August 24, 2022

ATTENTION ALL REQUEST FOR PROPOSALS (RFP) HOLDERS

RFP NO. 322033 - ADDENDUM NO. 1

STREAM CORRIDOR RESTORATION – BLACK EARTH CREEK

PROPOSALS DUE: TUESDAY, AUGUST 30, 2022, 2:00 PM. DUE DATE AND TIME ARE NOT CHANGED BY THIS ADDENDUM.

This Addendum is issued to modify, explain or clarify the original Request for Proposal (RFP) and is hereby made a part of the RFP. Please attach this Addendum to the RFP.

PLEASE NOTE THE FOLLOWING CONSULTANT SUBMITTED QUESTIONS:

1) **Q**: Has there been any dialog with the utility company about the overhead transmission line that crosses the site?

   A: No

2) **Q**: Has there been or will there need to be archeological surveying?

   A: An archeological survey has not been done. One will need to be completed as part of the project.

3) **Q**: Does the County have any soil borings taken within or near the project area?

   A: No the county does not have any soil borings within or near the project.

4) **Q**: What level of construction observation can be expected - will the County's representative provide daily oversight and the consultant be brought in during crucial habitat installations or project milestones? Or will consultant staff be present on a near-daily basis throughout construction?

   A: The consultant will need to provide the necessary oversight and on site construction observations to perform all items under F. of the *Scope of Work*. A county representative will be available and may assist in providing oversight. Specifics will be established within the *Professional Services Agreement*, examples of which can be found under Article 2.G, attached at the end of the RFP.

5) **Q**: The MN SQT guidance lists water quality, macroinvertebrates, and fish parameters of the SQT as optional. Has the County decided if these optional parameters will be required? If they are, has the County had any discussions regarding County or DNR staff (eg. fisheries biologists) assisting in collecting and analyzing these data?

   A: The physicochemical and biology parameters will not be required in the applying the MN SQT to Black Earth Creek. However, if a consultant can make a strong case that their design would cause measureable improvements in one or more of the parameters, they may be included. The county does not have plans to collect physicochemical or biological data for this project, but may do so if recommended by a consultant. There are no recent macroinvertebrate or physicochemical data available around the project reach. DNR fisheries completed a trout assessment of Black Earth

Creek in 2019, which included sites near the project reach and could be used baseline fish data: https://dnr.wisconsin.gov/sites/default/files/topic/Fishing/Reports_DaneBlackEarthCreek2019WatershedTrout.pdf.

If any additional information about this Addendum is needed, please contact Ryan Shore at 608/445-0109, shore@countyofdane.com.

Sincerely,

Ryan L Shore

Project Manager

Enclosures:

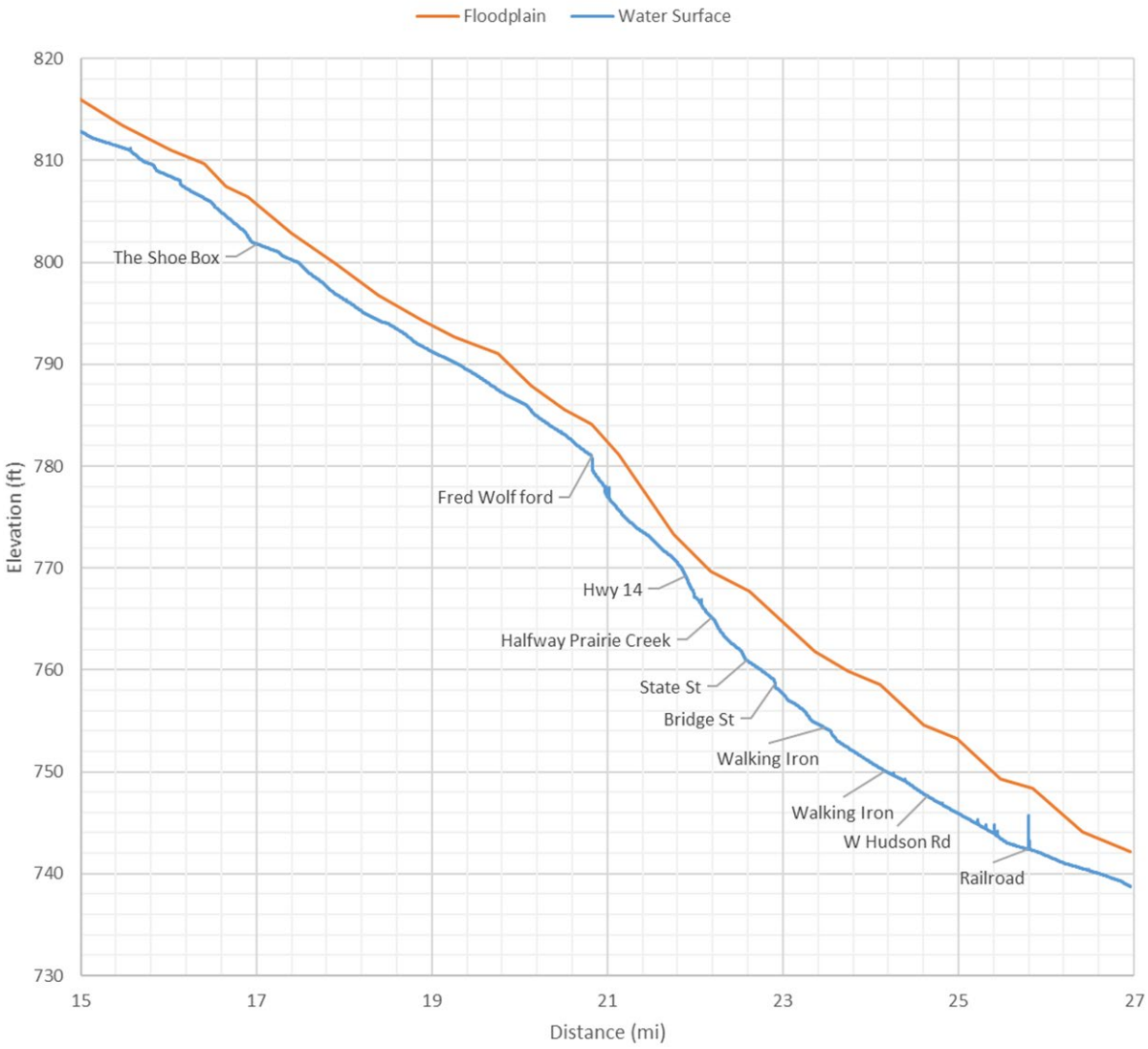
Preliminary Assessment of Black Earth Creek at Walking Iron County Park
MNSQTv2.0 Black Earth Creek
Appendix B MNSQT Field Forms
Black Earth Creek Bank Erosion Summary Table w/ BEHI & NBS Forms

Preliminary Assessment of Black Earth Creek at Walking Iron County Park

Matt Diebel, Dane County Land & Water Resources Department

Black Earth Creek near Mazomanie has high eroding banks that are a sediment source to the stream. The cause of the high banks appears to be that the stream has incised to convey increased peak flows from Halfway Prairie and Wendt Creeks. These two streams have very low gradients and no evidence of natural channels and were probably slow-moving wetland systems prior to agricultural development of their valleys. Channelization would have greatly increased peak flows from these two valleys. Black Earth Creek would have either flooded more frequently downstream of the confluence of these streams or if the banks were armored in the Village of Mazomanie or the channel was cleared of debris, these activities would have facilitated incision of the stream bed. The longitudinal profile of the stream and floodplain elevations supports this hypothesis - the stream bed drops away relative to the floodplain right at the confluence. Given that the hydrology of Halfway Prairie and Wendt Creeks is unlikely to be restored to its natural state and the increasing flooding in Mazomanie is unacceptable, the best option for reducing bank erosion is to lower the grade of the stream banks and establish vegetation.

Longitudinal profile of water surface and floodplain elevations on Black Earth Creek from upstream of the Village of Black Earth to the Dane-Iowa County line. Elevations were taken from the 2017 Dane County LiDAR DEM.



Programmatic Goals

Select:
Mitigation - Credits

Reach Description

Reach ID:

Describe this reach and reach break criteria:

Lat:

Long:

Reference Stream Type: C

Reference stream type is the stream type that should occur in a given landscape setting given the hydrogeomorphic processes occurring at the watershed and reach scales. Channel evolution scenarios should be used to inform the reference stream type in the MNSQT.

Describe the rationale used to select the reference stream type:

Restoration Approach

Expand on the programmatic goals of this project:

Explain the restoration potential of this project based on the programmat
(based on catchment assessment form):

Explain the goals and objectives for this project:

Goals:

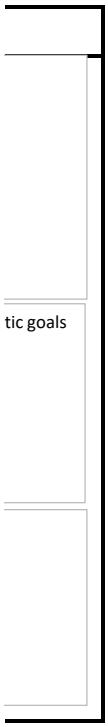
Objectives:

NOTICE: If you find errors or problems, please email StPaulSQT@usace.army.mil

The Stream Quantification Tool Credits:
Lead Agency: U.S. Army Corps of Engineers, St. Paul District
Contributing Agencies: U.S. Environmental Protection Agency
Minnesota Board of Water and Soil Resources
Minnesota Department of Natural Resources
Minnesota Pollution Control Agency

Contractors:
Ecosystem Planning and Restoration (EPR) through a contract with the U.S. Environmental Projection Agency (Contract No. EP-C-17-001).
Stream Mechanics as a sub-contractor to EPR

Version 2.0
Version Last Updated 10/27/2020


tic goals

Insert Aerial Photo of Project Reach

Catchment Name and Number: **Rater(s):**
Watershed Name (HUC 8) and Number: **Date:**

Overall Watershed Condition	Purpose: This form is used to determine the project's restoration potential. The catchment assessment is performed on the catchment and contributing area for the project reach. Note the contributing area may be downstream as well, as in the case where a dam exists downstream which restricts movement/recovery of fishes.
Restoration Potential	

CATCHMENT ASSESSMENT

	Categories	Description of Catchment Condition			Rating (P/F/G)
		Poor	Fair	Good	
1	Flow Alteration - Water Use (Hydrology)	Substantial reduction or augmentation of natural flow regime.	Moderate reduction or augmentation of natural flow regime.	Minimal reduction or augmentation of natural flow regime.	
2	Impervious Cover (Hydrology)	Impervious Cover (IC) Index Score of 40% or less.	IC Index Score Between 41% and 70%.	IC Index score of 71% or greater.	
3	Land Use Change (Hydrology)	Perennial Cover (PC) Index Score of 40% or less = % PC remaining -> Highly Altered Landscape.	PC Index Score of 41 to 70% or less -> Altered Landscape.	PC Index Score of 71% or greater -> Minimally Altered Landscape.	
4	Roads (Hydrology)	Major roads located in or adjacent to project reach and/or high road density in catchment.	Few major or minor roads in or adjacent to project reach. Moderate road density in catchment.	No major or minor roads in or adjacent to project reach. Low road density in catchment.	
5	Percent Forested (Hydrology)	≤20%	>20% and <70%	≥70%	
6	Percent Agricultural Land (Hydrology/Physicochemical)	≥ 70%	>20% and <70%	≤20%	
7	Flashiness Index (Hydrology)	IHA Analysis: Use the Rate and Frequency of Change metric (H_M_FV_RFC) and the Frequency and Duration of High/Low Pulses metric (H_M_FV_FDP) - scores of 40% or less.	IHA Analysis: Use the Rate and Frequency of Change metric (H_M_FV_RFC) and the Frequency and Duration of High/Low Pulses metric (H_M_FV_FDP) - scores of between 41% to 70%.	IHA Analysis: Use the Rate and Frequency of Change metric (H_M_FV_RFC) and the Frequency and Duration of High/Low Pulses metric (H_M_FV_FDP) - scores of 71% or more.	
8	Riparian Connectivity - Vegetation (Geomorphology)	Riparian Connectivity (RC) Index Score of 40% or less.	RC Index Score Between 41% and 70%.	RC Index score of 71% or greater.	
9	Sediment Supply (Geomorphology)	High sediment supply from upstream bank erosion and surface runoff. Use scores for Soil Erosion Susceptibility and for Steep Slopes Near Streams to estimate sediment supply - scores of 40% or less.	Moderate sediment supply from upstream bank erosion and surface runoff. Use scores for Soil Erosion Susceptibility and for Steep Slopes Near Streams to estimate sediment supply - scores between 41 to 70%.	Low sediment supply. Upstream bank erosion and surface runoff is minimal. Use scores for Soil Erosion Susceptibility and for Steep Slopes Near Streams to estimate sediment supply - scores of 71% or greater.	
10	Minnesota Integrated Report (305(b) and 303(d)) designated use support status *(Note: impairments with atmospheric deposition as a source should be excluded*)*	On or immediately upstream or downstream of a waterbody in Category 5 OR in Category 4c (i.e., designated use impairment not actively being mitigated).	On or immediately upstream or downstream of a waterbody in Category 4a or 4b (i.e., active mitigation of designated use impairment through approved TMDL or other control mechanisms).	No adjacent waterbodies listed as not supporting a designated use (i.e., all designated uses either unassessed or in Category 1, 2, or 3).	
11	Localized Potential Pollution Sources, Animal Units (Physicochemical)	Extensive Livestock (animal units) in area and potential access to stream - scores of 40% or less.	Moderate Livestock (animal units) in area and potential access to stream - scores between 41% and 70%.	Low levels of Livestock (animal units) in area and low likely access to stream - scores of 71% or greater.	
12	Longitudinal Connectivity of the stream network (Biology)	Aquatic Connectivity (AC) Index Score of 40 or less.	AC Index Score Between 41% and 70%.	AC Index score of 71% or greater.	
13	Organism Recruitment (Biology)	Stream Species Quality Fish /Stream Species Quality Invertebrates - scores of 40% or less.	Stream Species Quality Fish /Stream Species Quality Invertebrates - scores between 41 to 70%.	Stream Species Quality Fish /Stream Species Quality Invertebrates - scores of 71% or greater.	
14	Ditched or straightened streams (Hydrology)	Altered Watercourse Index Score of 40% or less.	Altered watercourse score between 41 and 70%.	Altered watercourse score - 71% or greater.	
15	Other				

The following Major Flow Variablity Metrics are provided for the evaluation of the Flashiness Index (Hydrology) category of the Catchment Assessment.						
MAJOR HUC-8	H_I_FV Flow Variability, Combined Index	H_M_FV_MM Flow Variability, Monthly Magnitude	H_M_FV_RFC Flow Variability, Rate and Frequency of Change	H_M_FV_MDX Flow Variability, Magnitude and Duration of Annual Extremes	H_M_FV_TX Flow Variability, Timing of Annual Extremes	H_M_FV_FDP Flow Variability, Frequency and Duration of High/Low Pulses
7	76		67	82	99	55
8	76		67	82	99	55
9	53	69	29	68	50	48
10	68	56	66	79	87	50
11	68	56	66	79	87	50
12	74	84	64	79	96	48
13	74	84	64	79	96	48
14	69	68	67	68	94	47
15	71	64	63	71	97	59
16	71	64	63	71	97	59
17	73	75	60	86	98	48
18	69	50	71	73	98	52
19	69	50	71	73	98	52
20	65	50	66	59	99	51
21	73	59	69	85	93	58
22	54	13	75	38	99	45
23	63	43	73	48	94	54
24	61	29	76	55	99	44
25	61	38	71	63	94	39
26	66	54	71	67	90	50
27	71	58	64	74	99	58
28	66	51	62	61	98	58
29	64	35	73	69	96	49
30	58	46	39	63	96	49
31	66	40	68	71	99	51
32	65	50	64	63	98	53
33	64	46	61	64	100	51
34	67	90	16	93	90	47
35	66	72	50	69	99	41
36	66	59	53	70	95	55
37	66	59	53	70	95	55
38	74	79	52	79	99	58
39	68	73	44	78	100	45
41	69	71	43	88	100	45
47	74	75	58	88	93	57
48	71	73	41	82	98	62
49	71	73	41	82	98	62
50	71	73	41	82	98	62
51	64	53	53	66	95	51
52	64	53	53	66	95	51
53	64	53	53	66	95	51
54	63	47	60	62	99	48
55	63	47	60	62	99	48
56	65	74	60	58	98	37
57	67	46	72	72	98	49
58	67	46	72	72	98	49
59	62	39	69	55	91	54
60	69	63	63	72	99	48
61	66	52	62	75	95	45
62	61	38	84	40	68	74
63	61	51	47	70	91	44
65	53	20	72	45	87	43
66	66	69	40	84	92	45
67	58	22	73	59	95	42
68	58	22	73	59	95	42
74	74	81	59	78	93	57
76	60	72	42	51	97	37
77	69	74	52	70	98	49
78	58	36	68	55	94	39
81	61	58	48	69	91	41
82	61	58	48	69	91	41
83	61	58	48	69	91	41
84	61	58	48	69	91	41
1	70	80	48	63	93	63
2	61	78	29	53	97	45
3	54	77	11	56	90	35
4	54	77	11	56	90	35
5	65	74	38	63	98	54
40	69	71	43	88	100	45
42	74	75	58	88	93	57
43	74	75	58	88	93	57
44	74	75	58	88	93	57
46	74	75	58	88	93	57

The following Major Flow Variablity Metrics are provided for the evaluation of the Flashiness Index (Hydrology) category of the Catchment Assessment.						
MAJOR HUC-8	H_I_FV Flow Variability, Combined Index	H_M_FV_MM Flow Variability, Monthly Magnitude	H_M_FV_RFC Flow Variability, Rate and Frequency of Change	H_M_FV_MDX Flow Variability, Magnitude and Duration of Annual Extremes	H_M_FV_TX Flow Variability, Timing of Annual Extremes	H_M_FV_FDP Flow Variability, Frequency and Duration of High/Low Pulses
69	58	22	73	59	95	42
70	55	25	63	45	98	44
71	57	40	67	55	91	31
72	74	84	70	76	96	44
73	74	81	59	78	93	57
75	69	74	52	70	98	49
79	58	36	68	55	94	39
80	57	40	67	55	91	31

Measurement Selection Guide

The following table is provided to assist project owners, regulators and practitioners in selecting the appropriate parameters and metrics for each stream restoration project reach. All parameters and metrics would rarely, if ever, be used for a single project. The scenarios below show when each parameter could be used. Note, if a metric is selected, it must be assessed for the existing **and** proposed condition.

Functional Category	Function-Based Parameters	Metric	Scenarios
Hydrology	Reach Runoff	Land Use Coefficient	Required for all assessments, except when BMP MIDS is used.
		BMP MIDS Rv Coefficient	Optional. Use where BMPs are proposed on adjacent drainage.
		Concentrated Flow Points / 1,000 feet	Required for all assessments, except when BMP MIDS is used.
Hydraulics	Floodplain Connectivity	Bank Height Ratio	Required for all assessments.
		Entrenchment Ratio	Required for all assessments. Not applicable in stream/wetland complexes with DA stream types.
Geomorphology	Large Woody Debris	LWD Index	Required to use either LWDI or No. of LWD Pieces, but not both.
		No. of LWD Pieces / 100 meters	Required to use either LWDI or No. of LWD Pieces, but not both.
	Lateral Migration	Dominant BEHI/NBS	Required for all assessments.
		Percent Streambank Erosion (%)	Required for all assessments.
		Percent Armoring (%)	Only use when armoring techniques are present or proposed. If armoring is proposed, use instead of BEHI/NBS for proposed condition score.
	Bed Material Characterization	Size Class Pebble Count Analyzer (p-value)	Optional. Contact coordinating agency before including this parameter.
	Bed Form Diversity	Pool Spacing Ratio	Required for all assessments. Not applicable to stream/wetland complexes with DA stream types.
		Pool Depth Ratio	Required for all assessments. Not applicable to stream/wetland complexes with DA stream types.
		Percent Riffle (%)	Required for all assessments. Not applicable to stream/wetland complexes with DA stream types.
		Aggradation Ratio	Optional. Recommended for meandering single-thread stream types where the riffles are exhibiting signs of aggradation. Not applicable to stream/wetland complexes with DA stream types.
		Effective Vegetated Riparian Area (%)	Required for all assessments.
		Canopy Cover (%)	Required for all assessments.

Site Information and Reference Selection	
Project Name:	Black Earth Creek
Reach ID:	1
Restoration Potential:	0
Existing Stream Type:	C
Reference Stream Type:	C
Woody Vegetation Natural Component:	Yes
Use Class:	2A
River Nutrient Regions:	Central
Drainage Area (sq.mi.):	101
Proposed Bed Material:	Gravel
Existing Stream Length (ft):	703
Proposed Stream Length (ft):	703
Macroinvertebrate IBI Class:	Northern Coldwater
Fish IBI Class:	Southern Streams
Valley Type:	Unconfined Alluvial
Flow Permanence:	Perennial
Strahler Stream Order:	Fourth

Notes
1. Users input values that are highlighted based on restoration potential
2. Users select values from a pull-down menu
3. Leave values blank for field values that were not measured

FUNCTIONAL CHANGE SUMMARY	
Existing Condition Score (ECS)	0.42
Proposed Condition Score (PCS)	0.49
Change in Functional Condition (PCS - EC	0.07
Existing Stream Length (ft)	703
Proposed Stream Length (ft)	703
Change in Stream Length (ft)	0
Existing Functional Feet (FF)	295
Proposed Functional Feet (FF)	344
Proposed FF - Existing FF	49
Percent Change in FF (%)	17%
FF Yield (FF/ft)	0.07

MITIGATION SUMMARY		
49	(FF)	Lift

FUNCTION BASED PARAMETERS SUMMARY			
Functional Category	Function-Based Parameters	Existing Parameter	Proposed Parameter
Hydrology	Reach Runoff	0.68	0.87
Hydraulics	Floodplain Connectivity	0.75	0.75
Geomorphology	Large Woody Debris	0.45	0.79
	Lateral Migration	1.00	1.00
	Bed Material Characterization		
	Bed Form Diversity	0.92	0.92
	Riparian Vegetation	0.35	0.66
Physicochemical	Temperature		
	Dissolved Oxygen		
	Total Suspended Solids		
Biology	Macroinvertebrates		
	Fish		

FUNCTIONAL CATEGORY REPORT CARD			
Functional Category	ECS	PCS	Functional Change
Hydrology	0.68	0.87	0.19
Hydraulics	0.75	0.75	0.00
Geomorphology	0.68	0.84	0.16
Physicochemical			
Biology			

EXISTING CONDITION ASSESSMENT					Roll Up Scoring		
Functional Category	**Function-Based Parameter**	**Metric**	**Field Value**	**Index Value**	**Parameter**	**Category**	**Category**
Hydrology	Reach Runoff	Land Use Coefficient	64	0.74	0.68	0.68	Functioning At Risk
		BMP MIDS Rv Coefficient					
		Concentrated Flow Points / 1,000 feet	1.25	0.61			
Hydraulics	Floodplain Connectivity	Bank Height Ratio	1.3	0.57	0.75	0.75	Functioning
		Entrenchment Ratio	4.3	0.92			
Geomorphology	Large Woody Debris	LWD Index	284	0.45	0.45	0.68	Functioning At Risk
		No. of LWD Pieces / 100 meters					
	Lateral Migration	Dominant BEHI/NBS	L/H	1.00	1.00		
		Percent Streambank Erosion (%)	1.7	1.00			
		Percent Armoring (%)					
	Bed Material Characterization	Size Class Pebble Count Analyzer (p-value)					
	Bed Form Diversity	Pool Spacing Ratio	5.1	1.00	0.92		
		Pool Depth Ratio	2.2	0.76			
		Percent Riffle (%)	59	1.00			
		Aggradation Ratio					
	Riparian Vegetation	Effective Vegetated Riparian Area (%)	7	0.00	0.35		
		Canopy Cover (%)	17	0.00			
		Herbaceous Strata Vegetation Cover (%)	95	1.00			
		Woody Stem Basal Area (sqm/hectare)	11	0.40			
Physicochemical	Temperature	Summer Average (^{o}C)					
	Dissolved Oxygen	DO (mg/L)					
	Total Suspended Solids	TSS (mg/L)					
Biology	Macroinvertebrates	Macroinvertebrate IBI					
	Fish	Fish IBI					

PROPOSED CONDITION ASSESSMENT					Roll Up Scoring		
Functional Category	**Function-Based Parameter**	**Metric**	**Field Value**	**Index Value**	**Parameter**	**Category**	**Category**
Hydrology	Reach Runoff	Land Use Coefficient	64	0.74	0.87	0.87	Functioning
		BMP MIDS Rv Coefficient					
		Concentrated Flow Points / 1,000 feet	0	1.00			
Hydraulics	Floodplain Connectivity	Bank Height Ratio	1.3	0.57	0.75	0.75	Functioning
		Entrenchment Ratio	4.3	0.92			
Geomorphology	Large Woody Debris	LWD Index	500	0.79	0.79	0.84	Functioning
		No. of LWD Pieces / 100 meters					
	Lateral Migration	Dominant BEHI/NBS	L/H	1.00	1.00		
		Percent Streambank Erosion (%)	1.7	1.00			
		Percent Armoring (%)					
	Bed Material Characterization	Size Class Pebble Count Analyzer (p-value)					
	Bed Form Diversity	Pool Spacing Ratio	5.1	1.00	0.92		
		Pool Depth Ratio	2.2	0.76			
		Percent Riffle (%)	59	1.00			
		Aggradation Ratio					
	Riparian Vegetation	Effective Vegetated Riparian Area (%)	45	0.21	0.66		
		Canopy Cover (%)	75	0.83			
		Herbaceous Strata Vegetation Cover (%)	80	1.00			
		Woody Stem Basal Area (sqm/hectare)	12	0.60			
Physicochemical	Temperature	Summer Average (^{o}C)					
	Dissolved Oxygen	DO (mg/L)					
	Total Suspended Solids	TSS (mg/L)					
Biology	Macroinvertebrates	Macroinvertebrate IBI					
	Fish	Fish IBI					

As-Built					Roll Up Scoring		
Functional Category	**Function-Based Parameters**	**Measurement Method**	**Field Value**	**Index Value**	**Parameter**	**Category**	**Category**
Hydrology	Reach Runoff	Land Use Coefficient BMP MIDS Rv Coefficient Concentrated Flow Points / 1,000 feet					
Hydraulics	Floodplain Connectivity	Bank Height Ratio Entrenchment Ratio					
Geomorphology	Large Woody Debris	LWD Index No. of LWD Pieces / 100 meters					
	Lateral Migration	Dominant BEHI/NBS Percent Streambank Erosion (%) Percent Armoring (%)					
	Bed Material Characterization	Size Class Pebble Count Analyzer (p-value)					
	Bed Form Diversity	Pool Spacing Ratio Pool Depth Ratio Percent Riffle (%) Aggradation Ratio					
	Riparian Vegetation	Effective Vegetated Riparian Area (%) Canopy Cover (%) Herbaceous Strata Vegetation Cover (%) Woody Stem Basal Area (sqm/hectare)					
Physicochemical	Temperature	Summer Average (^{o}C)					
	Dissolved Oxygen	DO (mg/L)					
	Total Suspended Solids	TSS (mg/L)					
Biology	Macroinvertebrates	Macroinvertebrate IBI	65	1.00	1.00	1.00	Functioning
	Fish	Fish IBI					

Monitoring Year	1	Date			Roll Up Scoring		
Functional Category	**Function-Based Parameters**	**Measurement Method**	**Field Value**	**Index Value**	**Parameter**	**Category**	**Category**
Hydrology	Reach Runoff	Land Use Coefficient BMP MIDS Rv Coefficient Concentrated Flow Points / 1,000 feet					
Hydraulics	Floodplain Connectivity	Bank Height Ratio Entrenchment Ratio					
Geomorphology	Large Woody Debris	LWD Index No. of LWD Pieces / 100 meters					
	Lateral Migration	Dominant BEHI/NBS Percent Streambank Erosion (%) Percent Armoring (%)					
	Bed Material Characterization	Size Class Pebble Count Analyzer (p-value)					
	Bed Form Diversity	Pool Spacing Ratio Pool Depth Ratio Percent Riffle (%) Aggradation Ratio					
	Riparian Vegetation	Effective Vegetated Riparian Area (%) Canopy Cover (%) Herbaceous Strata Vegetation Cover (%) Woody Stem Basal Area (sqm/hectare)					
Physicochemical	Temperature	Summer Average (^{o}C)					
	Dissolved Oxygen	DO (mg/L)					
	Total Suspended Solids	TSS (mg/L)					
Biology	Macroinvertebrates	Macroinvertebrate IBI					
	Fish	Fish IBI					

