019 | DUNS # 009437082

Primary Contact: Becky Lihme	Signatory: Darris Flanagan
Title: District Administrator	Title: Chairperson, Lincoln Conservation District
Address: 949 U.S. Highway 93 North / P.O. Box 2170	Address: 949 U.S. Highway 93 North / P.O. Box 2170
City: Eureka State: Montana Zip Code: 59917	City: Eureka State: Montana Zip Code: 59917
Phone Number: (406) 297-2233	Phone Number: (406) 297-2233
Fax Number: (406) 296-7188	Fax Number: (406) 296-7188
E-mail Address: lincolncd@interbel.net	E-mail Address: lincolncd@interbel.net
Signature: Becky Lihme	Signature: Darris R. Flanagan

Project Location

12 Digit HUC #(s): 170101010306 (Tobacco River)

(1) Waterbody Name from 2014 List of Impaired Waters: Tobacco River

(1) Probable cause(s) of impairment to be addressed (ex. metals): 1) Sedimentation / Siltation 2) Physical Substrate Habitat Alteration

(2) Waterbody Name from 2014 List of Impaired Waters:

(2) Probable cause(s) of impairment to be addressed (ex. metals):

(3) Waterbody Name from 2014 List of Impaired Waters:

(3) Probable cause(s) of impairment to be addressed (ex. metals):

Activity 1 Name: Tobacco River Restoration Project - Phase 1	Latitude (1): 48, 53' 19" North	Longitude (1): 115, 4' 19" West
Activity 2 Name:	Latitude (2):	Longitude (2):
Activity 3 Name:	Latitude (3):	Longitude (3):

Nonpoint Source (NPS) Information

Which WRP does the project implement? Kootenai Basin WRP | What is the WRP status? Under Development

Does the project address impairments identified in a TMDL? Yes | Waterbody Type: River/Stream

Functional Category: Stream Bank Stabilization

Pollution Category		Percent of Total (%)
1st Pollution Category	Hydromodification (Channelization)	30
2nd Pollution Category	Hydromodification (Removal of Riparian Vegetation)	30
3rd Pollution Category	Hydromodification (Streambank or Shoreline Modification/Destabilization)	30
4th Pollution Category	Resource Extraction (Sand/Gravel Mining)	10

Project Funding

319 Funds Requested	$288,996.00	Does the project sponsor have any open 319 contracts?	No
Matching Funds		Project Title	
State Cash Match		DEQ Contract Number	
Local Cash Match		319 Award	
In-Kind Match	$192,664.00	Projected Closing Date	
Total Match	$192,664.00	Project Title	
Other Federal Funds	$0.00	DEQ Contract Number	
Total Project Budget	$481,660.00	319 Award	
Administrative Fee	$20,750.00	Projected Closing Date	

Section II: Project Description

Goal and Objectives: Describe the overall goal and specific objectives for this project.

The goal is to improve water quality and river and floodplain processes by restoring a 0.4 mile reach of the Tobacco River near Eureka, Montana. This is Phase 1 of a two-phase project (see Page 11). Objectives include: 1) Reducing sediment inputs to the river resulting from severe streambank and terrace erosion; 2) Improving riparian and floodplain conditions by establishing a vegetated buffer and channel migration zone along the entire length of the project area; and 3) Creating complex aquatic habitat components to support life history stages of native bull trout and westslope cutthroat. The project will enhance habitat conditions in this important reach of the Tobacco River which serves as a critical migratory corridor to spawning and rearing tributaries in the Upper Tobacco River drainage.

Methods: Describe the approach selected to address/correct the problem(s), e.g. types of BMPs to be installed, and other important activities.

The restoration methods are based on the premise of natural channel design that involves restoring fluvial and biological processes so the Tobacco River can be self-maintaining in the long-term. The project will: 1) reconstruct a meandering, riffle-pool, gravel bed stream type (2,120 feet): 2) create/restore 2.0 acres of riparian floodplain; and 3) treat approximately 2,400 feet of highly eroding streambank with bioengineered treatments including vegetated wood and brush fascines, vegetated soil lifts, and plantings. Restoration design components include: 1) channel and floodplain construction; 2) point bar development; 3) bank restoration; and 4) establishment of a diverse, native riparian vegetation community within the constructed floodplain. These components are integral to: 1) curbing accelerated bank erosion; and 2) providing clean, cold water to support designated beneficial uses. Alternatives to river and floodplain reconstruction were considered but dismissed from further consideration due to the high degree of floodplain disconnection, and geotechnical instability of streambanks. In order to successfully restore natural processes and reduce sediment loading, it is necessary to correct the dimension, pattern, and profile of the river.

Summary: Provide a brief summary of the project.

The Tobacco River is a fifth order watershed draining approximately 440 square miles between the Kootenai River on the west, the Whitefish Range on the east, and the Salish Mountains to the south. The Tobacco River is an important spawning and rearing habitat corridor for fluvial and adfluvial fish populations inhabiting the upper Kootenai River drainage. Bull trout and wetstlope cutthroat trout utilize the mainstem Tobacco River as a migratory corridor to spawning and rearing tributaries including Grave Creek. Populations of both species have declined due to habitat loss caused by poor grazing practices, sedimentation, mining, agriculture, and others (MDEQ 2011). The Tobacco River has been identified by MDEQ as water quality impaired due to sedimentation and siltation resulting from grazing in riparian areas and streambank modifications. The TMDL, and WRP (in progress) provide recommendations on restoration strategies to reduce sediment inputs to the Tobacco River. This project phase will address severe streambank erosion resulting from channelization, past gravel mining operations, removal of riparian vegetation, and overgrazing.

In 2013, the landowner, Kassler Family Limited Partnership, paid for and completed a preliminary restoration design a 5,200 foot reach of the Tobacco River. In 2014, Lincoln Conservation District (LCD) was awarded a DNRC Resource Development Bureau grant to complete a watershed-scale analysis and 75% restoration plan for the same reach. 319 funding will be used to complete the restoration design, prepare and apply for regulatory permits, implement construction, conduct effectiveness monitoring and reporting, and develop and implement a public eduction and outreach program. These planning documents are included as attachments to this grant.

Section III: Background Information

Statement of Project Need and Intent

This project is needed to facilitate EPA mandated sediment reduction targets established in the 2011 Tobacco Planning Area Sediment TMDLs and Framework Water Quality Improvement Plan (MDEQ 2011). This project will substantially reduce sediment loading by restoring approximately 0.5 miles of severely eroding streambank, re-establishing functioning floodplain surfaces, and reducing channel width to depth ratios along 0.4 miles of the Tobacco River. The Kootenai River Basin Watershed Restoration Plan (July 31, 2015 draft) identifies non-point source management measures and restoration projects that will address the causes of water quality impairment in the Kootenai Basin, including the Tobacco River. Human sources of sediment to the Tobacco River identified in the WRP include, among others, channel modifications and riparian revegetation removal. This proposed project addresses the primary causes and sources of water quality impairment by implementing channel, floodplain and streambank restoration actions recommended in the WRP (see Section 4.1.9 of draft WRP). Techniques are described below and in the attached Tobacco River Restoration Project Preliminary Design plan set and accompanying reports (see attachments).

Describe the pre-project planning that has already occurred.

Significant grass root efforts have been made to facilitate restoration of this reach of the Tobacco River. In 2013, Kassler Family Limited Partnership, LLC, with assistance from LCD, developed a conceptual restoration plan that described the factors limiting water quality in the project area, identified project goals, and developed preliminary drawings illustrating the desired future condition of the river and floodplain. The report and conceptual design was submitted to the DNRC Resource Development Bureau, and in 2014, LCD received a $50,000 grant to develop a preliminary restoration design for the project area. The preliminary design drawings and report, which are included as attachments to this 319 grant application, represent a 75% level design and was developed by a multi-disciplinary team comprised of engineers, hydrologists, wetland ecologist and fisheries biologists from state and federal agencies, as well as private consulting.

In anticipation of the project, the landowners have gathered and stockpiled restoration materials that will be used as in-kind match. The landowners are also committed to sustainable grazing management practices, and are working with the Natural Resources Conservation Service and lessee to develop an improved grazing management plan for the properties that excludes grazing from riparian floodplain areas that will be restored as part of this project.

Collaborative Effort: Describe the collaborative effort you have engaged in to ensure support from all appropriate partners.

As reflected in the attached letters of support, the landowners and local, state and federal agencies are fully supportive of this project which has been conceptualized and developed over the past several years through a collaborative process. The attached letter from landowner Karl Kassler outlines the family's stewardship ethic and actual contributions to this project. Agencies who have contributed to this project to date include the U.S. Fish and Wildlife Service, Natural Resources Conservation Service, Montana Fish, Wildlife & Parks, Department of Natural Resources and Conservation, and LCD. As the main project sponsor, LCD has worked in earnest with the landowners and the greater Eureka community to generate enthusiasm and support for the project. Through meetings and field tours, the project concepts have been well vetted and reflect input received from the community at large. The landowners envision this project will be an important asset to the community by providing both education as well as recreational opportunities immediately adjacent to downtown Eureka and the existing Eureka Rails to Trail trail network.

Partners and Roles: Identify the project partners and their roles.

Partner	Role
Lincoln Conservation District	- Project Lead / Grant Administrator / Public Education and Outreach
Kassler Family Limited Partnership, LLC Jim Bushfield	- Landowners / In-Kind Donation of Restoration Materials / Community Outreach
D.N.R.C. Resource Development Bureau	- Stakeholder / Funding to Prepare Preliminary Design
Montana Fish, Wildlife and Parks Natural Resources Conservation Service	- Stakeholder / Technical Review of Preliminary and Final Design Deliverables - Fisheries and Grazing Management Technical Assistance
Kootenai River Network, Inc.	- Stakeholder / Lead Organization for Development of Kootenai Basin W.R.P. (In Progress)

Technical and Administrative Qualifications

LCD will assume the lead role in administering the contract with MDEQ and subcontractors. LCD has a proven track record in applying for, receiving, and managing contracts, the most recent example being the DNRC Resource Development Bureau $50,000 planning grant.

LCD and Kassler Family Limited Partnership, LLC have contracted with River Design Group, Inc. (RDG) on previous phases of this project, including the conceptual and preliminary restoration plans. RDG is a private consulting firm based in Whitefish, Montana specializing in river, stream and wetland restoration projects in the Pacific Northwest and Intermountain West states. RDG maintains the highest level of technical expertise and a well-trained multi-disciplinary staff that works exclusively in the river environment. RDG will provide the following services: 1) finalize construction plans including drawings and technical specifications; 2) prepare and submit local, state and federal project permitting; 3) provide construction stakeout and construction oversight; and 4) implement monitoring plan and prepare as-built documentation.

Attached to this grant application are the planning documents prepared for both the conceptual restoration plan (2013) and preliminary restoration design (2014). The documents demonstrate the contractor's technical capacity and approach to the project, which has included detailed engineering analysis supported by geomorphic and biological based assessments of reference reach conditions on the Tobacco River upstream of the project area.

Past and Current Projects

Funding Organization	Award Amount	Project Description	Project Status	Contact Information
Kassler Family Limited Partnership, LLC	$10,000.00	- 2013 Conceptual Restoration Plan Development (Cash Contribution) *See Attachment Landowner with assistance from LCD retained River Design Group, Inc. to complete a river corridor assessment and prepare a conceptual restoration plan for the Tobacco River on the Kassler and Bushfield properties.	Completed	Karl Kassler, Landowner (406) 549-0026
D.N.R.C. Resource Development Bureau	$50000.00	- 2014 75% Restoration Plan Development (Grant Award) *See Attachment Grant award funded a 75% design for a 1 mile reach of the Tobacco River on the Kassler and Bushfield properties. The design facilitated the 319 grant application and identified next steps in the planning process leading to implementation.	Completed	Becky Lihme Lincoln Conservation District (406) 297-2233
Kassler Family Limited Partnership, LLC	$7,500.00	- 2014 75% Restoration Plan Development (Cash Match) Kassler Family Limited Partnership provided a cash match of $7,500 to complete the 75% design.	Completed	Karl Kassler, Landowner (406) 549-0026

Section III: Scope of Work

Task 1 Title Project Management and Grant Administration

Description

This task will be completed by LCD. Sub-tasks will include acquiring landowner agreements, completing monthly status reports, communicating (both oral and written) with Montana DEQ, landowners and other state, federal and local agencies, and general administration of the grant including quarterly invoicing and reporting. LCD will assist Contractor with preparation of regulatory permit applications under Task 1 as needed.

LCD will also manage and oversee the selected engineering firm who will perform the work described under Tasks 2-4. This will include overseeing the sub-contract for final design and permitting, construction implementation, and effectiveness monitoring.

Deliverables

- Signed landowner agreement
- Quarterly status reports for life of contract
- Annual status reports for life of contract
- Quarterly invoicing
- Assistance with Joint Permit Application

Task 1 Funding

319 Funds	$20,750.00
Non-Federal Match	$0.00
Other Federal Funds	$0.00
Total Cost	$20,750.00
Is Match Secured?	No

Timeline 2016-2018

Match Source N/A

Task 2 Title Final Design Engineering and Regulatory Permitting

Description

Contractor will finalize design documents (plan set, drawings, specifications) and prepare regulatory permit applications. This task will be completed in close coordination with landowners, regulatory agencies, and funding partners. Final design tasks will include:

1) Hydraulic and sediment transport modeling to develop final design criteria for channel and floodplain;
2) Channel and floodplain grading plans (plan and profile sheets, channel cross sections);
3) Streambank and channel treatments (details, drawings and specifications); and
4) Streambank and floodplain riparian revegetation plan.

Contractor shall prepare and submit the following regulatory permit applications: 1) 310 Permit (Lincoln Conservation District); 2) Floodplain Development Permit (Lincoln County / DNRC); 3) Section 404 Permit (US Army Corps of Engineers); 4) 318 Authorization (Montana DEQ); and 5) Navigable Rivers Land Use License, if applicable (Montana DNRC).

Deliverables

- Final Restoration Plan Set, Drawings and Specifications
- Completed 310 Permit
- Completed Floodplain Development Permit
- Completed Section 404 Permit and Nationwide 27 Guidance Document
- Completed 318 Authorization
- Completed Navigable Rivers Land Use License, If Applicable

Task 2 Funding

319 Funds	$25,500.00
Non-Federal Match	$5,000.00
Other Federal Funds	
Total Cost	$30,500.00
Is Match Secured?	Yes

Timeline 2016-2018

Match Source Contractor

Task 3 Title Construction Implementation

Description

This task includes preparing bid packages, conducting contractor tours of the project area, reviewing bids, and awarding the contract. Prior to construction, the project will be staked using GPS by a qualified oversight personnel involved with the project design. Equipment restriction zones will be flagged and identified, including sensitive riparian and wetland areas located within the project area. All trees will be gathered on site from upland borrow areas located on the Kassler and Bushfield properties. The landowner has contributed up to $188,634 of in-kind materials to the project, including screened alluvium, rock, and trees. All revegetation and restoration materials will be inspected and approved by the Engineer prior to construction.

Equipment to be used during construction include off-road haul trucks, 200-class excavators with hydraulic thumbs or equivalent, a D8 dozer, and skidsteer. Prior to construction, all applicable BMP's will be installed including silt fences, straw wattles, and temporary bypass channels to minimize turbidity. Construction will be supervised by a qualified Stream Restoration Specialist (Contractor). Elevations, grading, and installed streambank restoration structures will be inspected and approved. GPS surveys will be completed to document the post-restoration conditions, and to facilitate preparation of the project completion report and QAPP/SAP, as described for Task 4.

Deliverables

- 2,120 feet of channel construction and restoration
- 2,400 linear feet of streambank restoration and revegetation
  + Approximately 6,000 riparian cuttings
  + Approximately 150 5-gallon containerized plants
  + Approximately 1,000 1-gallon containerized plants
- 2.1 acres of riparian floodplain restoration and revegetation
  + Approximately 175 5-gallon containerized plants
  + Approximately 1,000 1-gallon containerized plants

Task 3 Funding

319 Funds	$231,746.00
Non-Federal Match	$177,964.00
Other Federal Funds	
Total Cost	$409,710.00
Is Match Secured?	Yes

Timeline 2016-2018

Match Source Kassler Family Limited Partnership / Jim Bushfield (Owners)

Task 4 Title As-Built Documentation and Effectiveness Monitoring

Description

LCD will develop a Quality Assurance Project Plan / Sampling and Analysis Plan (QAPP/SAP) to evaluate the effectiveness of the project in reducing streambank erosion and sediment loading to the Tobacco River. Sediment loads will be predicted before and after restoration using the Bank Assessment for Non-Point Source Consequences of Sediment (BANCS) model (Rosgen 2001a). Vegetation sampling will be completed to document trends in floodplain and streambank plant community establishment and revegetation treatment effectiveness, including: 1) containerized plant survival; 2) percent cover of woody vegetation on restored streambanks; and 3) floodplain transects to document riparian plant community successional processes.

Geomorphic monitoring parameters will include Wolman pebble counts (2), channel cross-sections (6), photo points (10), and a complete as-built longitudinal profile (2,120 feet). The monitoring plan will be developed based on input from MDEQ and project stakeholders.

Deliverables

- QAPP/SAP Monitoring and As-Built Documentation Report
  + Pre-construction sediment loading analysis utilizing BANCS model (Rosgen 2001a)
  + Post-construction sediment loading reduction analysis utilizing BANCS model (Rosgen 2001a)
  + Greenline transects and effectiveness monitoring of floodplain and streambank revegetation
  + As-built channel cross-sections (6), longitudinal profile (2,120 feet), and Wolman pebble counts
  + Project Photo Points (Before/After)

Task 4 Funding

319 Funds	$7,500.00
Non-Federal Match	$2,000.00
Other Federal Funds	
Total Cost	$9,500.00
Is Match Secured?	Yes

Timeline 2018

Match Source Contractor

Task 5 Title Education and Outreach

Description

LCD envisions this project to be a "showpiece" for other potential projects on the Tobacco River and adjacent waterbodies. The project area also includes a one-mile section of the Eureka Rails to Trails trail system, which will provide opportunities to showcase the project to the community. The project will be displayed and highlighted on LCD's website, and articles will be submitted to the local newspapers, MACD newsletter "Montana Conservationist", and Montana NRCS newsletter. An educational display will be developed and hosted at the Lincoln County Fair, and a permanent interpretive/educational display will be developed and installed along the Eureka Rails to Trails trail system adjacent to the project area. For all components of the education and outreach program, the target audience will include the greater community of Eureka, Lincoln Count and City of Eureka officials, the Eureka school district, local contractors, and project stakeholders.

Deliverables

- Educational displays, including a permanent display to be installed along the Eureka Rails to Trails trail network adjacent to the project area
- Conduct field tour of project area with project stakeholders and general public, both during and following construction
- Organize tour of other successful watershed restoration projects in the Eureka area
- Highlight project on LCD website and display at Lincoln County Fair
- Articles to local newspapers, MACD newsletter "Montana Conservationist", and Montana NRCS newsletter

Task 5 Funding

319 Funds	$3,500.00
Non-Federal Match	$3,500.00
Other Federal Funds	
Total Cost	$7,000.00
Is Match Secured?	Yes

Timeline 2016-2018

Match Source Lincoln Conservation District

Task 6 Title

Description

Deliverables

Task 6 Funding

319 Funds	
Non-Federal Match	
Other Federal Funds	
Total Cost	
Is Match Secured?	

Timeline

Match Source

Detailed Project Budget

Task Number and Specific Action	319 Funds	State Cash Match	Local Cash Match	In-Kind Match	Federal Funds	Total Costs
Task 1. All Sub-Tasks Identified in Section III	$20,750			$0		$20,750
Task 2a. Final Design Documents	$20,500					$20,500
Task 2b. Regulatory Permitting	$5,000			$5,000		$10,000
Task 3a. Channel and Floodplain Construction	$212,000					$212,000
Task 3b. Revegetation (Streambank and Floodplain)	$19,746					$19,746
Task 3c. Materials (Trees, Alluvium, Growth Media)				$182,164		$182,164
Task 4a. Prepare QAPP/SAP	$2,500					$2,500
Task 4b. Prepare As-Built Monitoring Report	$5,000			$2,000		$7,000
Task 5a. Articles, Website Development, Project Tours				$3,500		$3,500
Task 5b. Develop and Install Interpretive Display	$3,500					$3,500
TOTAL	$288,996			$192,664		$481,660

Project Milestone Table: Complete the following Project Milestone Table by entering task numbers and titles in the left hand column, then check the box(es) for the appropriate quarter(s) and years(s) in which you will be working on the task.

Milestone	Spring 2016	Summer 2016	Fall 2016	Winter 2016	Spring 2017	Summer 2017	Fall 2017	Winter 2017	Spring 2018	Summer 2018	Fall 2018
Task 1. All Sub-Tasks Identified in Section III	☒	☒	☒	☒	☒	☒	☒	☒	☒	☒	☒
Task 2a. Final Design Documents	☐	☒	☒	☒	☐	☐	☐	☐	☐	☐	☐
Task 2b. Regulatory Permitting	☐	☐	☐	☒	☒	☒	☒	☐	☐	☐	☐
Task 3a. Channel and Floodplain Construction	☐	☐	☐	☐	☐	☐	☐	☐	☐	☒	☒
Task 3b. Revegetation (Streambank and Floodplain)	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☒
Task 3c. Materials (Trees, Alluvium, Growth Media)	☐	☐	☐	☐	☐	☐	☐	☐	☒	☒	☒
Task 4a. Prepare QAPP/SAP	☐	☐	☐	☒	☒	☐	☐	☐	☐	☐	☐
Task 4b. Prepare As-Built Monitoring Report	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☒
Task 5a. Articles, Website Development, Project Tours	☐	☒	☒	☐	☐	☒	☒	☐	☐	☒	☒
Task 5b. Develop and Install Interpretive Display	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☒
Completion Report and Project Closeout	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☒

Submit **project map(s)** and **letters of support (at least 3)** along with the Final Project Proposal form. If your organization is not the author of the WRP you hope to implement, you must request a letter of support from the original authoring entity. If the authoring entity refuses to provide a letter of support, use the additional space at the end of the application to describe their response. If design drawings are available, provide those as well. For on-the-ground work, include copies of applicable permits if available.

☒ Project Map

☒ Letters of Support

☒ Design Drawings

☐ Applicable Permits

☒ Draft of amended WRP (if applicable)

☒ Photos

☒ Landowner Agreements

Use the space provided for any additional information that may not have been captured elsewhere in this Final Project Proposal

Implementation of the Tobacco River Restoration Project will require a multi-year (2-3), phased implementation schedule base on funding availability. The total project length is 1.1 miles. This grant will fund implementation of the upper 0.4 miles of the project. Since 2003, state and federal agencies provided funding for several large-scale restoration projects in the Upper Tobacco River drainage, including Grave Creek (2003-2010), Therriault Creek (2006-2012), and Sinclair Creek (2013). These tributary projects restored aquatic habitat conditions for bull trout and westslope cutthroat trout with an emphasis on migratory, rearing, and adult overwintering habitat. Implementation of the Tobacco River Restoration Project will further watershed restoration efforts by improving migratory habitat conditions that are critical for the life history stages of bull trout and westslope cutthroat trout.

Alternatives to channel and floodplain restoration were analyzed, but dismissed from further consideration due to the degree of channel incision, floodplain disconnection, geotechnical instability of streambanks related to channel incision, and past straightening of the river that continues to impair natural river and floodplain ecosystem processes. In order to effectively reduce sediment loading, improve water quality, and improve aquatic habitat conditions and beneficial uses, it is necessary to re-establish the proper channel geometry, including longitudinal profile, cross-section, and planform dimensions. Reference reach investigations, hydraulic modeling, and empirical methods were used to guide development of the preliminary restoration design. Design criteria will be refined as part of the final design process.

ATTACHMENTS

Project Map
Refer to Preliminary Design Report

Letters of Support

Design Drawings

WRP Draft

Photos
Refer to Conceptual Restoration Plan & Preliminary Design Report

Landowner Agreement

Tobacco River Restoration Project Preliminary Design Report

Eureka, Montana
Lincoln County

Submitted To
Lincoln Conservation District
PO Box 2170
Eureka, Montana 59917

Lincoln Conservation District

Submitted By
River Design Group, Inc.
5098 Hwy 93 South
Whitefish, Montana 59937

River Design Group, Inc.

January 2015

This page left intentionally blank

Contents

1 Introduction

1.1 Project Background

Lincoln Conservation District (LCD) in cooperation with the Montana Department of Natural Resources and Conservation (DNRC) and Kassler Family Limited Partnership retained River Design Group, Inc. (RDG) to develop a preliminary restoration plan for a one-mile reach of the Tobacco River located in Lincoln County near the town of Eureka, Montana (Figure 1). Subject to riparian grazing, gravel extraction, riparian modifications, and channelization, the Tobacco River on the Kassler property is currently functioning in an impaired condition due to excessive streambank erosion, channel widening, and loss of floodplain connection.

In 2012, RDG prepared a conceptual restoration plan for the project area. The plan provided a summary of existing river and floodplain conditions, and presented a range of restoration treatments intended to address the causes and sources of water quality and aquatic habitat impairment. In 2014, Lincoln Conservation District was awarded a grant through the Montana DNRC Resource Development Bureau to fund preliminary engineering services. In January 2015, RDG submitted the Tobacco River Restoration Project Preliminary Design plan set to LCD. The 31 page plan set provides detailed information and drawings illustrating the preliminary design.

1.2 Document Purpose

This purpose of this report is to summarize the preliminary design process; specifically the results of the hydrology and hydraulic analyses used to support development of the channel and floodplain design. It is a companion document to the Tobacco River Restoration Project Preliminary Design plan set. This report is organized in five sections including:

- **Section 1. Introduction** provides a brief summary of the project background and purpose of this document;
- **Section 2. Hydrologic Analysis** summarizes the results of the hydrologic analysis used to estimate the discharges used for channel and floodplain design;
- **Section 3. Hydraulic Analysis** describes the hydraulic modeling effort used to evaluate the preliminary channel and floodplain design in terms of hydraulic performance and sediment transport continuity;
- **Section 4. Design Criteria** summarizes the preliminary design criteria; and
- **Section 5. Conclusion and Next Steps** summarizes the subsequent planning and design steps that will be required to finalize the design and bid package for construction.

Figure 1-1. Project area vicinity map.

2 Hydrologic Analysis

This section describes the hydrologic analysis used to estimate the discharges for developing channel and floodplain design criteria. The results presented in this section form the basis for the range of discharges modeled as described in Section 3 of this report. Methods and results are described in the following sections.

2.1 Watershed Hydrology

The project area has a catchment area of 403 square miles with a mean basin slope of 7.5%, approximately 80% forest cover, and mean annual precipitation of 30 inches (Figure 2). There is one long-term stream gage on the Tobacco River in the vicinity of the project area. The U.S. Geological Survey (USGS) gage Tobacco River near Eureka, Montana (Station No. 12301300) is located approximately two miles downstream of the project area. A summary of the gage information is provided in Table 2-1.

Table 2-1. Summary of Tobacco River USGS stream gage data.

Gage #	Name	Drainage Area (mi^2)	Period of Record	Gage Datum	Distance from Project Area
USGS 12301300	Tobacco River near Eureka, MT	418.6	WY 1958 - 2014	2,518.85 ft NGVD29	2 miles downstream

The published drainage area for the Tobacco River near Eureka USGS gaging station is 418.6 square miles (USGS 2014). The effective drainage area at the gage was calculated at 407.7 square miles with the difference being attributable to Ksanka Creek, a tributary that historically joined the Tobacco River near the downstream end of the project area. Currently, Ksanka Creek is diverted for agricultural use with excess flows returning to Indian Creek which enters the Tobacco River downstream of the USGS gaging station. The catchment area at the upstream limit of the project area is 402.6 square miles, which is approximately 98% of the effective drainage area reported for the USGS gaging station. Due to the proximity of the USGS gage to the project area, hydrology derived from gage analysis was utilized for hydraulic design investigations. Hydrologic statistics were estimated by evaluating the gage record and regional regression equations developed by the USGS. Mean daily flows for the Tobacco River for the available period of record are summarized in Figure 2-2.

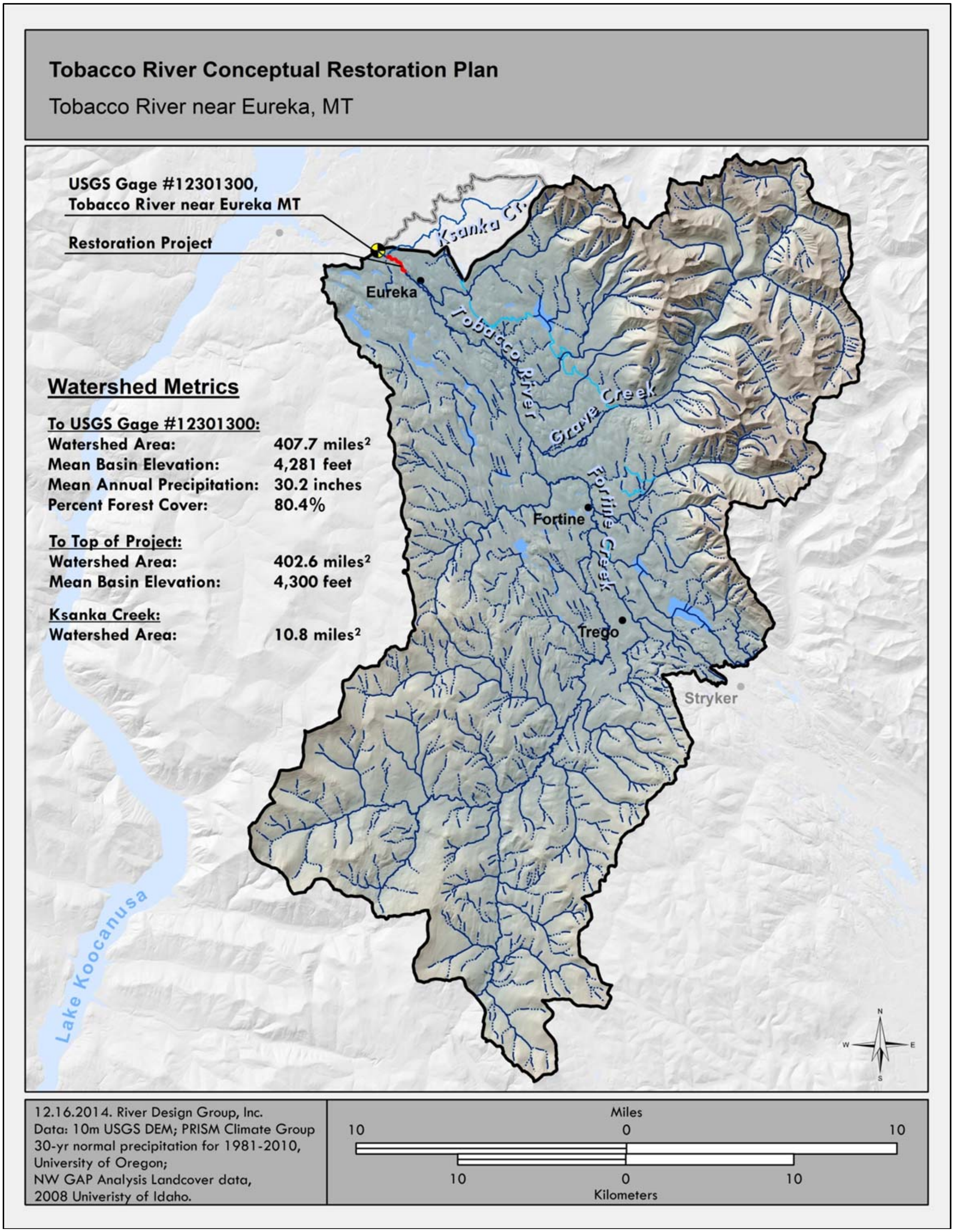


Figure 2-1. Tobacco River USGS gaging station location and watershed summary metrics.

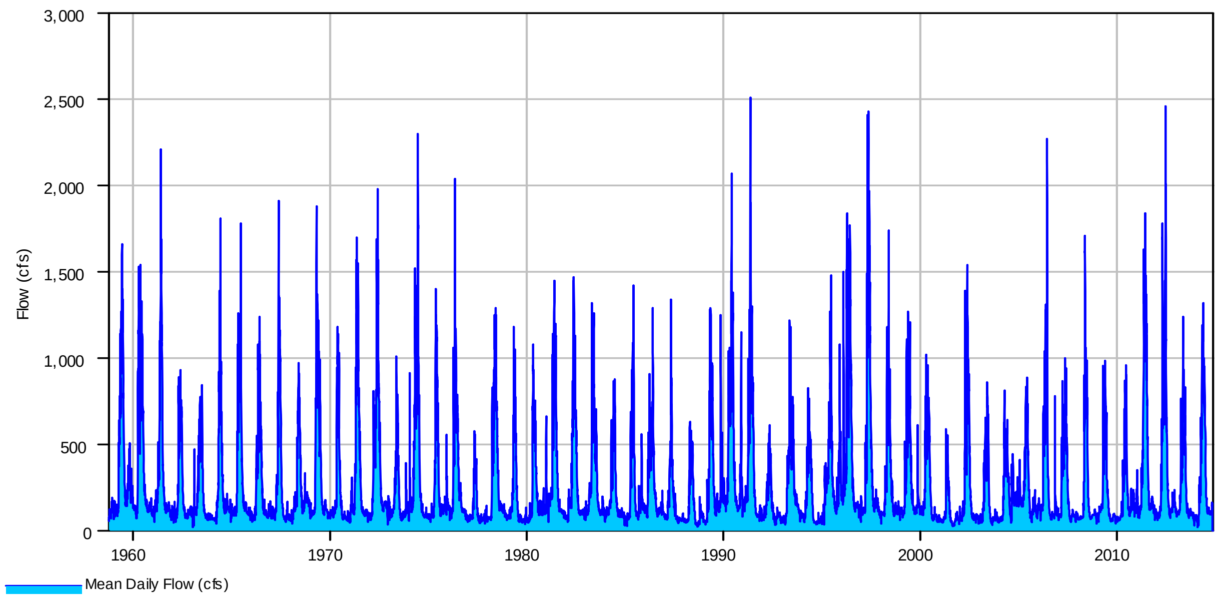


Figure 2-2. Summary of mean daily flows for WY 1958-2014 at Tobacco River near Eureka USGS gaging station.

2.2 Flood Series Estimation

Measured peak flows from the Tobacco River gaging station indicates that most annual peaks occur early in the spring coincident with snowmelt runoff, although some infrequent peaks have been observed in November and January, likely as a result of early winter rain-on-snow events. Flood frequency estimates for the Tobacco River project area were developed using the Montana regional regression equations for the West Region based on drainage area and mean basin elevation as presented in USGS WRIR-03-4308 (USGS 2004). In addition, flood frequency estimates for the Tobacco River USGS gage were computed in accordance with standard techniques identified in Technical Bulletin 17B Guidelines for Determining Flood Flow Frequency (USGS 1982).

A summary of flood frequency estimates for the Tobacco River project area is provided in Table 2-2 and Figure 2-3. Flows reported in the USGS WRIR-03-4308 and the effective Federal Emergency Management Agency (FEMA) Flood Insurance Study (FEMA 2006) are included for reference. The West Region regression estimates were outside the 90% confidence limits of the 17B analysis for USGS gage #12301300 for all recurrence intervals. Due to the relatively short period of record available at the time of the FEMA study, the FEMA estimates were generated using a weighted average of regional regression, rainfall/runoff, and Log-Pearson Type III analyses (FEMA 2006) and the resulting estimates are conservative, falling near the upper confidence limit of the 17B analysis.

Table 2-2. Summary of flood frequency estimates for the Tobacco River at USGS gage #12301300.

Recurrence Interval (yrs)	Probability	West Region Regression Equations (cfs)	1981 FEMA FIS (cfs)	USGS WRIR 03-4308 (cfs)	17B Flood Frequency (cfs)	
					Computed Curve (cfs)	90% Conf. Limits (cfs)
1.5	0.67	n/a	n/a	n/a	1,197	1,083 - 1,311
2	0.5	1,770	n/a	1,510	1,430	1,304 - 1,567
5	0.2	2,562	n/a	2,110	2,002	1,814 - 2,249
10	0.1	3,178	2,700	2,490	2,374	2,124 - 2,725
25	0.04	3,791	n/a	2,940	2,836	2,496 - 3,339
50	0.02	4,364	3,830	3,270	3,174	2,761 - 3,803
100	0.01	4,956	4,360	3,580	3,507	3,018 - 4,270
200	0.005	5,578	n/a	3,890	3,838	3,269 - 4,743
500	0.002	6,477	5,460	4,290	4,274	3,595 - 5,379

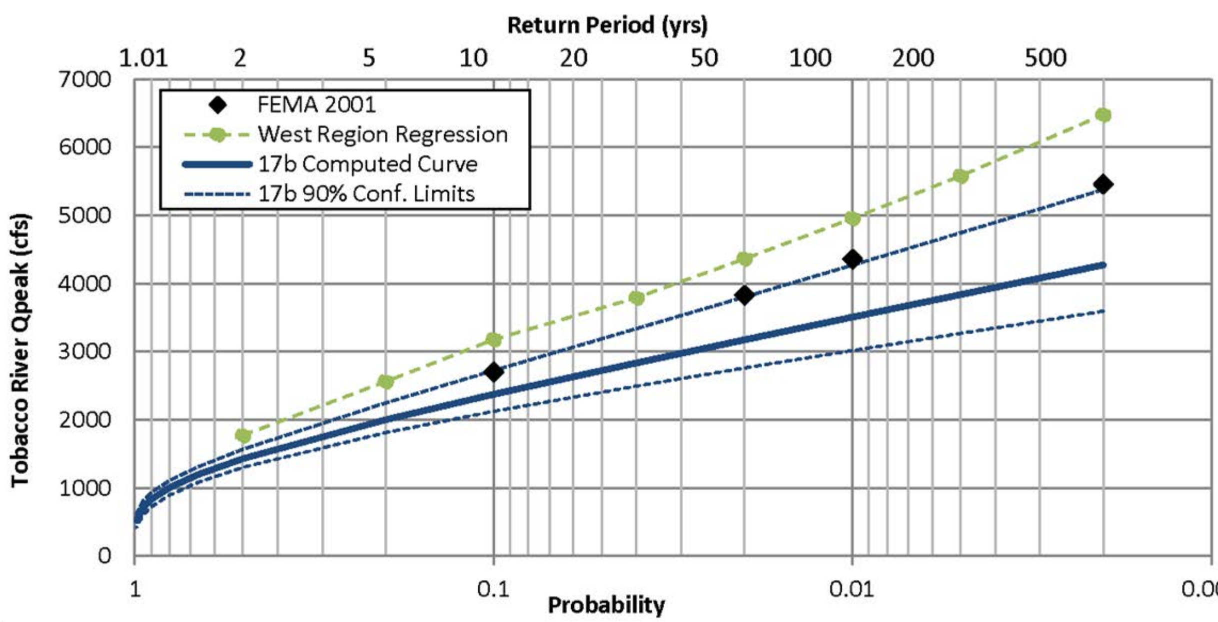


Figure 2-3. Tobacco River flood frequency estimates for USGS gage #12301300 with 90% confidence limits and West Region regression estimates from USGS WRIR-03-4308.

2.3 Mean Daily Flow

The mean daily flow estimates for the project area were grouped by day of the water year and ranked to evaluate the daily percentiles for the available period of record (Figure 2-4). As illustrated in Figure 2-5, the runoff is characterized by a dominant snowmelt driven rising limb beginning in March and peaking between April and June, with a symmetrical descending limb lasting two months on average. The median daily flows range from 80 to 870 cubic feet per second (cfs). A flow duration curve showing the percent of time exceeded for mean daily flows for the Tobacco River gaging station is provided in Figure 2-4.

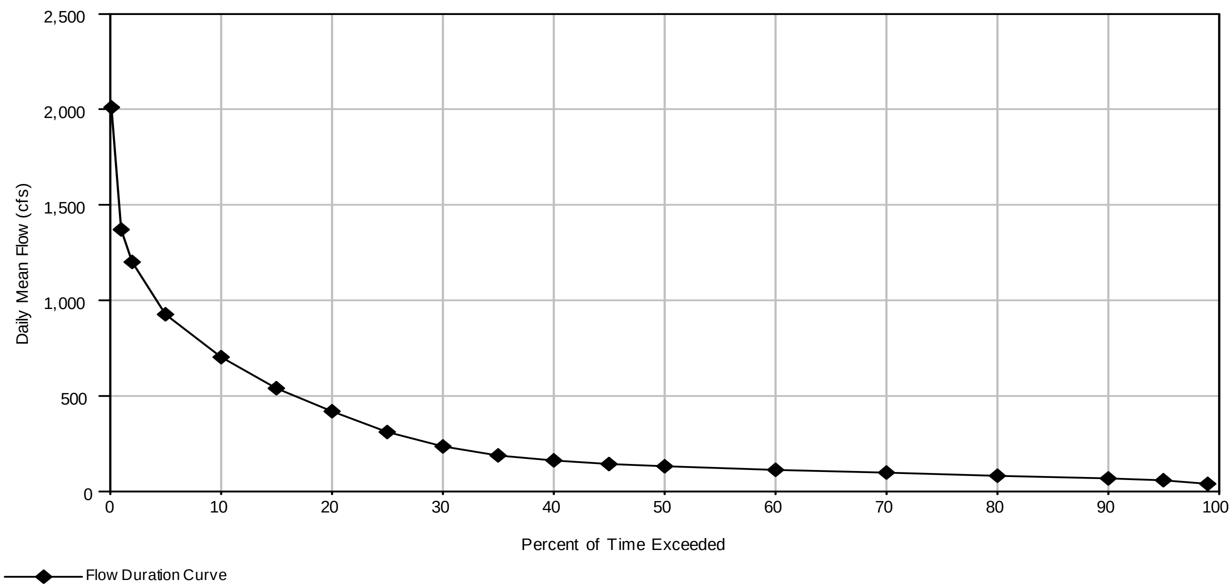


Figure 2-4. Flow duration curve for WY 1958-2014 for USGS gaging station 12301300.

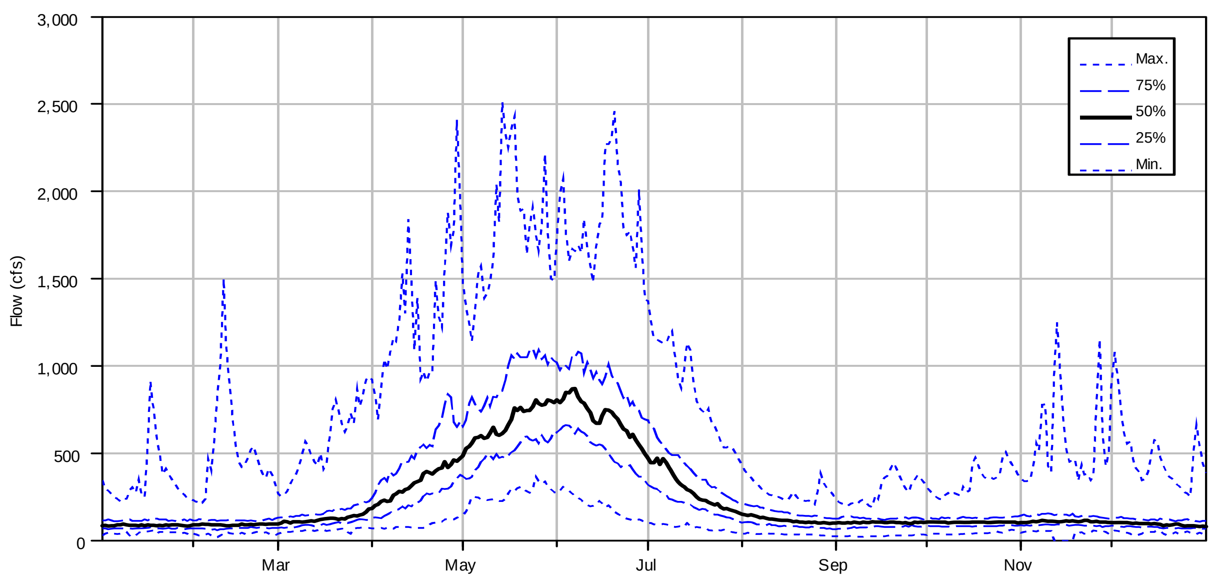


Figure 2-5. Summary of mean daily flow quartiles for the Tobacco River at USGS gaging station 12301300.

2.4 Base Flow Discharge Estimation

Low frequency flow statistics are important to determine the minimum water availability for fish passage under extreme conditions as well as to evaluate the risk of channel dewatering. As illustrated in Figure 2-5, mean base flow conditions are most common between August and October. For the project area, base flow statistics were estimated from available gage data and using regional regression equations (USGS 1985). A summary of base flow estimates for a consecutive number of days and recurrence interval is presented in Table 2-3.

Table 2-3. Summary of base flow estimates for the project area.

Base Flow Statistic	Gage Duration (cfs)	Regional Regression (cfs)*
50% Exceedance / Mean Annual	130 (50% Exceedance)	215 (Mean Annual)
80% Exceedance	82	22.7
90% Exceedance	68	N/A
95% Exceedance	58	16.5
99% Exceedance	40	N/A

** See USGS WRIR-1985-4071*

2.5 Bankfull Discharge Estimation

Reference channel cross-sections and a longitudinal profile were measured upstream of the project area. Water surface profiles were correlated with measured discharge at the Tobacco River USGS gaging station to calibrate channel roughness values. The estimated bankfull elevations at riffle cross-sections were used to calculate conveyance area and wetted perimeter of the bankfull channel. Hydraulic relationships were used to estimate bankfull flow as a function of conveyance area, wetted perimeter, slope and roughness. Results indicate that bankfull discharge ranges from 1,040 cfs to 1,200 cfs with an average of 1,120 cfs.

3 Hydraulic Analysis

This section describes the hydraulic modeling effort used to evaluate the preliminary channel and floodplain design in terms of hydraulic performance and sediment transport continuity. The purpose for completing the modeling exercise was to evaluate hydraulic performance both at the reach and project-scales in order to validate the preliminary channel and floodplain design dimensions. The information presented in this section forms the basis for the geomorphic design criteria described in Section 4 of this report. Methods and results are described in the following sections.

3.1 Methods

Hydraulic performance for channel and floodplain design geometry was simulated using HEC-RAS version 4.1.0 (USACE 2010), a one-dimensional gradually varied flow hydraulic model. The model schematic is shown in Figure 3-1. The model extends approximately 1,200 feet downstream and 2,500 feet upstream of the project area. The downstream boundary is located a sufficient distance downstream for any boundary condition effects to dissipate without affecting results in the project area. The upstream portion of the model includes 13 surveyed cross sections in the reference reach. The model domain was divided into five reaches including the reference reach; the project reach, which is sub-divided into three reaches based on bankfull slope; and the exit reach downstream of the project.

3.1.1 Model Geometry

The preliminary design channel and floodplain grading surfaces were merged with the existing ground Light Detection and Ranging (LiDAR) surface in AutoCAD Civil 3D to create a seamless digital terrain model of the channel and floodplain morphology. The grading surface for the project extends over 5,537 lineal feet and is comprised of both channel (pool and riffle templates) and floodplain grading. The reference reach upstream of the project area was modeled using the existing ground LiDAR Digital Elevation Model (DEM) merged with surveyed cross section points in the channel. Reach 4, the exit reach downstream of the project, was modeled using a composite existing ground LiDAR DEM with a merged bathymetric surface that extends approximately 500 feet downstream of the project.

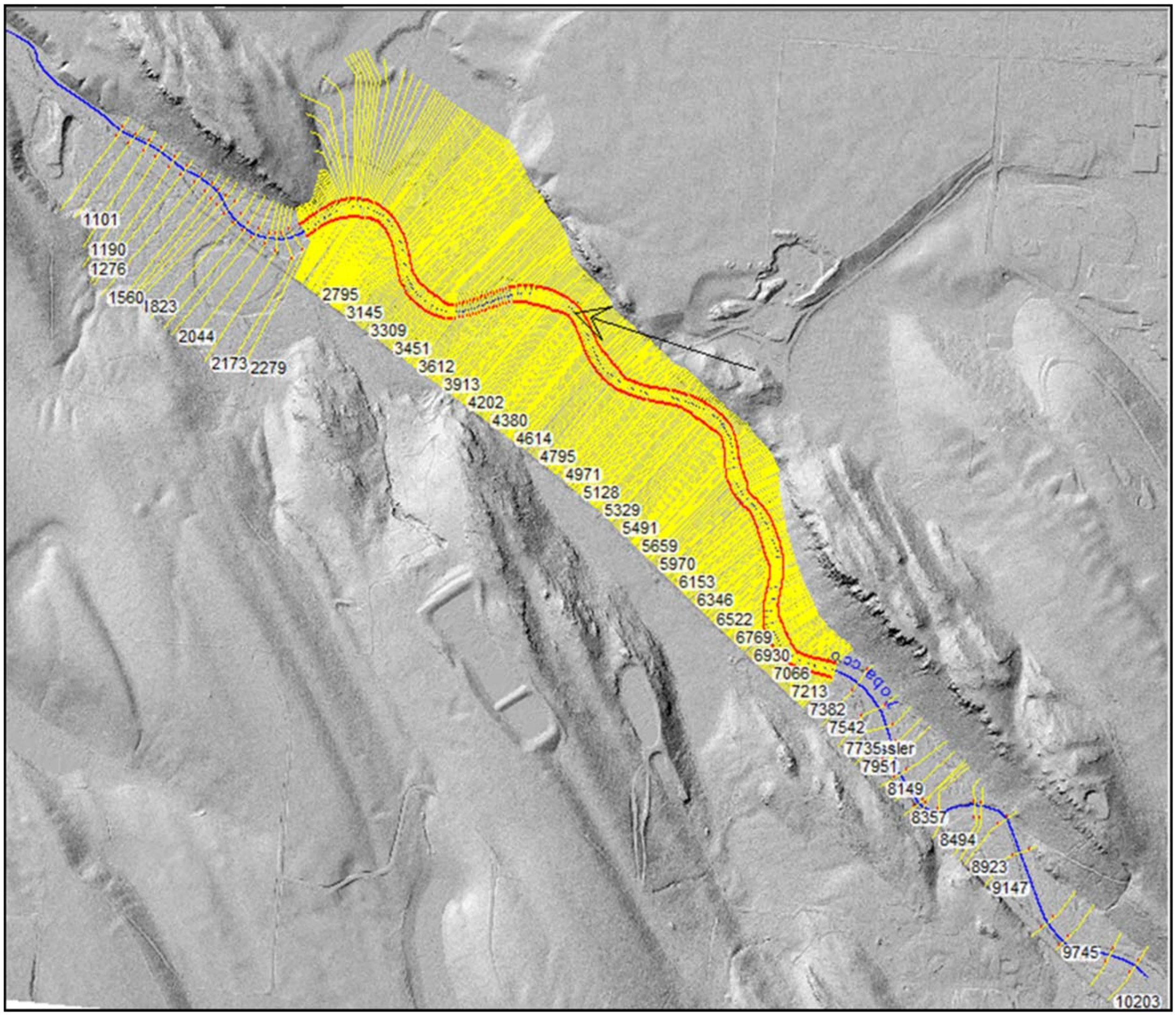


Figure 3-1. HEC-RAS model schematic. Yellow lines represent modeled cross-sections. Red lines correspond to bank stations.