Monitoring Year	2	Date			Roll Up Scoring		
Functional Category	**Function-Based Parameters**	**Measurement Method**	**Field Value**	**Index Value**	**Parameter**	**Category**	**Category**
Hydrology	Reach Runoff	Land Use Coefficient BMP MIDS Rv Coefficient Concentrated Flow Points / 1,000 feet					
Hydraulics	Floodplain Connectivity	Bank Height Ratio Entrenchment Ratio					
Geomorphology	Large Woody Debris	LWD Index No. of LWD Pieces / 100 meters					
	Lateral Migration	Dominant BEHI/NBS Percent Streambank Erosion (%) Percent Armoring (%)					
	Bed Material Characterization	Size Class Pebble Count Analyzer (p-value)					
	Bed Form Diversity	Pool Spacing Ratio Pool Depth Ratio Percent Riffle (%) Aggradation Ratio					
	Riparian Vegetation	Effective Vegetated Riparian Area (%) Canopy Cover (%) Herbaceous Strata Vegetation Cover (%) Woody Stem Basal Area (sqm/hectare)					
Physicochemical	Temperature	Summer Average (^{o}C)					
	Dissolved Oxygen	DO (mg/L)					
	Total Suspended Solids	TSS (mg/L)					
Biology	Macroinvertebrates	Macroinvertebrate IBI					
	Fish	Fish IBI					

Monitoring Year	3	Date			Roll Up Scoring		
Functional Category	**Function-Based Parameters**	**Measurement Method**	**Field Value**	**Index Value**	**Parameter**	**Category**	**Category**
Hydrology	Reach Runoff	Land Use Coefficient BMP MIDS Rv Coefficient Concentrated Flow Points / 1,000 feet					
Hydraulics	Floodplain Connectivity	Bank Height Ratio Entrenchment Ratio					
Geomorphology	Large Woody Debris	LWD Index No. of LWD Pieces / 100 meters					
	Lateral Migration	Dominant BEHI/NBS Percent Streambank Erosion (%) Percent Armoring (%)					
	Bed Material Characterization	Size Class Pebble Count Analyzer (p-value)					
	Bed Form Diversity	Pool Spacing Ratio Pool Depth Ratio Percent Riffle (%) Aggradation Ratio					
	Riparian Vegetation	Effective Vegetated Riparian Area (%) Canopy Cover (%) Herbaceous Strata Vegetation Cover (%) Woody Stem Basal Area (sqm/hectare)					
Physicochemical	Temperature	Summer Average (°C)					
	Dissolved Oxygen	DO (mg/L)					
	Total Suspended Solids	TSS (mg/L)					
Biology	Macroinvertebrates	Macroinvertebrate IBI					
	Fish	Fish IBI					

Monitoring Year	4	Date			Roll Up Scoring		
Functional Category	**Function-Based Parameters**	**Measurement Method**	**Field Value**	**Index Value**	**Parameter**	**Category**	**Category**
Hydrology	Reach Runoff	Land Use Coefficient BMP MIDS Rv Coefficient Concentrated Flow Points / 1,000 feet					
Hydraulics	Floodplain Connectivity	Bank Height Ratio Entrenchment Ratio					
Geomorphology	Large Woody Debris	LWD Index No. of LWD Pieces / 100 meters					
	Lateral Migration	Dominant BEHI/NBS Percent Streambank Erosion (%) Percent Armoring (%)					
	Bed Material Characterization	Size Class Pebble Count Analyzer (p-value)					
	Bed Form Diversity	Pool Spacing Ratio Pool Depth Ratio Percent Riffle (%) Aggradation Ratio					
	Riparian Vegetation	Effective Vegetated Riparian Area (%) Canopy Cover (%) Herbaceous Strata Vegetation Cover (%) Woody Stem Basal Area (sqm/hectare)					
Physicochemical	Temperature	Summer Average (^{o}C)					
	Dissolved Oxygen	DO (mg/L)					
	Total Suspended Solids	TSS (mg/L)					
Biology	Macroinvertebrates	Macroinvertebrate IBI					
	Fish	Fish IBI					

Monitoring Year	5	Date			Roll Up Scoring		
Functional Category	**Function-Based Parameters**	**Measurement Method**	**Field Value**	**Index Value**	**Parameter**	**Category**	**Category**
Hydrology	Reach Runoff	Land Use Coefficient BMP MIDS Rv Coefficient Concentrated Flow Points / 1,000 feet					
Hydraulics	Floodplain Connectivity	Bank Height Ratio Entrenchment Ratio					
Geomorphology	Large Woody Debris	LWD Index No. of LWD Pieces / 100 meters					
	Lateral Migration	Dominant BEHI/NBS Percent Streambank Erosion (%) Percent Armoring (%)					
	Bed Material Characterization	Size Class Pebble Count Analyzer (p-value)					
	Bed Form Diversity	Pool Spacing Ratio Pool Depth Ratio Percent Riffle (%) Aggradation Ratio					
	Riparian Vegetation	Effective Vegetated Riparian Area (%) Canopy Cover (%) Herbaceous Strata Vegetation Cover (%) Woody Stem Basal Area (sqm/hectare)					
Physicochemical	Temperature	Summer Average (^{o}C)					
	Dissolved Oxygen	DO (mg/L)					
	Total Suspended Solids	TSS (mg/L)					
Biology	Macroinvertebrates	Macroinvertebrate IBI					
	Fish	Fish IBI					

Monitoring Year	6	Date			Roll Up Scoring		
Functional Category	**Function-Based Parameters**	**Measurement Method**	**Field Value**	**Index Value**	**Parameter**	**Category**	**Category**
Hydrology	Reach Runoff	Land Use Coefficient BMP MIDS Rv Coefficient Concentrated Flow Points / 1,000 feet					
Hydraulics	Floodplain Connectivity	Bank Height Ratio Entrenchment Ratio					
Geomorphology	Large Woody Debris	LWD Index No. of LWD Pieces / 100 meters					
	Lateral Migration	Dominant BEHI/NBS Percent Streambank Erosion (%) Percent Armoring (%)					
	Bed Material Characterization	Size Class Pebble Count Analyzer (p-value)					
	Bed Form Diversity	Pool Spacing Ratio Pool Depth Ratio Percent Riffle (%) Aggradation Ratio					
	Riparian Vegetation	Effective Vegetated Riparian Area (%) Canopy Cover (%) Herbaceous Strata Vegetation Cover (%) Woody Stem Basal Area (sqm/hectare)					
Physicochemical	Temperature	Summer Average (^{o}C)					
	Dissolved Oxygen	DO (mg/L)					
	Total Suspended Solids	TSS (mg/L)					
Biology	Macroinvertebrates	Macroinvertebrate IBI					
	Fish	Fish IBI					

Monitoring Year	7	Date			Roll Up Scoring		
Functional Category	**Function-Based Parameters**	**Measurement Method**	**Field Value**	**Index Value**	**Parameter**	**Category**	**Category**
Hydrology	Reach Runoff	Land Use Coefficient BMP MIDS Rv Coefficient Concentrated Flow Points / 1,000 feet					
Hydraulics	Floodplain Connectivity	Bank Height Ratio Entrenchment Ratio					
Geomorphology	Large Woody Debris	LWD Index No. of LWD Pieces / 100 meters					
	Lateral Migration	Dominant BEHI/NBS Percent Streambank Erosion (%) Percent Armoring (%)					
	Bed Material Characterization	Size Class Pebble Count Analyzer (p-value)					
	Bed Form Diversity	Pool Spacing Ratio Pool Depth Ratio Percent Riffle (%) Aggradation Ratio					
	Riparian Vegetation	Effective Vegetated Riparian Area (%) Canopy Cover (%) Herbaceous Strata Vegetation Cover (%) Woody Stem Basal Area (sqm/hectare)					
Physicochemical	Temperature	Summer Average (^{o}C)				0.04	Not Functioning
	Dissolved Oxygen	DO (mg/L)	5.5	0.07	0.07		
	Total Suspended Solids	TSS (mg/L)	27	0.00	0.00		
Biology	Macroinvertebrates	Macroinvertebrate IBI					
	Fish	Fish IBI					

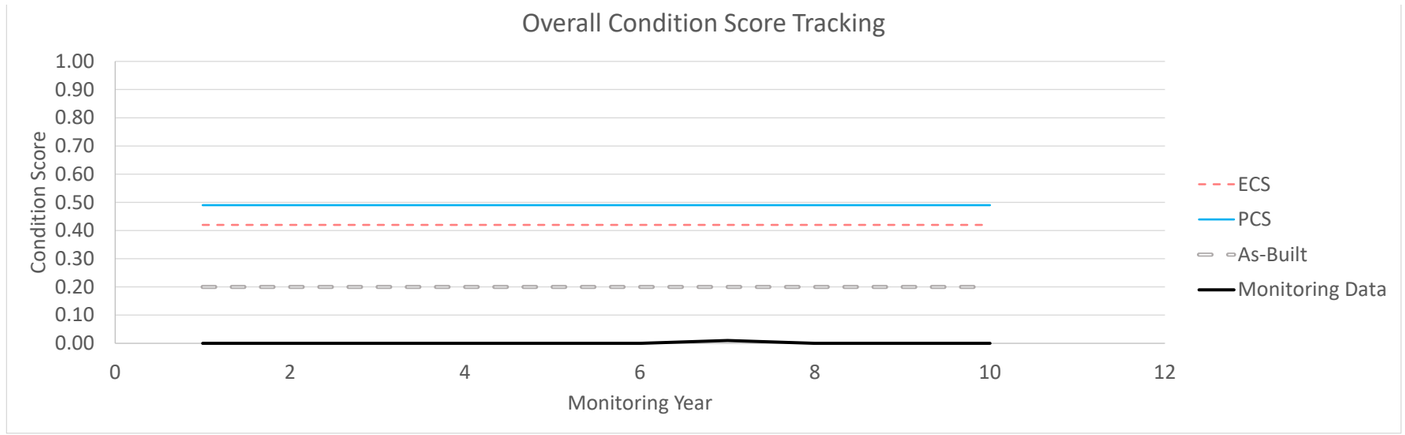
Monitoring Year	8	Date			Roll Up Scoring		
Functional Category	**Function-Based Parameters**	**Measurement Method**	**Field Value**	**Index Value**	**Parameter**	**Category**	**Category**
Hydrology	Reach Runoff	Land Use Coefficient BMP MIDS Rv Coefficient Concentrated Flow Points / 1,000 feet					
Hydraulics	Floodplain Connectivity	Bank Height Ratio Entrenchment Ratio					
Geomorphology	Large Woody Debris	LWD Index No. of LWD Pieces / 100 meters					
	Lateral Migration	Dominant BEHI/NBS Percent Streambank Erosion (%) Percent Armoring (%)					
	Bed Material Characterization	Size Class Pebble Count Analyzer (p-value)					
	Bed Form Diversity	Pool Spacing Ratio Pool Depth Ratio Percent Riffle (%) Aggradation Ratio					
	Riparian Vegetation	Effective Vegetated Riparian Area (%) Canopy Cover (%) Herbaceous Strata Vegetation Cover (%) Woody Stem Basal Area (sqm/hectare)					
Physicochemical	Temperature	Summer Average (^{o}C)					
	Dissolved Oxygen	DO (mg/L)					
	Total Suspended Solids	TSS (mg/L)					
Biology	Macroinvertebrates	Macroinvertebrate IBI					
	Fish	Fish IBI					

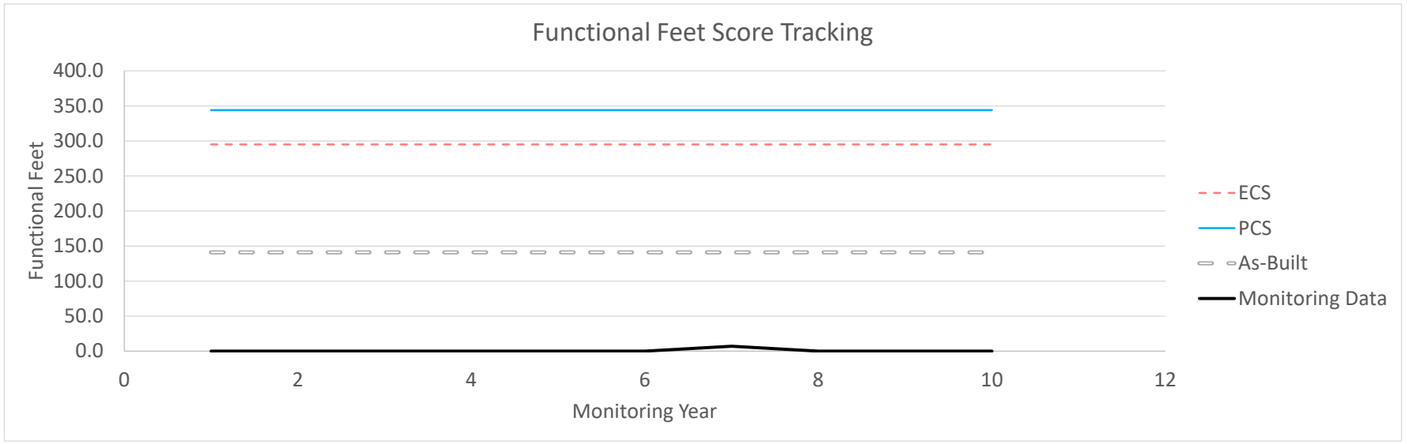
Monitoring Year	9	Date			Roll Up Scoring		
Functional Category	**Function-Based Parameters**	**Measurement Method**	**Field Value**	**Index Value**	**Parameter**	**Category**	**Category**
Hydrology	Reach Runoff	Land Use Coefficient BMP MIDS Rv Coefficient Concentrated Flow Points / 1,000 feet					
Hydraulics	Floodplain Connectivity	Bank Height Ratio Entrenchment Ratio					
Geomorphology	Large Woody Debris	LWD Index No. of LWD Pieces / 100 meters					
	Lateral Migration	Dominant BEHI/NBS Percent Streambank Erosion (%) Percent Armoring (%)					
	Bed Material Characterization	Size Class Pebble Count Analyzer (p-value)					
	Bed Form Diversity	Pool Spacing Ratio Pool Depth Ratio Percent Riffle (%) Aggradation Ratio					
	Riparian Vegetation	Effective Vegetated Riparian Area (%) Canopy Cover (%) Herbaceous Strata Vegetation Cover (%) Woody Stem Basal Area (sqm/hectare)					
Physicochemical	Temperature	Summer Average (^{o}C)					
	Dissolved Oxygen	DO (mg/L)					
	Total Suspended Solids	TSS (mg/L)					
Biology	Macroinvertebrates	Macroinvertebrate IBI					
	Fish	Fish IBI					

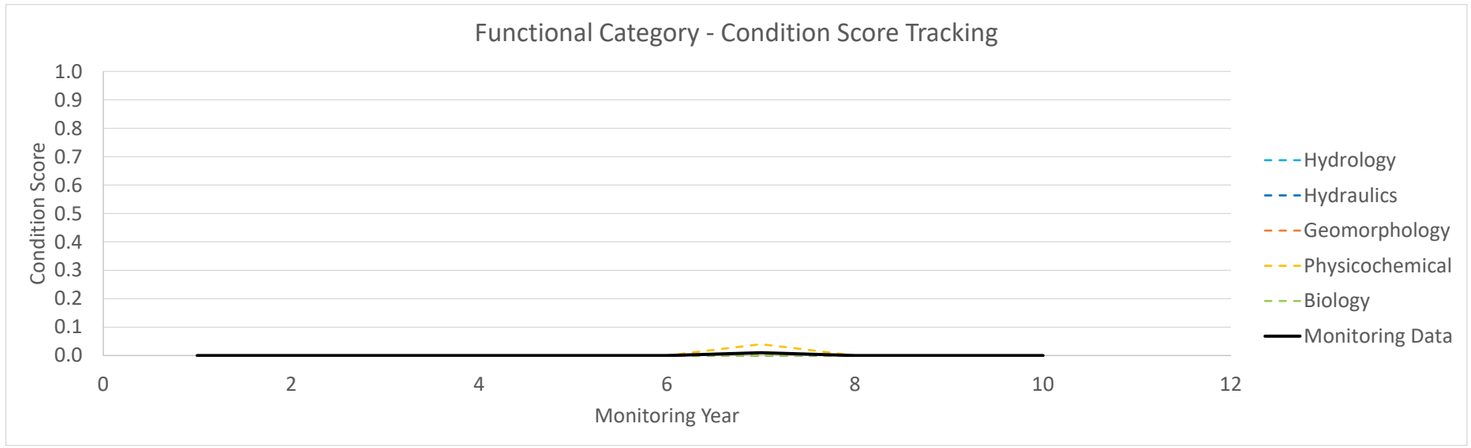
Monitoring Year	10	Date			Roll Up Scoring		
Functional Category	**Function-Based Parameters**	**Measurement Method**	**Field Value**	**Index Value**	**Parameter**	**Category**	**Category**
Hydrology	Reach Runoff	Land Use Coefficient BMP MIDS Rv Coefficient Concentrated Flow Points / 1,000 feet					
Hydraulics	Floodplain Connectivity	Bank Height Ratio Entrenchment Ratio					
Geomorphology	Large Woody Debris	LWD Index No. of LWD Pieces / 100 meters					
	Lateral Migration	Dominant BEHI/NBS Percent Streambank Erosion (%) Percent Armoring (%)					
	Bed Material Characterization	Size Class Pebble Count Analyzer (p-value)					
	Bed Form Diversity	Pool Spacing Ratio Pool Depth Ratio Percent Riffle (%) Aggradation Ratio					
	Riparian Vegetation	Effective Vegetated Riparian Area (%) Canopy Cover (%) Herbaceous Strata Vegetation Cover (%) Woody Stem Basal Area (sqm/hectare)					
Physicochemical	Temperature	Summer Average (^{o}C)					
	Dissolved Oxygen	DO (mg/L)					
	Total Suspended Solids	TSS (mg/L)					
Biology	Macroinvertebrates	Macroinvertebrate IBI					
	Fish	Fish IBI					

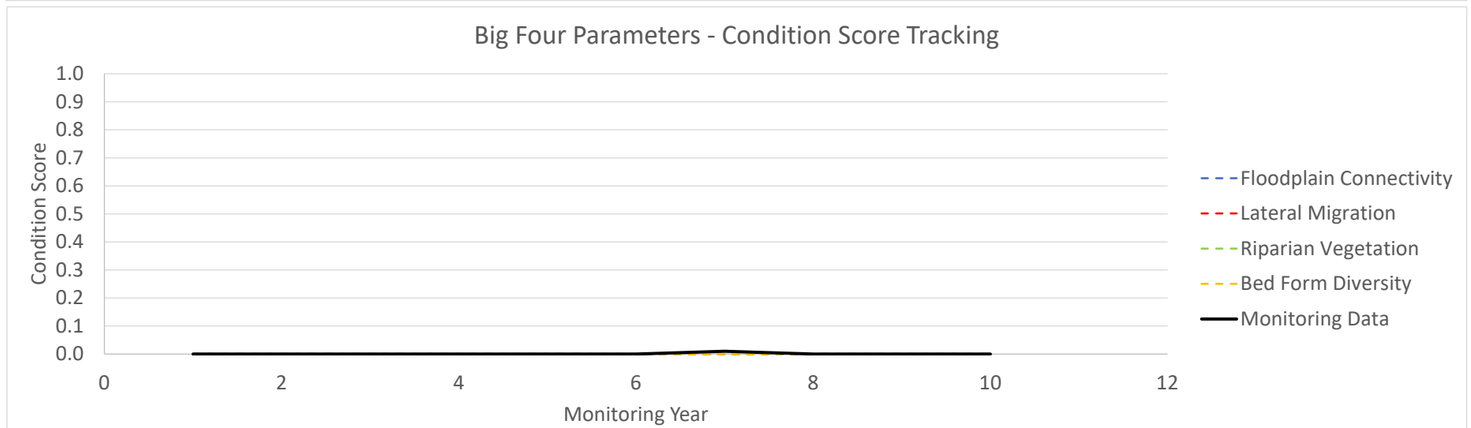
FUNCTION BASED PARAMETERS SUMMARY															
Functional Category	Function-Based Parameters	Existing Parameter	Proposed Parameter	As-Built	Monitoring Year									
					1	2	3	4	5	6	7	8	9	10
Hydrology	Reach Runoff	0.68	0.87											
Hydraulics	Floodplain Connectivity	0.75	0.75											
Geomorphology	Large Woody Debris	0.45	0.79											
	Lateral Migration	1.00	1.00											
	Bed Material Characterization													
	Bed Form Diversity	0.92	0.92											
	Riparian Vegetation	0.35	0.66											
Physicochemical	Temperature													
	Dissolved Oxygen										0.07			
	Total Suspended Solids										0.00			
Biology	Macroinvertebrates			1.00										
	Fish													

FUNCTIONAL CATEGORY REPORT CARD														
Functional Category	ECS	PCS	As-Built	Monitoring Year										
				1	2	3	4	5	6	7	8	9	10	
Hydrology	0.68	0.87												
Hydraulics	0.75	0.75												
Geomorphology	0.68	0.84												
Physicochemical										0.04				
Biology			1.00											
Overall Score	**0.42**	**0.49**	**0.20**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.01**	**0.00**	**0.00**	**0.00**	
Functional Feet	**295.0**	**344.0**	**141.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**7.0**	**0.0**	**0.0**	**0.0**	


Overall Condition Score Tracking
Condition Score
1.00
0.90
0.80
0.70
0.60
0.50
0.40
0.30
0.20
0.10
0.00
0
2
4
6
8
10
12
Monitoring Year
ECS
PCS
As-Built
Monitoring Data


Functional Feet Score Tracking
Functional Feet
400.0
350.0
300.0
250.0
200.0
150.0
100.0
50.0
0.0
0
2
4
6
8
10
12
Monitoring Year
ECS
PCS
As-Built
Monitoring Data

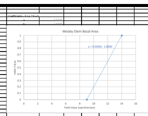

Functional Category - Condition Score Tracking
Condition Score
1.0
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0.0
0
2
4
6
8
10
12
Monitoring Year
Hydrology
Hydraulics
Geomorphology
Physicochemical
Biology
Monitoring Data


Big Four Parameters - Condition Score Tracking
Condition Score
1.0
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0.0
0
2
4
6
8
10
12
Monitoring Year
Floodplain Connectivity
Lateral Migration
Riparian Vegetation
Bed Form Diversity
Monitoring Data

Coefficients - Y = a * X + b

a

b



Project:
Reach ID:

Minnesota Stream Quantification Tool
Parameter Selection Checklist

	Function-Based Parameter	Metric(s)	Datasheets for Field-based Metrics
☐	Reach Runoff*	☐ Land Use Coefficient (D) **AND** Concentrated Flow Points (F)	Project Reach Form Section II(B)** **AND** Reach Runoff Form**
		or	
		☐ BMP MIDS Rv Coefficient (D)	
☐	Floodplain Connectivity*	☐ Bank Height Ratio* **AND** Entrenchment Ratio* (F)	Rapid Survey Form** **OR** Cross Section **AND** Longitudinal Survey Forms
☐	Large Woody Debris (LWD)	☐ LWD Index (F)	LWDI Form
		or	
		☐ No. of LWD Pieces/ 100 meters (F)	Project Reach Form Section VI**
☐	Lateral Migration*	☐ Dominant BEHI/NBS* **AND** Percent Streambank Erosion* (F)	Lateral Migration Form**
		or	
		☐ ***Optional:*** Percent Armoring (F)	Project Reach Form Section II(C)**
☐	Bed Material Characterization	☐ ***Optional:*** Size Class Pebble Count Analyzer (F)	Pebble Count Form
☐	Bed Form Diversity*	☐ Pool Spacing Ratio* **AND** Pool Depth Ratio* **AND** Percent Riffle* (F)	Longitudinal Survey **OR** Rapid Survey Form**
		☐ ***Optional:*** Aggradation Ratio (F)	Cross Section Form **OR** Rapid Survey Form**
☐	Riparian Vegetation*	☐ Effective Vegetated Riparian Area* (D/F) **AND** Canopy Cover* (F) **AND** Herbaceous Vegetation Cover* (F) **AND** Woody Stem Basal Area[1] (F)	Effective Vegetated Riparian Area Documentation Form **AND** Riparian Width, Area, and Vegetation Forms**
☐	Temperature	☐ ***Optional:*** Summer Average (F)	Temperature Logger SOP Form
☐	Dissolved Oxygen	☐ ***Optional:*** Dissolved Oxygen Concentration (F)	Sensor Log
☐	Total Suspended Solids	☐ ***Optional:*** Total Suspended Solids Concentration (F)	Sensor Log
☐	Macroinvertebrates	☐ ***Optional:*** Macroinvertebrate IBI (F)	Macroinvertebrate Sample Sorting Bench Sheet **AND** Stream Invertebrate Visit Form
☐	Fish	☐ ***Optional:*** Fish IBI (F)	Fish Survey Record Form **AND** Visit Summary Form

* Include in all assessments. If % armoring is >75%, other lateral migration measurements are not recommended and the parameter score is a 0.
** Field/Desktop values can be entered directly from field forms into MNSQT; all other metrics require additional post-processing or analysis to calculate values.
(D) indicates metrics are calculated using desktop methods
(F) indicates metrics are calculated or verified using field methods
[1] Include Woody Stem Basal Area only if woody vegetation is determined to be a signification natural component of the riparian zone.

Date:
Investigators:

Minnesota Stream Quantification Tool
Project Reach Form

I. Site Information

Project Name:	Black Earth Creek at Walkin
Reach ID:	
Drainage Area (sq. mi.):	101
Use Class:	
River Nutrient Region:	
Valley Type:	
Stream Reach length (ft):	703
Latitude:	
Longitude:	

Shading Key
Desktop Value
Field Value
Calculation

II. Reach Walk

A.

Difference between bankfull (BKF) stage and water surface (WS) (ft)							
Difference between BKF stage and WS (ft) *Average or consensus value from reach walk.*							

B.

Number Concentrated Flow Points	
Concentrated Flow Points/ 1,000 L.F.	0.0

C.

Length of Armoring on banks (ft)							
Total (ft)	0.0						
Percent Armoring (%)	0%						

Note: If %armoring is >75%, it is recommended to not measure other lateral migration metrics.

D.

Valley length (ft)	
Stream Length (ft)	
Sinuosity	

III. Identification of Representative Sub-Reach

Representative Sub-Reach Length At least 20 x the Bankfull Width	
Latitude of downstream extent:	
Longitude of downstream extent:	

20*Bankfull Width	916.0

Sub-Reach Survey Method

□ Longitudinal Profile & Cross Section
□ Rapid Survey

Date:
Investigators:

Minnesota Stream Quantification Tool
Project Reach Form

IV. Bankfull Verification and Representative Riffle Cross Section

Is Cross Section located within Representative Sub-Reach? □ Yes □ No

If no, explain why:

A.	Bankfull Width (ft)	45.8
B.	Bankfull Mean Depth (ft) = Average of cross-section depths	3.5
C.	Bankfull Area (sq. ft.) Width * Mean Depth	161.0
D.	Regional Curve Bankfull Width (ft)	64.3
E.	Regional Curve Bankfull Mean Depth (ft)	3.8
F.	Regional Curve Bankfull Area (sq. ft.)	247.7
G.	Curve Used	

NOTE: Space is provided here to survey a cross section using rapid survey methods. A cross section form is also available for cross section surveys.

Cross Section Measurements Depth measured from bankfull			
Station	Depth	Station	Depth
0	0	26	3.5
1.6	1.9	30	3.3
2.3	3.2	35	3.8
8	3.8	38	3.9
13	4	43	4
18	3.8	45	1.9
22	3.7	45.8	0

V. Stream Classification

A.	Width Depth Ratio (ft/ft) Bankfull Width / Bankfull Mean Depth	13.0
B.	Bankfull Max Riffle Depth	4
C.	Floodprone Area Width (ft)	
D.	Entrenchment Ratio (ft/ft) Floodprone Area Width /Bankfull Width	0.0
E.	Slope Estimate (%)	
F.	Channel Material Estimate	
G.	Stream Type	

Average slope from the representative sub-reach will be measured and calculated. Pebble count forms are available to aid in this determination.

VI. Large Woody Debris (100m (328 ft) assessment length within Sub-Reach)

A.	Number of Pieces	

NOTE: Complete this section only if the LWDI is not being used. Otherwise complete the LWDI Field Form.