The cross-sections were oriented to remain perpendicular to the expected flood flow lines for both moderate (e.g. 10-year and 50-year recurrence interval discharges) and larger magnitude (e.g. 100-year and 500-year recurrence interval discharges) flood elevations, requiring the addition of multiple horizontal inflection points. The cross-sections extend orthogonally across the floodplain to capture the maximum potential inundation for the estimated 500-year flood elevations.

3.1.2 Modeled Flows

Discrete design discharges selected for evaluation were estimated using a combination of hydraulic and hydrologic analyses as described in Section 2 of this report. Design discharges modeled are listed in Table 3-1. In addition to discrete discharges, a continuous range of discharges spanning the range of potential discharges (1 - 5,500 cfs) were modeled in order to analyze hydraulic performance at selected locations in the project area.

Table 3-1. Summary of Tobacco River design discharges (cfs).

Q_{base}	Q_{bkf}	Q_2	Q_5	Q_{10}	Q_{25}	Q_{50}	Q_{100}	Q_{200}	Q_{500}
40	1,120	1,430	2,002	2,374	2,836	3,174	3,507	3,838	4,274

3.1.3 Boundary Conditions and Model Calibration

Boundary conditions were set using the normal depth approximation with a slope of 0.0015 ft/ft for all profiles modeled. The slope was determined by sampling the water surface profile from the LiDAR surface downstream of the project. The sensitivity of the model to the normal depth slope was tested by doubling the slope.

The Limerinos equation for relative roughness (Limerinos 1970) was used to estimate initial channel roughness values. The D84 value of 79 millimeters (mm) used to estimate bed material roughness was based on pebble count data from the reference reach field survey (RDG 2014). These gradations represent an estimate of material sizes that will be available for construction of the new channel as well as materials that are currently being supplied to the system. Maximum channel roughness values were determined by calibrating the hydraulic model to water surface elevations surveyed August 25, 2013 at a discharge of approximately 103 cfs. Nominal channel roughness values were correlated with field surveyed bankfull indicators. Nominal floodplain roughness values were selected to be representative of post-restoration conditions that will include vegetative, coarse wood, and micro-topographic treatments as shown in the preliminary design drawings. Nominal channel and floodplain roughness values were adjusted to vary by flow using flow roughness factors calculated from the Rosgen roughness curve (1998) shown in Figure 3-2. Channel roughness values were then adjusted to ensure that relative roughness was balanced with modeled hydraulic (mean) depth using the Limerinos equation for relative roughness (Limerinos 1970).

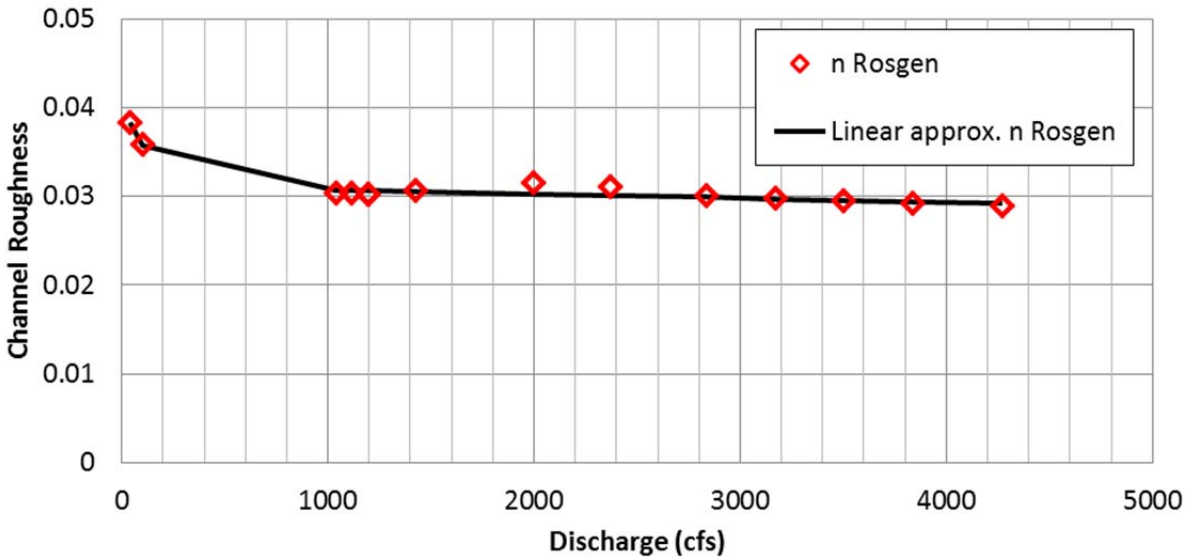


Figure 3-2. Flow-dependent channel roughness values estimated using Rosgen (1998).

3.2 Results

Data summary graphs were prepared to illustrate mean channel velocity, section averaged channel shear stress, and estimated mobile particle size (Figures 3-4, 3-5 and 3-6). Estimated mobile particle size was calculated using the average of three power function methods including Shields (1936), Leopold, et. al. (1964), and Rosgen (2006). These hydraulic parameters were evaluated for discrete recurrence intervals including baseflow (Qbase), bankfull discharge (Q1.5), Q10, Q25, Q50 and Q100 flood discharges throughout the project area and for a range of discharges at selected locations. Hydraulic modeling results indicate a moderate range of hydraulic and bed mobility conditions.

Longitudinal plots of modeled water surface elevation, average channel velocity, average channel shear stress and average mobile particle size are presented in Figures 3-3 through 3-6 below. These plots show the range of values for discrete recurrence intervals including flow at the time of the field survey (Qsurvey), the estimated bankfull discharge (Qbkf) and the 100-year flood discharge (Q100) as listed in Table 3-1. All profiles list the main channel distance (HEC-RAS station) in feet. The corresponding CAD design stations and reference reach cross section numbers are also listed above the X axis on the profile showing water surface elevations.

The longitudinal plot of modeled average channel velocities in Figure 3-4 shows that channel velocities in the project area are generally consistent within geomorphic units. Average channel velocities for the project reach at bankfull and Q100 are 3.9 and 5.9 feet per second (fps). Minimum values range from 2.5 to 3.2 fps in the pools and maximum values range from 6.0 to 8.4 fps in the riffles for bankfull and Q100, respectively.

Longitudinal plots of modeled average channel shear stress in Figure 3-5 shows that channel shear stress values in the project area are also relatively consistent. Reach-average channel shear stress values within the project reach at bankfull and Q100 are 0.4 and 0.6 pounds (force) per square foot (lbf/ft^2) with maximum values of 1.0 and 1.7 lbf/ft^2, respectively.

The longitudinal plot of average mobile particle size shown in Figure 3-6 indicates that particle sizes likely to be transported at bankfull flow in project reach range from 12 to 131 mm, medium gravel (MG) to small cobble (SC). In the entrance reach, modeling results suggest that similar size materials may be transported. In the exit reach, modeling results suggest that the range of material sizes may be limited to the 21 to 50 mm range, or coarse gravel (CG) to very coarse gravel (VCG).

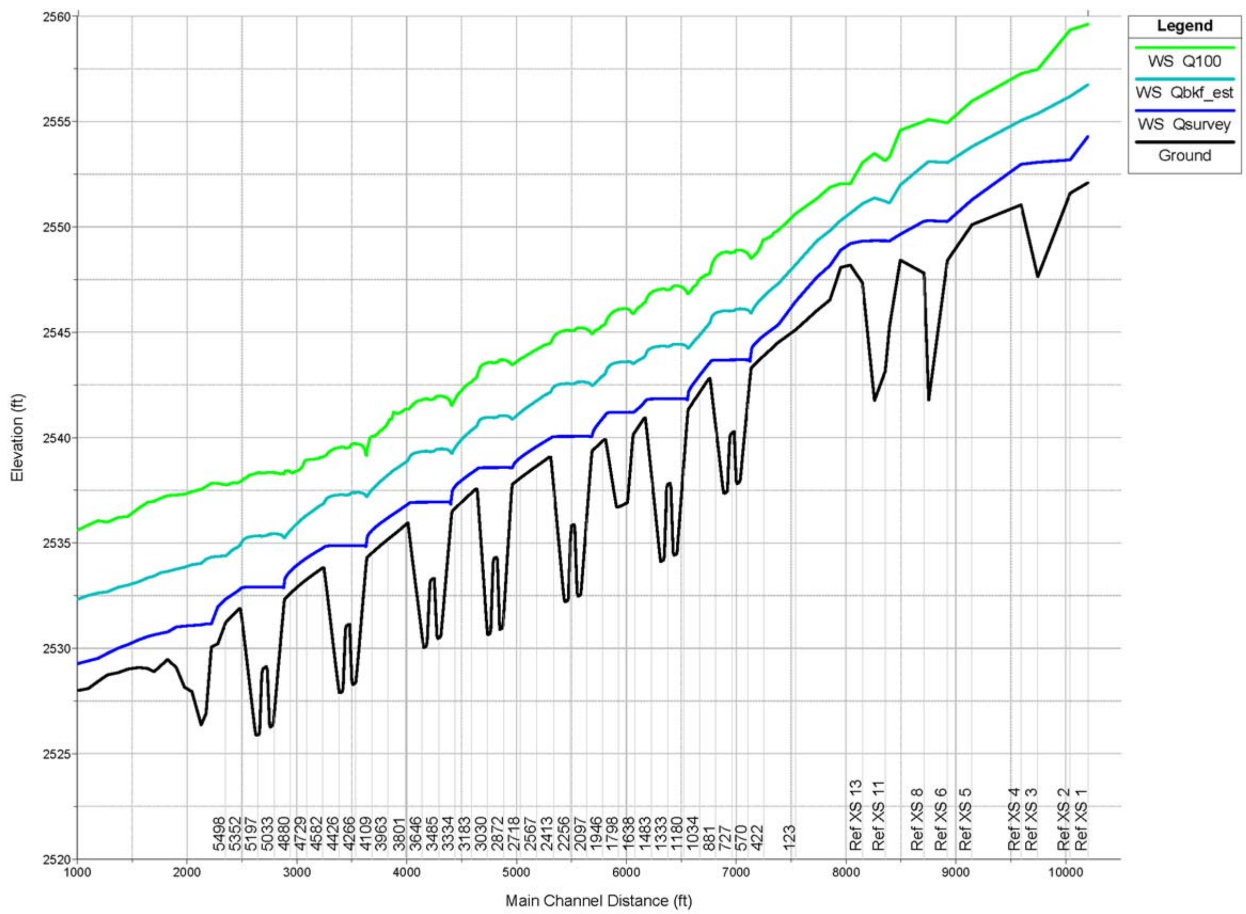


Figure 3-3. Longitudinal plot of modeled water surface elevations for selected design discharges. Flow direction is right to left.

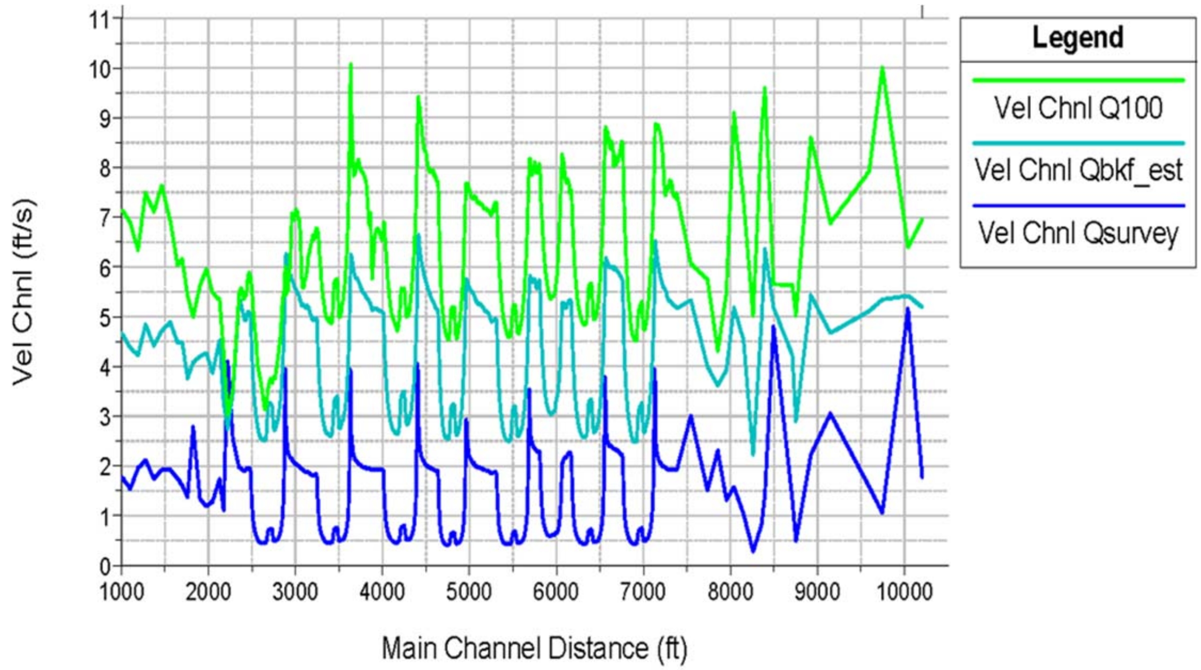


Figure 3-4. Longitudinal plot of modeled average channel velocities for selected design discharges. Flow direction is from right to left.

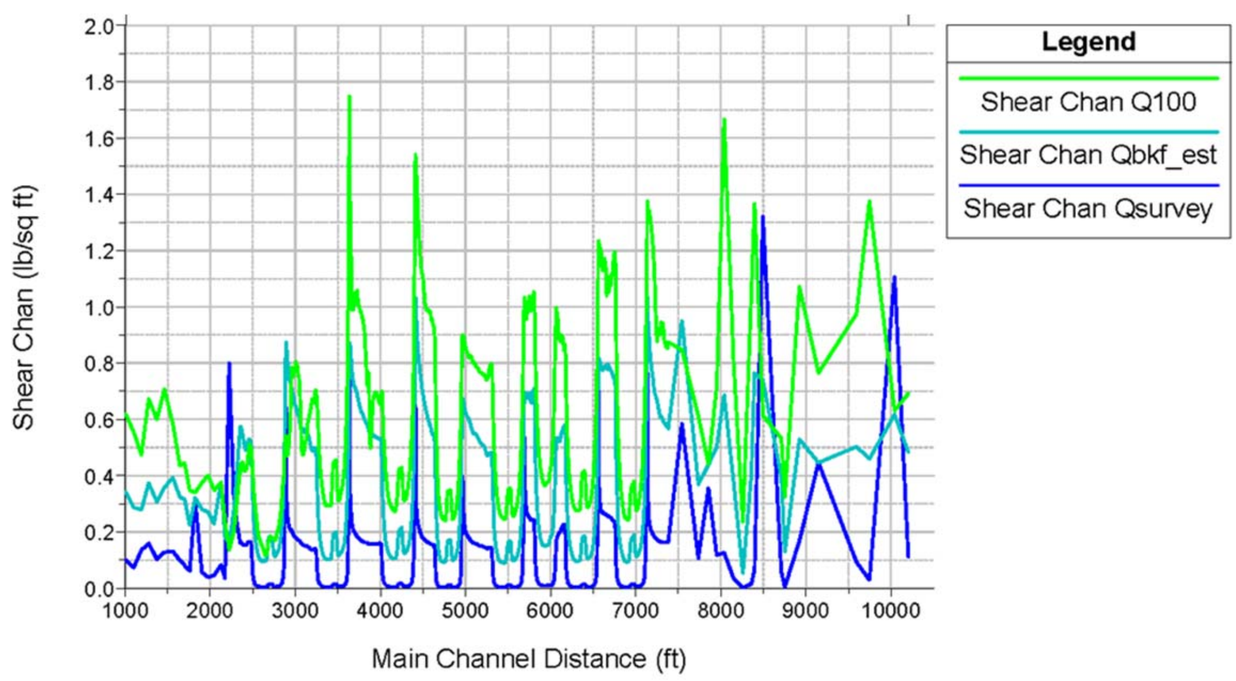


Figure 3-5. Longitudinal plot of modeled average channel shear stress for selected design discharges. Flow direction is from right to left.

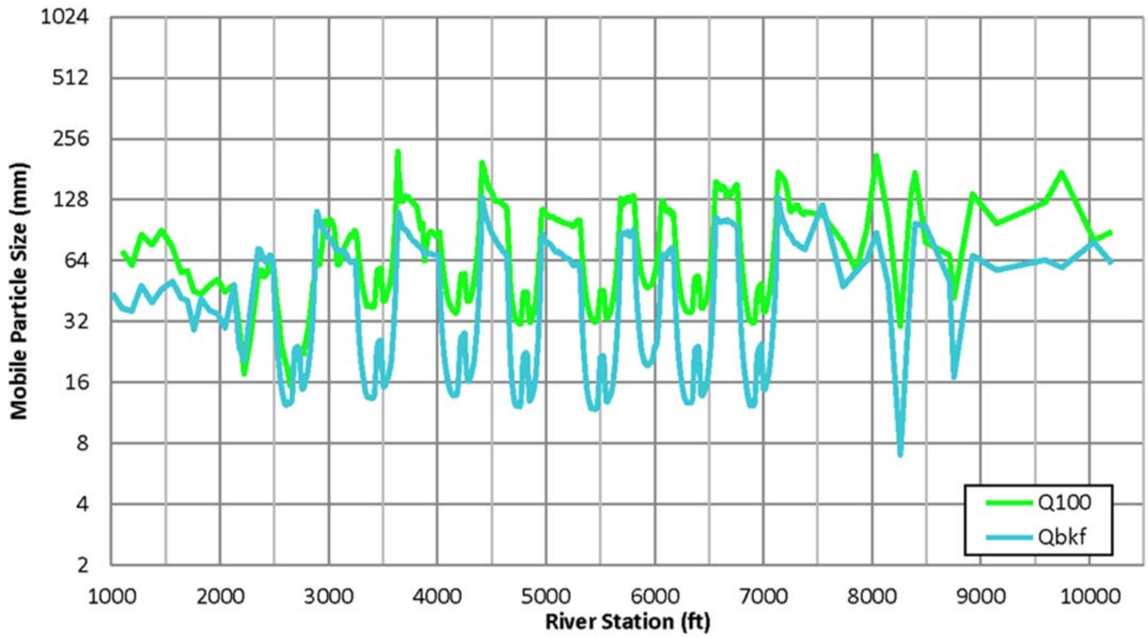


Figure 3-6. Longitudinal plot of modeled average channel mobile particle sizes for selected design discharges.

Appendix A includes a more detailed summary of the hydraulic modeling results including Geographic Information Systems (GIS) exhibits illustrating the spatial distribution of velocity, depth, and mobile particle size for each of the project reaches.

4 Design Criteria

4.1 Introduction

This section presents the criteria used to develop the preliminary design. In addition to the hydrologic and hydraulic analyses summarized and described in Section 3, detailed geomorphic reference reach investigations were completed upstream of the project area to support development of channel and floodplain design dimensions. A geomorphic data summary report is included in Appendix B.

4.2 Geomorphic Design Criteria

This section describes the geomorphic design criteria for the project area. The criteria emphasize creating a range of channel geometries that are appropriately suited to the desired future morphology of the Tobacco River in the project area.

4.2.1 Channel Cross-Section Dimensions and Planform Design Criteria

At the reach-scale, the Tobacco River within the project area has been designed to accommodate the estimated bankfull discharge and to hydrologically interact with the floodplain at the incipient point of flooding. Floodplains and terraces will convey flows greater than bankfull discharge including the estimated Q100 flood flow. The channel shape will exhibit stage-progressive geometry and exhibit a range of natural variability in order to support characteristics of a natural system. Design bankfull and recurrence interval flood flows are summarized in Section 2 of this report.

The design channel will integrate planform and longitudinal profile variability. Design channel features include riffle, run, pool, and glide channel units in order to create complex habitats with variable depth, velocity, and substrate characteristics. The design channel alignment will exhibit a variety of planform patterns depending on slope and valley confinement, and will include ranges for all geomorphic variables. Planform metrics used to develop geometry for the channel alignments include meander wavelength, belt width, radius of curvature and sinuosity. Schematics illustrating the terminology related to planform geometry for a typical meandering, riffle-pool channel type are shown in Figure 4-1.

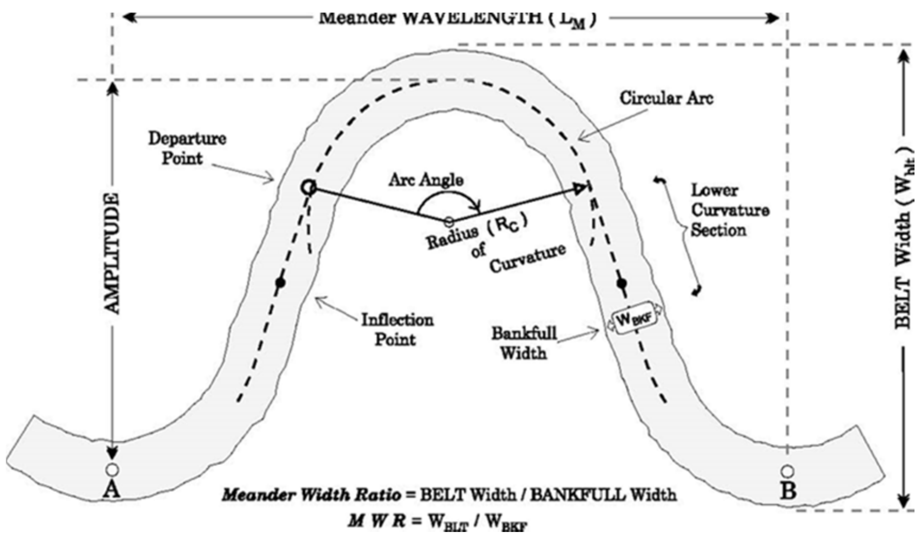


Figure 4-1. Schematic illustrating terminology for meander planform geometry (Rosgen 1996 after Williams 1986).

Tables 4-1, 4-2 and 4-3 summarize bankfull channel cross-section design criteria for the Tobacco River for Reaches 1, 2 and 3 of the project area. The desired morphology is a non-entrenched, moderately sinuous, gravel bed riffle-pool stream type formed within a well-developed terraced alluvial valley. Sinuosity in the project area will range from 1.1-1.3. Average bankfull channel slope ranges from 0.0022 ft/ft (0.22%) in Reach 2 to a high of 0.0032 (0.32%) ft/ft in Reach 3.

Table 4-1. Bankfull channel cross-section design criteria for Reach 1[1] (in feet).

Dimension	Channel Unit			
	Riffle	Run	Pool	Glide
Area	230	253	414	391
Width/Depth Ratio Range	32 30-34	 N/A	 N/A	 N/A
Bankfull Width Range	86 83-88	73 69-86	103 86-120	111 103-120
Average Depth Range	2.7 2.6-2.8	3.3 2.9-3.7	3.9 3.3-4.6	3.7 3.4-4.0
Maximum Depth Range	3.0 2.7-3.2	5.3 5.1-5.6	6.7 6.2-7.2	8.5 8.3-8.8

[1] Design station 0+00 to 8+90

Table 4-2. Bankfull channel cross-section design criteria for Reach 2[1] (in feet).