Date:
Investigators:

Minnesota Stream Quantification Tool
Project Reach Form

VII. Representative Sub-Reach Sketch

VIII. Notes

Date:
Investigators:

Minnesota Stream Quantification Tool
Reach Runoff Form

Project Name:

See Table 9 of the User Manual for Land Use Descriptions and Land Use Coefficients

Land Use Description	(A) Land Use Coefficient	(B) Drainage Area (acres)	(A) * (B)
			0
			0
			0
			0
			0
	Sum:	0	0
		Weighted Land Use:	

Shading Key
Desktop Value
Calculation

Date:
Investigators:

Minnesota Stream Quantification Tool
Rapid Survey Form

Reach ID:

I. Riffle Data (Floodplain Connectivity & Bed Form Diversity)

A.	Representative Sub-Reach Length	703		20*Bankfull Width	916.0

B. Bank Height & Riffle Data: Record for each riffle in the Sub-Reach

	R1	R2	R3	R4	R5	R6	R7	R8
Begin Station	0	275	357	420	556	703		
End Station	208	308	378	506	624			
Low Bank Height (ft)	5.4	5.9	5.9	5.3	5.3			
BKF Max Depth (ft)	4	4.5	4.5	4.2	4.2			
BKF Mean Depth (ft)								
BKF Width (ft)	45.8	41.2	41.2	44.7	44.7			
Flood Prone Width (ft)	250	155	155	130	130			
Riffle Length (ft) *Including Run*	208	33	21	86	68			
Bank Height Ratio (BHR) Low Bank H / BKF Max D	1.4	1.3	1.3	1.3	1.3			
BHR * Riffle Length (ft)	280.8	43.3	27.5	108.5	85.8			
Entrenchment Ratio (ER)	5.5	3.8	3.8	2.9	2.9			
ER * Riffle Length (ft)	1135.4	124.2	79.0	250.1	197.8			
WDR BKF Width/BKF Mean Depth								

C.	Total Riffle Length (ft) *Excludes Additional Pool Lengths*	416.0
D.	**Weighted BHR** $\frac{\Sigma(Bank\ Height\ Ratio_i \times \text{Riffle Length}_i)}{\Sigma Riffle\ Length}$	1.3
E.	**Weighted ER**	4.3
F.	**Maximum WDR**	
G.	**Percent Riffle (%)**	59%

Shading Key
Field Value
Calculation

Date:
Investigators:

Minnesota Stream Quantification Tool
Rapid Survey Form

II. Pool Data (Bed Form Diversity)

A. Pool Data: Record for each pool within the Sub-Reach

	P1	P2	P3	P4	P5	P6	P7	P8
Geomorphic Pool?	G		G		G			
Station	225	322	385	536	689			
P-P Spacing (ft)			160.0		304.0			
Pool Spacing Ratio Pool Spacing/BKF Width			3.5		6.6			
Pool Depth (ft) Measured from BKF	11.3	7.6	8	7.6	4.7			
Pool Depth Ratio Pool Depth/BKF Mean Depth	3.2	2.2	2.3	2.2	1.3			

B.	**Average Pool Depth Ratio**	**2.2**	C.	**Median Pool Spacing Ratio**	**5.1**

III. Slope

	Begin	End	Difference	Slope (ft/ft)
Station along tape (ft)	0	1300	1300.0	0.002
Stadia Rod Reading (ft)	754	752	2.0	

IV. Notes

Minnesota Stream Quantification Tool
Cross Section Form

Date:	Rod Team:
Stream Name:	Instrument Team:
Reach I.D.	Notes Team:
Team Number:	

Key Codes:

Head of Riffle	R	Bankfull	BKF	Benchmark	TBM
Head of Run	N	Top of Bank	TOB	Turning Point	TP
Head of Pool	P	Edge of Channel	EC	Backsight	BS
Head of Glide	G	Inner Berm	IB	Foresight	FS
Thalweg	TW			Height of Instrument	HI

Cross Section Field Form

Station	BS (+)	HI	FS (-)	Elevation	Notes

Minnesota Stream Quantification Tool

Longitudinal Profile Form

Date:	Rod Team:
Stream Name:	Instrument Team:
Reach I.D.	Notes Team:
Team Number:	

Longitudinal Profile Field Form

Key Codes:

Head of Riffle	R	Bankfull	BKF	Benchmark	TBM
Head of Run	N	Top of Bank	TOB	Turning Point	TP
Head of Pool	P	Edge of Channel	EC	Backsight	BS
Head of Glide	G	Inner Berm	IB	Foresight	FS
Thalweg	TW			Height of Instrument	HI

Survey:			**Thalweg**		**Water Surface**		**Bankfull**		**Top of Low Bank**			
Station	**BS (+)**	**HI**	**FS (-)**	**Elevation**	**FS (-)**	**Elevation**	**FS (-)**	**Elevation**	**FS (-)**	**Elevation**	**FS (-)**	**Elevation**

Minnesota Stream Quantification Tool
Longitudinal Profile Form

Survey:			Thalweg		Water Surface		Bankfull		Top of Low Bank			
Station	BS (+)	HI	FS (-)	Elevation	FS (-)	Elevation	FS (-)	Elevation	FS (-)	Elevation	FS (-)	Elevation

LARGE WOODY DEBRIS FIELD FORM

Date Revised: 10/19/2016

Investigator(s)		State		Forest Type	Deciduous Evergreen Mixed Other
Date		County		Forest Age (yrs)	
Stream Name		Phys. Province		Latitude (dd)	
Reach ID		Drainage Area (mi^2)		Longitude (dd)	
Watershed Name		Dominant Species			
Survey Length (ft)	328 Survey Length = 328 ft/100 m	BKF Width (ft)		Slope (ft/ft)	
Stream Classification	Ephemeral Intermittent Perennial	BKF Mean Depth (ft)		Bed material	
Stream Condition	Degraded Restored Reference Managed	Floodprone Width (ft)		Rosgen Type	
Field Notes:					

SCORE

	1		2		3		4		5		
CATEGORY	*** PIECES ***										**TOTAL PIECES**
Length/BKF Width	0 to 0.4		0.4 to 0.6		0.6 to 0.8		0.8 to 1.0		> 1.0		
Diameter (cm)	10 to 20		20 to 30		30 to 40		40 to 50		>50		
Location	**Zone 4** (Above BKF/Extending into Channel)				**Zone 3** (Above BKF/Within Streambanks)		**Zone 2** (Above WS/Below BKF)		**Zone 1** (Below WS)		
Type	Bridge				Ramp		Submersed		Buried		
Structure	Plain		Plain/Int		Intermediate		Int/Sticky		Sticky		
Stability	Moveable		Mov/Int		Intermediate		Int/Sec		Secured		
Orientation (deg)	0 to 20		20 to 40		40 to 60		60 to 80		80 to 90		
Total											
CATEGORY	**** DEBRIS DAMS ****										**TOTAL DAMS**
Length (% of BKF Width)	0 to 20		20 to 40		40 to 60		60 to 80		80 to 100		
Height (% of BKF Depth)	0 to 20		20 to 40		40 to 60		60 to 80		80 to 100		
Structure	Coarse		Coarse/Int		Intermediate		Int/Fine		Fine		
Location	Partially high flow		In high flow		Partially low flow		Mid low flow		In low flow		
Stability	Moveable		Mov/Int		Intermediate		Int/Sec		Secured		
								Total		LWDI	

* Pieces - Non-living wood that has a large end diameter ≥ 10 cm and has a length ≥ 1 m. ** Debris Dams - Three (3) or more pieces touching.

LARGE WOODY DEBRIS FIELD FORM

Revised: 10/18/2016

Investigator(s)		State		Forest Type		
Date		County		Forest Age (yrs)		
Stream Name		Phys. Province		Latitude (dd)		
Reach ID		Drainage Area (mi^2)		Longitude (dd)		
Watershed Name		Dominant Species				
Survey Length (ft)	328 Survey Length = 328 ft/100 m	BKF Width (ft)		Slope (ft/ft)		
Stream Classification		BKF Mean Depth (ft)		Bed material		
Stream Condition		Floodprone Width (ft)		Rosgen Type		
Field Notes:						

SCORE										
	1		2		3		4		5		
CATEGORY	*** PIECES ***									**PIECE SCORES**
Length/BKF Width	0 to 0.4		0.4 to 0.6		0.6 to 0.8		0.8 to 1.0		> 1.0		0
Diameter (cm)	10 to 20		20 to 30		30 to 40		40 to 50		>50		0
Location	**Zone 4** (Above BKF/Hanging into Ch)				**Zone 3** (Above BKF/Within Streambanks)		**Zone 2** (Above WS/Below BKF)		**Zone 1** (Below WS)		0
Type	Bridge				Ramp		Submersed		Buried		0
Structure	Plain		Plain/Int		Intermediate		Int/Sticky		Sticky		0
Stability	Moveable		Mov/Int		Intermediate		Int/Sec		Secured		0
Orientation (deg)	0 to 20		20 to 40		40 to 60		60 to 80		80 to 90		0
CATEGORY	**** DEBRIS DAMS ****									**DAM SCORES**
Length (% of BKF Width)	0 to 20		20 to 40		40 to 60		60 to 80		80 to 100		0
Height (% of BKF Depth)	0 to 20		20 to 40		40 to 60		60 to 80		80 to 100		0
Structure	Coarse		Coarse/Int		Intermediate		Int/Fine		Fine		0
Location	Partially high flow		In high flow		Partially low flow		Mid low flow		In low flow		0
Stability	Moveable		Mov/Int		Intermediate		Int/Sec		Secured		0

Additional Notes:

LWDI Summary

Sheet	No.	Reach ID	Stream Name	Physiographic Province	Stream Condition	Rosgen Type	Drainage Area mi^2	Slope ft/ft	Stream Classification	Latitude	Longitude	No. of Pieces	No. of Dams	Pieces + Dams	Piece Score	Dam Score	Weighted Dam Score	LWDI
_Blank_Data_Entry_	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	2	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!
	3	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!
	4	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!
	5	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!
	6	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!
	7	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!
	8	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!
	9	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!
	10	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!

Date:
Investigators:

Minnesota Stream Quantification Tool
Lateral Migration Form

Reach ID:
Valley Type:
Bed Material:

			Bank Erosion Hazard Index								
Station ID	**Bank Length (Ft)**	**Study Bank Height (ft)**	**BKF Height (ft)**	**Root Depth (ft)**	**Root Density (%)**	**Bank Angle (degrees)**	**Surface Protection (%)**	**Bank Material Adjustment**	**Stratification Adjustment**	**BEHI Total/ Category**	**NBS Ranking**

Date:
Investigators:

Minnesota Stream Quantification Tool
Lateral Migration Form

Summary Table

BEHI/NBS Ranking	Enter Bank Length from all rows on p.1 with same ranking									Length (Feet)	Percent of Total
Ex/Ex											
Ex/VH											
Ex/H											
Ex/M											
Ex/L											
Ex/VL											
VH/Ex											
Vh/VH											
VH/H											
VH/M											
VH/L											
VH/VL											
H/Ex											
H/VH											
H/H											
H/M											
H/L											
H/VL											
M/Ex											
M/VH											
M/H											
M/M											
M/L											
M/VL											
L/Ex											
L/VH											
L/H											
L/M											
L/L											
L/VL											
VL/Ex											
VL/VH											
VL/H											
VL/M											
VL/L											
VL/VL											
									Total Bank Length:		
									Total Eroding Bank Length:		
									Percent Bank Erosion (%):		

Shading Key
Field Value
Calculation

PEBBLE COUNT DATA SHEET

SITE OR PROJECT:
REACH/LOCATION:
DATE COLLECTED:
FIELD COLLECTION BY:
DATA ENTERED BY:

			PARTICLE CLASS			Reach Summary	
MATERIAL	**PARTICLE**	**SIZE (mm)**	**Riffle**	**Pool**	**Total**	Class %	% Cum
	Silt / Clay	< .063					
	Very Fine	.063 - .125					
	Fine	.125 - .25					
	Medium	.25 - .50					
	Coarse	.50 - 1.0					
	Very Coarse	1.0 - 2.0					
	Very Fine	2.0 - 2.8					
	Very Fine	2.8 - 4.0					
	Fine	4.0 - 5.6					
	Fine	5.6 - 8.0					
	Medium	8.0 - 11.0					
	Medium	11.0 - 16.0					
	Coarse	16 - 22.6					
	Coarse	22.6 - 32					
	Very Coarse	32 - 45					
	Very Coarse	45 - 64					
	Small	64 - 90					
	Small	90 - 128					
	Large	128 - 180					
	Large	180 - 256					
	Small	256 - 362					
	Small	362 - 512					
	Medium	512 - 1024					
	Large-Very Large	1024 - 2048					
	Bedrock	> 2048					

Totals

Effective Vegetated Riparian Area Documentation Form

Reach Name: Black Creek - Walking Iron County Park

Bankfull Width: 64 feet from regional curve, 50 feet measured from aerial images.

Valley Type: Unconfined Alluvial Valley

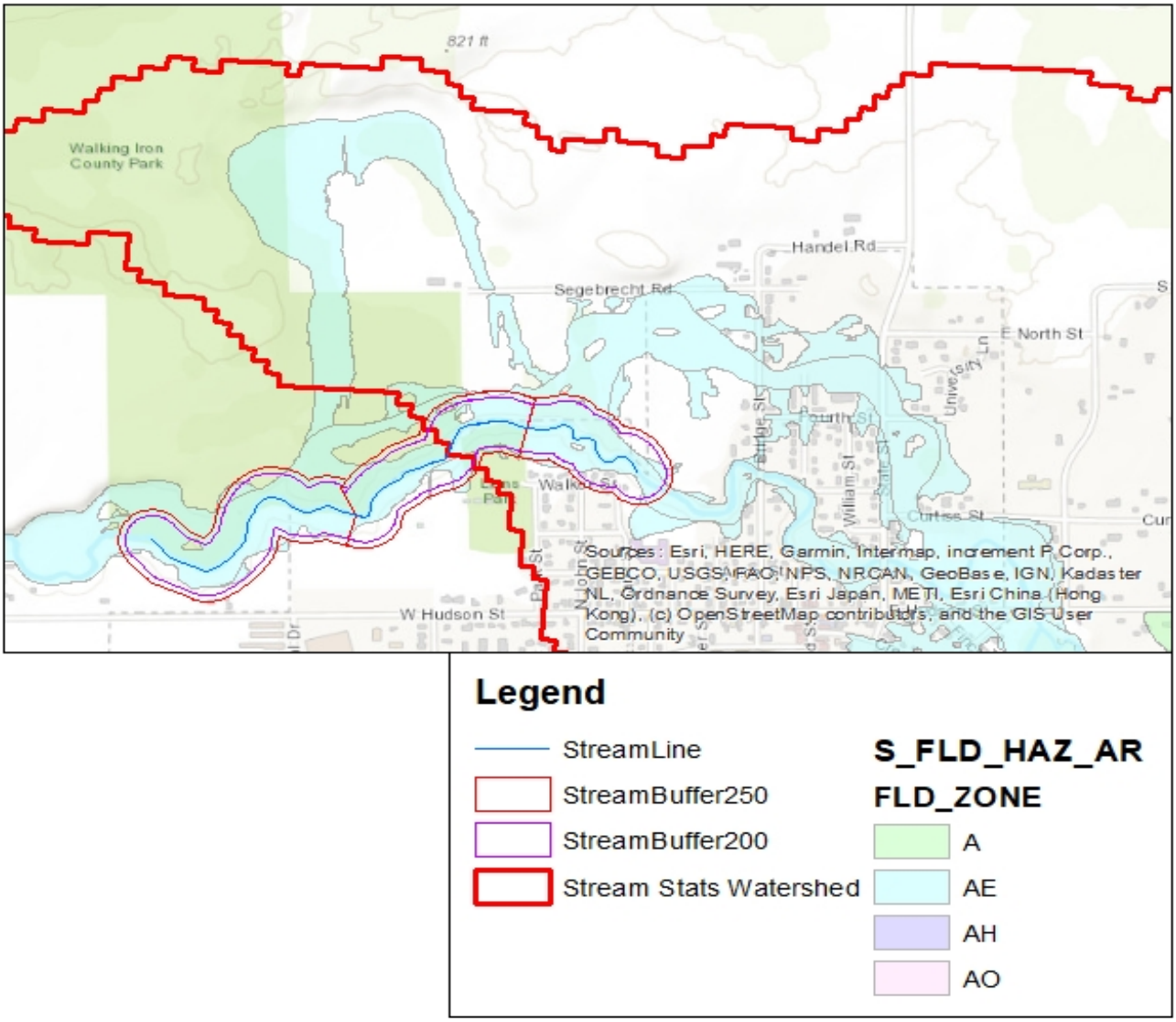
Effective Riparian Area Width Calculation (ft): 400' to 500'

Wbankfull ____ *50-64* _ *(ft) * MWR* ___ *7*_ _ *+ 2 * Wadditional* ____ *25* _____ *(ft)*

Insert Image/Map with aerial photo base and topographic contour elevations showing application of effective riparian width to stream channel per Steps 1 through 5 in Appendix A. Show channel center points and associated riparian width lines.

Wide valley, topo hillslopes not evident in USGS mapping on GIS.

Pulled FEMA SFHA mapping for 100-year FP overlap with effective polygon.



Insert Image/Map with aerial photo base and topographic contour elevations showing Effective Riparian Area Polygon (Step 6 in Appendix A):

Legend

- StreamLine
- Effective Vegetaated Riparian Area
- Stream Buffer 200-250 ft

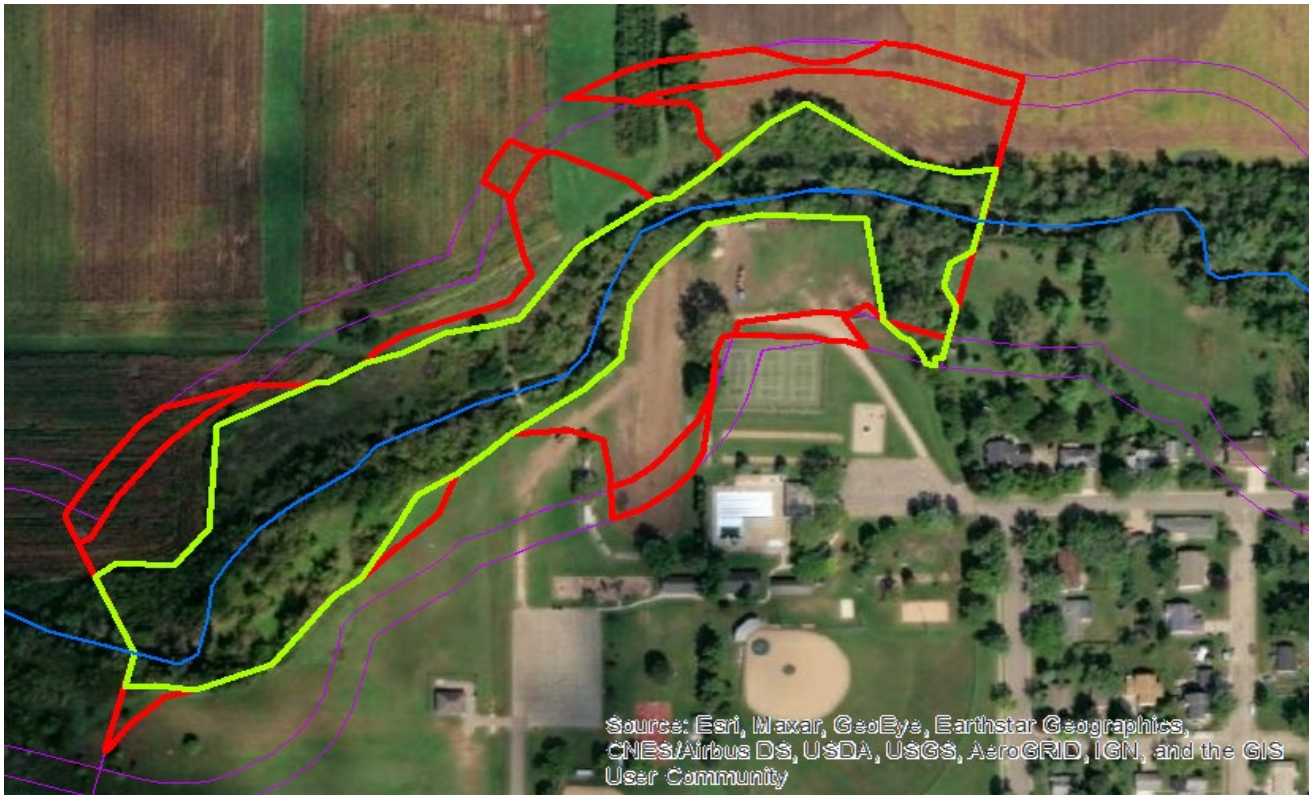
S_FLD_HAZ_AR

FLD_ZONE

- A
- AE
- AH
- AO

Size of Effective Riparian Area Polygon: _____ (square meters).

Area to 250 ft buffer, assuming 64ft bankfull width.	55,430
Area to 200 ft buffer, assuming 50ft bankfull width.	49,300



Vegetated widths range from 100 - 300 feet. Average width (FT) based on area calculations:	160.08

Insert Image/Map with aerial photo base showing areas determined to be non-vegetated per Step 7 in User Manual (2.7.E):

Green delineated area (24,670 sq.m.) is assumed vegetated based on aerial imagery and will be confirmed in the field. The remainder is considered not vegetated/artificial vegetation.	24,670
Total size of area within Effective Riparian Area that is **Non-Vegetated** (square meters):	30,760 24,630
Percent of Effective Riparian Area that is **Vegetated**:	45% 50%

Date:
Investigators:

Minnesota Stream Quantification Tool
Riparian Width Form

Reach Name: : Creek - Walking Iron County
Reach Length: 1,658 feet

Shading Key
Desktop Value
Field Value
Calculation

Plot ID: _____ **Reach STA:** _____

Effective Vegetated Riparian Width [1] (ft)	113		
Artificial Veg. Widths [2]	Width (ft)	Width (ft)	Width (ft)
	92		
Type of Artificial Vegetation [3]			
Actual Vegetated Area Width (ft) [4]	21		

Plot ID: _____ **Reach STA:** _____

Effective Vegetated Riparian Width [1] (ft)	113		
Artificial Veg. Widths [2]	Width (ft)	Width (ft)	Width (ft)
	84		
Type of Artificial Vegetation [3]			
Actual Vegetated Area Width [4] (ft)	29		

Plot ID: _____ **Reach STA:** _____

Effective Vegetated Riparian Width [1] (ft)	320		
Artificial Veg. Widths [2]	Width (ft)	Width (ft)	Width (ft)
	309		
Type of Artificial Vegetation [3]			
Actual Vegetated Area Width [4] (ft)	11		

Plot ID: _____ **Reach STA:** _____

Effective Vegetated Riparian Width [1] (ft)	320		
Artificial Veg. Widths [2]	Width (ft)	Width (ft)	Width (ft)
	292		
Type of Artificial Vegetation [3]			
Actual Vegetated Area Width [4] (ft)	28		

Plot ID: _____ **Reach STA:** _____

Effective Vegetated Riparian Width [1] (ft)			
Artificial Veg. Widths [2]	Width (ft)	Width (ft)	Width (ft)
Type of Artificial Vegetation [3]			
Actual Vegetated Area Width [4] (ft)	0		

[1] Calculated value using equation from in Riparian Vegetation section of Field manual.

[2] If artificial vegetation is identified, measure widths and enter into cells to the right.

[3] Examples of artificial vegetation: lawns, ag. crops, roads, paths, buildings, utility easements, etc.)

[4] Is the Expected Vegetated Area Width minus the sum of all artificial vegetation widths for this plot id/reach sta.

Date:
Investigators:

Minnesota Stream Quantification Tool
Riparian Area Form

Reach Name: Black Creek - Walking Iron County Park
Reach Length:

Shading Key
Desktop Value
Field Value
Calculation

Riparian Width & Area

Desktop Review Values

Effective Vegetated Riparian Area Width [1] (ft)	320
Total Reach Length (ft)	1658
Estimate of Effective Vegetated Riparian Area (ft^2)	530,560

Metric Area Conversion

Estimate of Effective Vegetated Riparian Area (m^2)	49,291

Sampling Plots

Riparian Vegetation Plot Area Needed for 2% Coverage (m^2)	986

Total 5m x 5m plots needed	Total 10m x 10m plots needed
39	10

Field Verification

Average of Actual Vegetated Riparian Widths [2] (ft)	22
Total Reach Length (ft)	1658

Actual Vegetated Riparian Area (ft^2)	36,476
Actual Vegetated Riparian Area (m^2)	3,389

% of Riparian Area that is Vegetated
6.9

[1] Calculated value using equation from in Riparian Vegetation section of Field manual.

[2] Value determined from field measurements (exclusion of artificial/non-vegetated areas).

Date: Minnesota Stream Quantification Tool

Investigators: Riparian Vegetation Form

Project/Reach Name: _____

Plot ID#	
Side	

Left or **Right** side of stream (view facing downstream)

Relative Areal Cover[1] by Strata

Strata	Strata Parameters	Cover Midpt.	Range	Midpt.
Herb	all veg < 1.37 m in height [2]		>95-100%	97.5%
Shrub	woody veg 1.37m in height and <7.62cm dbh [3]		>75-95%	85.0%
Tree	woody veg ≥1.37m in height and ≥7.62 cm dbh [3]		>50-75%	62.5%
Canopy	sum of shrub + tree strata cover midpoints		>25-50%	37.50%
Notes:			>5-25%	15%
			>1-5%	3%
			>0-1%	0.50%
			0%	0.00%

[1] Relative Areal Cover is the proportional cover by vegetation as a percentage of the total plot, ranging from 0-100%.

[2] Height is the length of a woody, perennial stem, measured to the terminal bud of longest woody stem (rather than the height above the ground).

[3] Dbh is measured in centimeters at a height of 1.37m above ground.

Woody Stem Basal Area by dbh[A]

Write down the plot dimensions used (e.g. 5m x 5m)

Plot Dimensions	

List the plot size in hectares from table below

Plot Size (ha)	

DBH Classes (cm)	DBH Midpoint/Actual DBH (cm) [A]	Individual BA/Stem (m^2)	X [B]
0 - 2.5	1.25	0	
2.5 - 5.0	3.75	0	
5.0 - 7.5	6.75	0	
7.5 - 12.5	10.00	0	
12.5 - 20.5	16.50	0	
20.5 - 30.5	25.50	0	
>30.5		0	
		0	
		0	
		0	
		0	
		0	
		0	
		0	
		0	
		0	
		0	
		0	
		0	
	Plot BA Total:	**0.000000**	**m^2**

Plot BA on hectare basis (m^2/ha)
#DIV/0!

Plot	Area (ha)	Type
5m x 5m	0.0025	Full
10m x 10m	0.01	Full
2m x 5m	0.001	Sub-Plot [C]
2m x 10m	0.002	Sub-Plot [C]

$BA\ (m^2) = 0.00007854 * (dbh^2)$

$$BA\ (m^2/ha) = \frac{\text{Plot BA Total (m2)}}{\text{Plot Size (ha)}}$$

Shading Key
Field Value
Calculation

[A] Dbh is measured in centimeters at a height of 1.37m above ground.

[B] The user can input the actual stem count by dbh midpoint or individually measured dbh's >30.5 cm.

Example . 12, 1-cm stems. Enter 1 under dbh (cm). Enter 12 in this column and the BA will be calculated correctly.

[C] Subplot is a 1-meter wide strip along the right and left sides of either a 10m x 10m or 5m x 5m plots. Cannot be used for post-project assessment if woody plantings present.

Date: Minnesota Stream Quantification Tool

Investigators: Riparian Vegetation Form

Project/Reach Name: _____

Plot ID#	
Side	

Left or **Right** side of stream (view facing downstream)

Relative Areal Cover[1] by Strata

Strata	Strata Parameters	Cover Midpt.	Range	Midpt.
Herb	all veg < 1.37 m in height [2]		>95-100%	97.5%
Shrub	woody veg 1.37m in height and <7.62cm dbh [3]		>75-95%	85.0%
Tree	woody veg ≥1.37m in height and ≥7.62 cm dbh [3]		>50-75%	62.5%
Canopy	sum of shrub + tree strata cover midpoints		>25-50%	37.50%
Notes:			>5-25%	15%
			>1-5%	3%
			>0-1%	0.50%
			0%	0.00%

[1] Relative Areal Cover is the proportional cover by vegetation as a percentage of the total plot, ranging from 0-100%.

[2] Height is the length of a woody, perennial stem, measured to the terminal bud of longest woody stem (rather than the height above the ground).

[3] Dbh is measured in centimeters at a height of 1.37m above ground.

Woody Stem Basal Area by dbh[A]

Write down the plot dimensions used (e.g. 5m x 5m)

Plot Dimensions	

List the plot size in hectares from table below

Plot Size (ha)	

DBH Classes (cm)	DBH Midpoint/Actual DBH (cm) [A]	Individual BA/Stem (m^2)	X [B]
0 - 2.5	1.25	0	
2.5 - 5.0	3.75	0	
5.0 - 7.5	6.75	0	
7.5 - 12.5	10.00	0	
12.5 - 20.5	16.50	0	
20.5 - 30.5	25.50	0	
>30.5		0	
		0	
		0	
		0	
		0	
		0	
		0	
		0	
		0	
		0	
		0	
		0	
		0	
	Plot BA Total:	**0.000000**	**m^2**

Plot BA on hectare basis (m^2/ha)
#DIV/0!

Plot	Area (ha)	Type
5m x 5m	0.0025	Full
10m x 10m	0.01	Full
2m x 5m	0.001	Sub-Plot [C]
2m x 10m	0.002	Sub-Plot [C]

$BA\ (m^2) = 0.00007854 * (dbh^2)$

$$BA\ (m^2/ha) = \frac{\text{Plot BA Total (m2)}}{\text{Plot Size (ha)}}$$

Shading Key
Field Value
Calculation

[A] Dbh is measured in centimeters at a height of 1.37m above ground.

[B] The user can input the actual stem count by dbh midpoint or individually measured dbh's >30.5 cm.

Example . 12, 1-cm stems. Enter 1 under dbh (cm). Enter 12 in this column and the BA will be calculated correctly.

[C] Subplot is a 1-meter wide strip along the right and left sides of either a 10m x 10m or 5m x 5m plots. Cannot be used for post-project assessment if woody plantings present.

VISIT SUMMARY MPCA

VISIT INFORMATION

Field Number:_____ Stream Name:_____
Date (mm/dd/yy):_____ Crew:_____
Visit Result and Reason (check one in appropriate column):

Reportable
☐Reportable: Sufficient and representative sample
☐Reportable: Low sample size (<25 fish)

Non-reportable
☐Non-reportable: Unsatisfactory taxis
☐Non-reportable: Outside base flow,

Replicate
☐Replicate: Sufficient and representative sample
☐Replicate: Low sample size (<25 fish)

Not sampled
☐Non-sampleable: Insufficient flow
☐Non-sampleable: Beaver dam – too
☐Non-sampleable: No definable channel
☐Non-sampleable: Other (explain in

If **GPS** coordinates taken during site visit:

DS FileName:_____ **X** FileName:_____ **US** FileName:_____
DS Lat:_____ **X** Lat:_____ **US** Lat:_____
DS Lon:_____ **X** Lon:_____ **US** Lon:_____

FIELD WATER CHEMISTRY

Time (24 hr clock):_____ Water Temp. (°C):_____ Air Temp. (°C):_____ HACH Meter #:_____ Conductivity (umhos@25°C):_____ pH:_____ Dissolved Oxygen (DO)(mg/l):_____ %DO Saturation:_____ Secchi Tube:_____ /100cm
Water Level: ☐ Normal ☐ Below _____(m) ☐ Above _____(m)
Precipitation (if box(es) checked indicate intensity in comments) ☐ Currently raining ☐ Rain yesterday

LAB WATER CHEMISTRY

Chem. Sample ID (field sample):_____ Chem. Sample ID (field duplicate):_____ Collection Time (field sample):_____ Collection Time (field duplicate):_____

TAPE DOWN DISTANCE MEASUREMENT

Tape Down Length (100ths of ft):_____

CHANNEL CHARACTERISTICS

Transect Spacing (m):_____ Station Length (m):_____
Channel Condition (check appropriate box): ☐ Natural Channel ☐ Recent Channelization ☐ Old Channelization
Visual Condition (refer to the ratings and codes on the backside of this form):
Appearance:_____ Recreational Suitability:_____ Stream Condition:_____ / _____ / _____
Does the site appear to be low gradient? ☐ No ☐ Yes (use checkboxes on back to describe observations)

COMMENTS/NOTES:_____

Visual Condition - Ratings and Codes

RATING	APPEARANCE DEFINITION
1A	Clear – crystal, clear transparent water
1B	Tea-colored – transparent water, which has been colored by dissolved organic matter from upstream bogs or wetlands
2	Cloudy – not quite crystal clear; cloudy white, gray or light brown
3	Muddy – cloudy brown due to high sediment levels
4	Green – due to algae growth; indicative of excess nutrients released into stream
5	Muddy AND Green – a combination of cloudy brown from high sediment levels and green from algae growth
RATING	**RECREATIONAL SUITABILITY DEFINITION**
1	Beautiful, could not be better
2	Very minor aesthetic problems: excellent for body-contact recreation
3	Body-contact recreation and aesthetic enjoyment slightly impaired
4	Recreation potential and level of enjoyment of the stream substantially reduced (would not swim but boating/canoeing is okay)
5	Swimming and aesthetic enjoyment of the stream nearly impossible

STREAM CONDITION: **N**=Normal, **L**=Low, **Z**= No Flow, **D**=Dry, **I**=Interstitial, **H**=High **SW**=Swift, **SL**=Slow, **MO**=Moderate **C**=Clear, **M**=Muddy, **O**=Other

Low Gradient Site Characteristics (check all that apply) (note any comments):

- ☐ Flow velocity only slow, or slow and moderate
- ☐ Riffles absent or representing very low percentage of reach (typically <5%)
- ☐ Dominated (>80%) by fines (silt, sand, detritus), coarse substrate uncommon (<10%)
- ☐ Wetland vegetation (cattails, arum, water lily, etc.) in channel or riparian zone
- ☐ It looks like a low gradient stream

PROCEDURE FOR TEMPERATURE LOGGER DEPLOYMENT AT STREAM MONITORING SITES

updated 04/30/2015

I. PURPOSE

To describe the methods used by the Minnesota Pollution Control Agency's (MPCA) Biological Monitoring Program to place, check and retrieve temperature loggers that are placed at stream biological monitoring sites.

II. SCOPE/LIMITATIONS

This procedure applies to all sites where a temperature logger is placed.

III. GENERAL INFORMATION

Sites may be selected to have a temperature logger placed for a number of reasons including:

1) Site is a designated coldwater stream
2) Site is a 10x water chemistry site
3) Site is a Long Term Monitoring Reference site
4) Site thought to be coldwater, although not currently designated
5) Site is in coldwater/warmwater transition zone
6) Site is warmwater and chosen for further warmwater or climate change data collection

IV. REQUIREMENTS

A. Qualifications of crew leaders: The crew leader must be a professional aquatic biologist with a minimum of a Bachelor of Science degree in aquatic biology or closely related specialization. Field crew leaders should also possess excellent map reading skills and a demonstrated proficiency in the use of a GPS (Global Positioning System) receiver and orienteering

B. Qualifications of field technicians/student interns: A field technician/student intern must have at least one year of college education and coursework in environmental and/or biological science.

C. General qualifications: All personnel conducting this procedure must have the ability to perform rigorous physical activity. It is often necessary to wade through streams and/or wetlands, canoe, or hike for long distances to reach a sampling site where a temperature logger may be placed.

V. RESPONSIBILITIES

A. Field crew leader: Implement the procedures outlined in the action steps and ensure that the data generated meets the standards and objectives of the Biological Monitoring Program.

B. Technicians/interns: Implement the procedures outlined in the action steps, including maintenance and stocking of equipment, data collection and recording.

VI. QUALITY ASSURANCE AND QUALITY CONTROL

A. Logger QA/QC: Every winter, all data loggers will be deployed and tested in a lab setting. All loggers will also be checked for battery life during data downloading in the fall.

B. Data QA/QC: All data collected by each temp logger each summer will be verified by trained staff to assure temperature logger was logging properly, and remained in the water, out of the sun, and did not become buried in sediment throughout the

VII. TRAINING

A. All inexperienced personnel will receive instruction from a trainer designated by the program manager. Major revisions in this protocol require that all personnel be re-trained in the revised protocol by an authorized trainer.

B. The field crew leader will provide instruction in the field and administer a field test to ensure personnel can execute this procedure.

A. Equipment List: Verify that all necessary items are present before commencement of this procedure (Table 1).

B. Method: Sites that require temperature loggers can generally be put in during recon, but if high water persists may be put in at a later date, but no later than May 31st. If suitable deployment locations do not exist within the stream reach, temperature logger can be placed above or below the stream reach.

1) Record the Temperature Logger Serial Number on the Temp Logger form before deploying the logger.

2) Find a suitable location that the temperature logger can be placed.

    a. The logger should remain in the water column during the entire deployment and not exposed to the surface.
    b. The location should be: out of direct sunlight; in flowing water; intermediate depth.
    c. Logger should be placed no closer than 6 inches from the stream bottom to avoid siltation and burial.
    d. Measures should be taken to avoid backwaters, eddies, standing water, point source discharges, lake outlets, springs, groundwater seeps, beaver activity, wetlands and wetlands in stream margins.
    e. Measures should also be taken to choose a location that will protect the logger from future high velocities, substrate movement and debris that may dislodge the logger.
    f. Water should be well mixed. This can be verified by taking numerous temperature measurements near the deployment location. A 10 measurement cross-section can be taken looking at variable stream temperature, dissolved oxygen levels and conductivity. Variability in measurements may indicate sources of thermal variation. If this is true, find a new deployment location.
    g. Extra caution should be taken to place the temperature logger in a discrete location so they are not easily seen unless specifically looking for them. For watershed sites, locating the temperature logger at X, or further away from the road is preferred.

3) Attach the temperature logger to protective radiation shield.

    a. Deployment methodologies.

    i. Rebar – Adhere logger tightly to rebar with wire or heavy duty zip ties. In softer substrates this can be done by hand but in some areas hammers will help secure the rebar into the stream bed. Acceptable method in areas not heavily impacted by fine sediments (sand silt) or streams with unpredictable flows that may dislodge the rebar. Bent rebar can provide extra stability by securely anchoring the rebar into the substrate in two locations as well as allowing for easier deployment and retrieval.

        ii. Dog tie – Adhere logger tightly to end of triangle tie with wire or heavy duty zip tie. Screw tie down into side of stream bank within the channel. Logger should be placed no closer than 6 inches from the stream bank to avoid potential groundwater influence. Acceptable method in streams

iii. Airline Cable – Adhere wire to stable location (rebar on stream bank not prone to collapse, around a tree on stream bank not prone to falling into the stream during a high flow event, a large boulder (in stream laden with bed rock, only if no fine sediment are present), or a bridge pillar or pilon). Wire can be crimped using cable ferrules or wire rope clips. If wire is adhered to object on stream bank measures should be taken to hide evidence of the deployment from would be vandals or curious citizens by hiding exposed wire under vegetation or rocks.

4) Take a GPS waypoint of the temperature logger. Name the waypoint with the prefix "TL" followed by the logger serial number (eg.,TL644619). If the logger is later moved, and a new GPS point collected, label the new waypoint with the prefix "TL", the logger serial number, followed by the letter "M" for "moved" (e.g., TL644619M).

5) If the logger is deployed in a low traffic area, consider documenting the logger's location with a piece of flagging attached to a nearby tree or on the rebar stick.

6) Record the temperature of the water in the exact location of the logger. This should be done with a calibrated high precision electronic thermometer with a lead attached to the probe to get as close to the logger as possible.

7) Photograph the location of the logger by taking a photograph both upstream and downstream at deployment location and perpendicular to the stream towards the stream bank. Photographs will ease relocating the logger at future site visits

C. Temperature Logger Form

This form provides location, fish visit check, and retrieval notes for each temperature logger deployed. The form is completed upon placement of the temperature logger at the site.

C.1. Deployment Information

1) *Field Number* – A seven-digit code that uniquely identifies the station. The first two digits identify the year the station was established, the second two identify the major river basin, and the last three are numerically assigned in sequential order (example 02UM001). Assign the station an appropriate field number. For EMAP sites the last three digits should correspond to the sequential number provided by EPA for each site.

1) *Stream Name* – The name of the stream as shown on the most recent USGS 7.5" topographic map. Include all parts of the name (i.e. "North Branch", "Creek", "River", "Ditch", etc.).

2) *Date* – The date fish sampling is conducted in month/day/year format (MM/DD/YY).

2) *Crew* – The personnel who conducted the temperature logger deployment.

3) *Temp Logger Serial Number* – The unique identifier of the individual temperature logger.

4) *GPS Date* – The date that the final GPS file is taken in month/day/year format (MM/DD/YY).

5) *GPS Time* – The time of day (24-hour clock) that the GPS file is taken.

6) *Latitude* – The angular distance north or south of the equator. Record the latitude of the temperature logger as displayed on the GPS receiver in degrees, minutes, seconds format.

7) *Longitude* – The angular distance east or west of the prime meridian. Record the longitude of the temperature logger as displayed on the GPS receiver in degrees, minutes, seconds format.

8) *Placement Description* – Detailed description of where the temperature logger was placed in relation to all features of the stream (Riffle/Run/Pool) and location within the longitudinal reach (Upstream (US) / Midreach(X) / Downstream (DS) and the lateral reach left bank (LB) / right bank (RB) / mid channel (Mid). Special attention needs to be given so staff members are able to come back and retrieve the logger based on this description.

9) *Comments* – Written explanation of the temperature logger's location and placement. Special attention needs to be given so staff members are able to come back and retrieve the logger based on this description. Example: Temp logger 5 meters upstream from X flag in pool 3 feet off of right bank. Pounded rebar down in gravel until TL was 6" off bottom.

10) *Photographs of reach segments (frame #)* - In the first photograph, identify the site by writing the field number on a piece of paper held within the picture frame. Take two pictures (one facing upstream and one facing downstream) at the exact deployment location and a straight shot perpendicular to (or facing) the stream bank. Record the order the photos were taken or the frame numbers of each photograph to assist in identifying the pictures for each site after developing or downloading.

11) *Protective case* – Indicate type of radiation shield (case) utilized during deployment PVC or Metal.

12) *Precision thermometer #* - Identify meter utilized to take temperature during temperature logger deployment.

13) *Temperature (C)* – Temperature recorded during temperature logger launch. Temperature is tested with a calibrated thermometer.

14) *Time* : Indicate the time of day (24-hour clock) that the temperature is taken at deployment.

C.2. Fish Visit Information:

1) Site Visit 1
   a. *Date* – The date the temperature logger check was completed.
   b. *Crew* – The personnel who conducted the temperature logger check.
   c. *Was temp logger checked?* – A Yes/No option indicating whether or not the temperature logger was checked.
   d. *TL in good location?* – A Yes/No option indicating whether or not the temperature logger was in an appropriate location.
   e. *Comments* – Any additional comment about the condition the temp logger was found in.
   f. *Precision thermometer #* - Identify meter utilized to take temperature during temperature logger during site visit.
   g. *Temperature (C)* – Temperature recorded during site visit. Temperature is tested with a calibrated thermometer.
   h. *Time* : Indicate the time of day (24-hour clock) that the temperature is taken.

2) Site Visit 2
   a. *Date* – If there was a second visit, the date the temperature logger check was completed.
   b. *Crew* – If there was a second visit, the personnel who conducted the temperature logger check.
   c. *Was temp logger checked?* – If there was a second visit, a Yes/No option indicating whether or not the temperature logger was checked.
   d. *TL in good location?* – If there was a second visit, a Yes/No option indicating whether or not the temperature logger was in an appropriate location.

e. *Comments* – If there was a second visit, any additional comment about the condition the temp logger was found in.

f. *Precision thermometer #* - If there was a second visit, identify meter utilized to take temperature during site visit.

g. *Temperature (C)* – If there was a second visit, temperature recorded during site visit. Temperature is tested with a calibrated thermometer.

h. *Time:* If there was a second visit, indicate the time of day (24-hour clock) that the temperature is taken.

3) Site Visit 3

a. *Date* – If there was a third visit, the date the temperature logger check was completed.

b. *Crew* – If there was a third visit, the personnel who conducted the temperature logger check.

c. *Was temp logger checked?* – If there was a third visit, a Yes/No option indicating whether or not the temperature logger was checked.

d. *TL in good location?* – If there was a third visit, a Yes/No option indicating whether or not the temperature logger was in an appropriate location.

e. *Comments* – If there was a third visit, any additional comment about the condition the temp logger was found in.

f. *Precision thermometer #* - If there was a third visit, identify meter utilized to take temperature during site visit.

g. *Temperature (C)* – If there was a third visit, temperature recorded during site visit. Temperature is tested with a calibrated thermometer.

h. *Time* : If there was a third visit, indicate the time of day (24-hour clock) that the temperature is taken.

C.4. <u>If TL was moved…</u>

1) *Temp Logger Serial Number* – The unique identifier of the individual temperature logger.

2) *GPS Date* – The date that the final GPS file is taken in month/day/year format (MM/DD/YY).

3) *GPS Time* – The time of day (24-hour clock) that the GPS file is taken.

4) *Latitude* – The angular distance north or south of the equator. Record the latitude of the temperature logger as displayed on the GPS receiver in degrees, minutes, seconds format.

5) *Longitude* – The angular distance east or west of the prime meridian. Record the longitude of the temperature logger as displayed on the GPS receiver in degrees, minutes, seconds format.

6) *Placement Description* – Detailed description of where the temperature logger was placed in relation to all features of the stream (Riffle/Run/Pool) and location within the longitudinal reach (Upstream (US) / Mid reach (X) / Downstream (DS) and the lateral reach left bank (LB) / right bank (RB) / mid channel (Mid). Special attention needs to be given so staff members are able to come back and retrieve the logger based on this description.

C.5. Retrieval Notes:

i. *TL Retrieved* – Check box, indicates whether or not the temperature logger was collected.

j. *Date Attempted* – If an unsuccessful attempt to collect temperature logger was made, indicate date here.

k. *Crew* – The personnel who conducted the unsuccessful temperature logger check.

l. *Date Retrieved* – The date the temperature logger retrieval was completed.

m. *Retrieval Crew* - The personnel who conducted the successful temperature logger retrieval.

n. *Comments* – Any additional comments about where the temperature logger was found, especially noting if there were any issues with its location. If the temperature logger retrieval was unsuccessful indicate information about the search and whether or not additional attempts are warranted.

o. *Precision thermometer #* - Identify meter utilized to take temperature at temperature logger retrieval.

p. *Temperature (C)* – Temperature recorded during logger retrieval. Temperature is tested with a calibrated thermometer.

q. *Time:* Indicate the time of day (24-hour clock) that the temperature is taken at retrieval.

Table 1. Equipment List – This table identifies all equipment needed in order to deploy a temperature logger at a stream biological monitoring site.

Stream information sheet – for location of site

1:24,000 USGS topographical maps – for navigation to and from the sampling site

County Platte maps – for determining land ownership

Aerial photographs – for navigation to and from the sampling site

DeLorme atlas – for vehicular navigation to and from the sampling site

GPS receiver – to locate and document temperature logger location

Flagging – to mark the temperature logger location if needed

Pencil – for filling out forms

Permanent marker – to label flagging

Clipboard – to store forms/maps and record data

Waders – because it is necessary to enter the stream to place temperature logger

Cellular telephone – to contact landowners, to communicate between field crews, and for safety

Rebar – for anchoring temperature logger into the stream bed

Cable – for anchoring temperature logger to stable object

Dog ties – for anchoring temperature logger to side of stream bank

Cable Ferrules – for securing temperature logger to cable

Wire Cutter and Crimper – for cutting wire and securing cable ferrules to cable

Heavy duty Zip ties – for securing logger to rebar and dog ties

Hammer – to assist in getting rebar into the stream bed

Temperature Logger – to record temperature data

Wire – to attach temperature logger to rebar or dog tie

Temperature Logger Cases – radiation shields to protect temperature logger during deployment and (metal) enable deployment in streams with hard substrates (bedrock, cobble, boulder)

Water Chemistry Meter – to take DO and Conductivity measurements during deployment to insure water at deployment location is well mixed.

Calibrated Precision Thermometer – to record temperature at temperature logger deployment, site visits and temperature logger retrieval

Temperature Logger Form

(Revised 4/2015)

Deployment Information					
Field Number:		Stream Name:			
Date:		Crew:			
Temp Logger Serial Number		GPS Date		GPS Time	
Field GPS		Latitude		Longitude	
Decimal Degrees		____.____		____.____	
Placed in a: Riffle Run Pool	Placed Near: US X DS / LB RB Mid				
Comments:					
Photos of Temp Logger Deployment					
Site number:	Logger looking DS:	Logger Looking US:	Straight on:		
Case used : PVC or Metal		Deployment Method:			
Precision Thermometer		Temperature (C)		Time	

Visit information					
Date:		Crew:			
Was temp logger checked?		TL in a good location (not at surface, or buried)?			
Comments:					
Precision Thermometer #:		Temperature (C)		Time	
Date:		Crew:			
Was temp logger checked?		TL in a good location (not at surface, or buried)?			
Comments:					
Precision Thermometer #:		Temperature (C)		Time	
Date:		Crew:			
Was temp logger checked?		TL in a good location (not at surface, or buried)?			
Comments:					
Precision Thermometer #:		Temperature (C)		Time	
If TL was moved to a new location, please describe and include GPS Coordinates					
Temp Logger Serial Number		GPS Date		GPS Time	
Field GPS		Latitude		Longitude	
Decimal Degrees		____.____		____.____	
Placed in a: Riffle Run Pool	Placed Near: US X DS LB RB Mid				
Comments:					

Retrieval Notes					
TL retrieved? ☐		If no, Date Attempted :		Crew:	
Date retrieved:		Retrieval Crew:			
Comments: (At water surface, out of water, buried, no shade, surrounded by veg, looked good)					
Precision Thermometer #:		Temperature (C)		Time	

Date:
Investigators:

Minnesota Stream Quantification Tool
Sensor Log

Stream Name:
Sub-reach Name:

Dissolved Oxygen Logger Deployed? □ **Yes** □ **No**

Date Deployed:	
Date Retreived:	

Frequency of data: □ Daily □ Other: _____
Timing of data: □ 1-3pm □ Other: _____

Describe sensor location within reach:

Total Suspended Solids Sample Obtained? Sample Type:

Date Obtained:	

Describe location within reach:

Other Sensor Deployed? Sensor Type:

Date Deployed:	
Date Retreived:	

Frequency of data (if applicable): _____

Describe location within reach:

ALSO IDENTIFY ALL SENSOR LOCATIONS ON SUB-REACH SKETCH ON PROJECT REACH FORM

-MPCA Biological Monitoring Program-

Macroinvertebrate Identification Lab Bench Sheet

Field Number	**Sample Date**
Site Name	**Taxonomist:**
Sample Type QMH* QR HD other_____	**Date of Sample ID:** ____/____/____

*A processed QMH sample consists of 2 parts, the subsample(ss) and large/rare (l/r), both parts must be identified

Order/Family	Genus	Species/Notes	ss	l/r
Ephemeroptera				
Baetiscidae	Baetisca			
Caenidae	Bracycercus			
	Caenis			
Ephemerellidae	Attenella			
	Ephemerella			
	Serratella			
Ephemeridae	Ephemera			
	Hexagenia			
Leptohyphidae	Tricorythodes			
Leptophlebiidae	Leptophlebia			
	Paraleptophlebia			
Polymitarcidae	Ephoron			
Potamanthidae	Anthopotamus			
Heptageniidae	Epeorus			
	Heptagenia			
	Stenacron			
	Stenonema			
Isonychiidae	Isonychia			
Ametropodidae	Ametropus			
Baetidae	Acerpenna			
	Baetis			
	Callibaetis			
	Heterocloeon			
notes/additional taxa				
Plecoptera				
Leuctridae				
Taeniopterygidae				
Perlidae	Acroneuria			
	Agnetina			
	Attaneuria			
	Neoperla			
	Paragnetina			
	Perlinella			
Perlodidae				
Pteronarycyidae	Pteronarcys			
notes/additional taxa				
Lepidoptera				
Pyralidae	Paraponyx			
	Petrophila			
notes/additional taxa				
Megaloptera				
Corydalidae	Chauliodes			
	Corydalus			
	Nigronia			
Sialidae	Sialis			
notes/additional taxa				
Isopoda				
Asselidae	Asselus			
notes/additional taxa				

Order/Family	Genus	Species/Notes	ss	l/r
Odonata				
Calopterygidae	Calopteryx			
	Hetaerina			
Coenagrionidae	Argia			
	Enallagma			
	Nehalennia			
Lestidae	Lestes			
Aeshnidae	Aeschna			
	Anax			
	Basiaeschna			
	Boyeria			
Cordulegastridae	Cordulegaster			
Corduliidae	Cordulia			
	Dorocordulia			
	Epitheca			
	Somatochlora			
Gomphidae	Dromogomphus			
	Gomphurus			
	Gomphus			
	Hagenius			
	Ophiogomphus			
	Phanogomphus			
	Progomphus			
notes/additional taxa				
Hemiptera				
Belostomatidae	Belstoma			
	Corixidae			
Corixidae	Hesperocorixa			
	Sigara			
	Trichocorixa			
Nepidae	Ranatra			
Notonectidae	Buenoa			
	Notonecta			
notes/additional taxa				
Amphipoda				
Talitridae	Hyallela	azteca		
Gammaridae	Gammarus			
notes/additional taxa				
Decapoda				
Cambaridae	Cambarus			
	Orconectes			
	Procambarus			
notes/additional taxa				
Pelecypoda				
Sphaeriidae				
Corbiculidae				
Unionidae				
notes/additional taxa				

entered into DataInverts by _____ --- (initials) date _____

Order/Family	Genus	Species/Notes	ss	l/r	Order/Family	Genus	Species/Notes	ss	l/r
Trichoptera					**Diptera**				
Dipseudopsidae	Phylocentropus				Ceratopogonidae	Alluaudomyia			
Hydropsycidae	Ceratopsyche					Atrichopogon			
	Cheumatopsyche					Bezzia			
	Diplectrona					Ceratopogon			
	Hydropsyche					Culicoides			
	Potamyia					Nilobezzia			
Philopotamidae	Chimarra					Palpomyia			
	Dolophilodes					Probezzia			
Polycentropodidae	Cernotina					Sphaeromias			
	Cyrnellus				Chironomidae	G.			
	Neureclipsis				Dixidae	Dixa			
	Paranyctiophylax					Dixella			
	Polycentropus				Simuliidae	Simulium			
Psychomyiidae	Lype				Tipulidae	Antocha			
	Psychomyia					Dicranota			
Glossosomatidae	Agapetus					Hexatoma			
	Glossosoma					Limnophila			
	Protoptila					Limonia			
Hydroptilidae	Hydroptila					Pilaria			
	Leucotrichia					Tipula			
	Mayatrichia				Athericidae	Atherix			
	Oxyethira				Empididae	Hemerodromia			
	Orthotrichia				Tabanidae	Chrysops			
Rhyacophilidae	Rhyacophila					Tabanus			
Brachyecentridae	Brachycentrus				***notes/additional taxa***				
	Micrasema								
Helicopsychidae	Helicopsyche								
Lepidostomatidae	Lepidostoma								
Leptoceridae	Ceraclea				**Coleoptera**				
	Leptocerus				Dytiscidae	Agabus			
	Mystacides					Laccophilus			
	Nectopsyche					Liodessus			
	Oecetis				Gyrinidae	Dineutus			
	Trianodes					Gyrinus			
Limnephilidae	Limnephilus				Elmidae	Ancyronyx			
	Hydatophylax					Dubiraphia			
Molannidae	Molanna					Macronychus			
Phryganeidae	Phryganea					Optioservus			
	Ptilostomis					Stenelmis			
Sericostomatidae	Agarodes				Hydrophilidae	Berosus			
notes/additional taxa						Helocombus			
						Laccobius			
						Sperchopsis			
						Tropisternus			
Gastropoda									
Ancylidae	Ferrissia								
Planorbidae	Helisoma				**Annelida**	Oligochaeta			
	Promentus					Hirudinea			
	Planorbula				***notes/additional taxa***				
	Gyraulus								
Vivaparidae	Campeloma								
Lymnaeidae	Lymnaea								
	Bulimnea								
	Fossaria				Hydracarina (trombidoformes, acarina)				
Hydrobiidae	Amnicola				Nematoda				
Pleuroceridae	Pleurocera				*notes/additional taxa*				
Physidae	Physa								
notes/additional taxa									

entered into DataInverts by _____ --- (initials) date _____

Macroinvertebrate Sample Sorting Bench Sheet

Field Number	Sample Date	Sample Type *	# Sample Bottles	Sample Sorting Date		# Organisms Picked	# Squares Picked**	L/R (y/n)	Chiro toVial (y/n)
				Begin	End				

* QMH, QR, HD, WTL

** Applies only to samples being subsampled

Macroinvertebrate Sorting QC Form

Sample Field Number	Sampling Date	Sample Type	Initials of QC Sorter	# Organisms found in QC	# Organisms originally found in sample	Sorting Efficiency	Date QC Sort Completed

Minnesota Pollution Control Agency

MPCA Stream Monitoring Program

INVERTEBRATE VISIT FORM

Stream Name:		**Date:**
Field Number:	**County:**	**Crew:**
Water Chemistry	Tape Down: ___.____ (1/100ths ft) Location: _____	

Time: (24 hr) ____:___ Air Temp:_____ (^{o}C) Water Temp:_____ (^{o}C) Conductivity: _____ (umhos@25^{o}C)
DO: _____(mg/L) DO % Saturation:_____ pH:_____ Secchi -Tube: _____ (cm)
Water Level: Normal Below _____ (m) Above _____ (m) Color _____ (pcu)

*****If Flagging is not found or if establishing a new site, fill out GPS info*****

Coordinates	**LATITUDE**	**LONGITUTDE**	**Time:**
Field GPS:	____.____	____.____	**Name:**

Notes:

Stream Classification Information

Flow	Flow over riffle(s)	High / Med / Low / NA	Channel	Excavated, trapezoidal channel	%
	Flow at reach constriction	High / Med / Low / NA		Shallow excavation, channelized wetland	%
	Flow over run	High / Med / Low / NA		Natural channel	%
	General flow pattern	High / Med / Low / NA	Vegetation	Emergent, aquatic vegetation in channel	Ext / Mod / Sparse / NA
	Intermittent sections	Yes / No		Emergent, aquatic vegetation along bank	Ext / Mod / Sparse / NA
Habitat	Riffle (with flow) present in reach			Floating or submerged aquatic vegetation	Ext / Mod / Sparse / NA
	Riffle (with flow) present outside of reach (riffles do not include riprap associated with bridges or bank stabilization)			Loosely attached filamentous algae	Ext / Mod / Sparse / NA
				Firmly attached algae or submerged veg	Ext / Mod / Sparse / NA
	Dominant invertebrate habitat (circle two) Riffle | Rocky Run-Pool | Aquatic Macrophyte | Bank-Overhanging Veg | Wood | Leaf				
Substrate	Dominant Run Substrate	bedrock / boulder / cobble / gravel / sand / silt			
	Dominant Pool Substrate	bedrock / boulder / cobble / gravel / sand / silt			
	Dominant Substrate receiving flow	bedrock / boulder / cobble / gravel / sand / silt			
	Dominant Substrate in reach	bedrock / boulder / cobble / gravel / sand / silt			
☐	Stream displays a typical riffle-run pool morphology ☐ adequate flow to maintain riffle organisms ☐ inadequate flow to maintain riffle organisms				
☐	Stream has adquate flow to maintain riffle organism, but does not have suitable coarse substrate to support these assemblages (riffles, rock substrate in runs or pools)				
☐	Stream has adquate flow to maintain riffle dwelling organism, woody debris has replaced rocks as primary coarse substrate				
☐	Stream is low gradient, stream bed is predominately fine substrate, inadequate flow to maintain riffle organisms				

Invertebrate Sample Information

Qualitative Multi-Habitat Sample (QMH)

Divide 20 samples equally among habitat types present in the reach. If three habitat types are present take 7 samples in each of the three dominant habitats (for a total of 21). If a habitat is present, but not in abundance to sample in equal proportion to other habitats, sample as much as possible and divide the remaining samples between the dominant habitat types.