Dimension	Channel Unit			
	Riffle	Run	Pool	Glide
Area	259	285	466	440
Width/Depth Ratio Range	24 22-26	 N/A	 N/A	 N/A
Bankfull Width Range	79 76-82	71 63-79	102 95-110	94 79-110
Average Depth Range	3.3 3.2-3.4	4.0 3.6-4.5	4.5 4.2-4.9	4.8 4.0-5.6
Maximum Depth Range	3.6 3.3-3.9	6.5 6.2-6.9	8.0 7.2-8.9	10.5 10.2-10.8

[1] Design station 8+90 to 30+98

Table 4-3. Bankfull channel cross-section design criteria for Reach 3[1] (in feet).

Dimension	Channel Unit			
	Riffle	Run	Pool	Glide
Area	245	270	417	441
Width/Depth Ratio Range	28 26-30	 N/A	 N/A	 N/A
Bankfull Width Range	83 80-86	74 66-83	99 83-116	107 99-116
Average Depth Range	3.0 2.9-3.1	3.7 3.3-4.1	4.3 3.6-5.0	4.1 3.8-4.4
Maximum Depth Range	4.4 3.8-5.0	5.9 5.6-6.2	6.8 6.5-7.1	9.5 9.2-9.8

[1] Design station 30+98 to 54+00

Average channel planform design criteria for Reaches 1, 2 and 3 based on a project averaged bankfull channel width of 83 feet are summarized in Table 4-4.

Table 4-4. Channel planform design criteria (in feet).

Dimension	Value
Radius of Curvature	303
Range	232-374
Meander Length	1,017
Range	830-1,204
Meander Belt Width	270
Range	150-390
Sinuosity	1.2
Range	1.1-1.3

4.3 Channel Hydraulic Design Criteria

Hydraulic investigations described in Section 3 of this report form the basis for the design criteria presented in this section. The intent of the channel hydraulic design is to create channels and streambank toes that will support sustainable habitat conditions, support streambank restoration treatments, maintain channel connection with the floodplain at the approximate bankfull discharge, and provide sediment transport continuity through the project area.

At this stage of planning, RDG is recommending a design criteria discharge equivalent to the 25-year recurrence interval flood. Therefore, a range of results are presented that can be used to help guide the design of riverbed and streambank toe gradations, as presented in Appendix A. The D84 size class of the riverbed gradation is considered the threshold particle size for mobility. Based on hydraulic modeling results, this represents a maximum particle size of 188 mm or 7.4 inches. Riverbed fill material sized smaller than the D84 would represent the 'mobile matrix' and would be constructed of graded alluvium ranging in size from sands and small gravels up to the estimated D84 size class. Riverbed material greater than the D84 size class would represent the riverbed 'framework' and would be comprised of immobile alluvium to provide vertical bed stability and maintain floodplain connection.

There are several factors to consider when selecting the channel hydraulic design criteria during the final design phase of this project. These include:

- Risk and Stability: The design should balance the need for short-term stability with long-term ecological function. Projects designed for higher recurrence interval flows (e.g. Q100) are resistant to floods and other natural disturbances to the detriment of the long-term ecological function of the channel and floodplain ecosystem, and the aquatic habitat environment. Projects designed for lower recurrence interval flows (e.g. Q10) are less resistant to floods and other disturbances which can increase the risk of structural failure in the short-term. Short-term structural failure can have significant implications on meeting project goals and objectives over time. From a restoration perspective, short-term structural failure can mean either project failure or success, depending on how risk is defined in terms of balancing structural stability with ecological function.

- Natural Channel Armoring: The bed surface of stream channels is typically armored or coarser than the subsurface material as a result of natural bed material sorting. This condition influences channel hydraulics and determines the sediment available for transport (Wilcock et al. 2005). Reconstructed stream channels typically require multiple runoff events to naturally sort and armor the bed surface of the channel. Without the appropriate riverbed gradation or armor layer, the channel can be at risk of downcutting particularly if the project is subject to a flood within the first few years following construction. An established bed armor layer is critical for maintaining vertical channel stability. For this reason, channels are sometimes constructed of slightly larger bed material than what is needed to provide a stable bed once material has been naturally sorted.

- Vegetation: The channel design approach for the Tobacco River is in part based on natural channel design philosophy which relies on streambank and floodplain vegetation to provide long-term planform stability to the channel. Channel design criteria can be used to specify materials that provide short-term, interim stability to allow for streambank and floodplain vegetation to establish and mature. This design emphasizes criteria that reduce short-term failure risk and increase the likelihood of success.

Hydraulic modeling output for the preliminary design conditions is included in Appendix A.

4.4 Floodplain and Revegetation Design Criteria

4.4.1 Introduction

Riparian vegetation within the project area has been heavily impacted by land use practices. Land clearing for grazing and agriculture and cattle grazing on the property has resulted in a lack of woody vegetation on approximately 1,500 lineal feet of river bank and former floodplain area on the west bank of the river within the project area. Land use has caused bank erosion, disconnection of the river and floodplain environment, and overwidening of the Tobacco River throughout the project area. Along with other restoration design components including channel and floodplain construction, point bar development, bank restoration and bioengineering treatments, the restoration of a diverse, native riparian vegetation community within the constructed floodplain is integral to curbing accelerated bank erosion, re-establishing a resilient ecosystem, and providing clean, cold, connected and complex fish habitat throughout the project reach.

The intent of the floodplain design is to create a floodplain that is hydrologically connected to the stream channel and therefore supports a mosaic of riparian and wetland plant communities represented by the cover types described in this section. In general, all reaches include a bankfull floodplain. Other features that occur in a subset of reaches include transition areas, point bars, low terrace features, off-channel wetlands and depressions, and side channels.

4.4.2 Tobacco River Reference Plant Communities

Reference conditions upstream of the project area reflect a single-thread channel with shrub and forested vegetation communities on floodplains and floodplain terraces. Streambanks are for the most part dominated by a thinleaf alder (*Alnus incana*) community type with inclusions of red osier dogwood (*Cornus stolonifera*). Floodplains within two feet above bankfull are composed of a black cottonwood/red-osier dogwood (*Populus trichocarpa*/*Cornus stolonifera*) community type (Hansen et al. 1995). Engelmann spruce (*Picea engelmannii*) and thinleaf alder can also comprise up to 10% of total cover, and currant species (*Ribes spp.*), rose (*Rosa woodsii*) and snowberry (*Symphoricarpos albus*) are common understory components along with herbaceous vegetation such as starry false solomons seal (*Maianthemum stellatum*), red baneberry (*Actea rubra*) and field mint (*Mentha arvensis*) (Hansen et al. 1995). Flooplain terraces, identified as occurring on elevations higher than two feet above bankfull in the Tobacco River reference reaches, are comprised of a spruce/red-osier dogwood (Picea/*Cornus stolonifera*) community type (Hansen et al. 1995) (Figure 4-2). Thinleaf alder, western serviceberry (*Amelanchier alnifolia*), and black hawthorn (*Crataegus douglasii*) occur as minor components in floodplain terrace vegetation communities.

Figure 4-2. Reference floodplain and floodplain terrace vegetation communities on the Tobacco River.

In all of the riparian communities, reed canarygrass (*Phalaris arundinacea*) occupies a large proportion of understory species composition, and in some streambank and floodplain communities is found in monoculture in the herbaceous stratum. Reed canarygrass is an aggressive non-native invasive grass species which has become ubiquitous in riparian ecosystems throughout the Northwest U.S. The grass spreads by underground rhizomes and by seed and outcompetes herbaceous and woody native vegetation for light, water, nutrients, and space. The vegetation restoration plan addresses reed canarygrass encroachment into the project site through the introduction of a structurally and functionally diverse native species community, including native grass groundcover. While the complete prevention of reed canarygrass establishment in the project area is unlikely given its prevalence in adjacent areas and efficient means of dispersal, encroachment will be kept to a minimum by planting a robust native vegetation community and monitoring both native and invasive plant success.

4.4.3 Preliminary Revegetation Design

All areas outside of the constructed river banks and within the grading extents of the Tobacco River Restoration Project will be revegetated with native species following floodplain and floodplain terrace construction. Vegetation composition will largely mirror that of the reference reach upstream of the project site. However, thinleaf alder will be kept to a minimum on streambanks, and willow (*Salix spp.*) will instead be incorporated into engineered bank structures. Willows were likely a larger component of the ecosystem prior to grazing and agricultural practices in the Tobacco River valley; thinleaf alder is a common primary succession species on disturbed riparian land throughout Montana. Where possible, red-osier dogwood shrubs as well as a limited number of alder shrubs will be salvaged from within the grading limits and planted in constructed floodplains. Young shrubs between four and ten feet tall will be identified for salvage, and one-third to one-half of aboveground biomass will be clipped following planting to compensate for lost root mass. All plantings will be protected from ungulate browse with eight feet tall wildlife fencing, and individual browse protectors around trees and shrubs will be used where fence installation is not practical. All ungulate exclosures will be kept in place for a minimum of three years following construction. In addition, a minimum of six inches of imported plant growth media (topsoil) will be placed over all constructed surfaces prior to planting.

Floodplains will be constructed within two feet of bankfull elevations and will consist of a black cottonwood/red-osier dogwood community type. Floodplain terrace surfaces will be constructed above primary floodplains and will sustain spruce forest (Figure 4-3). Other woody and herbaceous species common to the vegetation community types will be planted in non-dominant cover, and a native grass/forb seed mix will be broadcast over all bare ground surfaces. Floodplain roughness, which includes microtopography grading and large woody debris placement, will be incorporated into both the floodplain and floodplain terrace surfaces. Floodplain roughness provides surface heterogeneity and sites for natural seed recruitment during high flow events. In addition, sloped areas on outer meander bends will serve as a transition between uplands outside the grading extents and the constructed streambanks. These areas will be planted with red-osier dogwood and Drummond's willow (*Salix drummondiana*).

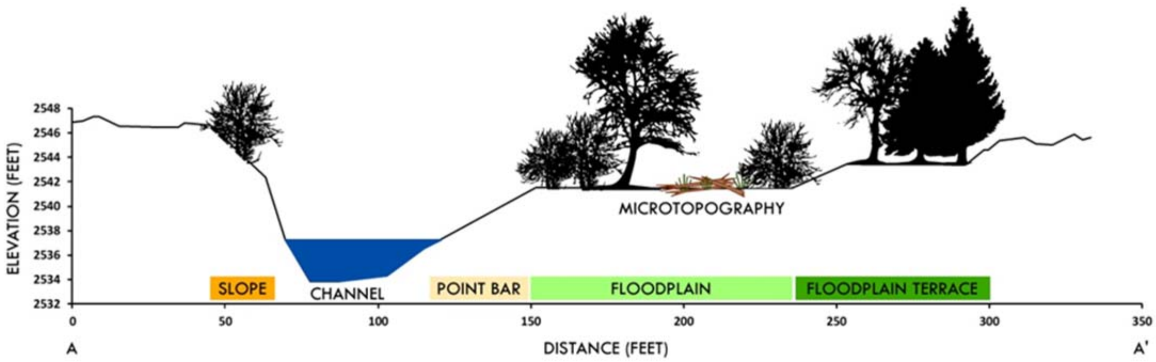


Figure 4-3. Typical cross-section along the Tobacco River and floodplain areas illustrating the conceptual post-restoration condition.

Plan sheets 9.0 through 9.3 in the Tobacco River Restoration Project Preliminary Design plan set provide additional detail and information regarding the preliminary revegetation plan.

5 Conclusion and Next Steps

Lincoln Conservation District in cooperation with the Department of Natural Resources and Conservation and Kassler Family Limited Partnership, retained River Design Group, Inc. to prepare a preliminary restoration design for a one-mile reach of the Tobacco River near Eureka, Montana. The preliminary design and supporting information contained in Appendices A and B define how channel, floodplain and riparian resources will be restored using an adaptive management approach. The primary restoration goals are to create conditions that will result in improved aquatic, riparian and terrestrial habitats by addressing severe streambank and terrace erosion and floodplain disconnection.

Next steps in the planning process include:

- Researching and securing funding to complete final design, permitting and construction implementation;
- Field staking the preliminary design alignment, channel limits, and floodplain grading plan extents and adjusting these parameters accordingly to minimize impacts to existing high quality vegetation and other infrastructure;
- Refining the final channel and floodplain grading plan and performing additional hydraulic modeling to demonstrate stability given a design criteria discharge equivalent to the 25-year recurrence interval flow;

- Selecting the proposed new bridge location and preparing an engineered plan set for the abutments, approach grades and bridge structure;
- Preparing a final design plan set and bid package;
- Coordinating with Lincoln County regarding floodplain permitting requirements;
- Preparing and submitting Joint Permit Application to the U.S. Army Corps of Engineers, Montana Department of Environmental Quality, Lincoln Conservation District, and Lincoln County Floodplain Administrator;
- Issuing bid packages and conducting contractor walk-through of project area; and
- Selecting contractor and scheduling construction in cooperation with Montana Fish, Wildlife and Parks.

6 Literature Cited

Federal Emergency Management Agency (FEMA). 2006. Flood Insurance Study for Lincoln County, Montana and Unincorporated Areas. FIS #300157V000A. Revised Sept. 29, 2006.

Hansen, P.L., R.D. Pfister, K. Boggs, B.J. Cook, J. Joy, and D.K. Hinckley. 1995. Classification and Management of Montana's Riparian and Wetland Sites. Montana Forest and Conservation Experiement Station, School of Forestry, the University fo Montana Miscellaneous Publication No. 54.

Leopold, Luna B., Wolman, Gordon M., and Miller, John P. 1964. Fluvial Processes in Geomorphology. W.H. Freeman and Co. San Francisco. 522 pp.

Limerinos, J.T. 1970. Determination of Manning Coefficient from Measured Bed Roughness in Natural Channels. Geological Survey Water-Supply Paper 1909-B.

Parrett, C. and D.R. Johnson. 2004. Methods for Estimating Flood Frequency in Montana Based on Data through Water Year 1998. U.S. Geological Survey Water-Resources Investigation Report 03-4308.

River Design Group, Inc. (RDG). 2013. Tobacco River Conceptual Restoration Plan – Kassler Family, LP. Whitefish, Montana.

Rosgen, D. L. 1998. The Reference Reach Field Book. Friction Factor (u/u*) vs. Manning's n Roughnes Coefficient table, p. 189.

Rosgen, D.L. 2006. Watershed Assessment of River Stability and Sediment Supply. Wildland Hydrology, Inc. Fort Collins, Colorado.

Shields, A. 1936. Anwendung der Aenlichkitsmechanik und der Turbulenzforshung auf die Geschiebebewegung [Application of Similarity Principles and Turbulence Research to Bed-Load Movement]. Berlin: Mitteilungen der Prevssischen Versuchsanstalt fur Wasserbau und Schiffbau.

U.S. Army Corps of Engineers Hydrologic Engineering Center. 2010. River Analysis System Hydraulic Reference Manual (HEC RAS 4.1.0).

U.S. Environmental Protection Agency (USEPA). 2008. Watershed Assessment of River Stability & Sediment Supply (WARSSS), available online:http://water.epa.gov/scitech/datait/tools/warsss/upload/2008_08_25_watershed_tools_warsss_pla_22st04figV26.pdf.

U.S. Geological Survey (USGS). 2004. Water-Resources Investigations Report 03-4308. Methods for Estimating Flood Frequency in Montana Based on Data through Water Year 1998 By Charles Parrett and D.R. Johnson. Helena, Montana. February 2004.

U.S. Geological Survey (USGS). 2014. USGS 12301300 Tobacco River near Eureka MT. Accessed online November 12, 2014: http://waterdata.usgs.gov/mt/nwis/inventory?search_site_no=12301300

U.S. Geological Survey (USGS). 1985. Water-Resources Investigations Report 85-4071. A Method For Estimating Mean And Low Flows Of Streams In National Forests Of Montana By Charles Parrett and J. A. Hull. Helena, Montana. May 1985.

U.S. Geological Survey (USGS). 1982. Guidelines for Determining Flood Flow Frequency. Bulletin #17B. Interagency Advisory Committee on Water Data. Reston, Virginia. March 1982.

Wilcock, P.R., and B.T. DeTemple. 2005. Persistence of armor layers in gravel-bed streams, Geophysical Research Letters 32: L08402.

Appendix A

Hydraulic Modeling Results

A-1 Reach Specific Hydraulic Variables

The following tables present the range of values for hydraulic variables over a range of flood recurrence intervals from Q_{bkf} to Q_{100} for the three project reaches as defined in Table A-1. CAD stations are shown on maps included in Section A-2 of this appendix. Hydraulic variables reported include mean depth in the channel and overbanks, average channel and overbank shear stress, and average mobile particle size.

Table A-1. Project reach stationing.

Reach	Reach Name	CAD Station Upstream	CAD Station Downstream	Bankfull Valley Slope
1	Reach 1	00+00	09+00	0.0033
2	Reach 2	09+00	31+00	0.0023
3	Reach 3	31+00	55+37	0.0038

Table A-2. Reach 1 average channel and overbank depth, velocity, shear stress and mobile particle size.

Parameter	Recurrence Interval	Minimum	Average	Maximum
Depth in Channel (ft)	Qbkf_est	1.51	3.05	4.22
	Q10_est	2.78	4.52	5.87
	Q25_est	3.21	4.99	6.34
	Q50_est	3.50	5.32	6.68
	Q100_est	3.76	5.62	6.99
Depth in Left Overbank (ft)	Qbkf_est	0.02	0.15	0.41
	Q10_est	0.32	0.58	1.02
	Q25_est	0.37	0.75	1.35
	Q50_est	0.42	0.87	1.45
	Q100_est	0.51	0.97	1.58
Depth in Right Overbank (ft)	Qbkf_est	0.00	0.18	0.68
	Q10_est	0.73	1.03	1.53
	Q25_est	0.42	1.10	1.82
	Q50_est	0.43	1.08	2.16
	Q100_est	0.63	1.10	2.38
Velocity in Channel (fps)	Qbkf_est	2.48	4.28	6.52
	Q10_est	3.70	5.70	7.82
	Q25_est	4.06	6.09	8.27
	Q50_est	4.30	6.33	8.56
	Q100_est	4.52	6.56	8.87

Table A-2. Reach 1 average channel and overbank depth, velocity, shear stress and mobile particle size.

Parameter	Recurrence Interval	Minimum	Average	Maximum
Velocity in Left Overbank (fps)	Qbkf_est	0.03	0.23	0.81
	Q10_est	0.28	0.66	1.32
	Q25_est	0.31	0.81	1.48
	Q50_est	0.31	0.90	1.62
	Q100_est	0.37	0.98	1.67
Velocity in Right Overbank (fps)	Qbkf_est	0.02	0.16	0.56
	Q10_est	0.44	1.01	1.49
	Q25_est	0.38	1.13	1.75
	Q50_est	0.39	1.16	1.91
	Q100_est	0.44	1.19	2.03
Shear Stress in Channel (lbf/ft^2)	Qbkf_est	0.09	0.42	1.03
	Q10_est	0.18	0.60	1.21
	Q25_est	0.21	0.64	1.28
	Q50_est	0.23	0.67	1.33
	Q100_est	0.24	0.69	1.38
Shear Stress in Left Overbank (lbf/ft^2)	Qbkf_est	0.00	0.02	0.15
	Q10_est	0.01	0.08	0.24
	Q25_est	0.01	0.11	0.27
	Q50_est	0.01	0.12	0.28
	Q100_est	0.02	0.13	0.30
Shear Stress in Right Overbank (lbf/ft^2)	Qbkf_est	0.00	0.01	0.03
	Q10_est	0.02	0.15	0.28
	Q25_est	0.02	0.17	0.38
	Q50_est	0.02	0.17	0.41
	Q100_est	0.02	0.16	0.40
Mobile Particle Size in Channel (mm)	Qbkf_est	12	54	131
	Q10_est	23	76	153
	Q25_est	27	82	162
	Q50_est	29	85	168
	Q100_est	32	88	174

Table A-3. Reach 2 average channel and overbank depth, velocity, shear stress and mobile particle size.

Parameter	Recurrence Interval	Minimum	Average	Maximum
Depth in Channel (ft)	Qbkf_est	2.35	3.39	4.62
	Q10_est	3.76	4.83	6.09
	Q25_est	4.16	5.25	6.50
	Q50_est	4.46	5.53	6.78
	Q100_est	4.71	5.78	7.05
Depth in Left Overbank (ft)	Qbkf_est	0.04	0.09	0.13
	Q10_est	0.13	0.92	1.42
	Q25_est	0.25	1.20	1.80
	Q50_est	0.24	1.38	2.06
	Q100_est	0.31	1.53	2.29
Depth in Right Overbank (ft)	Qbkf_est	0.01	0.14	0.48
	Q10_est	0.06	0.87	1.45
	Q25_est	0.39	1.22	1.87
	Q50_est	0.60	1.44	2.16
	Q100_est	0.67	1.63	2.41
Velocity in Channel (fps)	Qbkf_est	2.49	4.15	6.17
	Q10_est	3.72	5.53	7.68
	Q25_est	4.10	5.93	8.17
	Q50_est	4.34	6.20	8.48
	Q100_est	4.54	6.46	8.81
Velocity in Left Overbank (fps)	Qbkf_est	0.11	0.14	0.16
	Q10_est	0.18	0.82	1.47
	Q25_est	0.27	1.01	1.78
	Q50_est	0.34	1.13	1.96
	Q100_est	0.34	1.23	2.12
Velocity in Right Overbank (fps)	Qbkf_est	0.05	0.33	0.93
	Q10_est	0.15	0.78	1.47
	Q25_est	0.37	1.00	1.71
	Q50_est	0.45	1.13	1.83
	Q100_est	0.52	1.24	1.92
Shear Stress in Channel (lbf/ft^2)	Qbkf_est	0.09	0.36	0.82
	Q10_est	0.18	0.51	1.05
	Q25_est	0.21	0.56	1.13
	Q50_est	0.22	0.59	1.18
	Q100_est	0.24	0.62	1.23
Shear Stress in Left Overbank (lbf/ft^2)	Qbkf_est	0.01	0.01	0.01
	Q10_est	0.01	0.10	0.28
	Q25_est	0.01	0.14	0.37
	Q50_est	0.01	0.16	0.41
	Q100_est	0.02	0.18	0.46

Table A-3. Reach 2 average channel and overbank depth, velocity, shear stress and mobile particle size.

Parameter	Recurrence Interval	Minimum	Average	Maximum
Shear Stress in Right Overbank (lbf/ft^2)	Qbkf_est	0.01	0.04	0.15
	Q10_est	0.01	0.10	0.28
	Q25_est	0.02	0.14	0.35
	Q50_est	0.03	0.16	0.37
	Q100_est	0.04	0.18	0.38
Mobile Particle Size in Channel (mm)	Qbkf_est	12	46	104
	Q10_est	23	65	133
	Q25_est	27	71	143
	Q50_est	29	75	149
	Q100_est	31	79	156

Table A-4. Reach 3 average channel and overbank depth, velocity, shear stress and mobile particle size.