✓	Habitat		#Samples
☐	rock riffle/run	Flow adequate to carry insects	
	rock substrate	Artificial flow needed to carry insect into net	
☐	aquatic macrophyte		
☐	undercut bank, overhanging veg		
☐	snag, woody debris, root wad		
☐	leaf pack		

Number of multihabitat containers:

Additional Biological Information

Presence of freshwater sponge yes / no

Presence of exotic species yes / no

Presence of mussels yes / no

Description of mussel density and/or mussel bed location:

Notes

Pictures #: __ DD __ DU __ MD __ MU __ UD __ UU

-MPCA Biological Monitoring Program-

Macroinvertebrate Identification QC Form

Field Number	Sample Date	Identifiers' Initials		Discrepancies		Comments	Total # of Conflicts	Total # of Taxa	Precision	
		Original ID	QC ID	Original Identification	QC Identification				Original ID	QC ID

Stream Sample External Label:

MPCA Bioassessment – Invertebrate Sample
Sample Preservative - 100% reagent alcohol / 10% formalin
Sample Type: QMH / RTH
Sample Composition: Riffle / Bank / Wood / Veg
Date ____/____/20___ (mm/dd/yyyy)
Station Name _____ Station ID _____
Site Visit 1 / 2 Sample Jar ___ of ___ Collectors

Stream Sample Internal Label:

Invertebrate Sample – sample type _____
Site Name:_____
Field Number_____
Date:_____/_____/_____ Bottle No. _____of_____
Collected by:
_____

FISH SURVEY RECORD MPCA

Field Number:	Stream Name:	
Date (mm/dd/yyyy):	Crew:	
Gear Type (circle one): Backpack* Stream-electrofisher Boom-electrofisher Mini-Boom *Type of Backpack (circle one): Generator LR-24 Halltech		
Channel Position: Right Bank Mid-Channel Left Bank (circle one if boom-electrofisher site)		
Distance (m):	Time Fished (sec):	Identified By:
Visit Comments:		

Species (common name)	Length Range (mm)	Weight (g)	Number	Anomalies or YOY
1.				
2.				
3.				
4.				
5.				
6.				
7.				
8.				
9.				
10.				
11.				
12.				
13.				
14.				
15.				
16.				
17.				
18.				
19.				
20.				
21.				
22.				
23.				
24.				
25.				
26.				
27.				
28.				

Anomalies: **A**-anchor worm; **B**-black spot; **C**-leeches; **D**-deformities; **E**-eroded fins; **F**-fungus; **G**-yellow grub; **L**-lesions; **N**-blind; **P**=parasites; **PL**-parasite lesion; **Y**-popeye; **S**-emaciated; **W**-swirled scales; **T**-tumors; **Z**-other.

(Cont.)

Species (common name)	Length Range (mm)	Weight (g)	Number	Anomalies or YOY
29.				
30.				
31.				
32.				
33.				
34.				
35.				
36.				
37.				
38.				

INDIVIDUAL OR BATCH MEASUREMENTS

Species (common name)	Length Range (mm)	Weight (g)	Number	Anomalies or YOY
1.				
2.				
3.				
4.				
5.				
6.				
7.				
8.				
9.				
10.				
11.				
12.				
13.				
14.				
15.				
16.				
17.				
18.				
19.				
20.				
21.				
22.				
23.				
24.				
25.				
26.				
27.				
28.				
29.				
30.				
31.				
32.				

Instructions:

This spreadsheet automatically calculates bank erosion rates and quantities. Data is only entered in the BEHI and NBS forms and that data is used to populate the bank summary form.

There are 3 types of forms:

1. Bank summary form (1 form)
2. BEHI form (20 forms)
3. NBS form (Rosgen 2006) (20 forms)

The last tab also contains a Bank Erosion Rates table that was used to determine feet of erosion per year. These erosion rates are based on the combination of USFWS Bank Erosion Rates Curve and Rosgen's Colorado Bank Erosion Rates Curve.

How to Use:

--Blue cells - automatically populate
--Green cells - manually enter data

1. On the BEHI and NBS forms enter data only into the green cells.
2. On the bank summary form all the blue cells will be automatically populated with data entered in the BEHI and NBS forms. You only need to enter data

If adding extra banks

This workbook is set up to record 20 banks. There are 20 BEHI forms, 20 NBS forms, and 20 rows for banks on the bank summary sheet. If you are recording more than 20 banks you will need to add more BEHI and NBS forms by copying the forms to new tabs. You will also need to insert extra rows on the bank summary sheet. The new forms and rows will not be automatically linked.

To link the new BEHI and NBS forms to the new bank summary rows for the colums listed below, conduct the following:
1. Feature ID -use cell F6 on the BEHI form.
2. Length - use cell Y6 on the BEHI form.
3. Height - use cell A12 on the BEHI form.
4. BEHI Rating - use cell AU5 on the BEHI form.
5. NBS Rating - use cell I52 on the NBS form.

To polpulate the new bank summary rows for the columns listed below, copy the equations from existing rows within the same column.
1. Predicted Rate of Bank Erosion (ft/yr)
2. Predicted Erosion Amount (ft3/yr)
3. Predicted Erosion Amount (tons/yr)
4. Predicted Erosion Amount (tons/yr/ft)

Project Name	0										
Feature	Lat/Long		Length, ft (Bank or deposition)	Height, ft (Bank or Headcut)	BEHI Rating	NBS Rating	Predicted Rate of Bank Erosion (ft/year)	Predicted Erosion Amount (ft^3/year)	Predicted Erosion Amount (tons/year)	Predicted Erosion Rate (tons/year/ft)	Comments
Feature I.D. (Bank., Headcut or Deposition I.D.)	Start: Headcut Location or Start of Bank/Deposition	End: For Banks or Deposition only									
LB1			75.0	4.7	Low	High	0.16	56.64	1.61	0.04	
LB2			36.0	5.6	Low	High	0.16	32.37	0.92	0.04	
LB3			31.0	5.7	Low	Low	0.02	3.53	0.10	0.01	
RB1			9.0	4.8	Moderate	Low	0.13	5.40	0.15	0.03	
RB2			51.0	8.3	Low	High	0.16	67.73	1.93	0.06	
RB3			25.0	8.2	Moderate	High	0.80	164.00	4.67	0.32	
RB4			45.0	4.6	Moderate	Low	0.13	26.10	0.74	0.03	
RB5			16.0	4.5	Moderate	Low	0.13	9.00	0.26	0.03	
0			0.0	0.0							
0			0.0	0.0							
0			0.0	0.0							
0			0.0	0.0							
0			0.0	0.0							
0			0.0	0.0							
0			0.0	0.0							
0			0.0	0.0							
0			0.0	0.0							
0			0.0	0.0							
0			0.0	0.0							
0			0.0	0.0							
TOTAL OF ALL GRIDS			**288.0**	**N/A**	**N/A**	**N/A**	**1.7**	**364.8**	**10.4**	**0.5**	

USFWS - SHARP
STREAM NAME - REACH IDENTIFICATION

BANK EROSION HAZARD INDEX

Stream:		**Observer(s):**		**Data:**		**QA/QC:**		**Total Score:**		**13.39**	
Reach:		**Comments:**								**Low**	
Location:	LB1	**Bank Length**	75					**Total Score Values:**	**Very Low**	**Low**	**Moderate**
Date:									5-10	10-20	20-30

High	**Very High**	**Extreme**
30-40	40-45	45-50

Erodibility Variables

Bank Height / Bankfull Height Ratio					
Bank Height	Bankfull Height	Value	Index	Bank Erosion Potental	Notes
4.72	4.00	1.18	3.69	Low	
Root Depth / Bank Height Ratio					
Root Depth	Bank Height	Value	Index	Bank Erosion Potental	Notes
4.72	4.72	1.00	1.00	Very Low	
Weighted Root Density					
Root Density (%)	Root Depth / Bank Height	Value	Index	Bank Erosion Potental	Notes
80.00	1.00	80.00	1.90	Very Low	
Bank Angle (°)			Index	Bank Erosion Potental	Notes
70.00			4.90	Moderate	
Surface Protection					
Surface Protection (%)			Index	Bank Erosion Potental	Notes
80.00			1.90	Very Low	
			Adjustment		Notes
Bank Materials					
			Adjustment		Notes
Bank Stratification					
		TOTAL SCORE	**13.39**		

Bank Erosion Potential

		Very Low	Low	Moderate	High	Very High	Extreme
Erodibility Variables							
Bank Height / Bankfull Height	Value	1.00-1.10	1.11-1.19	1.20-1.50	1.60-2.00	2.10-2.80	>2.80
	Index	1.0-1.9	2.0-3.9	4.0-5.9	6.0-7.9	8.0-9.0	10
Root Depth / Bank Height	Value	1.00-0.90	0.89-0.50	0.49-0.30	0.29-0.15	0.14-0.05	<0.05
	Index	1.0-1.9	2.0-3.9	4.0-5.9	6.0-7.9	8.0-9.0	10
Weighted Root Density	Value	100-80	79-55	54-30	29-15	14-5	<5
	Index	1.0-1.9	2.0-3.9	4.0-5.9	6.0-7.9	8.0-9.0	10
Bank Angle	Value	0-20	21-60	61-80	81-90	91-119	>119
	Index	1.0-1.9	2.0-3.9	4.0-5.9	6.0-7.9	8.0-9.0	10
Surface Protection	Value	100-80	79-55	54-30	29-15	14-10	<10
	Index	1.0-1.9	2.0-3.9	4.0-5.9	6.0-7.9	8.0-9.0	10

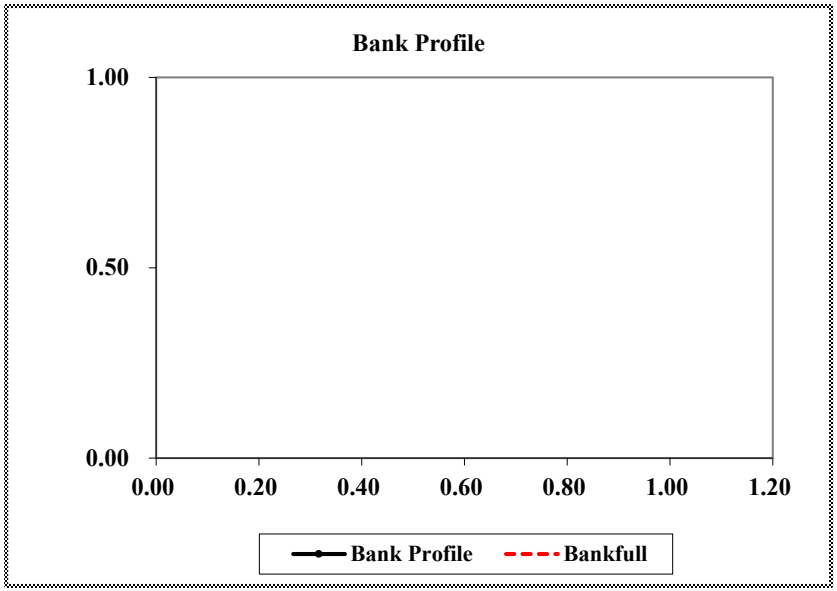
Adjustments

Bank Material	
Bedrock	Bedrock banks have a very low erosion potential.
Boulders	Boulder banks have a low erosion potential.
Cobble	Substract 10 points. No adjustment if sand/gravel compose greater than 50% of bank.
Clay/Silt Loam	Add 5 points.
Gravel	Add 5-10 points depending on percentage of bank material composed of sand.
Sand	Add 10 points.
Silt / Clay	No adjustment.

Stratification

Add 5-10 points depending on position of unstable layers in relation to bankfull stage.

Bank Profile		
Horizontal Distance	**Vertical Height**	**Notes**
Bankfull		
Horizontal Distance	**Vertical Height**	**Notes**



Worksheet 3-12. Various field methods of estimating Near-Bank Stress (NBS) risk ratings to calculate erosion rate.

Estimating Near-Bank Stress (NBS)

Stream:	Location:	
Station:	Stream Type:	Valley Type:
Observers:		Date:

Methods for Estimating Near-Bank Stress (NBS)

(1) Channel pattern, transverse bar or split channel/central bar creating NBS	Level I	Reconaissance
(2) Ratio of radius of curvature to bankfull width (R_c / W_{bkf})	Level II	General prediction
(3) Ratio of pool slope to average water surface slope (S_p / S)	Level II	General prediction
(4) Ratio of pool slope to riffle slope (S_p / S_{rif})	Level II	General prediction
(5) Ratio of near-bank maximum depth to bankfull mean depth (d_{nb} / d_{bkf})	Level III	Detailed prediction
(6) Ratio of near-bank shear stress to bankfull shear stress (τ_{nb} / τ_{bkf})	Level III	Detailed prediction
(7) Velocity profiles / Isovels / Velocity gradient	Level IV	Validation

Level I

(1)

Transverse and/or central bars-short and/or discontinuous……..…… ……..NBS = High / Very High
Extensive deposition (continuous, cross-channel)……..…….…… ……...NBS = Extreme
Chute cutoffs, down-valley meander migration, converging flow…… ……NBS = Extreme

Level II

(2)

Radius of Curvature R_c (ft)	Bankfull Width W_{bkf} (ft)	*Ratio* R_c / W_{bkf}	Near-Bank Stress (NBS)

(3)

Pool Slope S_p	Average Slope S	*Ratio* S_p / S	Near-Bank Stress (NBS)

(4)

Pool Slope S_p	Riffle Slope S_{rif}	*Ratio* S_p / S_{rif}	Near-Bank Stress (NBS)

Method	1
Dominant Near-Bank Stress	
High	

Level III

(5)

Near-Bank Max Depth d_{nb} (ft)	Mean Depth d_{bkf} (ft)	*Ratio* d_{nb} / d_{bkf}	Near-Bank Stress (NBS)

(6)

Near-Bank Max Depth d_{nb} (ft)	Near-Bank Slope S_{nb}	Near-Bank Shear Stress τ_{nb} (lb/ft^2)	Mean Depth d_{bkf} (ft)	Average Slope S	Bankfull Shear Stress τ_{bkf} (lb/ft^2)	Ratio τ_{nb} / τ_{bkf}	Near-Bank Stress (NBS)

Level IV

(7)

Velocity Gradient (ft / sec / ft)	Near-Bank Stress (NBS)

Converting Values to a Near-Bank Stress (NBS) Rating

Near-Bank Stress (NBS) ratings	Method number (1)	(2)	(3)	(4)	(5)	(6)	(7)
Very Low	N / A	> 3.00	< 0.20	< 0.40	< 1.00	< 0.80	< 0.50
Low	N / A	2.21 – 3.00	0.20 – 0.40	0.41 – 0.60	1.00 – 1.50	0.80 – 1.05	0.50 – 1.00
Moderate	N / A	2.01 – 2.20	0.41 – 0.60	0.61 – 0.80	1.51 – 1.80	1.06 – 1.14	1.01 – 1.60
High	See	1.81 – 2.00	0.61 – 0.80	0.81 – 1.00	1.81 – 2.50	1.15 – 1.19	1.61 – 2.00
Very High	(1)	1.50 – 1.80	0.81 – 1.00	1.01 – 1.20	2.51 – 3.00	1.20 – 1.60	2.01 – 2.40
Extreme	Above	< 1.50	> 1.00	> 1.20	> 3.00	> 1.60	> 2.40
	Overall Near-Bank Stress (NBS) rating					**High**	

USFWS - SHARP
STREAM NAME - REACH IDENTIFICATION

BANK EROSION HAZARD INDEX

Stream:		**Observer(s):**		**Data:**		**QA/QC:**		**Total Score:**		**16.11**	
Reach:		**Comments:**								**Low**	
Location:	LB2	**Bank Length**	36					**Total Score Values:**	**Very Low**	**Low**	**Moderate**
Date:									5-10	10-20	20-30

High	**Very High**	**Extreme**	
30-40	40-45	45-50	

Erodibility Variables

Bank Height / Bankfull Height Ratio					
Bank Height	Bankfull Height	Value	Index	Bank Erosion Potental	Notes
5.62	4.90	1.15	2.99	Low	
Root Depth / Bank Height Ratio					
Root Depth	Bank Height	Value	Index	Bank Erosion Potental	Notes
5.62	5.62	1.00	1.00	Very Low	
Weighted Root Density					
Root Density (%)	Root Depth / Bank Height	Value	Index	Bank Erosion Potental	Notes
55.00	1.00	55.00	3.90	Low	
Bank Angle					
Bank Angle (°)			Index	Bank Erosion Potental	Notes
60.00			3.90	Low	
Surface Protection					
Surface Protection (%)			Index	Bank Erosion Potental	Notes
50.00			4.32	Moderate	
			Adjustment		Notes
Bank Materials					
			Adjustment		Notes
Bank Stratification					
		TOTAL SCORE	**16.11**		

Bank Erosion Potential

		Very Low	Low	Moderate	High	Very High	Extreme
Erodibility Variables							
Bank Height / Bankfull Height	Value	1.00-1.10	1.11-1.19	1.20-1.50	1.60-2.00	2.10-2.80	>2.80
	Index	1.0-1.9	2.0-3.9	4.0-5.9	6.0-7.9	8.0-9.0	10
Root Depth / Bank Height	Value	1.00-0.90	0.89-0.50	0.49-0.30	0.29-0.15	0.14-0.05	<0.05
	Index	1.0-1.9	2.0-3.9	4.0-5.9	6.0-7.9	8.0-9.0	10
Weighted Root Density	Value	100-80	79-55	54-30	29-15	14-5	<5
	Index	1.0-1.9	2.0-3.9	4.0-5.9	6.0-7.9	8.0-9.0	10
Bank Angle	Value	0-20	21-60	61-80	81-90	91-119	>119
	Index	1.0-1.9	2.0-3.9	4.0-5.9	6.0-7.9	8.0-9.0	10
Surface Protection	Value	100-80	79-55	54-30	29-15	14-10	<10
	Index	1.0-1.9	2.0-3.9	4.0-5.9	6.0-7.9	8.0-9.0	10

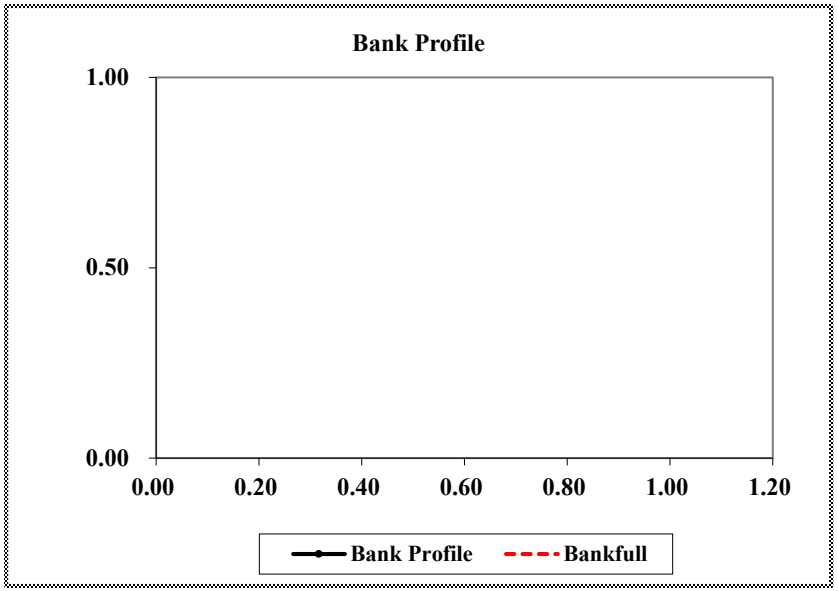
Adjustments

Bank Material	
Bedrock	Bedrock banks have a very low erosion potential.
Boulders	Boulder banks have a low erosion potential.
Cobble	Substract 10 points. No adjustment if sand/gravel compose greater than 50% of bank.
Clay/Silt Loam	Add 5 points.
Gravel	Add 5-10 points depending on percentage of bank material composed of sand.
Sand	Add 10 points.
Silt / Clay	No adjustment.

Stratification

Add 5-10 points depending on position of unstable layers in relation to bankfull stage.

Bank Profile		
Horizontal Distance	**Vertical Height**	**Notes**
Bankfull		
Horizontal Distance	**Vertical Height**	**Notes**



Worksheet 3-12. Various field methods of estimating Near-Bank Stress (NBS) risk ratings to calculate erosion rate.

Estimating Near-Bank Stress (NBS)

Stream: Location:

Station: Stream Type: Valley Type:

Observers: Date:

Methods for Estimating Near-Bank Stress (NBS)

(1) Channel pattern, transverse bar or split channel/central bar creating NBS	Level I	Reconaissance
(2) Ratio of radius of curvature to bankfull width (R_c / W_{bkf})	Level II	General prediction
(3) Ratio of pool slope to average water surface slope (S_p / S)	Level II	General prediction
(4) Ratio of pool slope to riffle slope (S_p / S_{rif})	Level II	General prediction
(5) Ratio of near-bank maximum depth to bankfull mean depth (d_{nb} / d_{bkf})	Level III	Detailed prediction
(6) Ratio of near-bank shear stress to bankfull shear stress (τ_{nb} / τ_{bkf})	Level III	Detailed prediction
(7) Velocity profiles / Isovels / Velocity gradient	Level IV	Validation

Level I

(1)

Transverse and/or central bars-short and/or discontinuous……..…… ……..…NBS = High / Very High

Extensive deposition (continuous, cross-channel)……..…….…… ……...NBS = Extreme

Chute cutoffs, down-valley meander migration, converging flow…… ……..…NBS = Extreme

Level II

(2)

Radius of Curvature R_c (ft)	Bankfull Width W_{bkf} (ft)	*Ratio* R_c / W_{bkf}	Near-Bank Stress (NBS)

(3)

Pool Slope S_p	Average Slope S	*Ratio* S_p / S	Near-Bank Stress (NBS)

(4)

Pool Slope S_p	Riffle Slope S_{rif}	*Ratio* S_p / S_{rif}	Near-Bank Stress (NBS)

Method	1
Dominant Near-Bank Stress	
High	

Level III

(5)

Near-Bank Max Depth d_{nb} (ft)	Mean Depth d_{bkf} (ft)	*Ratio* d_{nb} / d_{bkf}	Near-Bank Stress (NBS)

(6)

Near-Bank Max Depth d_{nb} (ft)	Near-Bank Slope S_{nb}	Near-Bank Shear Stress τ_{nb} (lb/ft^2)	Mean Depth d_{bkf} (ft)	Average Slope S	Bankfull Shear Stress τ_{bkf} (lb/ft^2)	Ratio τ_{nb} / τ_{bkf}	Near-Bank Stress (NBS)

Level IV

(7)

Velocity Gradient (ft / sec / ft)	Near-Bank Stress (NBS)

Converting Values to a Near-Bank Stress (NBS) Rating

Near-Bank Stress (NBS) ratings	Method number (1)	(2)	(3)	(4)	(5)	(6)	(7)
Very Low	N / A	> 3.00	< 0.20	< 0.40	< 1.00	< 0.80	< 0.50
Low	N / A	2.21 – 3.00	0.20 – 0.40	0.41 – 0.60	1.00 – 1.50	0.80 – 1.05	0.50 – 1.00
Moderate	N / A	2.01 – 2.20	0.41 – 0.60	0.61 – 0.80	1.51 – 1.80	1.06 – 1.14	1.01 – 1.60
High	See	1.81 – 2.00	0.61 – 0.80	0.81 – 1.00	1.81 – 2.50	1.15 – 1.19	1.61 – 2.00
Very High	(1)	1.50 – 1.80	0.81 – 1.00	1.01 – 1.20	2.51 – 3.00	1.20 – 1.60	2.01 – 2.40
Extreme	Above	< 1.50	> 1.00	> 1.20	> 3.00	> 1.60	> 2.40
		Overall Near-Bank Stress (NBS) rating				**High**	

USFWS - SHARP
STREAM NAME - REACH IDENTIFICATION

BANK EROSION HAZARD INDEX

Stream:		**Observer(s):**		**Data:**		**QA/QC:**		**Total Score:**		**19.38**		
Reach:		**Comments:**								**Low**		
Location:	LB3	**Bank Length**	31					**Total Score Values:**	**Very Low**	**Low**	**Moderate**	**High**	**Very High**	**Extreme**
Date:									5-10	10-20	20-30	30-40	40-45	45-50

Erodibility Variables

Bank Height / Bankfull Height Ratio					
Bank Height	Bankfull Height	Value	Index	Bank Erosion Potental	Notes
5.70	5.08	1.12	2.47	Low	
Root Depth / Bank Height Ratio					
Root Depth	Bank Height	Value	Index	Bank Erosion Potental	Notes
5.70	5.70	1.00	1.00	Very Low	
Weighted Root Density					
Root Density (%)	Root Depth / Bank Height	Value	Index	Bank Erosion Potental	Notes
40.00	1.00	40.00	5.11	Moderate	
Bank Angle					
Bank Angle (°)			Index	Bank Erosion Potental	Notes
78.00			5.70	Moderate	
Surface Protection					
Surface Protection (%)			Index	Bank Erosion Potental	Notes
40.00			5.11	Moderate	
			Adjustment		Notes
Bank Materials					
			Adjustment		Notes
Bank Stratification					
		TOTAL SCORE	**19.38**		

Bank Erosion Potential

		Very Low	Low	Moderate	High	Very High	Extreme
Erodibility Variables							
Bank Height / Bankfull Height	Value	1.00-1.10	1.11-1.19	1.20-1.50	1.60-2.00	2.10-2.80	>2.80
	Index	1.0-1.9	2.0-3.9	4.0-5.9	6.0-7.9	8.0-9.0	10
Root Depth / Bank Height	Value	1.00-0.90	0.89-0.50	0.49-0.30	0.29-0.15	0.14-0.05	<0.05
	Index	1.0-1.9	2.0-3.9	4.0-5.9	6.0-7.9	8.0-9.0	10
Weighted Root Density	Value	100-80	79-55	54-30	29-15	14-5	<5
	Index	1.0-1.9	2.0-3.9	4.0-5.9	6.0-7.9	8.0-9.0	10
Bank Angle	Value	0-20	21-60	61-80	81-90	91-119	>119
	Index	1.0-1.9	2.0-3.9	4.0-5.9	6.0-7.9	8.0-9.0	10
Surface Protection	Value	100-80	79-55	54-30	29-15	14-10	<10
	Index	1.0-1.9	2.0-3.9	4.0-5.9	6.0-7.9	8.0-9.0	10

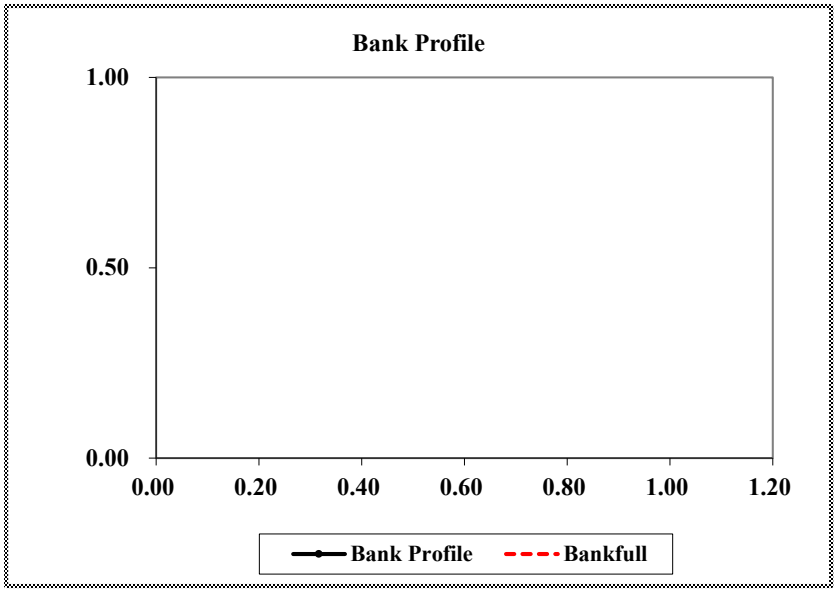
Adjustments

Bank Material	
Bedrock	Bedrock banks have a very low erosion potential.
Boulders	Boulder banks have a low erosion potential.
Cobble	Substract 10 points. No adjustment if sand/gravel compose greater than 50% of bank.
Clay/Silt Loam	Add 5 points.
Gravel	Add 5-10 points depending on percentage of bank material composed of sand.
Sand	Add 10 points.
Silt / Clay	No adjustment.