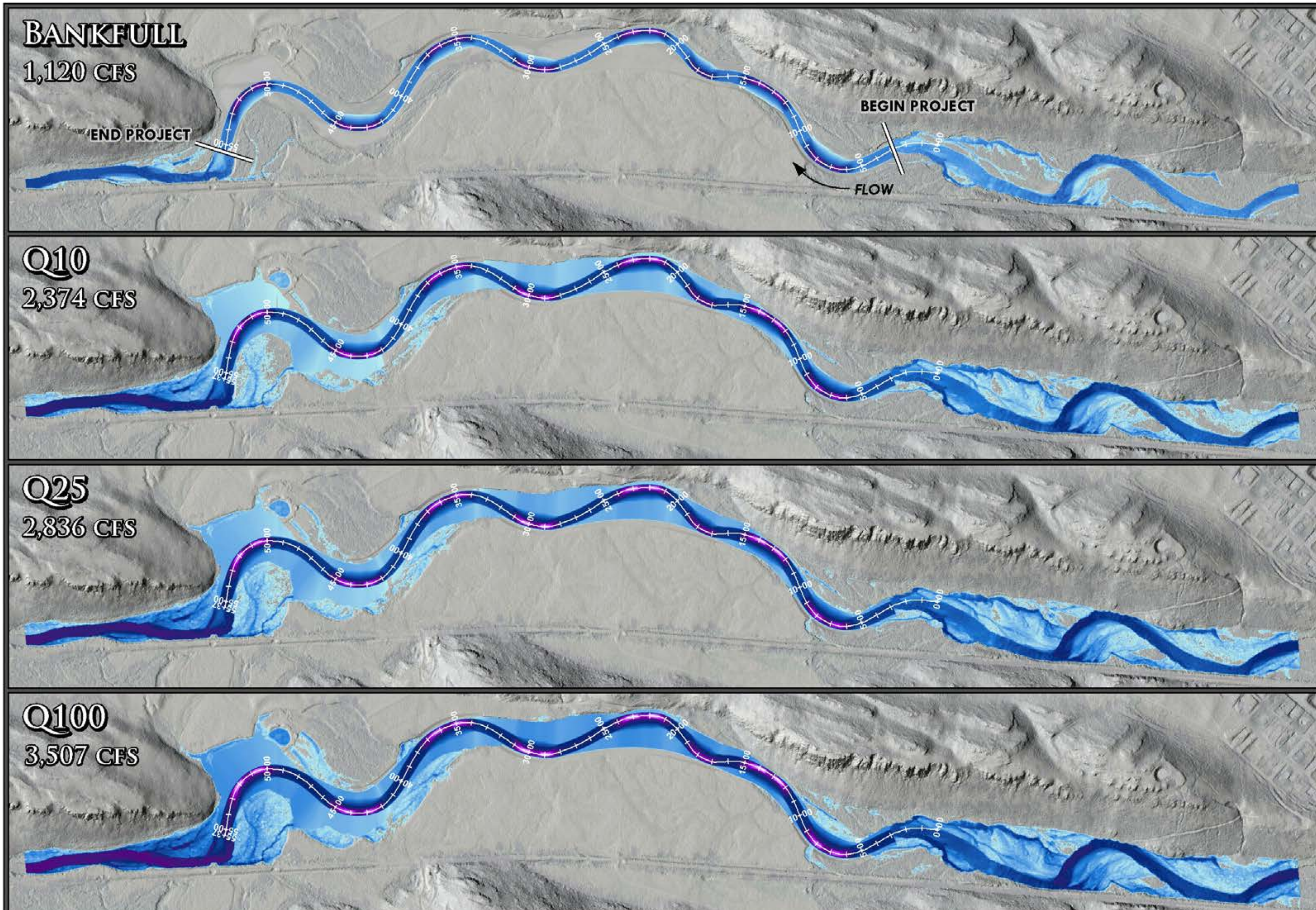
Parameter	Recurrence Interval	Minimum	Average	Maximum
Depth in Channel (ft)	Qbkf_est	2.23	3.16	4.31
	Q10_est	3.54	4.59	6.01
	Q25_est	3.81	5.02	6.53
	Q50_est	3.92	5.29	6.85
	Q100_est	4.16	5.57	7.18
Depth in Left Overbank (ft)	Qbkf_est	0.01	0.52	1.47
	Q10_est	0.09	0.75	1.37
	Q25_est	0.10	0.97	1.80
	Q50_est	0.05	1.13	2.13
	Q100_est	0.16	1.32	2.45
Depth in Right Overbank (ft)	Qbkf_est	0.01	0.09	0.42
	Q10_est	0.15	0.71	1.48
	Q25_est	0.05	0.99	1.94
	Q50_est	0.16	1.17	2.26
	Q100_est	0.35	1.34	2.61
Velocity in Channel (fps)	Qbkf_est	2.51	4.29	6.64
	Q10_est	3.12	5.49	8.27
	Q25_est	3.12	5.75	9.07
	Q50_est	3.14	5.93	9.81
	Q100_est	3.14	6.05	10.08
Velocity in Left Overbank (fps)	Qbkf_est	0.02	0.56	1.41
	Q10_est	0.28	0.77	1.36
	Q25_est	0.44	0.90	1.55
	Q50_est	0.26	0.98	1.73
	Q100_est	0.50	1.06	1.89

Table A-4. Reach 3 average channel and overbank depth, velocity, shear stress and mobile particle size.

Velocity in Right Overbank (fps)	Qbkf_est	0.02	0.16	0.70
	Q10_est	0.28	0.73	1.29
	Q25_est	0.19	0.88	1.55
	Q50_est	0.44	0.98	1.74
	Q100_est	0.50	1.05	1.89
Shear Stress in Channel (lbf/ft^2)	Qbkf_est	0.09	0.39	1.03
	Q10_est	0.13	0.52	1.32
	Q25_est	0.12	0.55	1.49
	Q50_est	0.12	0.56	1.71
	Q100_est	0.12	0.57	1.75
Shear Stress in Left Overbank (lbf/ft^2)	Qbkf_est	0.00	0.07	0.26
	Q10_est	0.01	0.09	0.22
	Q25_est	0.03	0.11	0.30
	Q50_est	0.02	0.12	0.34
	Q100_est	0.04	0.13	0.35
Shear Stress in Right Overbank (lbf/ft^2)	Qbkf_est	0.00	0.02	0.09
	Q10_est	0.02	0.08	0.22
	Q25_est	0.01	0.11	0.30
	Q50_est	0.03	0.13	0.36
	Q100_est	0.03	0.14	0.43
Mobile Particle Size in Channel (mm)	Qbkf_est	12	51	131
	Q10_est	17	67	167
	Q25_est	16	70	188
	Q50_est	16	72	215
	Q100_est	15	73	221

A-2 Hydraulic Model Output Maps

The following maps illustrate the hydraulics summarized in Tables A-2, A-3, and A-4. Design station numbers are in feet, and station numbers for reach delineations are described in Table A-1.



TOBACCO RIVER
PRELIMINARY DESIGN
DEPTH

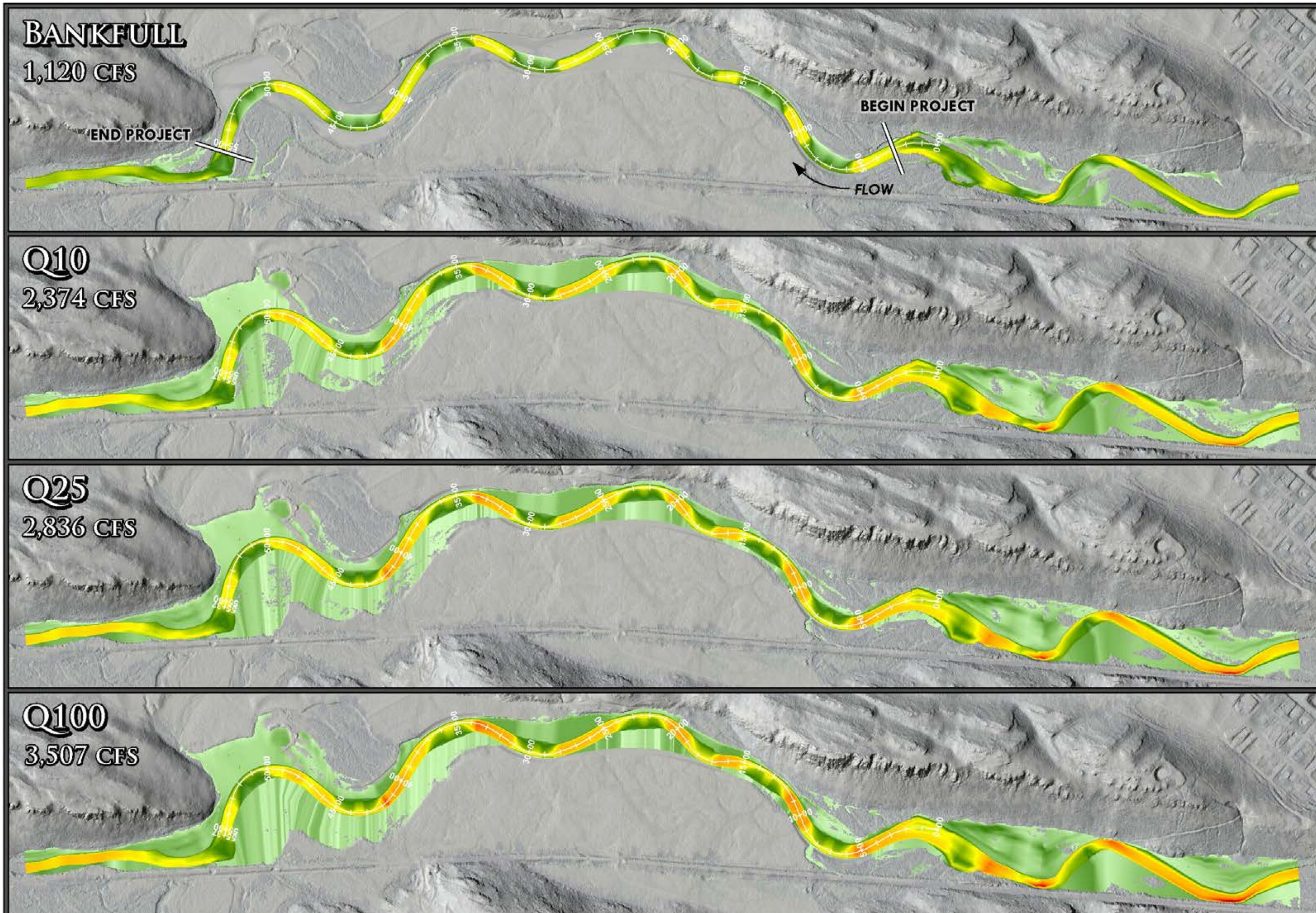
DEPTH (FEET) 0 2 4 6 8 10 12.9

0 250 500 1,000 Feet

RIVER DESIGN GROUP, INC.

12.15.2014. River Design Group, Inc.
Spatial Reference:
NAD83, MT State Plane.

DEPTH



Tobacco River
Preliminary Design
Velocity

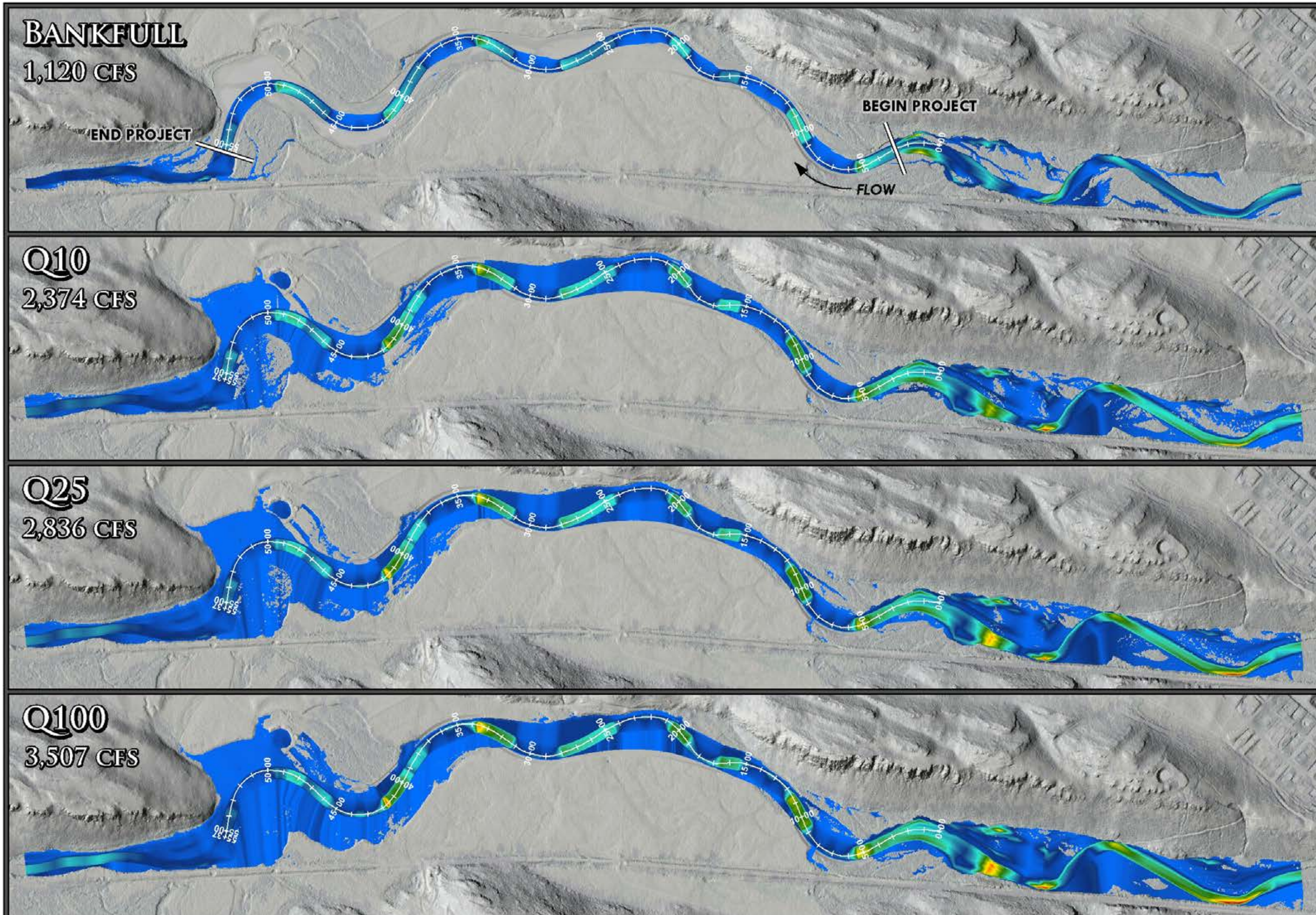
Velocity (FPS): 0 2 4 6 8 10 12 14

0 250 500 1,000 Feet

River Design Group, Inc.

12.15.2014. River Design Group, Inc.
Spatial Reference:
NAD83, MT State Plane.

Velocity



TOBACCO RIVER
PRELIMINARY DESIGN
SHEAR STRESS

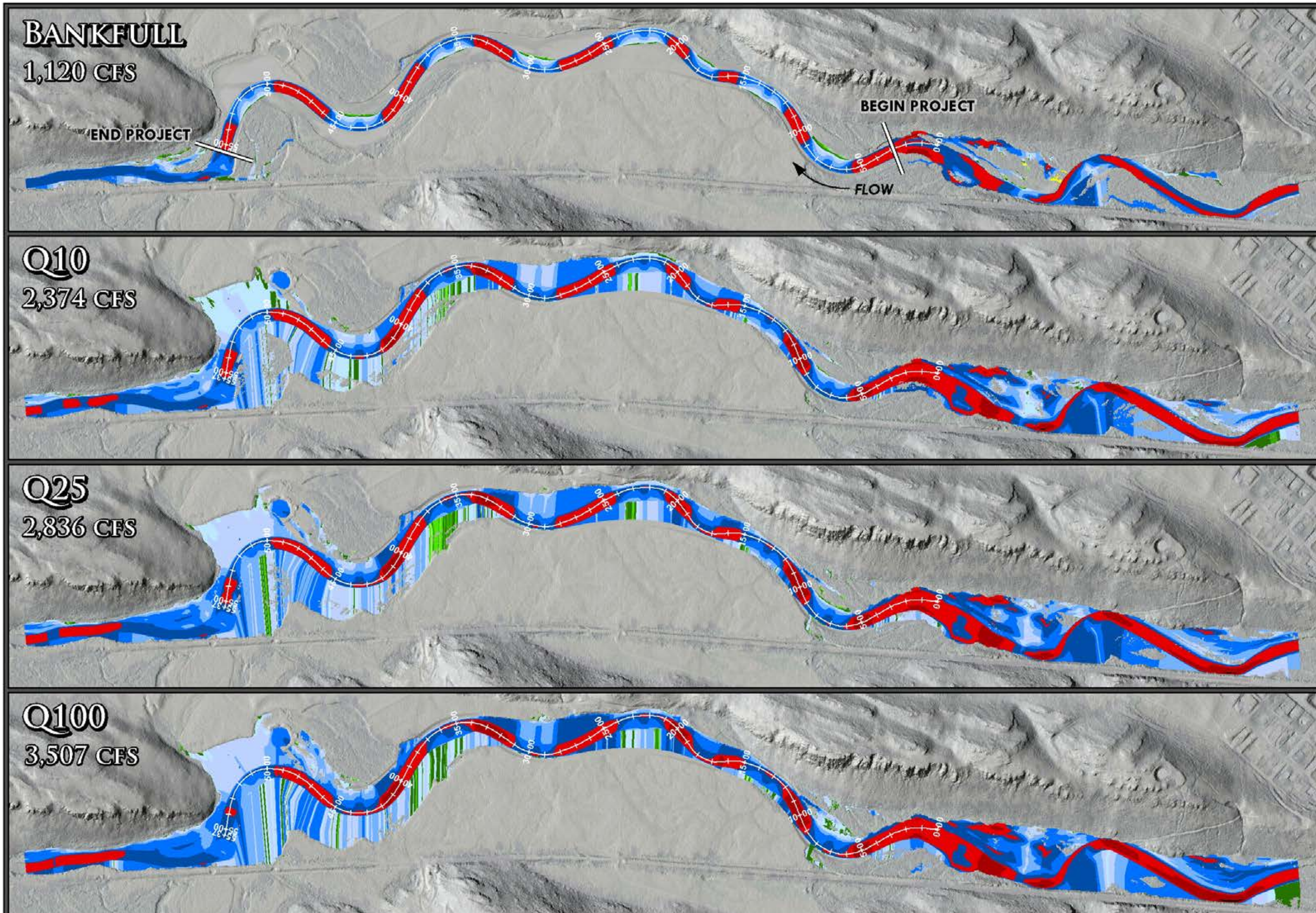
SHEAR STRESS (PSF)
0 0.4 0.8 1.2 1.5 1.9 2.3 2.7

0 250 500 1,000 Feet

RIVER DESIGN GROUP, INC.

12.15.2014. River Design Group, Inc.
Spatial Reference:
NAD83, MT State Plane.

SHEAR STRESS



TOBACCO RIVER
PRELIMINARY DESIGN
MOBILE PARTICLE SIZE

MOBILE PARTICLE SIZE

CL-M	VFS	FS	MS	CS	VCS	VFG	FG	MG	CG	VCG	SC	LC	SB
0	0.0625	0.125	0.25	0.5	1	2	4	8	16	32	64	128	256

512

0 250 500 1,000 Feet

RIVER DESIGN GROUP, INC.

12.15.2014. River Design Group, Inc.
Spatial Reference:
NAD83, MT State Plane.

MOBILE PARTICLE SIZE

Appendix B

Reference Reach Geomorphic Data

1 Tobacco River Feature Location Map

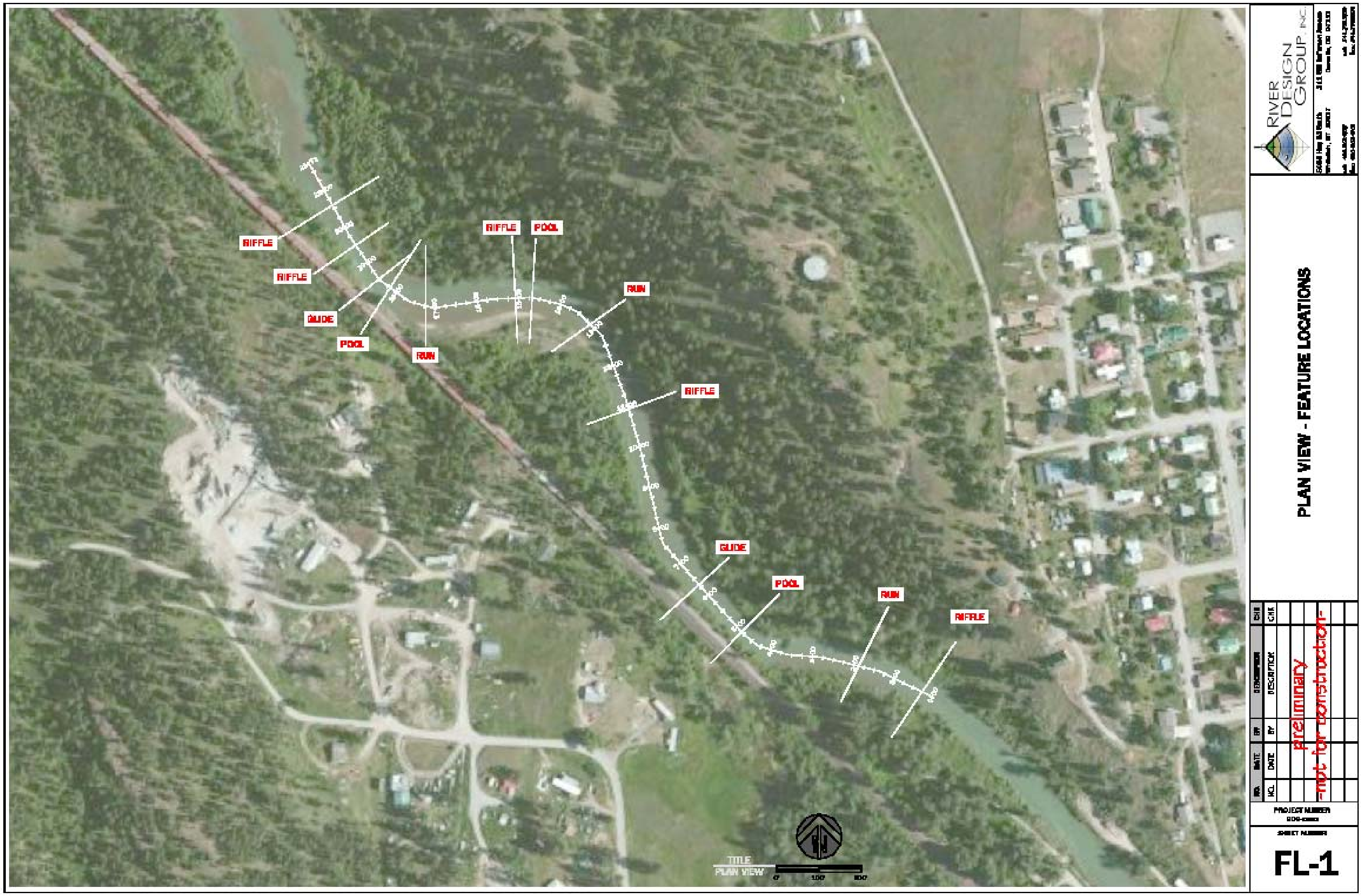


Figure 1-1. Tobacco River Reference Reach Feature Locations.

2 Survey Planview

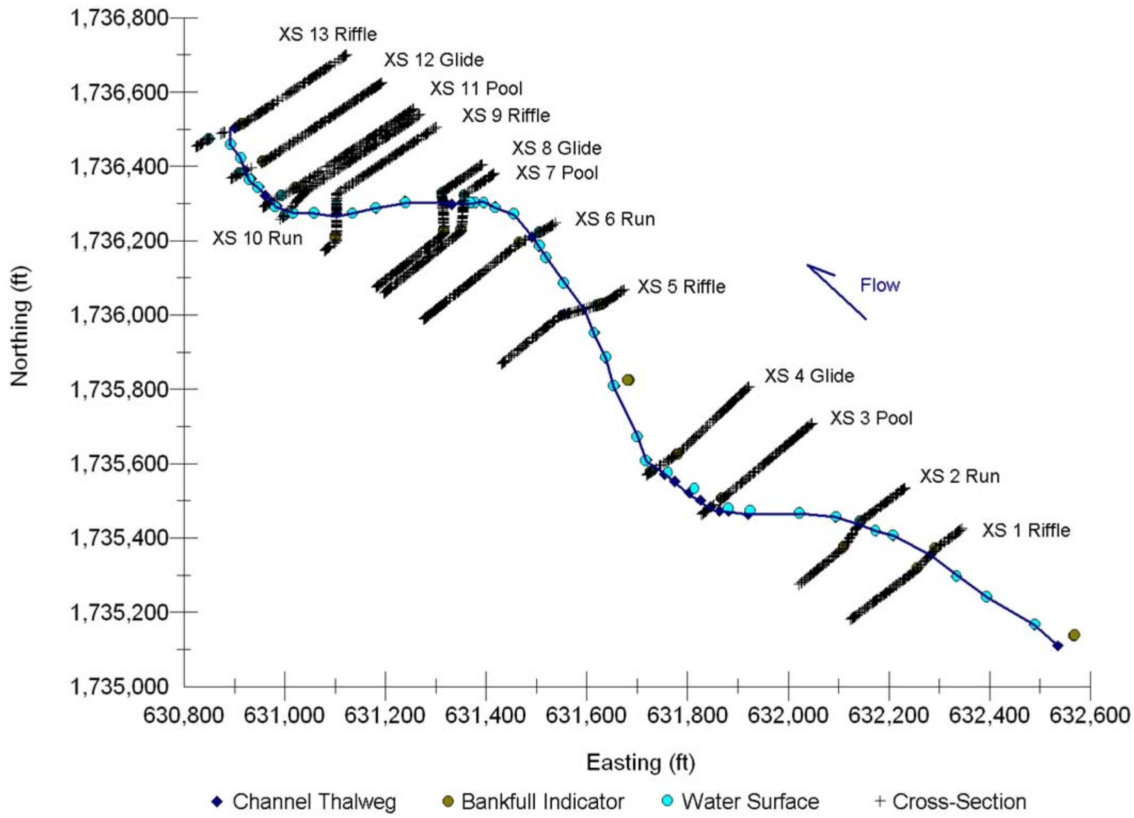


Figure 2-1. Planview of the surveyed points in the Tobacco River Reference Reach.

Figure 2-2. View of upper (left) and lower (right) survey extents in The Tobacco River Reference Reach.