Stratification

Add 5-10 points depending on position of unstable layers in relation to bankfull stage.

Bank Profile		
Horizontal Distance	**Vertical Height**	**Notes**
Bankfull		
Horizontal Distance	**Vertical Height**	**Notes**



Worksheet 3-12. Various field methods of estimating Near-Bank Stress (NBS) risk ratings to calculate erosion rate.

Estimating Near-Bank Stress (NBS)

Stream:	Location:	
Station:	Stream Type:	Valley Type:
Observers:		Date:

Methods for Estimating Near-Bank Stress (NBS)

(1) Channel pattern, transverse bar or split channel/central bar creating NBS	Level I	Reconaissance
(2) Ratio of radius of curvature to bankfull width (R_c / W_{bkf})	Level II	General prediction
(3) Ratio of pool slope to average water surface slope (S_p / S)	Level II	General prediction
(4) Ratio of pool slope to riffle slope (S_p / S_{rif})	Level II	General prediction
(5) Ratio of near-bank maximum depth to bankfull mean depth (d_{nb} / d_{bkf})	Level III	Detailed prediction
(6) Ratio of near-bank shear stress to bankfull shear stress (τ_{nb} / τ_{bkf})	Level III	Detailed prediction
(7) Velocity profiles / Isovels / Velocity gradient	Level IV	Validation

Level I

(1)

Transverse and/or central bars-short and/or discontinuous……..…… ……..…NBS = High / Very High
Extensive deposition (continuous, cross-channel)……..…….…… ……...NBS = Extreme
Chute cutoffs, down-valley meander migration, converging flow…… ……..…NBS = Extreme

Level II

(2)

Radius of Curvature R_c (ft)	Bankfull Width W_{bkf} (ft)	*Ratio* R_c / W_{bkf}	Near-Bank Stress (NBS)

(3)

Pool Slope S_p	Average Slope S	*Ratio* S_p / S	Near-Bank Stress (NBS)

(4)

Pool Slope S_p	Riffle Slope S_{rif}	*Ratio* S_p / S_{rif}	Near-Bank Stress (NBS)

Method	1
Dominant Near-Bank Stress	
Low	

Level III

(5)

Near-Bank Max Depth d_{nb} (ft)	Mean Depth d_{bkf} (ft)	*Ratio* d_{nb} / d_{bkf}	Near-Bank Stress (NBS)

(6)

Near-Bank Max Depth d_{nb} (ft)	Near-Bank Slope S_{nb}	Near-Bank Shear Stress τ_{nb} (lb/ft^2)	Mean Depth d_{bkf} (ft)	Average Slope S	Bankfull Shear Stress τ_{bkf} (lb/ft^2)	Ratio τ_{nb} / τ_{bkf}	Near-Bank Stress (NBS)

Level IV

(7)

Velocity Gradient (ft / sec / ft)	Near-Bank Stress (NBS)

Converting Values to a Near-Bank Stress (NBS) Rating

Near-Bank Stress (NBS) ratings	Method number (1)	(2)	(3)	(4)	(5)	(6)	(7)
Very Low	N / A	> 3.00	< 0.20	< 0.40	< 1.00	< 0.80	< 0.50
Low	N / A	2.21 – 3.00	0.20 – 0.40	0.41 – 0.60	1.00 – 1.50	0.80 – 1.05	0.50 – 1.00
Moderate	N / A	2.01 – 2.20	0.41 – 0.60	0.61 – 0.80	1.51 – 1.80	1.06 – 1.14	1.01 – 1.60
High	See	1.81 – 2.00	0.61 – 0.80	0.81 – 1.00	1.81 – 2.50	1.15 – 1.19	1.61 – 2.00
Very High	(1)	1.50 – 1.80	0.81 – 1.00	1.01 – 1.20	2.51 – 3.00	1.20 – 1.60	2.01 – 2.40
Extreme	Above	< 1.50	> 1.00	> 1.20	> 3.00	> 1.60	> 2.40
	Overall Near-Bank Stress (NBS) rating					Low	

USFWS - SHARP
STREAM NAME - REACH IDENTIFICATION

BANK EROSION HAZARD INDEX

Stream:		**Observer(s):**		**Data:**		**QA/QC:**		**Total Score:**		**20.52**		
Reach:		**Comments:**								**Moderate**		
Location:	RB1	**Bank Length**	9					**Total Score Values:**	**Very Low**	**Low**	**Moderate**	**High**	**Very High**	**Extreme**
Date:									5-10	10-20	20-30	30-40	40-45	45-50

Erodibility Variables

Bank Height / Bankfull Height Ratio

Bank Height	Bankfull Height	Value	Index	Bank Erosion Potental	Notes
4.80	3.80	1.26	4.40	Moderate	

Root Depth / Bank Height Ratio

Root Depth	Bank Height	Value	Index	Bank Erosion Potental	Notes
4.80	4.80	1.00	1.00	Very Low	

Weighted Root Density

Root Density (%)	Root Depth / Bank Height	Value	Index	Bank Erosion Potental	Notes
40.00	1.00	40.00	5.11	Moderate	

Bank Angle

Bank Angle (°)		Index	Bank Erosion Potental	Notes
70.00		4.90	Moderate	

Surface Protection

Surface Protection (%)		Index	Bank Erosion Potental	Notes
40.00		5.11	Moderate	

	Adjustment		Notes
Bank Materials			
	Adjustment		Notes
Bank Stratification			
TOTAL SCORE	**20.52**		

Bank Erosion Potential

		Very Low	Low	Moderate	High	Very High	Extreme
Erodibility Variables							
Bank Height / Bankfull Height	Value	1.00-1.10	1.11-1.19	1.20-1.50	1.60-2.00	2.10-2.80	>2.80
	Index	1.0-1.9	2.0-3.9	4.0-5.9	6.0-7.9	8.0-9.0	10
Root Depth / Bank Height	Value	1.00-0.90	0.89-0.50	0.49-0.30	0.29-0.15	0.14-0.05	<0.05
	Index	1.0-1.9	2.0-3.9	4.0-5.9	6.0-7.9	8.0-9.0	10
Weighted Root Density	Value	100-80	79-55	54-30	29-15	14-5	<5
	Index	1.0-1.9	2.0-3.9	4.0-5.9	6.0-7.9	8.0-9.0	10
Bank Angle	Value	0-20	21-60	61-80	81-90	91-119	>119
	Index	1.0-1.9	2.0-3.9	4.0-5.9	6.0-7.9	8.0-9.0	10
Surface Protection	Value	100-80	79-55	54-30	29-15	14-10	<10
	Index	1.0-1.9	2.0-3.9	4.0-5.9	6.0-7.9	8.0-9.0	10

Adjustments

Bedrock	Bedrock banks have a very low erosion potential.
Boulders	Boulder banks have a low erosion potential.
Cobble	Substract 10 points. No adjustment if sand/gravel compose greater than 50% of bank.
Clay/Silt Loam	Add 5 points.
Gravel	Add 5-10 points depending on percentage of bank material composed of sand.
Sand	Add 10 points.
Silt / Clay	No adjustment.

Bank Material

Stratification

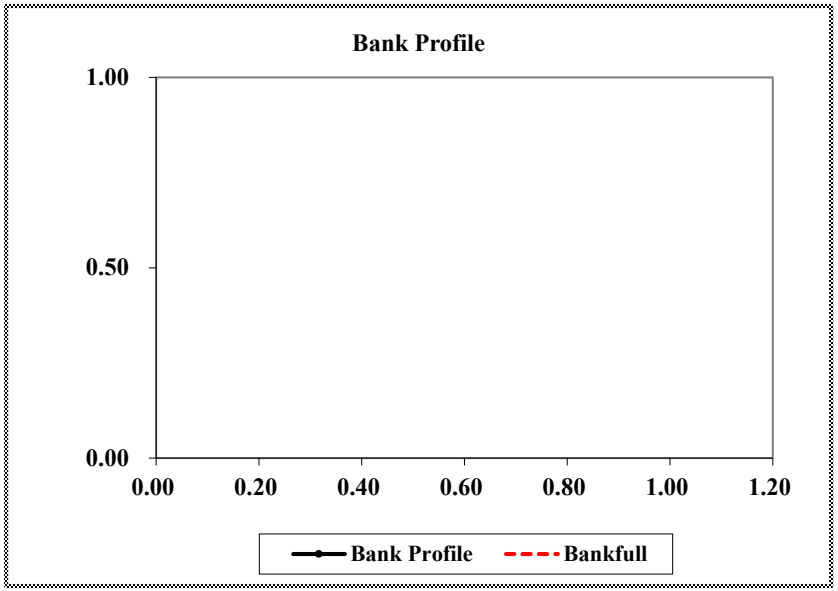
Add 5-10 points depending on position of unstable layers in relation to bankfull stage.

Bank Profile

Horizontal Distance	Vertical Height	Notes

Bankfull

Horizontal Distance	Vertical Height	Notes



Worksheet 3-12. Various field methods of estimating Near-Bank Stress (NBS) risk ratings to calculate erosion rate.

Estimating Near-Bank Stress (NBS)

Stream:	Location:	
Station:	Stream Type:	Valley Type:
Observers:		Date:

Methods for Estimating Near-Bank Stress (NBS)

(1) Channel pattern, transverse bar or split channel/central bar creating NBS	Level I	Reconaissance
(2) Ratio of radius of curvature to bankfull width (R_c / W_{bkf})	Level II	General prediction
(3) Ratio of pool slope to average water surface slope (S_p / S)	Level II	General prediction
(4) Ratio of pool slope to riffle slope (S_p / S_{rif})	Level II	General prediction
(5) Ratio of near-bank maximum depth to bankfull mean depth (d_{nb} / d_{bkf})	Level III	Detailed prediction
(6) Ratio of near-bank shear stress to bankfull shear stress (τ_{nb} / τ_{bkf})	Level III	Detailed prediction
(7) Velocity profiles / Isovels / Velocity gradient	Level IV	Validation

Level I

(1)

Transverse and/or central bars-short and/or discontinuous……..…… ……..…NBS = High / Very High
Extensive deposition (continuous, cross-channel)……..…….…… ……...NBS = Extreme
Chute cutoffs, down-valley meander migration, converging flow…… ……..…NBS = Extreme

Level II

(2)

Radius of Curvature R_c (ft)	Bankfull Width W_{bkf} (ft)	*Ratio* R_c / W_{bkf}	Near-Bank Stress (NBS)

(3)

Pool Slope S_p	Average Slope S	*Ratio* S_p / S	Near-Bank Stress (NBS)

(4)

Pool Slope S_p	Riffle Slope S_{rif}	*Ratio* S_p / S_{rif}	Near-Bank Stress (NBS)

Method	1
Dominant Near-Bank Stress	
Low	

Level III

(5)

Near-Bank Max Depth d_{nb} (ft)	Mean Depth d_{bkf} (ft)	*Ratio* d_{nb} / d_{bkf}	Near-Bank Stress (NBS)

(6)

Near-Bank Max Depth d_{nb} (ft)	Near-Bank Slope S_{nb}	Near-Bank Shear Stress τ_{nb} (lb/ft^2)	Mean Depth d_{bkf} (ft)	Average Slope S	Bankfull Shear Stress τ_{bkf} (lb/ft^2)	Ratio τ_{nb} / τ_{bkf}	Near-Bank Stress (NBS)

Level IV

(7)

Velocity Gradient (ft / sec / ft)	Near-Bank Stress (NBS)

Converting Values to a Near-Bank Stress (NBS) Rating

Near-Bank Stress (NBS) ratings	Method number (1)	(2)	(3)	(4)	(5)	(6)	(7)
Very Low	N / A	> 3.00	< 0.20	< 0.40	< 1.00	< 0.80	< 0.50
Low	N / A	2.21 – 3.00	0.20 – 0.40	0.41 – 0.60	1.00 – 1.50	0.80 – 1.05	0.50 – 1.00
Moderate	N / A	2.01 – 2.20	0.41 – 0.60	0.61 – 0.80	1.51 – 1.80	1.06 – 1.14	1.01 – 1.60
High	See	1.81 – 2.00	0.61 – 0.80	0.81 – 1.00	1.81 – 2.50	1.15 – 1.19	1.61 – 2.00
Very High	(1)	1.50 – 1.80	0.81 – 1.00	1.01 – 1.20	2.51 – 3.00	1.20 – 1.60	2.01 – 2.40
Extreme	Above	< 1.50	> 1.00	> 1.20	> 3.00	> 1.60	> 2.40
	Overall Near-Bank Stress (NBS) rating					Low	

USFWS - SHARP
STREAM NAME - REACH IDENTIFICATION

BANK EROSION HAZARD INDEX

Stream:		**Observer(s):**		**Data:**		**QA/QC:**		**Total Score:**		**17.43**	
Reach:		**Comments:**								**Low**	
Location:	RB2	**Bank Length**	51					**Total Score Values:**	**Very Low**	**Low**	**Moderate**	**High**	**Very High**	**Extreme**
Date:									5-10	10-20	20-30	30-40	40-45	45-50

Erodibility Variables

Bank Height / Bankfull Height Ratio

Bank Height	Bankfull Height	Value	Index	Bank Erosion Potental	Notes
8.30	4.00	2.08	8.26	Very High	

Root Depth / Bank Height Ratio

Root Depth	Bank Height	Value	Index	Bank Erosion Potental	Notes
8.30	8.30	1.00	1.00	Very Low	

Weighted Root Density

Root Density (%)	Root Depth / Bank Height	Value	Index	Bank Erosion Potental	Notes
80.00	1.00	80.00	1.90	Very Low	

Bank Angle

Bank Angle (°)		Index	Bank Erosion Potental	Notes
53.00		3.56	Low	

Surface Protection

Surface Protection (%)		Index	Bank Erosion Potental	Notes
70.00		2.71	Low	

	Adjustment		Notes
Bank Materials			
	Adjustment		Notes
Bank Stratification			
TOTAL SCORE	**17.43**		

Bank Erosion Potential

		Very Low	Low	Moderate	High	Very High	Extreme
Erodibility Variables							
Bank Height / Bankfull Height	Value	1.00-1.10	1.11-1.19	1.20-1.50	1.60-2.00	2.10-2.80	>2.80
	Index	1.0-1.9	2.0-3.9	4.0-5.9	6.0-7.9	8.0-9.0	10
Root Depth / Bank Height	Value	1.00-0.90	0.89-0.50	0.49-0.30	0.29-0.15	0.14-0.05	<0.05
	Index	1.0-1.9	2.0-3.9	4.0-5.9	6.0-7.9	8.0-9.0	10
Weighted Root Density	Value	100-80	79-55	54-30	29-15	14-5	<5
	Index	1.0-1.9	2.0-3.9	4.0-5.9	6.0-7.9	8.0-9.0	10
Bank Angle	Value	0-20	21-60	61-80	81-90	91-119	>119
	Index	1.0-1.9	2.0-3.9	4.0-5.9	6.0-7.9	8.0-9.0	10
Surface Protection	Value	100-80	79-55	54-30	29-15	14-10	<10
	Index	1.0-1.9	2.0-3.9	4.0-5.9	6.0-7.9	8.0-9.0	10

Adjustments

Bedrock	Bedrock banks have a very low erosion potential.
Boulders	Boulder banks have a low erosion potential.
Cobble	Substract 10 points. No adjustment if sand/gravel compose greater than 50% of bank.
Clay/Silt Loam	Add 5 points.
Gravel	Add 5-10 points depending on percentage of bank material composed of sand.
Sand	Add 10 points.
Silt / Clay	No adjustment.

Bank Material

Stratification

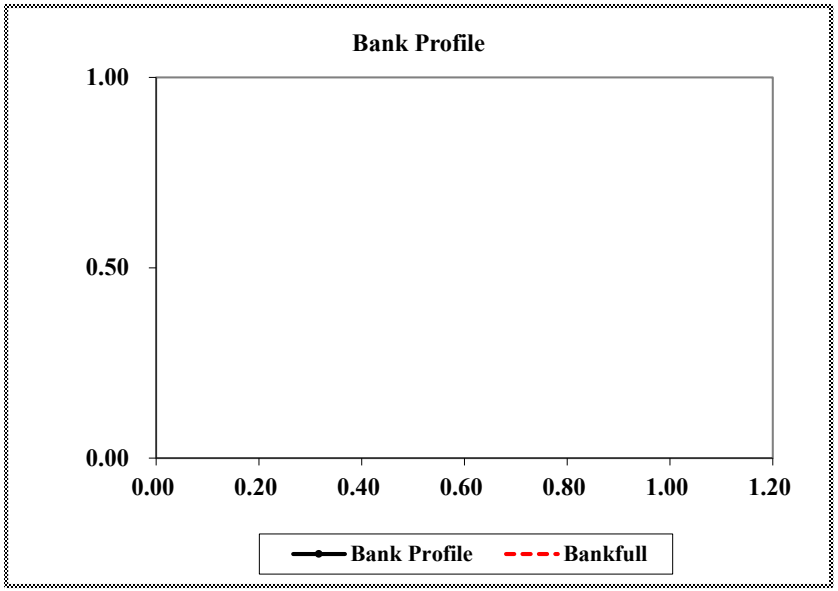
Add 5-10 points depending on position of unstable layers in relation to bankfull stage.

Bank Profile

Horizontal Distance	Vertical Height	Notes

Bankfull

Horizontal Distance	Vertical Height	Notes



Worksheet 3-12. Various field methods of estimating Near-Bank Stress (NBS) risk ratings to calculate erosion rate.

Estimating Near-Bank Stress (NBS)

Stream: Location:

Station: Stream Type: Valley Type:

Observers: Date:

Methods for Estimating Near-Bank Stress (NBS)

(1) Channel pattern, transverse bar or split channel/central bar creating NBS	Level I	Reconaissance
(2) Ratio of radius of curvature to bankfull width (R_c / W_{bkf})	Level II	General prediction
(3) Ratio of pool slope to average water surface slope (S_p / S)	Level II	General prediction
(4) Ratio of pool slope to riffle slope (S_p / S_{rif})	Level II	General prediction
(5) Ratio of near-bank maximum depth to bankfull mean depth (d_{nb} / d_{bkf})	Level III	Detailed prediction
(6) Ratio of near-bank shear stress to bankfull shear stress (τ_{nb} / τ_{bkf})	Level III	Detailed prediction
(7) Velocity profiles / Isovels / Velocity gradient	Level IV	Validation

Level I

(1)

Transverse and/or central bars-short and/or discontinuous……..…… ……..…NBS = High / Very High

Extensive deposition (continuous, cross-channel)……..…….…… ……...NBS = Extreme

Chute cutoffs, down-valley meander migration, converging flow…… ……..…NBS = Extreme

Level II

(2)

Radius of Curvature R_c (ft)	Bankfull Width W_{bkf} (ft)	*Ratio* R_c / W_{bkf}	Near-Bank Stress (NBS)

(3)

Pool Slope S_p	Average Slope S	*Ratio* S_p / S	Near-Bank Stress (NBS)

(4)

Pool Slope S_p	Riffle Slope S_{rif}	*Ratio* S_p / S_{rif}	Near-Bank Stress (NBS)

Method	1
Dominant Near-Bank Stress	
High	

Level III

(5)

Near-Bank Max Depth d_{nb} (ft)	Mean Depth d_{bkf} (ft)	*Ratio* d_{nb} / d_{bkf}	Near-Bank Stress (NBS)

(6)

Near-Bank Max Depth d_{nb} (ft)	Near-Bank Slope S_{nb}	Near-Bank Shear Stress τ_{nb} (lb/ft^2)	Mean Depth d_{bkf} (ft)	Average Slope S	Bankfull Shear Stress τ_{bkf} (lb/ft^2)	Ratio τ_{nb} / τ_{bkf}	Near-Bank Stress (NBS)

Level IV

(7)

Velocity Gradient (ft / sec / ft)	Near-Bank Stress (NBS)

Converting Values to a Near-Bank Stress (NBS) Rating

Near-Bank Stress (NBS) ratings	Method number (1)	(2)	(3)	(4)	(5)	(6)	(7)
Very Low	N / A	> 3.00	< 0.20	< 0.40	< 1.00	< 0.80	< 0.50
Low	N / A	2.21 – 3.00	0.20 – 0.40	0.41 – 0.60	1.00 – 1.50	0.80 – 1.05	0.50 – 1.00
Moderate	N / A	2.01 – 2.20	0.41 – 0.60	0.61 – 0.80	1.51 – 1.80	1.06 – 1.14	1.01 – 1.60
High	See	1.81 – 2.00	0.61 – 0.80	0.81 – 1.00	1.81 – 2.50	1.15 – 1.19	1.61 – 2.00
Very High	(1)	1.50 – 1.80	0.81 – 1.00	1.01 – 1.20	2.51 – 3.00	1.20 – 1.60	2.01 – 2.40
Extreme	Above	< 1.50	> 1.00	> 1.20	> 3.00	> 1.60	> 2.40
		Overall Near-Bank Stress (NBS) rating				**High**	

USFWS - SHARP
STREAM NAME - REACH IDENTIFICATION

BANK EROSION HAZARD INDEX

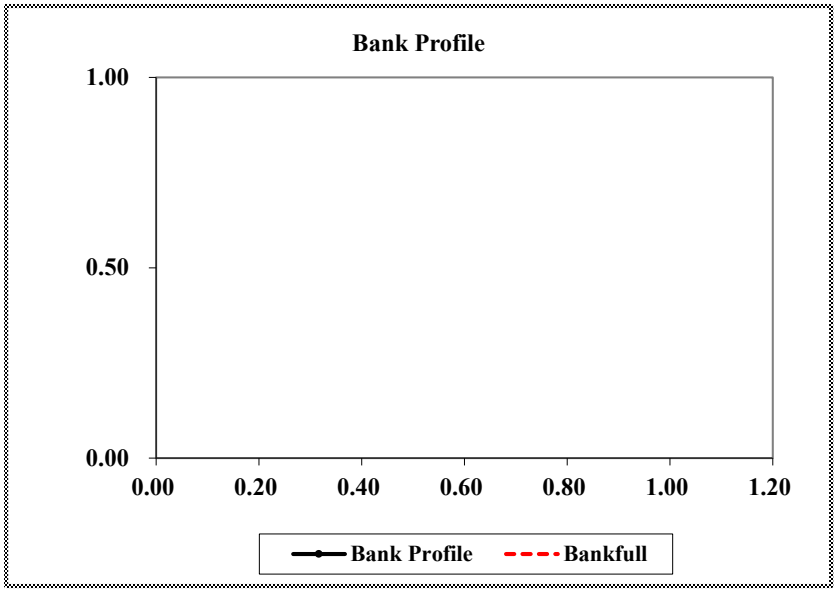
Stream:		**Observer(s):**		**Data:**		**QA/QC:**		**Total Score:**		**26.84**	
Reach:		**Comments:**								**Moderate**	
Location:	RB3	**Bank Length**	25					**Total Score Values:**	**Very Low**	**Low**	**Moderate**	**High**	**Very High**	**Extreme**
Date:									5-10	10-20	20-30	30-40	40-45	45-50

Erodibility Variables					
Bank Height / Bankfull Height Ratio					
Bank Height	Bankfull Height	Value	Index	Bank Erosion Potental	Notes
8.20	4.00	2.05	8.14	Very High	
Root Depth / Bank Height Ratio					
Root Depth	Bank Height	Value	Index	Bank Erosion Potental	Notes
8.20	8.20	1.00	1.00	Very Low	
Weighted Root Density					
Root Density (%)	Root Depth / Bank Height	Value	Index	Bank Erosion Potental	Notes
25.00	1.00	25.00	6.54	High	
Bank Angle					
Bank Angle (°)			Index	Bank Erosion Potental	Notes
85.00			6.84	High	
Surface Protection					
Surface Protection (%)			Index	Bank Erosion Potental	Notes
50.00			4.32	Moderate	
			Adjustment		Notes
Bank Materials					
			Adjustment		Notes
Bank Stratification					
		TOTAL SCORE	**26.84**		

Bank Erosion Potential							
		Very Low	Low	Moderate	High	Very High	Extreme
Erodibility Variables							
Bank Height / Bankfull Height	Value	1.00-1.10	1.11-1.19	1.20-1.50	1.60-2.00	2.10-2.80	>2.80
	Index	1.0-1.9	2.0-3.9	4.0-5.9	6.0-7.9	8.0-9.0	10
Root Depth / Bank Height	Value	1.00-0.90	0.89-0.50	0.49-0.30	0.29-0.15	0.14-0.05	<0.05
	Index	1.0-1.9	2.0-3.9	4.0-5.9	6.0-7.9	8.0-9.0	10
Weighted Root Density	Value	100-80	79-55	54-30	29-15	14-5	<5
	Index	1.0-1.9	2.0-3.9	4.0-5.9	6.0-7.9	8.0-9.0	10
Bank Angle	Value	0-20	21-60	61-80	81-90	91-119	>119
	Index	1.0-1.9	2.0-3.9	4.0-5.9	6.0-7.9	8.0-9.0	10
Surface Protection	Value	100-80	79-55	54-30	29-15	14-10	<10
	Index	1.0-1.9	2.0-3.9	4.0-5.9	6.0-7.9	8.0-9.0	10

Adjustments	
Bank Material	
Bedrock	Bedrock banks have a very low erosion potential.
Boulders	Boulder banks have a low erosion potential.
Cobble	Substract 10 points. No adjustment if sand/gravel compose greater than 50% of bank.
Clay/Silt Loam	Add 5 points.
Gravel	Add 5-10 points depending on percentage of bank material composed of sand.
Sand	Add 10 points.
Silt / Clay	No adjustment.
Stratification	
Add 5-10 points depending on position of unstable layers in relation to bankfull stage.	

Bank Profile		
Horizontal Distance	**Vertical Height**	**Notes**
Bankfull		
Horizontal Distance	**Vertical Height**	**Notes**



Worksheet 3-12. Various field methods of estimating Near-Bank Stress (NBS) risk ratings to calculate erosion rate.

Estimating Near-Bank Stress (NBS)

Stream: Location:

Station: Stream Type: Valley Type:

Observers: Date:

Methods for Estimating Near-Bank Stress (NBS)

(1) Channel pattern, transverse bar or split channel/central bar creating NBS	Level I	Reconaissance
(2) Ratio of radius of curvature to bankfull width (R_c / W_{bkf})	Level II	General prediction
(3) Ratio of pool slope to average water surface slope (S_p / S)	Level II	General prediction
(4) Ratio of pool slope to riffle slope (S_p / S_{rif})	Level II	General prediction
(5) Ratio of near-bank maximum depth to bankfull mean depth (d_{nb} / d_{bkf})	Level III	Detailed prediction
(6) Ratio of near-bank shear stress to bankfull shear stress (τ_{nb} / τ_{bkf})	Level III	Detailed prediction
(7) Velocity profiles / Isovels / Velocity gradient	Level IV	Validation

Level I

(1)

Transverse and/or central bars-short and/or discontinuous……..…… ……..…NBS = High / Very High

Extensive deposition (continuous, cross-channel)……..…….…… ……...NBS = Extreme

Chute cutoffs, down-valley meander migration, converging flow…… ……..…NBS = Extreme

Level II

(2)

Radius of Curvature R_c (ft)	Bankfull Width W_{bkf} (ft)	*Ratio* R_c / W_{bkf}	Near-Bank Stress (NBS)

(3)

Pool Slope S_p	Average Slope S	*Ratio* S_p / S	Near-Bank Stress (NBS)

(4)

Pool Slope S_p	Riffle Slope S_{rif}	*Ratio* S_p / S_{rif}	Near-Bank Stress (NBS)

Method	1
Dominant Near-Bank Stress	
High	

Level III

(5)

Near-Bank Max Depth d_{nb} (ft)	Mean Depth d_{bkf} (ft)	*Ratio* d_{nb} / d_{bkf}	Near-Bank Stress (NBS)

(6)

Near-Bank Max Depth d_{nb} (ft)	Near-Bank Slope S_{nb}	Near-Bank Shear Stress τ_{nb} (lb/ft^2)	Mean Depth d_{bkf} (ft)	Average Slope S	Bankfull Shear Stress τ_{bkf} (lb/ft^2)	Ratio τ_{nb} / τ_{bkf}	Near-Bank Stress (NBS)

Level IV

(7)

Velocity Gradient (ft / sec / ft)	Near-Bank Stress (NBS)

Converting Values to a Near-Bank Stress (NBS) Rating

Near-Bank Stress (NBS) ratings	Method number (1)	(2)	(3)	(4)	(5)	(6)	(7)
Very Low	N / A	> 3.00	< 0.20	< 0.40	< 1.00	< 0.80	< 0.50
Low	N / A	2.21 – 3.00	0.20 – 0.40	0.41 – 0.60	1.00 – 1.50	0.80 – 1.05	0.50 – 1.00
Moderate	N / A	2.01 – 2.20	0.41 – 0.60	0.61 – 0.80	1.51 – 1.80	1.06 – 1.14	1.01 – 1.60
High	See	1.81 – 2.00	0.61 – 0.80	0.81 – 1.00	1.81 – 2.50	1.15 – 1.19	1.61 – 2.00
Very High	(1)	1.50 – 1.80	0.81 – 1.00	1.01 – 1.20	2.51 – 3.00	1.20 – 1.60	2.01 – 2.40
Extreme	Above	< 1.50	> 1.00	> 1.20	> 3.00	> 1.60	> 2.40
		Overall Near-Bank Stress (NBS) rating				**High**	

USFWS - SHARP
STREAM NAME - REACH IDENTIFICATION

BANK EROSION HAZARD INDEX

Stream:		**Observer(s):**		**Data:**		**QA/QC:**		**Total Score:**		**26.85**		
Reach:		**Comments:**								**Moderate**		
Location:	RB4	**Bank Length**	45					**Total Score Values:**	**Very Low**	**Low**	**Moderate**	**High**	**Very High**	**Extreme**
Date:									5-10	10-20	20-30	30-40	40-45	45-50

Erodibility Variables					
Bank Height / Bankfull Height Ratio					
Bank Height	Bankfull Height	Value	Index	Bank Erosion Potental	Notes
4.64	3.80	1.22	4.13	Moderate	
Root Depth / Bank Height Ratio					
Root Depth	Bank Height	Value	Index	Bank Erosion Potental	Notes
2.90	4.64	0.63	3.29	Low	
Weighted Root Density					
Root Density (%)	Root Depth / Bank Height	Value	Index	Bank Erosion Potental	Notes
29.00	0.63	18.13	7.48	High	
Bank Angle					
Bank Angle (°)			Index	Bank Erosion Potental	Notes
85.00			6.84	High	
Surface Protection					
Surface Protection (%)			Index	Bank Erosion Potental	Notes
40.00			5.11	Moderate	
			Adjustment		Notes
Bank Materials					
			Adjustment		Notes
Bank Stratification					
		TOTAL SCORE	**26.85**		

Bank Erosion Potential

		Very Low	Low	Moderate	High	Very High	Extreme
Erodibility Variables							
Bank Height / Bankfull Height	Value	1.00-1.10	1.11-1.19	1.20-1.50	1.60-2.00	2.10-2.80	>2.80
	Index	1.0-1.9	2.0-3.9	4.0-5.9	6.0-7.9	8.0-9.0	10
Root Depth / Bank Height	Value	1.00-0.90	0.89-0.50	0.49-0.30	0.29-0.15	0.14-0.05	<0.05
	Index	1.0-1.9	2.0-3.9	4.0-5.9	6.0-7.9	8.0-9.0	10
Weighted Root Density	Value	100-80	79-55	54-30	29-15	14-5	<5
	Index	1.0-1.9	2.0-3.9	4.0-5.9	6.0-7.9	8.0-9.0	10
Bank Angle	Value	0-20	21-60	61-80	81-90	91-119	>119
	Index	1.0-1.9	2.0-3.9	4.0-5.9	6.0-7.9	8.0-9.0	10
Surface Protection	Value	100-80	79-55	54-30	29-15	14-10	<10
	Index	1.0-1.9	2.0-3.9	4.0-5.9	6.0-7.9	8.0-9.0	10

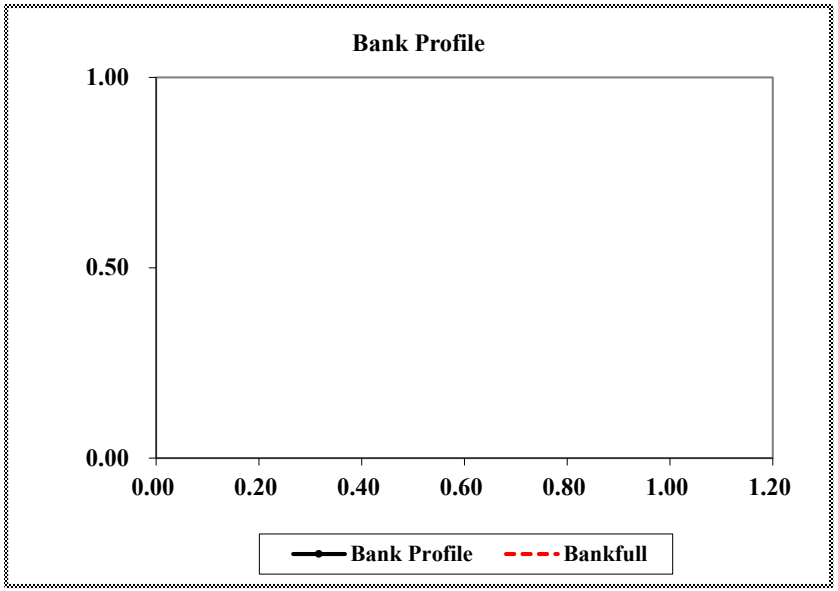
Adjustments

Bank Material	
Bedrock	Bedrock banks have a very low erosion potential.
Boulders	Boulder banks have a low erosion potential.
Cobble	Substract 10 points. No adjustment if sand/gravel compose greater than 50% of bank.
Clay/Silt Loam	Add 5 points.
Gravel	Add 5-10 points depending on percentage of bank material composed of sand.
Sand	Add 10 points.
Silt / Clay	No adjustment.

Stratification

Add 5-10 points depending on position of unstable layers in relation to bankfull stage.

Bank Profile		
Horizontal Distance	**Vertical Height**	**Notes**
Bankfull		
Horizontal Distance	**Vertical Height**	**Notes**



Worksheet 3-12. Various field methods of estimating Near-Bank Stress (NBS) risk ratings to calculate erosion rate.

Estimating Near-Bank Stress (NBS)

Stream:	Location:	
Station:	Stream Type:	Valley Type:
Observers:		Date:

Methods for Estimating Near-Bank Stress (NBS)

(1) Channel pattern, transverse bar or split channel/central bar creating NBS	Level I	Reconaissance
(2) Ratio of radius of curvature to bankfull width (R_c / W_{bkf})	Level II	General prediction
(3) Ratio of pool slope to average water surface slope (S_p / S)	Level II	General prediction
(4) Ratio of pool slope to riffle slope (S_p / S_{rif})	Level II	General prediction
(5) Ratio of near-bank maximum depth to bankfull mean depth (d_{nb} / d_{bkf})	Level III	Detailed prediction
(6) Ratio of near-bank shear stress to bankfull shear stress (τ_{nb} / τ_{bkf})	Level III	Detailed prediction
(7) Velocity profiles / Isovels / Velocity gradient	Level IV	Validation

Level I

(1)

Transverse and/or central bars-short and/or discontinuous……..…… ……..…NBS = High / Very High
Extensive deposition (continuous, cross-channel)……..…….…… ……...NBS = Extreme
Chute cutoffs, down-valley meander migration, converging flow…… ……..…NBS = Extreme

Level II

(2)

Radius of Curvature R_c (ft)	Bankfull Width W_{bkf} (ft)	*Ratio* R_c / W_{bkf}	Near-Bank Stress (NBS)

(3)

Pool Slope S_p	Average Slope S	*Ratio* S_p / S	Near-Bank Stress (NBS)

(4)

Pool Slope S_p	Riffle Slope S_{rif}	*Ratio* S_p / S_{rif}	Near-Bank Stress (NBS)

Method	1
Dominant Near-Bank Stress	
Low	

Level III

(5)

Near-Bank Max Depth d_{nb} (ft)	Mean Depth d_{bkf} (ft)	*Ratio* d_{nb} / d_{bkf}	Near-Bank Stress (NBS)

(6)

Near-Bank Max Depth d_{nb} (ft)	Near-Bank Slope S_{nb}	Near-Bank Shear Stress τ_{nb} (lb/ft^2)	Mean Depth d_{bkf} (ft)	Average Slope S	Bankfull Shear Stress τ_{bkf} (lb/ft^2)	Ratio τ_{nb} / τ_{bkf}	Near-Bank Stress (NBS)

Level IV

(7)

Velocity Gradient (ft / sec / ft)	Near-Bank Stress (NBS)

Converting Values to a Near-Bank Stress (NBS) Rating

Near-Bank Stress (NBS) ratings	Method number (1)	(2)	(3)	(4)	(5)	(6)	(7)
Very Low	N / A	> 3.00	< 0.20	< 0.40	< 1.00	< 0.80	< 0.50
Low	N / A	2.21 – 3.00	0.20 – 0.40	0.41 – 0.60	1.00 – 1.50	0.80 – 1.05	0.50 – 1.00
Moderate	N / A	2.01 – 2.20	0.41 – 0.60	0.61 – 0.80	1.51 – 1.80	1.06 – 1.14	1.01 – 1.60
High	See	1.81 – 2.00	0.61 – 0.80	0.81 – 1.00	1.81 – 2.50	1.15 – 1.19	1.61 – 2.00
Very High	(1)	1.50 – 1.80	0.81 – 1.00	1.01 – 1.20	2.51 – 3.00	1.20 – 1.60	2.01 – 2.40
Extreme	Above	< 1.50	> 1.00	> 1.20	> 3.00	> 1.60	> 2.40
	Overall Near-Bank Stress (NBS) rating					Low	

USFWS - SHARP
STREAM NAME - REACH IDENTIFICATION

BANK EROSION HAZARD INDEX

Stream:		**Observer(s):**		**Data:**		**QA/QC:**		**Total Score:**		**25.60**		
Reach:		**Comments:**								**Moderate**		
Location:	RB5	**Bank Length**	16					**Total Score Values:**	**Very Low**	**Low**	**Moderate**	**High**	**Very High**	**Extreme**
Date:									5-10	10-20	20-30	30-40	40-45	45-50

Erodibility Variables					
Bank Height / Bankfull Height Ratio					
Bank Height	Bankfull Height	Value	Index	Bank Erosion Potental	Notes
4.50	3.80	1.18	3.78	Low	
Root Depth / Bank Height Ratio					
Root Depth	Bank Height	Value	Index	Bank Erosion Potental	Notes
3.70	4.50	0.82	2.33	Low	
Weighted Root Density					
Root Density (%)	Root Depth / Bank Height	Value	Index	Bank Erosion Potental	Notes
60.00	0.82	49.33	4.37	Moderate	
Bank Angle					
Bank Angle (°)			Index	Bank Erosion Potental	Notes
90.00			7.90	High	
Surface Protection					
Surface Protection (%)			Index	Bank Erosion Potental	Notes
20.00			7.22	High	
			Adjustment		Notes
Bank Materials					
			Adjustment		Notes
Bank Stratification					
		TOTAL SCORE	**25.60**		

Bank Erosion Potential

		Very Low	Low	Moderate	High	Very High	Extreme
Erodibility Variables							
Bank Height / Bankfull Height	Value	1.00-1.10	1.11-1.19	1.20-1.50	1.60-2.00	2.10-2.80	>2.80
	Index	1.0-1.9	2.0-3.9	4.0-5.9	6.0-7.9	8.0-9.0	10
Root Depth / Bank Height	Value	1.00-0.90	0.89-0.50	0.49-0.30	0.29-0.15	0.14-0.05	<0.05
	Index	1.0-1.9	2.0-3.9	4.0-5.9	6.0-7.9	8.0-9.0	10
Weighted Root Density	Value	100-80	79-55	54-30	29-15	14-5	<5
	Index	1.0-1.9	2.0-3.9	4.0-5.9	6.0-7.9	8.0-9.0	10
Bank Angle	Value	0-20	21-60	61-80	81-90	91-119	>119
	Index	1.0-1.9	2.0-3.9	4.0-5.9	6.0-7.9	8.0-9.0	10
Surface Protection	Value	100-80	79-55	54-30	29-15	14-10	<10
	Index	1.0-1.9	2.0-3.9	4.0-5.9	6.0-7.9	8.0-9.0	10

Adjustments

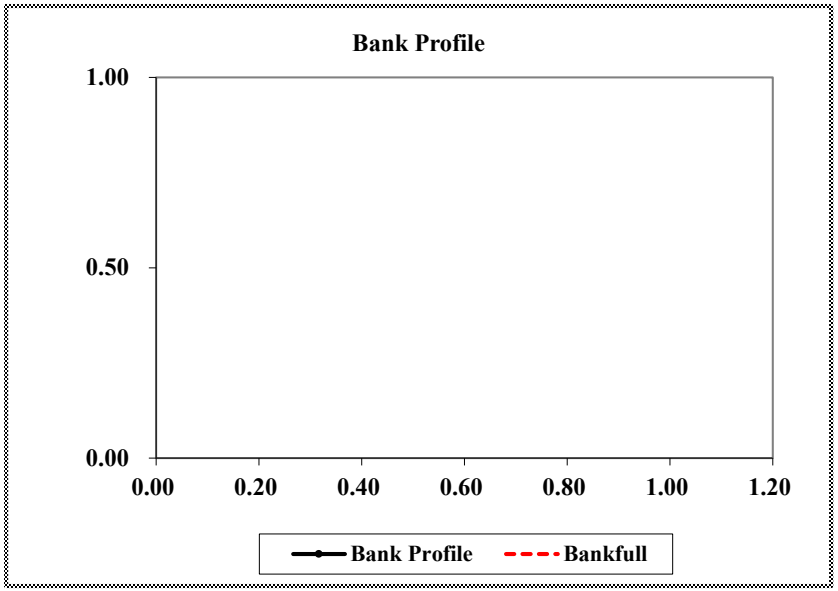
Bedrock	Bedrock banks have a very low erosion potential.
Boulders	Boulder banks have a low erosion potential.
Cobble	Substract 10 points. No adjustment if sand/gravel compose greater than 50% of bank.
Clay/Silt Loam	Add 5 points.
Gravel	Add 5-10 points depending on percentage of bank material composed of sand.
Sand	Add 10 points.
Silt / Clay	No adjustment.

Bank Material

Stratification

Add 5-10 points depending on position of unstable layers in relation to bankfull stage.

Bank Profile		
Horizontal Distance	**Vertical Height**	**Notes**
Bankfull		
Horizontal Distance	**Vertical Height**	**Notes**



Worksheet 3-12. Various field methods of estimating Near-Bank Stress (NBS) risk ratings to calculate erosion rate.

Estimating Near-Bank Stress (NBS)

Stream:	Location:	
Station:	Stream Type:	Valley Type:
Observers:		Date:

Methods for Estimating Near-Bank Stress (NBS)

(1) Channel pattern, transverse bar or split channel/central bar creating NBS	Level I	Reconaissance
(2) Ratio of radius of curvature to bankfull width (R_c / W_{bkf})	Level II	General prediction
(3) Ratio of pool slope to average water surface slope (S_p / S)	Level II	General prediction
(4) Ratio of pool slope to riffle slope (S_p / S_{rif})	Level II	General prediction
(5) Ratio of near-bank maximum depth to bankfull mean depth (d_{nb} / d_{bkf})	Level III	Detailed prediction
(6) Ratio of near-bank shear stress to bankfull shear stress (τ_{nb} / τ_{bkf})	Level III	Detailed prediction
(7) Velocity profiles / Isovels / Velocity gradient	Level IV	Validation

Level I

(1)

Transverse and/or central bars-short and/or discontinuous……..…… ……..…NBS = High / Very High
Extensive deposition (continuous, cross-channel)……..…….…… ……...NBS = Extreme
Chute cutoffs, down-valley meander migration, converging flow…… ……..…NBS = Extreme

Level II

(2)

Radius of Curvature R_c (ft)	Bankfull Width W_{bkf} (ft)	*Ratio* R_c / W_{bkf}	Near-Bank Stress (NBS)

(3)

Pool Slope S_p	Average Slope S	*Ratio* S_p / S	Near-Bank Stress (NBS)

(4)

Pool Slope S_p	Riffle Slope S_{rif}	*Ratio* S_p / S_{rif}	Near-Bank Stress (NBS)

Method	1
Dominant Near-Bank Stress	
Low	

Level III

(5)

Near-Bank Max Depth d_{nb} (ft)	Mean Depth d_{bkf} (ft)	*Ratio* d_{nb} / d_{bkf}	Near-Bank Stress (NBS)

(6)

Near-Bank Max Depth d_{nb} (ft)	Near-Bank Slope S_{nb}	Near-Bank Shear Stress τ_{nb} (lb/ft^2)	Mean Depth d_{bkf} (ft)	Average Slope S	Bankfull Shear Stress τ_{bkf} (lb/ft^2)	Ratio τ_{nb} / τ_{bkf}	Near-Bank Stress (NBS)

Level IV

(7)

Velocity Gradient (ft / sec / ft)	Near-Bank Stress (NBS)

Converting Values to a Near-Bank Stress (NBS) Rating

Near-Bank Stress (NBS) ratings	Method number (1)	(2)	(3)	(4)	(5)	(6)	(7)
Very Low	N / A	> 3.00	< 0.20	< 0.40	< 1.00	< 0.80	< 0.50
Low	N / A	2.21 – 3.00	0.20 – 0.40	0.41 – 0.60	1.00 – 1.50	0.80 – 1.05	0.50 – 1.00
Moderate	N / A	2.01 – 2.20	0.41 – 0.60	0.61 – 0.80	1.51 – 1.80	1.06 – 1.14	1.01 – 1.60
High	See	1.81 – 2.00	0.61 – 0.80	0.81 – 1.00	1.81 – 2.50	1.15 – 1.19	1.61 – 2.00
Very High	(1)	1.50 – 1.80	0.81 – 1.00	1.01 – 1.20	2.51 – 3.00	1.20 – 1.60	2.01 – 2.40
Extreme	Above	< 1.50	> 1.00	> 1.20	> 3.00	> 1.60	> 2.40
	Overall Near-Bank Stress (NBS) rating					Low	

USFWS - SHARP
STREAM NAME - REACH IDENTIFICATION

BANK EROSION HAZARD INDEX

Stream:		**Observer(s):**		**Data:**		**QA/QC:**		**Total Score:**				
Reach:		**Comments:**										
Location:		**Bank Length**						**Total Score Values:**	**Very Low**	**Low**	**Moderate**	**High**	**Very High**	**Extreme**
Date:									5-10	10-20	20-30	30-40	40-45	45-50

Erodibility Variables					
Bank Height / Bankfull Height Ratio					
Bank Height	Bankfull Height	Value	Index	Bank Erosion Potental	Notes
Root Depth / Bank Height Ratio					
Root Depth	Bank Height	Value	Index	Bank Erosion Potental	Notes
Weighted Root Density					
Root Density (%)	Root Depth / Bank Height	Value	Index	Bank Erosion Potental	Notes
Bank Angle					
Bank Angle (°)			Index	Bank Erosion Potental	Notes
Surface Protection					
Surface Protection (%)			Index	Bank Erosion Potental	Notes
			Adjustment		Notes
Bank Materials					
			Adjustment		Notes
Bank Stratification					
		TOTAL SCORE			

Bank Erosion Potential

		Very Low	Low	Moderate	High	Very High	Extreme
Erodibility Variables							
Bank Height / Bankfull Height	Value	1.00-1.10	1.11-1.19	1.20-1.50	1.60-2.00	2.10-2.80	>2.80
	Index	1.0-1.9	2.0-3.9	4.0-5.9	6.0-7.9	8.0-9.0	10
Root Depth / Bank Height	Value	1.00-0.90	0.89-0.50	0.49-0.30	0.29-0.15	0.14-0.05	<0.05
	Index	1.0-1.9	2.0-3.9	4.0-5.9	6.0-7.9	8.0-9.0	10
Weighted Root Density	Value	100-80	79-55	54-30	29-15	14-5	<5
	Index	1.0-1.9	2.0-3.9	4.0-5.9	6.0-7.9	8.0-9.0	10
Bank Angle	Value	0-20	21-60	61-80	81-90	91-119	>119
	Index	1.0-1.9	2.0-3.9	4.0-5.9	6.0-7.9	8.0-9.0	10
Surface Protection	Value	100-80	79-55	54-30	29-15	14-10	<10
	Index	1.0-1.9	2.0-3.9	4.0-5.9	6.0-7.9	8.0-9.0	10

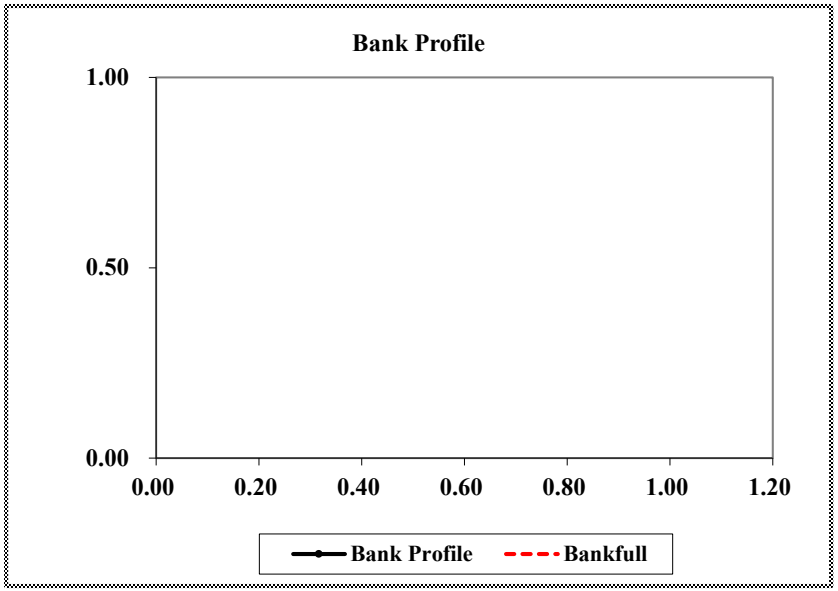
Adjustments

Bank Material	
Bedrock	Bedrock banks have a very low erosion potential.
Boulders	Boulder banks have a low erosion potential.
Cobble	Substract 10 points. No adjustment if sand/gravel compose greater than 50% of bank.
Clay/Silt Loam	Add 5 points.
Gravel	Add 5-10 points depending on percentage of bank material composed of sand.
Sand	Add 10 points.
Silt / Clay	No adjustment.

Stratification

Add 5-10 points depending on position of unstable layers in relation to bankfull stage.

Bank Profile		
Horizontal Distance	**Vertical Height**	**Notes**
Bankfull		
Horizontal Distance	**Vertical Height**	**Notes**



Worksheet 3-12. Various field methods of estimating Near-Bank Stress (NBS) risk ratings to calculate erosion rate.

Estimating Near-Bank Stress (NBS)

Stream: Location:

Station: Stream Type: Valley Type:

Observers: Date:

Methods for Estimating Near-Bank Stress (NBS)

(1) Channel pattern, transverse bar or split channel/central bar creating NBS	Level I	Reconaissance
(2) Ratio of radius of curvature to bankfull width (R_c / W_{bkf})	Level II	General prediction
(3) Ratio of pool slope to average water surface slope (S_p / S)	Level II	General prediction
(4) Ratio of pool slope to riffle slope (S_p / S_{rif})	Level II	General prediction
(5) Ratio of near-bank maximum depth to bankfull mean depth (d_{nb} / d_{bkf})	Level III	Detailed prediction
(6) Ratio of near-bank shear stress to bankfull shear stress (τ_{nb} / τ_{bkf})	Level III	Detailed prediction
(7) Velocity profiles / Isovels / Velocity gradient	Level IV	Validation

Level I

(1)

Transverse and/or central bars-short and/or discontinuous…… ……..…NBS = High / Very High

Extensive deposition (continuous, cross-channel)……..…… ……...NBS = Extreme

Chute cutoffs, down-valley meander migration, converging flow…… ……..…NBS = Extreme

Level II

(2)

Radius of Curvature R_c (ft)	Bankfull Width W_{bkf} (ft)	*Ratio* R_c / W_{bkf}	Near-Bank Stress (NBS)

(3)

Pool Slope S_p	Average Slope S	*Ratio* S_p / S	Near-Bank Stress (NBS)

(4)

Pool Slope S_p	Riffle Slope S_{rif}	*Ratio* S_p / S_{rif}	Near-Bank Stress (NBS)

Method	
Dominant Near-Bank Stress	

Level III

(5)

Near-Bank Max Depth d_{nb} (ft)	Mean Depth d_{bkf} (ft)	*Ratio* d_{nb} / d_{bkf}	Near-Bank Stress (NBS)

(6)

Near-Bank Max Depth d_{nb} (ft)	Near-Bank Slope S_{nb}	Near-Bank Shear Stress τ_{nb} (lb/ft^2)	Mean Depth d_{bkf} (ft)	Average Slope S	Bankfull Shear Stress τ_{bkf} (lb/ft^2)	Ratio τ_{nb} / τ_{bkf}	Near-Bank Stress (NBS)

Level IV

(7)

Velocity Gradient (ft / sec / ft)	Near-Bank Stress (NBS)

Converting Values to a Near-Bank Stress (NBS) Rating

Near-Bank Stress (NBS) ratings	Method number (1)	(2)	(3)	(4)	(5)	(6)	(7)
Very Low	N / A	> 3.00	< 0.20	< 0.40	< 1.00	< 0.80	< 0.50
Low	N / A	2.21 – 3.00	0.20 – 0.40	0.41 – 0.60	1.00 – 1.50	0.80 – 1.05	0.50 – 1.00
Moderate	N / A	2.01 – 2.20	0.41 – 0.60	0.61 – 0.80	1.51 – 1.80	1.06 – 1.14	1.01 – 1.60
High	See	1.81 – 2.00	0.61 – 0.80	0.81 – 1.00	1.81 – 2.50	1.15 – 1.19	1.61 – 2.00
Very High	(1)	1.50 – 1.80	0.81 – 1.00	1.01 – 1.20	2.51 – 3.00	1.20 – 1.60	2.01 – 2.40
Extreme	Above	< 1.50	> 1.00	> 1.20	> 3.00	> 1.60	> 2.40
		Overall Near-Bank Stress (NBS) rating					

USFWS - SHARP
STREAM NAME - REACH IDENTIFICATION

BANK EROSION HAZARD INDEX

Stream:		**Observer(s):**		**Data:**		**QA/QC:**		**Total Score:**				
Reach:		**Comments:**										
Location:		**Bank Length**						**Total Score Values:**	**Very Low**	**Low**	**Moderate**	**High**	**Very High**	**Extreme**
Date:									5-10	10-20	20-30	30-40	40-45	45-50

Erodibility Variables					
Bank Height / Bankfull Height Ratio					
Bank Height	Bankfull Height	Value	Index	Bank Erosion Potental	Notes
Root Depth / Bank Height Ratio					
Root Depth	Bank Height	Value	Index	Bank Erosion Potental	Notes
Weighted Root Density					
Root Density (%)	Root Depth / Bank Height	Value	Index	Bank Erosion Potental	Notes
Bank Angle					
Bank Angle (°)			Index	Bank Erosion Potental	Notes
Surface Protection					
Surface Protection (%)			Index	Bank Erosion Potental	Notes
			Adjustment		Notes
Bank Materials					
			Adjustment		Notes
Bank Stratification					
		TOTAL SCORE			

Bank Erosion Potential

		Very Low	Low	Moderate	High	Very High	Extreme
Erodibility Variables							
Bank Height / Bankfull Height	Value	1.00-1.10	1.11-1.19	1.20-1.50	1.60-2.00	2.10-2.80	>2.80
	Index	1.0-1.9	2.0-3.9	4.0-5.9	6.0-7.9	8.0-9.0	10
Root Depth / Bank Height	Value	1.00-0.90	0.89-0.50	0.49-0.30	0.29-0.15	0.14-0.05	<0.05
	Index	1.0-1.9	2.0-3.9	4.0-5.9	6.0-7.9	8.0-9.0	10
Weighted Root Density	Value	100-80	79-55	54-30	29-15	14-5	<5
	Index	1.0-1.9	2.0-3.9	4.0-5.9	6.0-7.9	8.0-9.0	10
Bank Angle	Value	0-20	21-60	61-80	81-90	91-119	>119
	Index	1.0-1.9	2.0-3.9	4.0-5.9	6.0-7.9	8.0-9.0	10
Surface Protection	Value	100-80	79-55	54-30	29-15	14-10	<10
	Index	1.0-1.9	2.0-3.9	4.0-5.9	6.0-7.9	8.0-9.0	10

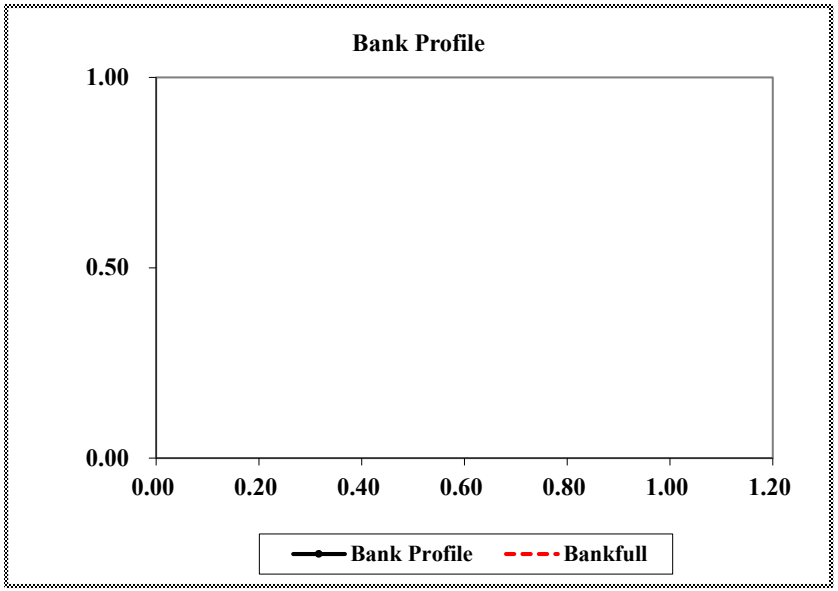
Adjustments

Bank Material	
Bedrock	Bedrock banks have a very low erosion potential.
Boulders	Boulder banks have a low erosion potential.
Cobble	Substract 10 points. No adjustment if sand/gravel compose greater than 50% of bank.
Clay/Silt Loam	Add 5 points.
Gravel	Add 5-10 points depending on percentage of bank material composed of sand.
Sand	Add 10 points.
Silt / Clay	No adjustment.