3 Longitudinal Profile

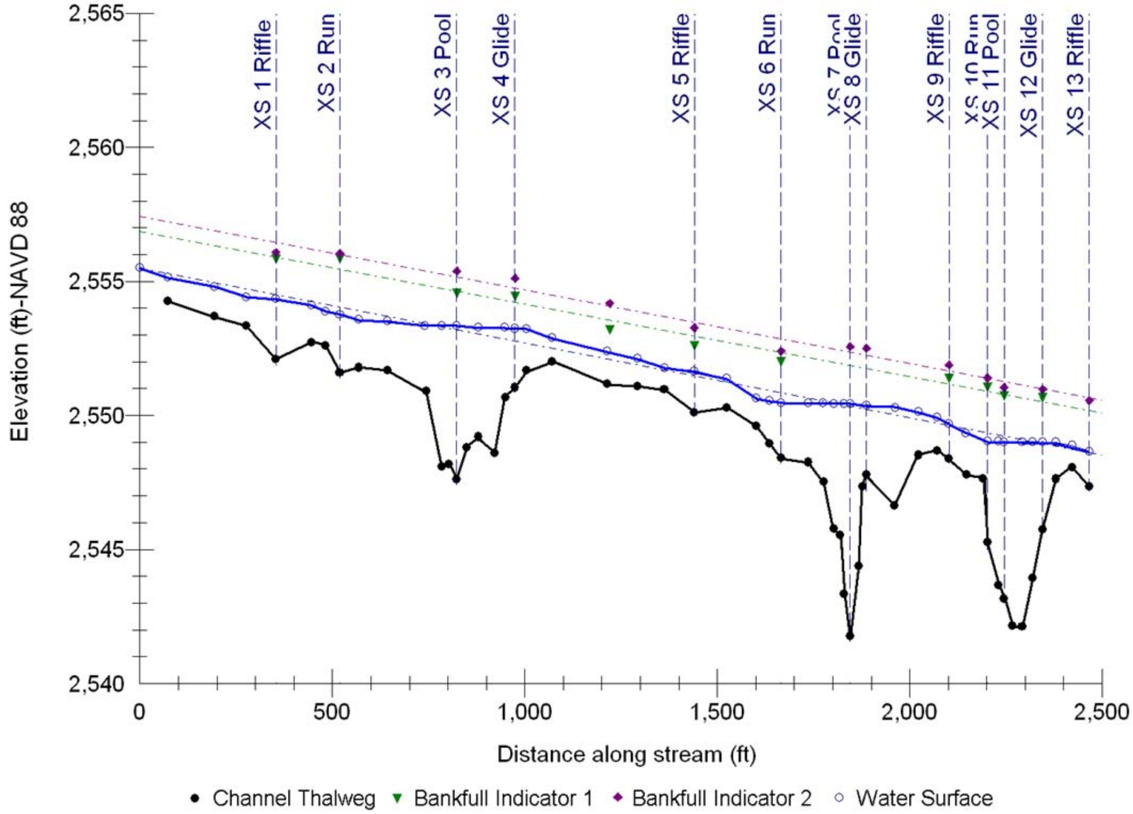


Figure 3-1. Tobacco river Reference Reach longitudinal profile.

Table 3-1. Longitudinal profile dimensions and dimensionless ratios for the Tobacco River Reference Reach.

Profile Dimensions Metric	Min	Mean	Max	Profile Dimensionless Ratios[1] Metric	Min	Mean	Max
WS Slope (%)		0.28		Bankfull Slope (%)		0.28	
S Riffle (%)	0.35	0.44	0.61	S Riffle / Sbkf	1.3	1.6	2.2
S Pool (%)	0.02	0.03	0.04	S Pool / Sbkf	0.1	0.1	0.2
S Run (%)	0.15	0.19	0.21	S Run / Sbkf	0.5	0.7	0.8
S Glide (%)	0.10	0.13	0.17	S Glide / Sbkf	0.4	0.5	0.6
Pool - Pool (ft)	436	728	1019	Pool - Pool / Wbkf	5.0	8.3	11.7
Pool Length (ft)	184	222	242	Pool Length / Wbkf	2.1	2.5	2.8
Riffle Length (ft)	168	351	502	Riffle Length/ Wbkf	1.9	4.0	5.7
Dmax Riffle (ft)	3.0	3.2	3.4	Dmax Riffle / Dbkf	1.3	1.4	1.5
Dmax Pool (ft)	7.6	9.1	10.6	Dmax Pool / Dbkf	3.3	4.0	4.6
Dmax Run (ft)	4.0	4.4	5.0	Dmax Run / Dbkf	1.8	1.9	2.2
Dmax Glide (ft)	3.5	4.2	4.8	Dmax Glide / Dbkf	1.6	1.8	2.1

[1]Sbkf=0. 28 %, Wbkf=80.5 ft, Dbkf=2.3 ft.

4 Planform Geometry

Table 4-1. Planform geometry summary table including actual values and dimensionless ratios for the Tobacco River Reference Reach.

Meander Location (ft)	Meander Wave Length (ft)	Meander Belt Width (ft)	Radius of Curvature (ft)	Lm / Wbkf[1]	Wblt / Wbkf[1] (MWR)	Rc / Wbkf[1]
XS 4	1,120	300	550	13.9	3.7	6.8
XS 6	1,080	360	466	13.4	4.5	5.8
XS 10	1,060	340	450	13.2	4.2	5.6
Minimum	1,060	300	450	13.2	3.7	5.6
Mean	1,087	333	489	13.5	4.1	6.1
Maximum	1,120	360	550	13.9	4.5	6.8
Standard Deviation	30.6	30.6	53.7	0.4	0.4	0.7
Coefficient of Variance	0.03	0.09	0.11	0.0	0.1	0.1
Sinuosity	1.13					

[1] Wbkf=80.5 ft

5 Cross-Section Dimensions

Table 5-1. Cross-section dimensions and dimensionless ratios for the Tobacco River Reference Reach.

Cross-Section Dimensions Metric	Min	Mean	Max	Cross-Section Dimensionless Ratios[1] Metric	Min	Mean	Max
Floodprone Width (ft)	262	313	380	Wfpa / Wbkf	3.3	3.9	4.7
Riffle Area (ft^2)	171	183	194	Riffle Area / Abkf	0.9	1.0	1.1
Max Riffle Depth (ft)	3.2	3.5	4.0	Max Riffle Depth / Dbkf	1.4	1.5	1.7
Mean Riffle Depth (ft)	2.1	2.3	2.5	Mean Riffle Depth / Dbkf	0.9	1.0	1.1
Riffle Width (ft)	67.5	80.5	91.3	Riffle Width / Wbkf	0.8	1.0	1.1
Entrenchment Ratio	3.3	3.9	4.2	Entrenchment Ratio/ER	0.7	1.0	1.2
Width/Depth Ratio	26.6	35.7	44.5	Width/Depth / W/D	0.8	1.0	1.1
Pool Area (ft^2)	204	249	333	Pool Area / Abkf	1.1	1.4	1.8
Max Pool Depth (ft)	7.8	8.8	10.8	Max Pool Depth / Dbkf	3.4	3.8	4.7
Mean Pool Depth (ft)	3.1	4.0	5.1	Mean Pool Depth / Dbkf	1.4	1.8	2.2
Pool Width (ft)	54.2	61.6	65.5	Pool Width / Wbkf	0.7	0.8	0.8
Run Area (ft^2)	159	185	204	Run Area / Abkf	0.9	1.0	1.1
Max Run Depth (ft)	4.0	4.9	6.1	Max Run Depth / Dbkf	1.7	2.1	2.7
Mean Run Depth (ft)	2.5	2.5	2.6	Mean Run Depth / Dbkf	1.1	1.1	1.1
Run Width (ft)	60.9	73.0	79.5	Run Width / Wbkf	0.8	0.9	1.0
Glide Area (ft^2)	200	214	228	Glide Area / Abkf	1.1	1.2	1.2
Max Glide Depth (ft)	4.1	4.7	5.2	Max Glide Depth / Dbkf	1.8	2.0	2.3
Mean Glide Depth (ft)	2.9	3.1	3.5	Mean Glide Depth /Dbkf	1.3	1.4	1.5
Glide Width (ft)	65.0	69.1	72.9	Glide Width / Wbkf	0.8	0.9	0.9

[1] Abkf=183 ft^2, Wbkf=80.5 ft, W/D=35.7, ER= 3.9, Dbkf=2.3 ft.

5.1 Surveyed Cross-Sections

5.1.1 Riffle Cross-Sections (2 of 4)

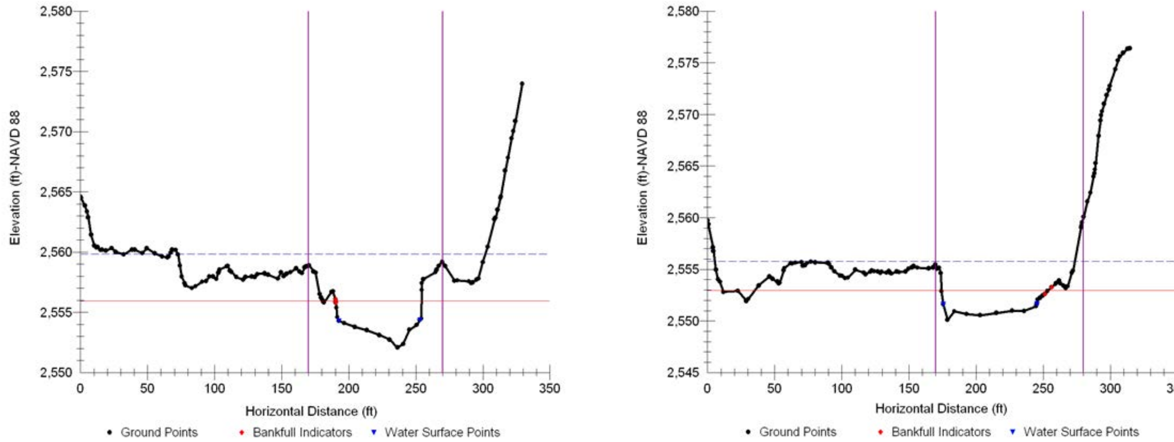


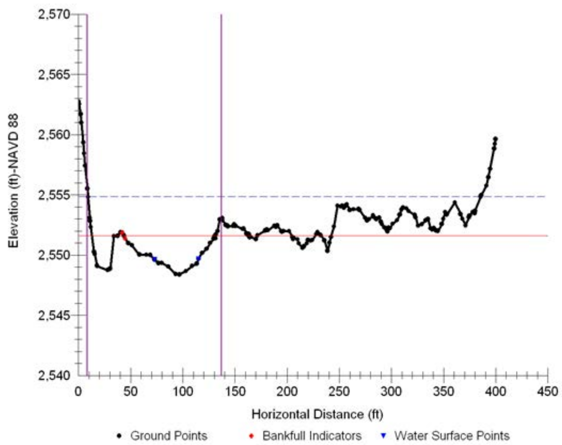
Figure 5-1. Riffle cross-sections 1 (left) and 5 (right).

Table 5-2. Riffle channel dimensions in the Tobacco River Reference Reach.

Metric	XS 1	XS 5
Floodprone Width (ft)	262	270
Bankfull Width (ft)	67.5	83.0
Entrenchment Ratio	3.9	3.3
Mean Depth (ft)	2.5	2.2
Maximum Depth (ft)	4.0	3.2
Width/Depth Ratio	26.6	38.4
Bankfull Area (ft^2)	171	179
Wetted Perimeter (ft)	70.0	84.6
Hydraulic Radius (ft)	2.5	2.1

Figure 5-2. View downstream of cross-sections 1 (left) and 5 (right).

5.1.2 Riffle Cross-Sections (4 of 4)



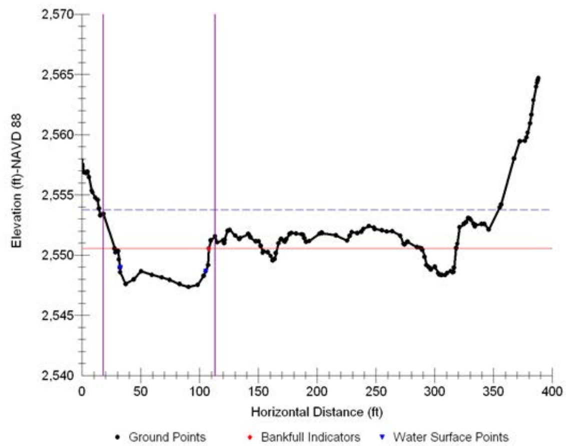


Figure 5-3. Riffle cross-sections 9 (left) and 13 (right).

Table 5-3. Riffle channel dimensions in the Tobacco River Reference Reach.

Metric	XS 9	XS 13
Floodprone Width (ft)	380	340
Bankfull Width (ft)	91.3	80.1
Entrenchment Ratio	4.2	4.2
Mean Depth (ft)	2.1	2.4
Maximum Depth (ft)	3.5	3.2
Width/Depth Ratio	44.5	33.1
Bankfull Area (ft^2)	188	194
Wetted Perimeter (ft)	91.8	82.3
Hydraulic Radius (ft)	2.0	2.4

Figure 5-4. View downstream of cross-sections 9 (left) and 13 (right).

5.1.3 Run Cross-Sections (2 of 3)

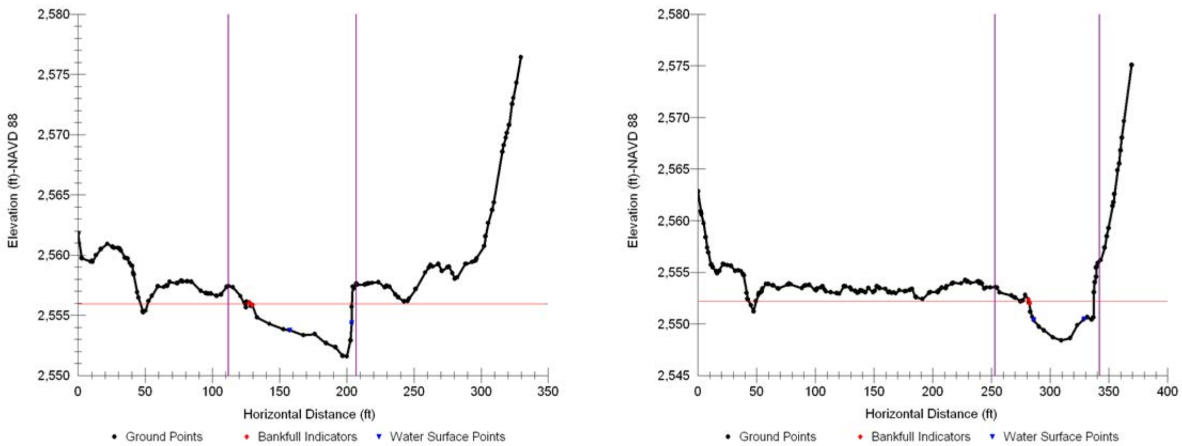


Figure 5-5. Run cross-sections 2 (left) and 6 (right).

Table 5-4. Run channel dimensions in the Tobacco River Reference Reach.

Metric	XS 2	XS 6
Floodprone Width (ft)	N/A	N/A
Bankfull Width (ft)	78.5	60.9
Entrenchment Ratio	N/A	N/A
Mean Depth (ft)	2.5	2.6
Maximum Depth (ft)	4.4	4.0
Width/Depth Ratio	31.9	23.4
Bankfull Area (ft^2)	193	159
Wetted Perimeter (ft)	81.7	63.5
Hydraulic Radius (ft)	2.4	2.5

Figure 5-6. View downstream of cross-sections 2 (left) and 6 (right).

5.1.4 Run Cross-Section (3 of 3)

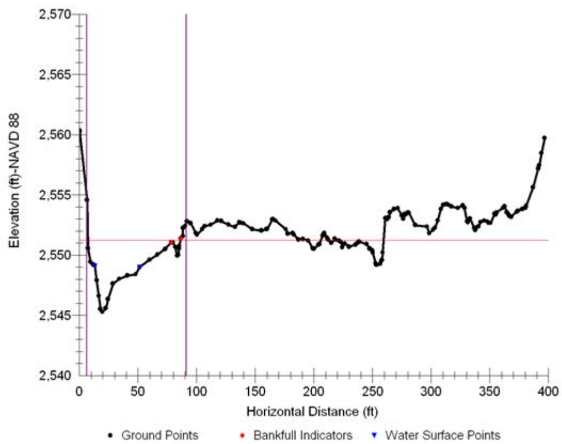


Figure 5-7. Run cross-section 10.

Table 5-5. Run channel dimensions in the Tobacco River Reference Reach.

Metric	XS 10
Floodprone Width (ft)	N/A
Bankfull Width (ft)	79.5
Entrenchment Ratio	N/A
Mean Depth (ft)	2.6
Maximum Depth (ft)	6.1
Width/Depth Ratio	31.0
Bankfull Area (ft^2)	204
Wetted Perimeter (ft)	82.8
Hydraulic Radius (ft)	2.5

Figure 5-8. View downstream (left) and across channel (right) of cross-section 10.

5.1.5 Pool Cross-Sections (2 of 3)

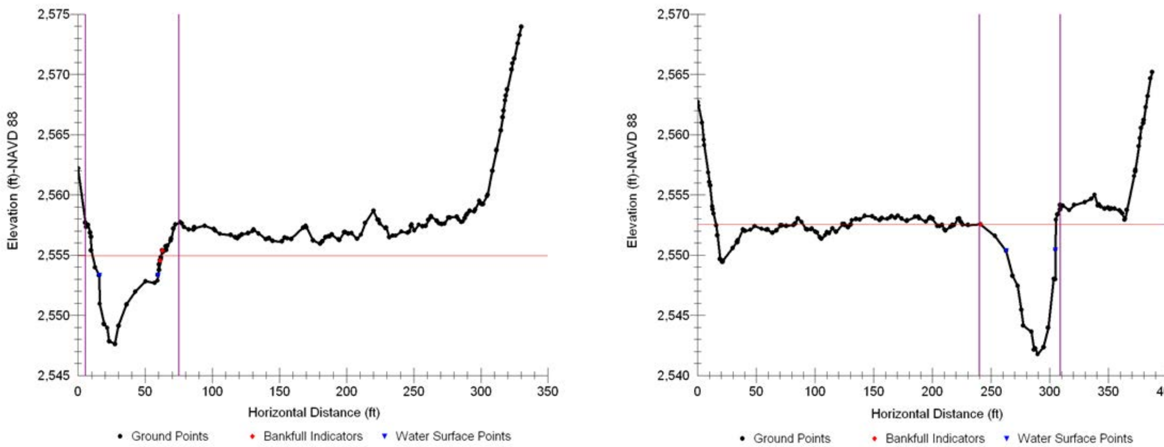


Figure 5-9. Pool cross-sections 3 (left) and 7 (right).

Table 5-6. Pool channel dimensions within the Tobacco River Reference Reach.

Metric	XS 3	XS 7
Floodprone Width (ft)	N/A	N/A
Bankfull Width (ft)	54.2	65.1
Entrenchment Ratio	N/A	N/A
Mean Depth (ft)	3.9	5.1
Maximum Depth (ft)	7.8	10.8
Width/Depth Ratio	13.9	12.7
Bankfull Area (ft^2)	211	333
Wetted Perimeter (ft)	59.9	73.3
Hydraulic Radius (ft)	3.5	4.6

Figure 5-10. View downstream of cross-section 3 (left) and upstream of cross-section 7 (right).

RIVER DESIGN GROUP, INC.

5.1.6 Pool Cross-Section (3 of 3)

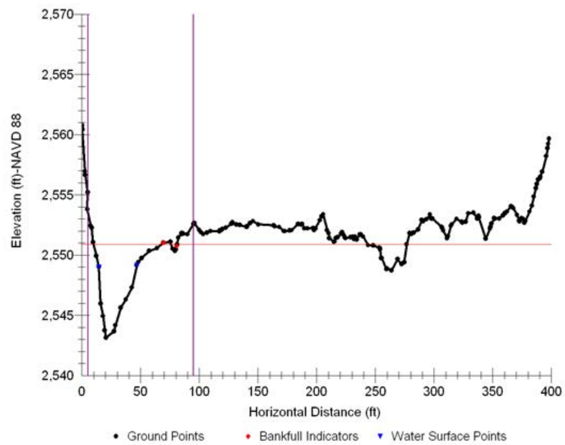


Figure 5-11. Pool cross-section 11.

Table 5-7. Pool channel dimensions in the Tobacco River Reference Reach.

Metric	XS 11
Floodprone Width (ft)	N/A
Bankfull Width (ft)	65.5
Entrenchment Ratio	N/A
Mean Depth (ft)	3.1
Maximum Depth (ft)	7.9
Width/Depth Ratio	21.1
Bankfull Area (ft^2)	204
Wetted Perimeter (ft)	69.9
Hydraulic Radius (ft)	2.9

Figure 5-12. View downstream (left) and across channel (right) of cross-section 11.

5.1.7 Glide Cross-Sections (2 of 3)

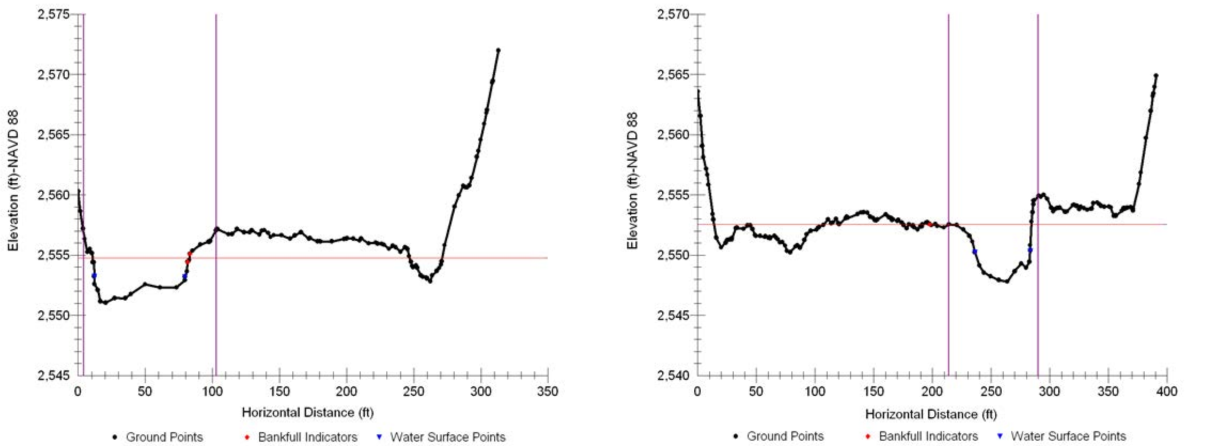


Figure 5-13. Glide cross-sections 4 (left) and 8 (right).

Table 5-8. Glide channel dimensions in the Tobacco River Reference Reach.

Metric	XS 4	XS 8
Floodprone Width (ft)	N/A	N/A
Bankfull Width (ft)	72.9	69.4
Entrenchment Ratio	N/A	N/A
Mean Depth (ft)	3.0	2.9
Maximum Depth (ft)	4.1	4.8
Width/Depth Ratio	24.7	24.1
Bankfull Area (ft^2)	215	200
Wetted Perimeter (ft)	76.2	72.8
Hydraulic Radius (ft)	2.8	2.8

Figure 5-14. View downstream of cross-section 4 (left) and cross-section 8 (right).

5.1.8 Glide Cross-Section (3 of 3)

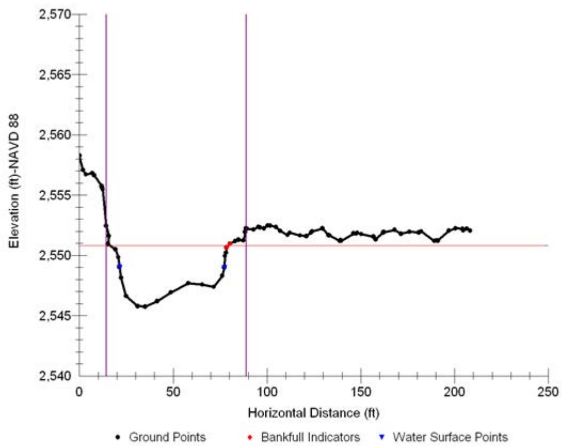


Figure 5-15. Glide cross-section 12.

Table 5-9. Glide channel dimensions in the Tobacco River Reference Reach.	
Metric	XS 12
Floodprone Width (ft)	N/A
Bankfull Width (ft)	65.0
Entrenchment Ratio	N/A
Mean Depth (ft)	3.5
Maximum Depth (ft)	5.2
Width/Depth Ratio	18.6
Bankfull Area (ft^2)	228
Wetted Perimeter (ft)	68.1
Hydraulic Radius (ft)	3.3

Figure 5-16. View downstream (left) and across channel (right) of cross-section 12.

6 Substrate Particle Size Distributions

6.1 Riffle Substrate

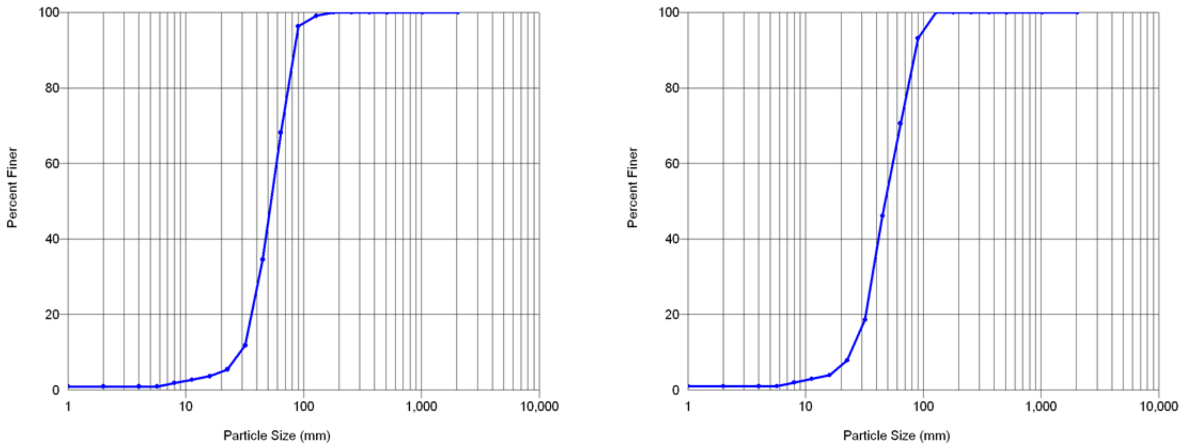


Figure 6-1. Riffle particle size distributions at cross-sections 5 (left) and 9 (right).

Table 6-1. Riffle particle size distribution at cross-sections 5 and 9.

Metric	XS 5 (mm)	XS 9 (mm)
D16	34	30
D35	45	40
D50	54	48
D84	79	79
D95	89	100
D100	180	128

Table 6-2. Riffle material composition at cross-sections 5 and 9.

Metric	XS 5 (mm)	XS 9 (mm)
Silt/Clay	0	0
Sand	1	1
Gravel	67	70
Cobble	32	29
Boulder	0	0
Bedrock	0	0

6.2 Riffle Stability Index

Table 6-3. Riffle Stability Index values for the Tobacco River Reference Reach.

		RSI Score	
Point Bar ID	Geometric Mean (mm)	XS 5	XS 9
XS 10	107.1	D98	D96
XS 11	106.7	D98	D96

7 Hydraulic Assessment

Table 7-1. Estimated bankfull flow metrics using the Manning's and Limerino's equations in the Tobacco River Reference Reach.

Cross-Section ID	D50 (mm)	D84 (mm)	Local Slope (ft/ft)	Bankfull Area (ft^2)	Mean Velocity (ft/sec)	Bankfull Flow (cfs)
XS 1	54	79	0.0034	172	4.6	782
XS 5	54	79	0.0044	179	4.6	830
XS 9	48	79	0.0068	188	5.6	1,041
XS 13	48	79	0.0050	194	5.3	1,036

Tobacco Valley Ranch
PO Box 1361
Eureka, MT 59917
(406) 297-7870
tobaccovalleyranch@gmail.com

14th September 2015

Mark Ockey, Water Activities Workgroup Leader
Water Quality Specialist
DEQ Watershed Protection Section
P.O. Box 200901
Helena, Montana 59620-0901

319 DNRC Grant Application - Tobacco Valley Ranch Owner Letter of Support

Dear Mr. Ockey,

I would like to take this opportunity to describe how I became involved in this project and my family's conservation ethic and commitment to this project.

In the early 1990's my family discovered the Tobacco Valley while searching Montana for a place to re-establish our family's roots after moving out of state from Ovando, Montana. Important criteria in my family's search was to invest in a place where we would be able to contribute to the conservation of the land, fisheries, forests, habitats, and biological diversity. We were neophytes in the necessary practices and real challenges of conservation, but we were certain of our commitment to conservation principles. My family found multiple contiguous properties that now comprises the Tobacco Valley Ranch (TVR) located in Eureka, Montana, which borders both sides of approximately one mile of the Tobacco River.

In every aspect, the Kassler Family acquisition of these properties met our criteria for being a place where conservation ethics and ambitions could be put into practice and from my family's perspective were needed. In 2009 I purchased nearly 3/4 miles of the historic Great Northern Railroad property that runs adjacent to the Tobacco River and provided an easement for a key section of the 7.5 mile Kootenai Rails-to-Trails. This trail system is open to the public for walking, cycling, and horseback riding. This "overland" public recreational access along the Tobacco River from the Town of Eureka to Lake Koocanusa is equally as important as the public's recreational use of the river.

The Kassler family took its first steps toward active conservation of the Tobacco River in 2001 when Jeff Dunn, currently employed by RESPEC, approached my family about conducting a stream assessment on the mile stretch of the river we border for his graduate work. From this assessment, my family began to grasp that restoration of streambanks and riparian vegetation would significantly contribute to the long term health of a biodiverse river habitat in the watershed. This initial assessment started to provide a blueprint of what would be necessary in the years ahead to advance our goals of stewardship and conservation.

I began to research on how to actually implement a plan for restoration for the TVR in 2011**.** In my study of the 2011 Tobacco Planning Area Sediment TMDLs and other documents, I became aware of restoration work being done on tributaries of the Tobacco River Watershed (Grave Creek, Therriault Creek, and Sinclair Creek). In 2012 I contracted with River Design Group (RDG) to do a "Conceptual River Restoration" for degraded streambank and riparian buffers. It soon became clear that this effort would be difficult for the TVR to accomplish alone. I approached the Lincoln Conservation District (LCD) and Rox Rogers, U.S. Fish and Wildlife Service in 2013 about becoming stakeholders. This in turn lead to a Reclamation and Project Development Planning Grant from the Montana Department of Natural Resources and Conservation (DNRC), and ultimately to this 319 application. To accomplish the goals of this application the Kassler Family has committed the following contributions and long-term responsibilities:

- Any and all material resources available on Tobacco Valley Ranch.
    - rock & boulders for riverbed and streambank fill
    - wood for bank and floodplain stabilization - logs, root-wads, woody vegetation salvage
    - topsoil - floodplain & riparian revegetation
- Abandonment and relocation of current private bridge crossing. Current bridge location and span causes hydraulic constriction affecting upstream and downstream bank and streambed degradation.
- Abandonment and relocation of current irrigation pump station concomitant with TVR water rights on the Tobacco River.
- Abandonment of productive agricultural and pasture ground to increase floodplain and riparian corridor.
- Coordinate with NRCS to develop and adopt a conservation plan for adjacent agricultural and pasture ground
- Implementation and maintenance of livestock fencing to protect sensitive new and established riparian habitat.
- Implement stewardship practices to uphold and maintain a healthy riparian buffer and streambed
- Support access by the public for recreational use of the Tobacco River and work with GOs and NGOs to promote educational awareness of conservation and restoration practices.

The Kassler Family has been impressed by the Tobacco Valley community's appreciation of their natural resources and by the natural resources themselves. The scope of knowledge, experience and financial demands necessary for this project has necessitated us to reach out for assistance and we are grateful for the significant contributions made by private and public organizations. Funding from this application would help us make the first critical step in funding Phase 1 of this project.

Thank you for your consideration of our application for 319 funding.

Sincerely,

Karl Kassler

Montana Fish, Wildlife & Parks

Mike E. Hensler MFWP
385 Fish Hatchery RD
Libby, MT 59923
(406) 293-4161
FAX 293-2235
mhensler@mt.gov
Ref: MH71.15
Date: 8/27/15

Mark Ockey, Water Activities Workgroup Leader
Water Quality Specialist
DEQ Watershed Protections Section
P.O. Box 200901
Helena, MT 59620-0901

SUBJECT: Letter of support for the construction of Phase 1 of the Tobacco River Restoration Project

Mr. Ockey;

I have reviewed the proposed project and design for the Kassler property. MFWP agrees with the basic design suggested for this project. The Tobacco River is important as a migration corridor for bull trout to and from Grave Creek which is the only significant spawning and rearing stream in Montana for Lake Koocanusa adfluvial bull trout. In addition, resident, fluvial and possibly adfluvial westslope cutthroat trout use the Tobacco River. Any opportunity to create, maintain or enhance stability in this section of the Tobacco River is a step forward in protecting habitat for important life stages of these and other fish including rainbow trout and kokanee salmon. If it is successful, it also could provide a template for future potential projects in this river and others in the vicinity.

Sincerely,

Mike E. Hensler
Fisheries Management Biologist

/meh

Kootenai River Network, Inc.
International Alliance for Water Quality and Aquatic Resources

James L. Dunnigan
Kootenai River Network
P.O. Box 419
Libby, MT 59923

September 8, 2015

Mark Ockey, Water Activities Workgroup Leader
Water Quality Specialist
DEQ Watershed Protection Section
P.O. Box 200901
Helena, MT 59620-0901

Dear Mark

Please consider this document to be a letter of support in principle from the Kootenai River Network (KRN) for the Tobacco River Restoration Project located on the Kassler property. The KRN has a lengthy history of involvement in restoration efforts in the Tobacco River Watershed. We have taken a leadership role in providing planning documents to prioritize and guide restoration in this important watershed in northwest Montana, as well as restored the ecological function to many miles of streams within this watershed.

The KRN recently initiated a collaborative effort to develop a watershed restoration plan for the entire Montana portion of the Kootenai River Basin. This effort required building coalitions with private industry, state and federal governmental agencies, and local communities. The plan will be completed in December 2015, and will identify and prioritize the Kassler property for restoration action.

I have personally visited the proposed project area. The previous land use issues that contributed to the loss of ecological function at this site changed substantially when the Kassler family purchased this property. Indeed, if previous landowner had shared land stewardship principles with the Kassler Family, restoration at this site would probably not be necessary today.

Completion of this important restoration project on the lower Tobacco River will do much to reduce instream sediment to the river and help move us closer to meeting water quality standards. This project is an excellent example of an engaged landowner initiating a meaningful restoration project, and seeking assistance to complete the work, and not interested conservation or government agencies working to initiate the project. The former ensures that the landowner has ownership and a vested interest in the restoration efforts and increases the probability of success. Please give this project your consideration. If you have any questions please do not hesitate to call or write.

Sincerely,

James L. Dunnigan, Kootenai River Network President

Little 69 Ranch
Osloski Road
Eureka, MT 59917
(406) 297-7870

21st September 2015

Mark Ockey, Water Activities Workgroup Leader
Water Quality Specialist
DEQ Watershed Protection Section
P.O. Box 200901
Helena, Montana 59620-0901

319 DNRC Grant Application - Tobacco Valley Ranch Owner Letter of Support

Dear Mr. Ockey,

This letter is to show my support for the Tobacco Valley Ranch 319 DNRC Grant Application and for the Kassler Families Owner Letter of Support. The overall scope of this Tobacco River Restoration Project encompasses Little 69 Ranch property immediately to the south of the Tobacco Valley Ranch. I know that funding of Phase 1 is critical to the project overall.

As a Stakeholder, I appreciate your consideration of our application for 319 funding.

Sincerely,

Jim Bushfield

United States Department of Agriculture

NRCS

Natural Resources Conservation Service
949 Hwy 93 North
Eureka, MT 59917
Phone: (406) 296-7152
Fax: (406) 296-7188
E-mail: Kirk.Sullivan@mt.usda.gov

August 31st, 2015

Dear Mr. Kassler,

The NRCS field office in Eureka, Montana would like to commend you for your leadership on the proposed Tobacco River restoration project adjacent to your property. We feel this will have a positive effect on water quality and stream bank stability in the future and serve as a good example of stewardship for the community.

We are committed to supporting this process in any way possible. From our past discussions, we are aware of your desire to ensure that agricultural practices along the river do not hinder the long term success of the project. NRCS is willing to provide technical assistance to you, or your lessee, to help ensure the integrity of the restoration. We will work with you to develop a conservation plan that will include:

1) Livestock exclusion from sensitive areas, including adequate stream buffer for filtration.
2) Proper stocking levels based on amount of available forage.
3) A rest - rotational grazing system to ensure proper recovery of plant communities.
4) Recommendations for noxious weed control.
5) Recommendations for proper irrigation scheduling.

We are always excited to see good conservation on the ground in Lincoln County and look forward to our future partnership. Please feel free to contact us for any assistance we can provide.

Sincerely,

Brian Ressel
Soil Conservationist

Kirk A. Sullivan
District Conservationist

Helping People Help the Land

An Equal Opportunity Provider and Employer

Town of Eureka

PO Box 313
Eureka, MT 59917
406-297-2123

September 22, 2015

Mark Ockey, Water Activities Workgroup Leader
Water Quality Specialist
DEQ Watershed Protection Section
P.O. Box 200901
Helena, MT 59620-0901

SUBJECT: Letter of Support; Tobacco River Restoration Project

Dear Mr. Ockey:

I am writing, on the behalf of the Town of Eureka, in support of the Tobacco River Restoration Project located on the Kassler property. The Town of Eureka is committed to providing continued support for the restoration and stewardship of our natural resources.

We encourage the Montana Department of Environmental Quality to award funding under the 319 Non-Point Source Grant program. Your support of this project will be instrumental insuring this project is implemented for the benefit of Montana's natural resources and the residents of the Town of Eureka and its surrounding communities.

Sincerely,

Lee Ann Schermerhorn
Mayor

TOBACCO RIVER CONCEPTUAL RESTORATION PLAN – KASSLER FAMILY, LP

Tobacco River near Eureka, Montana

Tobacco River – Kassler Property
October 2012

Submitted To:

Kassler Family Limited Partnership
PO Box 1361
Eureka, Montana 59917

Prepared By:

River Design Group, Inc.
5098 Highway 93 South
Whitefish, Montana 59937

February 2013

This page left intentionally blank

Table of Contents

Table of Figures

1 Background and Purpose

1.1 Project Background

Kassler Family Limited Partnership (KFLP) retained River Design Group, Inc. to develop a conceptual river and floodplain restoration plan for a 1.5 mile reach of the Tobacco River located in Lincoln County near the town of Eureka, Montana (Figure 1). Subject to riparian grazing, channelization, and riparian modifications, the Tobacco River through the Kassler property is currently functioning in an impaired condition due to excessive streambank erosion, channel widening, and loss of floodplain connection. This report describes a conceptual restoration plan (CRP) for the Tobacco River on the Kassler property. The over-arching purpose of developing this CRP is to define the restoration vision for the project area so redevelopment of the property can support a desired restoration outcome. To support this purpose, this document is organized into the following sections:

- ***Section 1. Introduction*** provides project background information, presents the draft project goals, and provides a general description of the Tobacco River watershed.
- ***Section 2. Existing Conditions*** describes the existing conditions of the Tobacco River including the factors limiting river stability and aquatic habitat.
- ***Section 3. Conceptual Restoration Plan*** describes descriptions of general restoration treatments applicable to the Tobacco River.
- ***Section 4. Potential Partnerships and Funding Opportunities*** summarizes the agencies and entities that may be interested in participating in the planning and implementation of the restoration plan presented in this report.

Appendix A of this report includes maps and exhibits describing the major components of the restoration plan.

1.2 Project Goals

In partnership with RDG, KFLP identified the following goals to help guide development of this conceptual restoration plan:

- Complete a river corridor assessment and determine the potential future condition of the Tobacco River and the adjacent floodplain-riparian corridor;
- Develop a ***Conceptual Restoration Plan (CRP)*** that identifies the general restoration approach and concepts including example techniques from rivers of similar size and morphology; and
- Identify potential restoration funding entities and partnership opportunities.

Figure 1-1. Tobacco River project vicinity map denoting the Kassler property.

1.3 Overview of the Tobacco River Watershed

The Tobacco River is a fifth order watershed draining approximately 440 mi^2 (282,000 acres) between the Kootenai River on the west, the Whitefish Range on the east, and the Salish Mountains to the south. The river forms at the confluence of Grave Creek and Fortine Creek and flows north and west into Lake Koocanusa near the town of Eureka, Montana (Figure 1). Average precipitation ranges from 16 inches/year at Fortine and 14 inches/year at Eureka, with average snowfall averages between 47 and 60 inches/year at the higher elevations. May and June are consistently the wettest months of the year and winter precipitation is dominated by snowfall (MDEQ 2011). Summer temperatures are typically in the high 70s to low 80s Fahrenheit, and winter lows fall to approximately 11 degrees Fahrenheit.

The hydrology of the Tobacco River is similar to most streams and rivers in northwest Montana. Runoff is driven by snowmelt in the higher elevations and is often driven by warm rain-on-snow events that can produce floods of significant magnitude. Tributary streams have evolved under an above averaged bedload supply regime due to the highly erodible, unconsolidated Quaternary alluvium that characterizes most of the tributary valley bottoms and the lower Tobacco River. Historical data indicate peak flows on the Tobacco River in May average approximately 750 cubic feet per second; however, flows from 2,300 to 3,180 have been recorded in the month of May. Based on 50 years of flow data, the mean monthly discharge averages below 150 cfs for the period August through February (MDEQ, 2011).

The Tobacco River is an important spawning and rearing habitat for fluvial and adfluvial fish populations inhabiting the upper Kootenai River drainage in northwest Montana and British Columbia. Bull trout (*Salvelinus confluentus*), a federally listed threatened species under the Endangered Species Act, inhabit the watershed and utilize the mainstem Tobacco River as a migratory corridor to spawning and rearing tributaries including Grave Creek. Bull trout in the Tobacco River drainage are at risk due to habitat degradation, hybridization and competition with non-native fish species, historical eradication efforts, historical over-harvest, and ongoing poaching and accidental harvest due to misidentification (Meehan and Bjornn 1991; Bond 1992; Leary et al. 1993). Similarly, westslope cutthroat trout (Oncorhynchus clarkia lewisi), a Montana Species of Special Concern, are found in the Tobacco River watershed. Cutthroat trout have declined due to habitat loss caused by poor grazing practices, historic logging practices, mining, agriculture, residential development, the impact of forest roads, dewatering and dams (MDEQ 2011). Currently, westslope cutthroat trout only occupy between 19%-27% of their historic range in Montana (Van Eimeren 1996).

1.4 Water Quality Status of the Tobacco River

In 1972, the U.S. Congress passed the Water Pollution Control Act, more commonly referred to as the Clean Water Act (CWA). The primary goal of the CWA is to "restore and maintain the chemical, physical, and biological integrity of the Nation's waters." The CWA requires each state to designate uses of their waters and to develop water quality standards to protect those uses (MDEQ 2011). Montana state law (Section 75-5-701 of the Montana Water Quality Act) and Section 303(d) of the federal CWA require the development of total maximum daily loads (TMDLs) for all impaired waterbodies when water quality is impaired by a pollutant. In simple terms, a TMDL is the maximum amount of a pollutant that a waterbody can receive and still meet state and federal water quality standards.

The Tobacco River within the project area has been identified by the Montana Department of Environmental Quality (MDEQ) as water quality impaired due to sedimentation and siltation resulting from grazing in riparian areas and streambank modifications. In 2011, MDEQ developed a water quality restoration plan to address Tobacco River impairments. Referred to as the "*Tobacco Planning Area Sediment TMDLs and Framework Water Quality Improvement Plan*" (MDEQ, 2011), the report presented an analysis of water quality information, established TMDLs for sediment problems in the Tobacco River TMDL Planning Area, and provided recommendations on restoration strategies to reduce sediment inputs to the Tobacco River.

The restoration concepts presented in this CRP are intended to address landowner goals and support the goals outlined in the 2011 MDEQ report.

2 Existing River and Floodplain Conditions

2.1 Introduction

This section describes existing river and floodplain conditions on the Kassler property and a portion of the downstream adjacent property owned by Comstock. In general, this reach of the Tobacco River has a long history of land use impacts that have collectively shaped the current river and floodplain environment. Commercial splash dams, log drives, riparian clearing, grazing, and channelization occurred throughout the watershed in the late 1800s and early 1900s to accommodate commerce and development. The direct and indirect effects of these activities were significant and likely mask many of the documented land uses presently impacting river stability, water quality, and aquatic resources on the Kassler reach of the Tobacco River.

For the purpose of describing existing conditions, the project area was segmented into river reaches based on changes in channel and floodplain morphology, and restoration potential. Figure A-1 in Appendix A includes the reach delineations. Reach descriptions are described in the following sections.

2.2 Reach 1 – River Station 0+00 – 30+50

Reach 1 begins at the upstream end of the Kassler property and includes approximately 3,050 feet (0.6 miles) of the Tobacco River. The river is characterized by alternating riffle and pool sequences and is bracketed by low terraces and floodplain surfaces comprised of mixed shrub and forested riparian community types. Impacts observed during the field assessment were related to infrastructure constraints, overgrazing of the riparian and floodplain areas, and loss of floodplain connectivity in the lower portion Reach 1 upstream of the existing bridge. The upstream meander (**M-1, Figure PV-1**) has migrated into an abandoned railroad grade and a large scour hold has formed at the base of the slope. The downstream left bank is eroding and sediment deposition in the pool tailout has resulted in split flow conditions where the channel is over-widened. Downstream of Meander 1, the river right terrace (**M-2, Figure PV-1**) is stable despite the over-widened channel geometry that has resulted in sediment deposition and minor channel braiding.

Land uses in the lower portion of Reach 1 have impacted channel stability. Land clearing for pasture and agricultural practices, overgrazing, and effects from the undersized bridge span have resulted in bank erosion on river left and loss of floodplain connection (**M-3, Figure PV-1**). The lower one-third of Meander 3 is actively eroding and the bank heights average 5-feet. Lack of vegetation structure is exacerbating streambank toe erosion and causing failure of the overlying soils. Figure 2-1 depicts existing conditions in the lower portion of Reach 1. As shown, the left terrace is actively eroding and the channel widens approaching the bridge opening. Bridge effects have compounded channel instability by constricting the channel and floodplain to a relatively narrow opening with reduced cross-sectional flow area. In addition, the bridge is skewed to the channel which further reduces hydraulic capacity and increases scour potential on the right bridge abutment. Hydraulic contraction at the bridge inlet, and expansion at the outlet, is exacerbating sediment deposition upstream and bed scour through and downstream of the bridge, with flow concentrating on the unstable bank on river right.

Figure 2-1. Existing terrace erosion in Reach 1 (M-3) and the existing bridge crossing.

Options for improving channel and streambank stability in Reach 1 are described in Section 3.

2.3 Reach 2 – River Station 30+50 – 41+50

Reach 2 begins at the bridge and extends downstream approximately 1,100 feet (0.2 miles). The channel is unstable in Reach 2 due to severe streambank erosion and floodplain disconnection. The channel width in Reach 2 increases to approximately 155 feet compared to 60 feet in Reach 1. Channel widening and enlargement has impaired the ability of the river to transport sediment resulting in a braided, depositional regime characterized by mid-channel and transverse bar deposits.

Historical land use practices in the floodplain of the Tobacco River have displaced native riparian communities in Reach 2 (**M-4, Figure PV-2**). Loss of riparian vegetation has decreased bank strength and contributed to accelerated erosion. Existing streambanks are characterized by pasture grasses that lack the rooting structure necessary to maintain stability. As a result, approximately 1,600 linear feet of streambank are actively eroding and contributing sediment to the river in Reach 2. Figure 2-2 includes a representative forested riparian condition in Reach 1 in contrast to the existing riparian conditions in Reach 2. As shown, conversion of riparian vegetation has resulted in severe bank instability and water quality and aquatic habitat impairment in Reach 2.

Figure 2-2. Forested and non-forested riparian conditions in Reach 1 and Reach 2 of the project area.

In addition to streambank erosion, floodplain disconnection has been identified as a major limiting factor in Reach 2. Historically the Tobacco River was bracketed by forested floodplains and terraces, as shown in Figure 2-2. Floods would access these broad surfaces at the approximate bankfull stage, or the 1.5 year recurrence interval flood. Floodplains and terraces would dissipate flood energy and velocities and provide areas for fine sediment to deposit. Direct and indirect disturbances including straightening of the river, have resulted in a lowering of the channel bed elevation in Reach 2. As a result, low to moderate floods that historically accessed the adjacent floodplain are now contained within the active channel. Unstable channel margins lack the vegetation structure necessary to resist erosive stream forces. Reconnecting and/or establishing floodplain surfaces are a priority for restoration in Reach 2, as described in Section 3.

2.4 Reach 3 – River Station 41+50 – 62+00

Reach 3 encompasses approximately 1,350 feet of river on the Kassler property and 500 feet on the Comstock property. Similar to Reach 1, the river is characterized by a primarily single-threaded channel pattern with riffle and pool sequences. Portions of the reach have intact riparian floodplain communities although land clearing for agriculture has contributed to river instability. As shown in Figure 2-3, several active avulsions and chute cut-off channels have formed in Reach 3. An avulsion is defined as the rapid abandonment of a river channel and the formation of a new river channel, typically occurring as a result of accelerated meander bend erosion. Channel avulsions have steepened the overall slope of the Tobacco River in Reach 3. The increased energy regime and lowering of the streambed elevation has contributed to slight floodplain disconnection and severe streambank erosion, particularly on the Comstock property.

Figure 2-3. Aerial view of Reach 3 in the project area noting active erosion on the Kassler and Comstock properties.

Restoration actions should focus on restoration of both meander sequences located on the Kassler and Comstock properties. Restoration techniques are described in Section 3.

2.5 Existing Conditions Summary

Floodplain and river ecosystems are dynamic mosaics that adjust over time to local and watershed-level changes in discharge, sediment delivery, debris inputs, and riparian vegetation conditions. Land uses and floodplain developments have influenced the geomorphic and ecological potential of the Tobacco River on the Kassler and Comstock properties. In the early part of the 20th century, the river was a vital component of the local economy providing the primary mechanism for transporting wood products to local mills. The river system has generally responded to increased sediment loading, constriction of the floodplain, and increased stream energy through accelerated lateral erosion of streambanks, localized braiding, straightening and downcutting. Accelerated delivery of sediment impairs the channel's ability to mobilize the available load, resulting in mid-channel bar development and down valley accretion of point bars. This pattern of bank erosion, channel widening, meander cutoff development, and isolated braiding is a common process in the Tobacco River. Infrequent high magnitude floods and periodic ice floes that occurred during the 20th century likely influenced channel adjustment. Despite these processes, a majority of the Tobacco River within the project area has trended towards a primarily single threaded, meandering channel form.

3 Conceptual Restoration Plan

3.1 Introduction

The chapter describes a conceptual water quality and habitat restoration plan for the Tobacco River on the Kassler and Comstock properties. The plan is intended to be an evolving document that can be updated as new information regarding resource conditions is collected as part of the TMDL process for the watershed. As described in preceding sections of this report, the Tobacco River has been subjected to a variety of direct and indirect natural and human-caused disturbances. Documented impacts to the channel and floodplain date back to the early 20th century when the valley was settled. With this in mind, it is not realistic to reverse impairment conditions in the short-term.

The vision for the Tobacco River within the project is to restore self-sustaining ecological processes that will result in clean, connected habitat for native fish species, while providing a degree of stability and aesthetic appeal that will serve as an amenity to the Kassler Limited Family Partnership and Comstock properties. This plan recognizes that existing constraints on the river system and funding limitations may preclude full or even partial implementation of the restoration actions recommended in this report; however, this CRP provides a path for effective restoration steps in the project area should funding become available. The following objectives have been developed to help guide the recommendations presented in this section.

Objective 1. Create complex aquatic habitat components that support the various life histories of the target fish species including bull trout and westslope cutthroat trout.

Objective 2. Minimize sediment inputs to the river resulting from accelerated streambank and terrace erosion, and channel bend migration.

Objective 3. Improve riparian and floodplain conditions by establishing a vegetated buffer and channel migration zone along the entire length of the project area.

Objective 4. Increase recreational opportunities for the local community and the owners.

The restoration approach presented in this section includes both passive and active practices necessary to address the limiting factors described in Section 2. Changing land management practices, in particular eliminating agricultural activities and grazing within the channel migration zone and riparian areas, will be necessary to support the long-term desired condition of the river and floodplain corridor. Figures denoting the conceptual channel alignment and major components of the plan are included in Appendix A.

3.2 Channel and Floodplain Corridor

The desired future condition of the Tobacco River is a meandering, riffle-pool stream type formed within a vegetated channel migration zone with a connected floodplain. The recommended channel restoration techniques are based on the premise of natural channel design that involves restoring fluvial and biological processes so that the river can be self-maintaining in the long-term. Natural channel design is based in part on sizing the active channel to the bankfull flow and providing an adequate floodplain to accommodate flood events (approximately 1,300 cfs), including the 100-year flood. For the Tobacco River, it will be necessary to construct, in areas, a channel and a connected floodplain to the appropriate dimensions. The channel would be designed to transport flow and sediment through normal runoff events, with a connected floodplain so that all flows are not forced into the normal active bankfull channel. This concept is essential for the river to maintain stability and reduce flood hazard and streambank erosion. Given the correct channel and floodplain geometry, lateral stream migration and erosion would be reduced, and aquatic habitat conditions would improve.

The CRP also defines a preliminary channel migration zone and proposed floodplain corridor that would be restored and protected from land use practices that result in removal and/or displacement of native vegetation. By definition, a channel migration zone (CMZ) includes areas affected by the movement of a river across its valley bottom. The recommended CMZ encompasses a portion of the mapped 100-year floodplain and will serve to maintain floodplain connectivity and habitat restoration actions associated with implementation of the CRP.

3.3 Restoration Techniques

This section describes potential techniques that may be used to support future restoration efforts on the Tobacco River on the Kassler property. These treatments have been successfully implemented on similar large scale restoration projects throughout Montana and the Pacific Northwest including Grave Creek near Eureka and the Clark Fork River in Missoula.

3.3.1 Channel Reconstruction

Where necessary and as depicted in Appendix A, the Tobacco River would be designed and constructed using natural channel design techniques. In general, the active channel would be designed to convey the estimated bankfull or effective discharge, with a connected floodplain to accommodate and route floods. The design concept is essential for the river to maintain stability and provide high quality, complex aquatic habitat. Re-establishing the proper channel geometry in over-widened areas would improve sediment transport capacity and competency of the Tobacco River and reduce bank erosion. A draft channel alignment is presented in Appendix A. As shown, channel reconstruction would begin approximately 500 feet upstream of the bridge and extend downstream through Reach 2 and Reach 3, terminating at the Comstock property boundary. The existing channel would be reshaped to an approximate bankfull width of 75 feet to 80 feet with a mean depth of 4.0 feet to 4.5 feet. The plan view pattern would be modified from existing conditions to increase stream length, decrease slope, and improve aquatic habitat including complex riffle, run, pool and glide habitat features. Floodplains, as described below in Section 3.4.2, would be designed to activate at the approximate 1.5 year recurrence interval discharge (+/- 1,300 cfs), and would provide essential functions such as energy dissipation and sediment storage.

Channel construction and associated channel gradients would vary longitudinally. At the reach scale, the channel would be designed with an undulating bed profile with stream gradients generally shallower in the meanders associated with pools, and steeper in the straight riffles. This undulating bed profile would function to dissipate stream energy and maintain the vertical stability of the channel profile, as well as provide a variety of habitat requirements for the focal fish species. While natural stream systems can maintain vertical grade control through naturally processes, reconstructed channels require some degree of vertical grade control to ensure the channel remains hydrologically connected to either a construction or natural floodplain surface. In Reaches 1, 2 and 3, the primary technique would include riffle and pool sequences in addition to channel planform modifications to balance the stream energy and flow and sediment regimes.

Constructed channels and riffles typically involved importing suitable graded alluvium placed within a framework of larger material to counteract scour of the finer gradation matrix. Hydraulic effects of the alluvium placement including spawning material retention and deposition along the glide face or pool tailout. Boulders can be incorporated in the bed material to dissipate energy, create velocity gradients, and consolidate base flows for fish passage. Collectively, constructed channels and riffles will replicate natural stream conditions.

Figure 3-1. Photos illustrating channel construction techniques on a large gravel bed river.

A more detailed engineering investigation is recommended to evaluate existing bridge hydraulics. Given the observed instabilities upstream and downstream of the bridge, and existing bridge span, it is likely that a new bridge with an increased span would be necessary to offset existing impacts to the river. In addition, it may be necessary to relocate the bridge to a more suitable crossing location, or at a minimum, adjust the bridge skew to minimize adverse impacts to the river.

3.3.2 Floodplain Construction and Point Bar Development

This treatment includes working with existing river processes to establish stable floodplain surfaces, targeting depositional surfaces created by the river. Point bars, mid-channel bars, and other depositional surfaces would be enhanced by adding roughness elements whose purpose would be to promote sediment deposition and storage. This would result in the bars aggrading to an elevation that would be more suitable for cottonwood and willow establishment. The desired condition would be a diverse mosaic of plant community cover types and age classes that would support primary production and provide habitat for multiple life stages of the focal fish species and other aquatic organisms. The long-term result of this treatment would be a stable depositional feature with diverse riparian vegetation, side channels, emergent wetland zones, and protected backwater habitat features.

Figure 3-2. Roughness elements including containerized plants, coarse wood, and micro-topography are used to create areas for sediment deposition and storage.

A more active restoration approach would involve constructing floodplain surfaces with native alluvial material and an overlying horizon of soil of varied textures depending on the revegetation zone. This technique would be used in conjunction with channel construction and installation of bank structures. Woody debris and micro-topography in the form of swales would be incorporated within floodplain surfaces. Woody debris and micro-topography function as sediment traps and microsites; they can increase sediment storage, flood storage, and debris retention, create stable points for vegetation development, promote topographic diversity on floodplain surfaces, and add habitat complexity.

3.3.3 Bank Restoration Structures

Installation of large wood in the proposed channel restoration is intended to serve multiple purposes. Observations from intact low-gradient rivers suggest the on-going loss of wood substantially reduces bio-complexity and alters key biophysical patterns in developed rivers. When present, wood enhances instream complexity and promotes floodplain inundation and flow partitioning. Studies have documented the importance of large wood within the stream channel to slow bedload movement, deposit and sort gravel, scour pools, and increase nutrients.

Large wood would be incorporated in engineered log jam structures (ELJs) and outer bend bank structures. ELJs are engineered wood structures that intercept flow and reduce near-bank velocities, protect new floodplain surfaces, promote pool scour and maintenance, and provide habitat along the land-water interface. These structures span from the anticipated depth of the channel to over the low terrace elevation, and tie into existing stable bank vegetation where available. Engineered log jams are constructed of logs, whole trees with attached root wads, and either large anchor rocks or tree members for ballast and structural support. Engineered log jams are used in combination with streambank bioengineering structures. They create stable tie-in points for the streambank structures and provide aquatic habitat by encouraging scour along outside streambanks and meander bends.

Outer bend bank structures would be used to protect and encourage riparian plant establishment along existing banks within the project area. This technique targets banks that are in balance with the morphological trends of the river. The intent of the structure is to protect the bank by redirecting flow towards the thalweg of the channel and create a zone of low velocity and eddy recirculation on the downstream side of the structure. The streamward face of the structure is protected with wood set below the anticipated scour depth of the channel. Structure elevations are stage-progressive thus providing the desired function for a range of flow between base flow and 100-year flows. Protected areas of the structure would be revegetated in order to establish native bank vegetation. Figure 3-3 depicts a variety of outer meander bend structures used in a specified sequence to protect the streambank, promote pool formation, and encourage riparian plant growth and maturation.

Figure 3-3. Example large wood and outer bend bank restoration structures.

3.3.4 Bioengineering and Vegetation Treatments

Riparian vegetation provides numerous benefits for the stream corridor. Plants maintain streambank integrity, filter runoff, maintain the water table, provide habitat and stream shading, and contribute organic debris to river systems. The deep, penetrating roots of sedges, rushes, willow, grasses and other herbaceous plants provide structural support for streambanks, while the thicker, harder roots of woody plants protect streambanks against bank scouring by floods and ice jams.

Streambank bioengineering consists of using live plant material in conjunction with biodegradable coconut fiber fabrics (coir) to create a streambank that is stable in the short term until native vegetation can become established. Streambank bioengineering treatments are used to encourage woody vegetation establishment in areas such as the land-water interface along outer meander bends. Because streambank bioengineering is a revegetation technique rather than a streambank stabilization technique, engineered log jams would also be constructed at these sites to provide more stability to the bioengineering structure while also providing in-stream habitat.

Vegetated Soil Lifts

Vegetated soil lifts are a revegetation and bank construction technique that combines layers of dormant willow cuttings with fabric-wrapped soil to revegetate and stabilize streambanks. Soil is wrapped within two layers of biodegradable coir fabric to hold the soil in place while vegetation becomes established in the relatively high stress land-water interface. The purpose of this treatment is to provide site conditions directly along the channel that are suitable for growing riparian vegetation. While vegetated soils lifts provide some degree of bank stabilization, they are primarily a revegetation technique. These structures reduce bank erosion rates, but they must be located within a sequence of other bank stabilization structures that provide bank stability. Over a five to seven year period, the fabric will decompose and be replaced by dense, woody vegetation that will provide rooting strength sufficient to maintain low bank erosion rates.

Coir Log Fascines

Coir log fascines are a revegetation and bank stabilization treatment that involves the placement of coir logs, combined with dormant willow cuttings, at the toe of streambanks along outer meander bends or areas with relatively high stress at the land-water interface. The purpose of this treatment is to establish woody vegetation along the channel in areas where scour is compromising the toe of banks and causing bank erosion and channel widening. Coir logs are constructed of high-density coir bales contained within coir fiber netting. Coir is used for bioengineering because it stores water for long periods, and its durable fibers trap sediment and mimic soil matrices formed by living roots. Coir fibers biodegrade over approximately five to seven years, and provide a stable growing medium while native riparian plants establish. The coir log fascine provides streambank toe stability to limit bank erosion due to scouring, allowing time for woody vegetation to establish and stabilize the bank over the long-term.

Log Toe and Willow Fascines

The log toe and willow fascine bank restoration technique is designed to create a highly complex, vegetated bank margin. The logs, brush and willow fascines provide habitat along the channel banks while providing stability. The structure is built on a cobble wood toe and transitions to a willow fascine at the bankfull elevation. The structure surfaces provide microsites to support natural recruitment of early successional species of desired vegetation community types. Elevations are set such that the floodplain is activated at bankfull discharge.

Figure 3-4. Example log toe and willow fascine bank restoration technique.

4 Partnership Opportunities and Cost Estimates

Section 4.1 includes an overview of the various local, state and federal programs that may be appropriate for assisting in the implementation of this CRP. Brief descriptions of the programs are provided, including contact information. Cost estimates for design and permitting, and approximate costs for project implementation are provided in Section 4.2.

4.1 Partnership Opportunities

4.1.1 USDA Natural Resources Conservation Service (NRCS)

The NRCS offers easements programs to landowners who want to maintain or enhance their land in a way beneficial to agriculture and the environment. All NRCS easement programs are voluntary. The most applicable programs include: 1) the Wetlands Reserve Program (WRP); and 2) the Conservation Reserve Enhancement Program (CREP).

Wetland Reserve Program (WRP)

The WRP is a voluntary program offering landowners the opportunity to protect, restore and enhance wetlands on their property. The USDA provides technical and financial support to help landowners with their wetland and riparian restoration efforts. Lands eligible for WRP include:

- Wetlands farmed under natural conditions
- Prior converted cropland
- Riparian areas that link protected wetlands
- Lands adjacent to protected wetlands that contribute significantly to wetland functions and values.

Conservation Reserve Enhancement Program (CREP)
The CREP is a voluntary land retirement program that helps agricultural producers protect environmentally sensitive land, decrease erosion, restore fish and wildlife habitat, and safeguard ground and surface water. The program is a partnership among tribal, state, and federal government, and in some cases, private groups. The CREP is administrated by the USDA's Farm Service Agency, and in combination with other partners, CREP provides farmers and ranchers with a sound financial package for conserving and enhancing the natural resources of farms.

CREP addresses high-priority conservation issues of both local and national significance, such as impacts to water supplies, loss of critical habitat for threatened and endangered species, soil erosion, and reduced habitat for fish populations.

Contact Information	(406) 296-7152 Mr. Kirk Sullivan, District Conservationist https://www.fsa.usda.gov/FSA/

4.1.2 Montana Department of Environmental Quality (MDEQ)

As described in Section 1, The Tobacco River has been identified by the Montana Department of Environmental Quality as water quality impaired due to sedimentation and siltation resulting from grazing in riparian areas and streambank modifications. In 2011, MDEQ developed a water quality restoration plan to address Tobacco River impairments. Referred to as the "Tobacco Planning Area Sediment TMDLs and Framework Water Quality Improvement Plan" (MDEQ 2011), the report presented an analysis of water quality information, established TMDLs for sediment problems in the Tobacco River TMDL Planning Area, and provided recommendations on restoration strategies to reduce sediment inputs to the Tobacco River.

Section 319(h) Program
MDEQ solicits project proposals from eligible applicants to further Montana's Non-Point Source Program goals. MDEQ issues a Call for Grant Applications every year under Section 319(h) of the Federal Clean Water Act (CWA). Section 319(h) funds for projects are distributed competitively to support the most effective and highest priority projects. To be eligible for this program, the Kassler and Comstock families would need to engage with a government entity of a nonprofit organization to qualify for a grant.

Contact Information	(406) 444-5319 Mr. Robert Ray, Program Manager http://deq.mt.gov/wqinfo/nonpoint/319GrantInfo.mcpx

4.1.3 U.S. Fish and Wildlife Service (USFWS)

Financial assistance provided by the USFWS can range from providing advice on the design and location of potential restoration projects, to designing a project and funding up to 50% of the implementation costs. Habitat restoration and enhancement projects may include, but are not limited to, restoring wetland hydrology, installing fencing along riparian areas to exclude livestock; rehabilitating in-stream aquatic habitats; removing nonnative plants; planting native trees, shrubs and plants to provide food and shelter for fish and wildlife in degraded habitats.

Partner for Fish and Wildlife Program

The Partners for Fish and Wildlife Program is the USFWS's habitat restoration cost-sharing program for private landowners. The program was established to provide technical and financial assistance to conservation minded farmers, ranchers, and other private landowners who wish to restore fish and wildlife habitat on their land. The program emphasizes the restoration of historic ecological communities for the benefit of native fish and wildlife in conjunction with the desires of private landowners. The goals of the program are to:

- Implement proactive, voluntary on-the-ground habitat restoration projects that benefit federal trust species and their habitats on private lands;
- Provide technical and financial assistance to landowners who are interested in providing suitable habitat for fish and wildlife on their property;
- Provide leadership and promote partnerships using the Service's and other organizations' expertise; and
- Conduct public outreach to broaden understanding of fish and wildlife habitats while encouraging and demonstration conservation efforts.

<u>Contact Information</u> USFWS Creston National Fish Hatchery
Ms. Rox Rogers, Private Lands Biologist
(406) 758-6880

4.1.4 Montana Fish, Wildlife & Parks (MFWP)

Montana Fish, Wildlife & Parks manages a variety of programs that acknowledge and support the role private landowners plan in maintaining Montana's rich conservation legacy.

Future Fisheries Improvement Program

MFWP's Future Fisheries Improvement Program has worked to restore rivers, streams and lakes to improve and restore Montana's wild fish habitats. Approximately $750,000 is available each year for projects that revitalize wild fish populations. Future Fisheries applications are considered every year in June and December. An independent review panel recommends Future Fisheries projects to fund to the MFWP Commission.

Contact Information	(406) 444-2449 http://fwp.mt.gov/fishAndWildlife/habitat/fish/futureFisheries/

4.2 Cost Estimates

This section provides a cost estimate for completing the project engineering and permitting, and a range of costs for implementation.

4.2.1 Final Design, Engineering and Permitting

Final design, engineering, and permitting tasks are described below. A detailed cost estimate is included in Table 4-1.

Task 1. Project Management and Meetings

Task 1 includes time and expenses related to meetings with the landowners, regulatory agencies, and funding entities. The budget assumes several meetings will be held in Eureka. This work item includes communications with the client (oral and written), invoicing, and general oversight of Tasks 2-6.

Task 2. Field Survey and Hydrologic Analysis

A field survey will be performed to detail portions of the channel and floodplain that were not captured by the LiDAR survey. This will involve a 2-person survey crew utilizing both a total station and survey-grade GPS units. Additional hydrologic data to support project design tasks will be collected including pebble counts, bar samples, and streambank inventories.

Site hydrology will be developed for a range of discharges including base flow, bankfull or effective discharge, and flood recurrence intervals including Q5, Q10, Q25, Q50 and Q100. The design team will complete an analysis of hydrologic and sediment data. A range of methods will be used to estimate the flood series including regional regression equations and USGS regional gages. Bankfull discharge will be evaluated using multiple methods based on gage data and measured field data for observed bankfull indicators.

Task 3. Develop Channel and Floodplain Dimensions

Using results from Task 2, and reference reach data collected in the upper Tobacco River near the confluence of Grave Creek and Fortine Creek (NRCS 1998), preliminary channel and floodplain dimensions will be developed for the project area. Bankfull channel dimensions will be determined using multiple methods including hydraulic geometry relationships, calibrated roughness based on empirical as well as measured field data and channel cross-sections.

Channel planform and longitudinal profile criteria will be developed iteratively with evaluations of channel hydraulics and incipient motion analyses, taking into consideration existing site constraints and infrastructure that will remain in place following restoration.

Task 4. Develop Channel and Floodplain Grading Plan

This work item includes developing the design surface topography for both the active channel and floodway. Specific tasks will include:

- Identifying locations and sizes of potential borrow sites for floodplain backfill in conjunction;
- Completing channel and floodplain tie-in analyses;
- Preparing final grading (restoration) surfaces; and
- Calculating earthwork quantities.

Task 5. Hydraulic and Sediment Transport Modeling

HEC-RAS modeling of the proposed condition will be completed to evaluate channel and floodplain performance. Geometry will be extracted from the proposed condition terrain model using HEC-GeoRAS to esta..blish the model schematic. Boundary conditions will be initialized from existing conditions at the upper and lower ends of the model. Model output will be post-processed and exported to GIS for mapping the spatial distribution of depth, velocity and shear stress for review by the design team. Model results will be used to refine design parameters for channel and floodplain designs.

A range of available methods, including HEC-RAS, will be used to estimate sediment transport capacity (Leopold 1964; Lorang and Hauer 2003; Rosgen 2006). Model output will be used to evaluate performance with respect to design criteria for sediment transport (i.e., routing versus storage). Model results will be used to refine parameters for channel and floodplain designs.

Task 6. Engineering and Permitting

RDG will prepare draft and final design reports and drawings. This task will be completed in close coordination with the Kassler family, regulatory agencies, and funding partners. Components of the design will include:

- Plan and profile sheets;
- Structure layout by reach;
- Structure details;
- Materials lists, quantities, and specifications;
- Infrastructure mitigation plan, as necessary;
- Dewatering plans and clearwater diversion engineering, as necessary and in conjunction with DEQ;
- HEC-RAS model results for proposed condition;
- Cost estimates for final engineering and construction; and

Tobacco River Restoration
Kootenai Watershed, Montana
2015 RIVER RESTORATION AGREEMENT
between Lincoln Conservation District
and Kassler Family Limited Partnership

This Agreement dated ______________ between Lincoln Conservation District (LCD), and Kassler Family Limited Partnership (KFLP) ATTN: Karl Kassler is entered into to authorize restoration work on the Tobacco River as it flows on KFLP property. This restoration project is located in Sections 14 and 15, Township 36N, Range 27W in Lincoln County, Montana. Work performed will be done as described in the final design and scope of work approved by the Lincoln Conservation District and outlined in DEQ Contract No ________, a copy of which has been reviewed by KFLP.

This restoration project is intended to effect stream and riparian improvements, which are enduring in nature. KFLP acknowledges and agrees that LCD has agreed only to conduct and administer the Tobacco River Restoration Project as set forth in DEQ Contract No. _____ ______, and that LCD shall not be required to operate and maintain the project. Therefore the KFLP agrees to operate and maintain all structures, vegetation, management measures, and water quality benefits associated with the project for the life of the project (typically 10 years according to DEQ Contract No ___________), and for a minimum of 5 years following completion of Task _____outlined in DEQ Contract No. _________. This includes KFLP's agreement to:

- Provide ingress and egress to the Project Site to the Contractor, the District and the Montana Department of Environmental Quality for the purpose of completing the work described in the final design and scope of work.
- Develop a grazing management plan with the Natural Resource and Conservation Service (NRCS) that promotes healthy riparian vegetation.;
- Maintain conditions that support water quality, specifically sediment control. This may include, but not limited to, supporting healthy riparian vegetation, revegetation of failed plantings, preventing and repairing stream bank erosion, supporting proper wetland function, and implementing appropriate grazing;
- Minimize the spread and persistence of noxious weeds and invasive species through appropriate weed management techniques;
- Assist in the implementation of a monitoring plan in accordance with Task ______ of the application.
- Ensure compliance with the restoration plan and associated revegetation plan developed in Task _____ of DEQ Contract No ______; and
- Prevent any other potentially negative land use impacts.

KFLP guarantees ownership of the above-described land and warrants that there are not outstanding rights that will interfere with this cooperative agreement. Further, if land ownership is transferred, this Agreement will remain valid and binding on the new land owner for the period of this Agreement.

DRAFT

This Agreement may be terminated in writing by either party by providing thirty (30) days advance notice. If terminated by the KFLP or the restoration site is degraded due to purposeful or negligent activities of the KFLP, the KFLP agrees to reimburse the LCD for the costs of the needed repair work or the original cost of the project.

The Lincoln Conservation District, or the Montana Department of Environmental Quality does not assume jurisdiction over the property or its management as a result of this Agreement. KFLP retains all normal property rights including the right to manage the property as wildlife habitat and for recreational use. Landowners agree that Lincoln Conservation District, the Montana Department of Environmental Quality or its agents may monitor and inspect the project to determine compliance with DEQ Contract No.___________ , as well as the effectiveness of the project in benefiting water quality. Access at all reasonable times to the project site and all pertinent records shall be granted to Lincoln Conservation, and the Montana Department of Environmental Quality, and its agents.

By: _______________________________ _______________

Lincoln Conservation District Date

Darris Flanagan, Chairperson

BY: ______________________________ ________________

Kassler Family Limited Partnership Date

Karl Kassler, Agent

DRAFT