Stratification

Add 5-10 points depending on position of unstable layers in relation to bankfull stage.

Bank Profile		
Horizontal Distance	**Vertical Height**	**Notes**
Bankfull		
Horizontal Distance	**Vertical Height**	**Notes**



Worksheet 3-12. Various field methods of estimating Near-Bank Stress (NBS) risk ratings to calculate erosion rate.

Estimating Near-Bank Stress (NBS)

Stream: Location:

Station: Stream Type: Valley Type:

Observers: Date:

Methods for Estimating Near-Bank Stress (NBS)

(1) Channel pattern, transverse bar or split channel/central bar creating NBS	Level I	Reconaissance
(2) Ratio of radius of curvature to bankfull width (R_c / W_{bkf})	Level II	General prediction
(3) Ratio of pool slope to average water surface slope (S_p / S)	Level II	General prediction
(4) Ratio of pool slope to riffle slope (S_p / S_{rif})	Level II	General prediction
(5) Ratio of near-bank maximum depth to bankfull mean depth (d_{nb} / d_{bkf})	Level III	Detailed prediction
(6) Ratio of near-bank shear stress to bankfull shear stress (τ_{nb} / τ_{bkf})	Level III	Detailed prediction
(7) Velocity profiles / Isovels / Velocity gradient	Level IV	Validation

Level I

(1)

Transverse and/or central bars-short and/or discontinuous…… ……..…NBS = High / Very High

Extensive deposition (continuous, cross-channel)……..…… ……...NBS = Extreme

Chute cutoffs, down-valley meander migration, converging flow…… ……..…NBS = Extreme

Level II

(2)

Radius of Curvature R_c (ft)	Bankfull Width W_{bkf} (ft)	*Ratio* R_c / W_{bkf}	Near-Bank Stress (NBS)

(3)

Pool Slope S_p	Average Slope S	*Ratio* S_p / S	Near-Bank Stress (NBS)

(4)

Pool Slope S_p	Riffle Slope S_{rif}	*Ratio* S_p / S_{rif}	Near-Bank Stress (NBS)

Method	
Dominant Near-Bank Stress	

Level III

(5)

Near-Bank Max Depth d_{nb} (ft)	Mean Depth d_{bkf} (ft)	*Ratio* d_{nb} / d_{bkf}	Near-Bank Stress (NBS)

(6)

Near-Bank Max Depth d_{nb} (ft)	Near-Bank Slope S_{nb}	Near-Bank Shear Stress τ_{nb} (lb/ft^2)	Mean Depth d_{bkf} (ft)	Average Slope S	Bankfull Shear Stress τ_{bkf} (lb/ft^2)	Ratio τ_{nb} / τ_{bkf}	Near-Bank Stress (NBS)

Level IV

(7)

Velocity Gradient (ft / sec / ft)	Near-Bank Stress (NBS)

Converting Values to a Near-Bank Stress (NBS) Rating

Near-Bank Stress (NBS) ratings	Method number (1)	(2)	(3)	(4)	(5)	(6)	(7)
Very Low	N / A	> 3.00	< 0.20	< 0.40	< 1.00	< 0.80	< 0.50
Low	N / A	2.21 – 3.00	0.20 – 0.40	0.41 – 0.60	1.00 – 1.50	0.80 – 1.05	0.50 – 1.00
Moderate	N / A	2.01 – 2.20	0.41 – 0.60	0.61 – 0.80	1.51 – 1.80	1.06 – 1.14	1.01 – 1.60
High	See	1.81 – 2.00	0.61 – 0.80	0.81 – 1.00	1.81 – 2.50	1.15 – 1.19	1.61 – 2.00
Very High	(1)	1.50 – 1.80	0.81 – 1.00	1.01 – 1.20	2.51 – 3.00	1.20 – 1.60	2.01 – 2.40
Extreme	Above	< 1.50	> 1.00	> 1.20	> 3.00	> 1.60	> 2.40
		Overall Near-Bank Stress (NBS) rating					

USFWS - SHARP
STREAM NAME - REACH IDENTIFICATION

BANK EROSION HAZARD INDEX

Stream:		**Observer(s):**		**Data:**		**QA/QC:**		**Total Score:**				
Reach:		**Comments:**										
Location:		**Bank Length**						**Total Score Values:**	**Very Low**	**Low**	**Moderate**	**High**	**Very High**	**Extreme**
Date:									5-10	10-20	20-30	30-40	40-45	45-50

Erodibility Variables					
Bank Height / Bankfull Height Ratio					
Bank Height	Bankfull Height	Value	Index	Bank Erosion Potental	Notes
Root Depth / Bank Height Ratio					
Root Depth	Bank Height	Value	Index	Bank Erosion Potental	Notes
Weighted Root Density					
Root Density (%)	Root Depth / Bank Height	Value	Index	Bank Erosion Potental	Notes
Bank Angle					
Bank Angle (°)			Index	Bank Erosion Potental	Notes
Surface Protection					
Surface Protection (%)			Index	Bank Erosion Potental	Notes
			Adjustment		Notes
Bank Materials					
			Adjustment		Notes
Bank Stratification					
		TOTAL SCORE			

Bank Erosion Potential

		Very Low	Low	Moderate	High	Very High	Extreme
Erodibility Variables							
Bank Height / Bankfull Height	Value	1.00-1.10	1.11-1.19	1.20-1.50	1.60-2.00	2.10-2.80	>2.80
	Index	1.0-1.9	2.0-3.9	4.0-5.9	6.0-7.9	8.0-9.0	10
Root Depth / Bank Height	Value	1.00-0.90	0.89-0.50	0.49-0.30	0.29-0.15	0.14-0.05	<0.05
	Index	1.0-1.9	2.0-3.9	4.0-5.9	6.0-7.9	8.0-9.0	10
Weighted Root Density	Value	100-80	79-55	54-30	29-15	14-5	<5
	Index	1.0-1.9	2.0-3.9	4.0-5.9	6.0-7.9	8.0-9.0	10
Bank Angle	Value	0-20	21-60	61-80	81-90	91-119	>119
	Index	1.0-1.9	2.0-3.9	4.0-5.9	6.0-7.9	8.0-9.0	10
Surface Protection	Value	100-80	79-55	54-30	29-15	14-10	<10
	Index	1.0-1.9	2.0-3.9	4.0-5.9	6.0-7.9	8.0-9.0	10

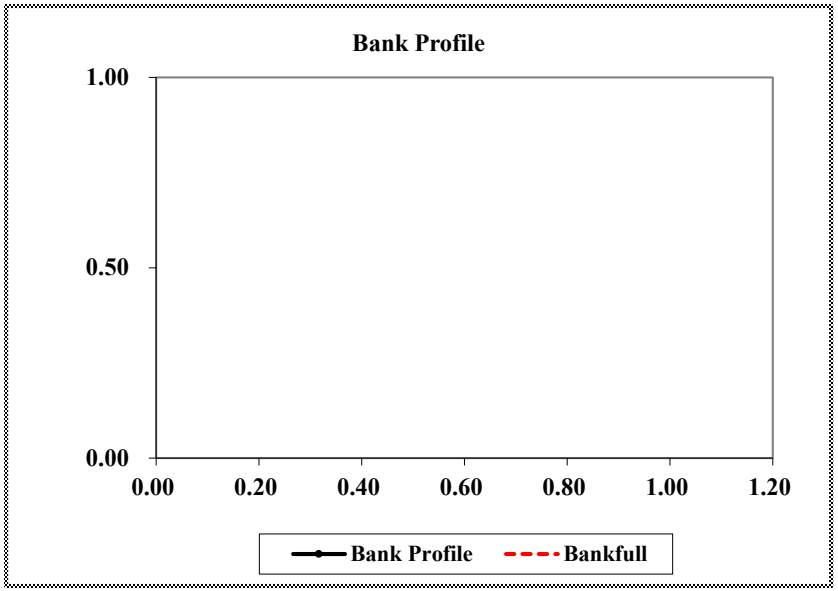
Adjustments

Bank Material	
Bedrock	Bedrock banks have a very low erosion potential.
Boulders	Boulder banks have a low erosion potential.
Cobble	Substract 10 points. No adjustment if sand/gravel compose greater than 50% of bank.
Clay/Silt Loam	Add 5 points.
Gravel	Add 5-10 points depending on percentage of bank material composed of sand.
Sand	Add 10 points.
Silt / Clay	No adjustment.

Stratification

Add 5-10 points depending on position of unstable layers in relation to bankfull stage.

Bank Profile		
Horizontal Distance	**Vertical Height**	**Notes**
Bankfull		
Horizontal Distance	**Vertical Height**	**Notes**



Worksheet 3-12. Various field methods of estimating Near-Bank Stress (NBS) risk ratings to calculate erosion rate.

Estimating Near-Bank Stress (NBS)

Stream: Location:

Station: Stream Type: Valley Type:

Observers: Date:

Methods for Estimating Near-Bank Stress (NBS)

(1) Channel pattern, transverse bar or split channel/central bar creating NBS	Level I	Reconaissance
(2) Ratio of radius of curvature to bankfull width (R_c / W_{bkf})	Level II	General prediction
(3) Ratio of pool slope to average water surface slope (S_p / S)	Level II	General prediction
(4) Ratio of pool slope to riffle slope (S_p / S_{rif})	Level II	General prediction
(5) Ratio of near-bank maximum depth to bankfull mean depth (d_{nb} / d_{bkf})	Level III	Detailed prediction
(6) Ratio of near-bank shear stress to bankfull shear stress (τ_{nb} / τ_{bkf})	Level III	Detailed prediction
(7) Velocity profiles / Isovels / Velocity gradient	Level IV	Validation

Level I

(1)

Transverse and/or central bars-short and/or discontinuous…… ……..…NBS = High / Very High

Extensive deposition (continuous, cross-channel)……..…… ……...NBS = Extreme

Chute cutoffs, down-valley meander migration, converging flow…… ……..…NBS = Extreme

Level II

(2)

Radius of Curvature R_c (ft)	Bankfull Width W_{bkf} (ft)	*Ratio* R_c / W_{bkf}	Near-Bank Stress (NBS)

(3)

Pool Slope S_p	Average Slope S	*Ratio* S_p / S	Near-Bank Stress (NBS)

(4)

Pool Slope S_p	Riffle Slope S_{rif}	*Ratio* S_p / S_{rif}	Near-Bank Stress (NBS)

Method	
Dominant Near-Bank Stress	

Level III

(5)

Near-Bank Max Depth d_{nb} (ft)	Mean Depth d_{bkf} (ft)	*Ratio* d_{nb} / d_{bkf}	Near-Bank Stress (NBS)

(6)

Near-Bank Max Depth d_{nb} (ft)	Near-Bank Slope S_{nb}	Near-Bank Shear Stress τ_{nb} (lb/ft^2)	Mean Depth d_{bkf} (ft)	Average Slope S	Bankfull Shear Stress τ_{bkf} (lb/ft^2)	Ratio τ_{nb} / τ_{bkf}	Near-Bank Stress (NBS)

Level IV

(7)

Velocity Gradient (ft / sec / ft)	Near-Bank Stress (NBS)

Converting Values to a Near-Bank Stress (NBS) Rating

Near-Bank Stress (NBS) ratings	Method number (1)	(2)	(3)	(4)	(5)	(6)	(7)
Very Low	N / A	> 3.00	< 0.20	< 0.40	< 1.00	< 0.80	< 0.50
Low	N / A	2.21 – 3.00	0.20 – 0.40	0.41 – 0.60	1.00 – 1.50	0.80 – 1.05	0.50 – 1.00
Moderate	N / A	2.01 – 2.20	0.41 – 0.60	0.61 – 0.80	1.51 – 1.80	1.06 – 1.14	1.01 – 1.60
High	See	1.81 – 2.00	0.61 – 0.80	0.81 – 1.00	1.81 – 2.50	1.15 – 1.19	1.61 – 2.00
Very High	(1)	1.50 – 1.80	0.81 – 1.00	1.01 – 1.20	2.51 – 3.00	1.20 – 1.60	2.01 – 2.40
Extreme	Above	< 1.50	> 1.00	> 1.20	> 3.00	> 1.60	> 2.40
		Overall Near-Bank Stress (NBS) rating					

USFWS - SHARP
STREAM NAME - REACH IDENTIFICATION

BANK EROSION HAZARD INDEX

Stream:		**Observer(s):**		**Data:**		**QA/QC:**		**Total Score:**				
Reach:		**Comments:**										
Location:		**Bank Length**						**Total Score Values:**	**Very Low**	**Low**	**Moderate**	**High**	**Very High**	**Extreme**
Date:									5-10	10-20	20-30	30-40	40-45	45-50

Erodibility Variables					
Bank Height / Bankfull Height Ratio					
Bank Height	Bankfull Height	Value	Index	Bank Erosion Potental	Notes
Root Depth / Bank Height Ratio					
Root Depth	Bank Height	Value	Index	Bank Erosion Potental	Notes
Weighted Root Density					
Root Density (%)	Root Depth / Bank Height	Value	Index	Bank Erosion Potental	Notes
Bank Angle					
Bank Angle (°)			Index	Bank Erosion Potental	Notes
Surface Protection					
Surface Protection (%)			Index	Bank Erosion Potental	Notes
			Adjustment		Notes
Bank Materials					
			Adjustment		Notes
Bank Stratification					
		TOTAL SCORE			

Bank Erosion Potential

		Very Low	Low	Moderate	High	Very High	Extreme
Erodibility Variables							
Bank Height / Bankfull Height	Value	1.00-1.10	1.11-1.19	1.20-1.50	1.60-2.00	2.10-2.80	>2.80
	Index	1.0-1.9	2.0-3.9	4.0-5.9	6.0-7.9	8.0-9.0	10
Root Depth / Bank Height	Value	1.00-0.90	0.89-0.50	0.49-0.30	0.29-0.15	0.14-0.05	<0.05
	Index	1.0-1.9	2.0-3.9	4.0-5.9	6.0-7.9	8.0-9.0	10
Weighted Root Density	Value	100-80	79-55	54-30	29-15	14-5	<5
	Index	1.0-1.9	2.0-3.9	4.0-5.9	6.0-7.9	8.0-9.0	10
Bank Angle	Value	0-20	21-60	61-80	81-90	91-119	>119
	Index	1.0-1.9	2.0-3.9	4.0-5.9	6.0-7.9	8.0-9.0	10
Surface Protection	Value	100-80	79-55	54-30	29-15	14-10	<10
	Index	1.0-1.9	2.0-3.9	4.0-5.9	6.0-7.9	8.0-9.0	10

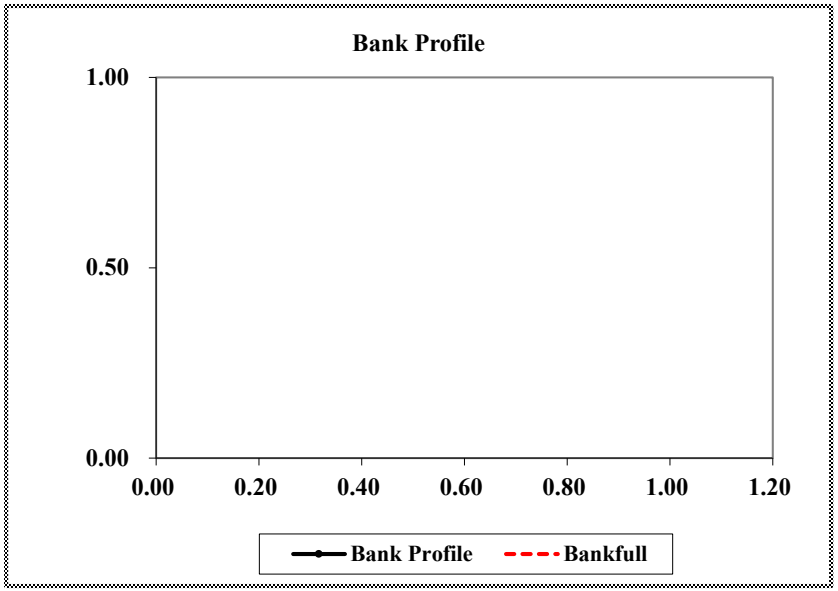
Adjustments

Bank Material	
Bedrock	Bedrock banks have a very low erosion potential.
Boulders	Boulder banks have a low erosion potential.
Cobble	Substract 10 points. No adjustment if sand/gravel compose greater than 50% of bank.
Clay/Silt Loam	Add 5 points.
Gravel	Add 5-10 points depending on percentage of bank material composed of sand.
Sand	Add 10 points.
Silt / Clay	No adjustment.

Stratification

Add 5-10 points depending on position of unstable layers in relation to bankfull stage.

Bank Profile		
Horizontal Distance	**Vertical Height**	**Notes**
Bankfull		
Horizontal Distance	**Vertical Height**	**Notes**



Worksheet 3-12. Various field methods of estimating Near-Bank Stress (NBS) risk ratings to calculate erosion rate.

Estimating Near-Bank Stress (NBS)

Stream: Location:

Station: Stream Type: Valley Type:

Observers: Date:

Methods for Estimating Near-Bank Stress (NBS)

(1) Channel pattern, transverse bar or split channel/central bar creating NBS	Level I	Reconaissance
(2) Ratio of radius of curvature to bankfull width (R_c / W_{bkf})	Level II	General prediction
(3) Ratio of pool slope to average water surface slope (S_p / S)	Level II	General prediction
(4) Ratio of pool slope to riffle slope (S_p / S_{rif})	Level II	General prediction
(5) Ratio of near-bank maximum depth to bankfull mean depth (d_{nb} / d_{bkf})	Level III	Detailed prediction
(6) Ratio of near-bank shear stress to bankfull shear stress (τ_{nb} / τ_{bkf})	Level III	Detailed prediction
(7) Velocity profiles / Isovels / Velocity gradient	Level IV	Validation

Level I

(1)

Transverse and/or central bars-short and/or discontinuous…… ……..…NBS = High / Very High

Extensive deposition (continuous, cross-channel)……..…… ……...NBS = Extreme

Chute cutoffs, down-valley meander migration, converging flow…… ……..…NBS = Extreme

Level II

(2)

Radius of Curvature R_c (ft)	Bankfull Width W_{bkf} (ft)	*Ratio* R_c / W_{bkf}	Near-Bank Stress (NBS)

(3)

Pool Slope S_p	Average Slope S	*Ratio* S_p / S	Near-Bank Stress (NBS)

(4)

Pool Slope S_p	Riffle Slope S_{rif}	*Ratio* S_p / S_{rif}	Near-Bank Stress (NBS)

Method	
Dominant Near-Bank Stress	

Level III

(5)

Near-Bank Max Depth d_{nb} (ft)	Mean Depth d_{bkf} (ft)	*Ratio* d_{nb} / d_{bkf}	Near-Bank Stress (NBS)

(6)

Near-Bank Max Depth d_{nb} (ft)	Near-Bank Slope S_{nb}	Near-Bank Shear Stress τ_{nb} (lb/ft^2)	Mean Depth d_{bkf} (ft)	Average Slope S	Bankfull Shear Stress τ_{bkf} (lb/ft^2)	Ratio τ_{nb} / τ_{bkf}	Near-Bank Stress (NBS)

Level IV

(7)

Velocity Gradient (ft / sec / ft)	Near-Bank Stress (NBS)

Converting Values to a Near-Bank Stress (NBS) Rating

Near-Bank Stress (NBS) ratings	Method number (1)	(2)	(3)	(4)	(5)	(6)	(7)
Very Low	N / A	> 3.00	< 0.20	< 0.40	< 1.00	< 0.80	< 0.50
Low	N / A	2.21 – 3.00	0.20 – 0.40	0.41 – 0.60	1.00 – 1.50	0.80 – 1.05	0.50 – 1.00
Moderate	N / A	2.01 – 2.20	0.41 – 0.60	0.61 – 0.80	1.51 – 1.80	1.06 – 1.14	1.01 – 1.60
High	See	1.81 – 2.00	0.61 – 0.80	0.81 – 1.00	1.81 – 2.50	1.15 – 1.19	1.61 – 2.00
Very High	(1)	1.50 – 1.80	0.81 – 1.00	1.01 – 1.20	2.51 – 3.00	1.20 – 1.60	2.01 – 2.40
Extreme	Above	< 1.50	> 1.00	> 1.20	> 3.00	> 1.60	> 2.40
		Overall Near-Bank Stress (NBS) rating					

USFWS - SHARP
STREAM NAME - REACH IDENTIFICATION

BANK EROSION HAZARD INDEX

Stream:		**Observer(s):**		**Data:**		**QA/QC:**		**Total Score:**				
Reach:		**Comments:**										
Location:		**Bank Length**						**Total Score Values:**	**Very Low**	**Low**	**Moderate**	**High**	**Very High**	**Extreme**
Date:									5-10	10-20	20-30	30-40	40-45	45-50

Erodibility Variables					
Bank Height / Bankfull Height Ratio					
Bank Height	Bankfull Height	Value	Index	Bank Erosion Potental	Notes
Root Depth / Bank Height Ratio					
Root Depth	Bank Height	Value	Index	Bank Erosion Potental	Notes
Weighted Root Density					
Root Density (%)	Root Depth / Bank Height	Value	Index	Bank Erosion Potental	Notes
Bank Angle					
Bank Angle (°)			Index	Bank Erosion Potental	Notes
Surface Protection					
Surface Protection (%)			Index	Bank Erosion Potental	Notes
			Adjustment		Notes
Bank Materials					
			Adjustment		Notes
Bank Stratification					
		TOTAL SCORE			

Bank Erosion Potential

		Very Low	Low	Moderate	High	Very High	Extreme
Erodibility Variables							
Bank Height / Bankfull Height	Value	1.00-1.10	1.11-1.19	1.20-1.50	1.60-2.00	2.10-2.80	>2.80
	Index	1.0-1.9	2.0-3.9	4.0-5.9	6.0-7.9	8.0-9.0	10
Root Depth / Bank Height	Value	1.00-0.90	0.89-0.50	0.49-0.30	0.29-0.15	0.14-0.05	<0.05
	Index	1.0-1.9	2.0-3.9	4.0-5.9	6.0-7.9	8.0-9.0	10
Weighted Root Density	Value	100-80	79-55	54-30	29-15	14-5	<5
	Index	1.0-1.9	2.0-3.9	4.0-5.9	6.0-7.9	8.0-9.0	10
Bank Angle	Value	0-20	21-60	61-80	81-90	91-119	>119
	Index	1.0-1.9	2.0-3.9	4.0-5.9	6.0-7.9	8.0-9.0	10
Surface Protection	Value	100-80	79-55	54-30	29-15	14-10	<10
	Index	1.0-1.9	2.0-3.9	4.0-5.9	6.0-7.9	8.0-9.0	10

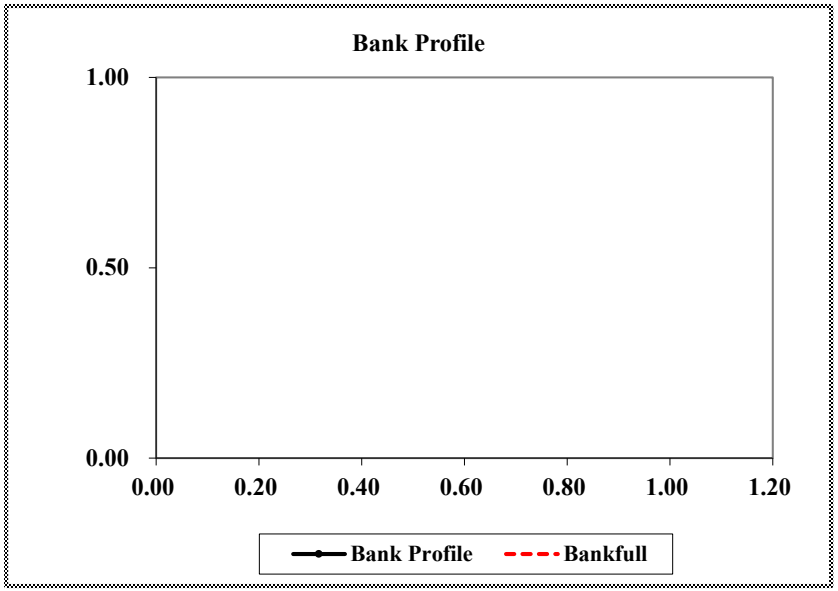
Adjustments

Bank Material	
Bedrock	Bedrock banks have a very low erosion potential.
Boulders	Boulder banks have a low erosion potential.
Cobble	Substract 10 points. No adjustment if sand/gravel compose greater than 50% of bank.
Clay/Silt Loam	Add 5 points.
Gravel	Add 5-10 points depending on percentage of bank material composed of sand.
Sand	Add 10 points.
Silt / Clay	No adjustment.

Stratification

Add 5-10 points depending on position of unstable layers in relation to bankfull stage.

Bank Profile		
Horizontal Distance	**Vertical Height**	**Notes**
Bankfull		
Horizontal Distance	**Vertical Height**	**Notes**



Worksheet 3-12. Various field methods of estimating Near-Bank Stress (NBS) risk ratings to calculate erosion rate.

Estimating Near-Bank Stress (NBS)

Stream: Location:

Station: Stream Type: Valley Type:

Observers: Date:

Methods for Estimating Near-Bank Stress (NBS)

(1) Channel pattern, transverse bar or split channel/central bar creating NBS	Level I	Reconaissance
(2) Ratio of radius of curvature to bankfull width (R_c / W_{bkf})	Level II	General prediction
(3) Ratio of pool slope to average water surface slope (S_p / S)	Level II	General prediction
(4) Ratio of pool slope to riffle slope (S_p / S_{rif})	Level II	General prediction
(5) Ratio of near-bank maximum depth to bankfull mean depth (d_{nb} / d_{bkf})	Level III	Detailed prediction
(6) Ratio of near-bank shear stress to bankfull shear stress (τ_{nb} / τ_{bkf})	Level III	Detailed prediction
(7) Velocity profiles / Isovels / Velocity gradient	Level IV	Validation

Level I

(1)

Transverse and/or central bars-short and/or discontinuous…… ……..…NBS = High / Very High

Extensive deposition (continuous, cross-channel)……..…… ……...NBS = Extreme

Chute cutoffs, down-valley meander migration, converging flow…… ……..…NBS = Extreme

Level II

(2)

Radius of Curvature R_c (ft)	Bankfull Width W_{bkf} (ft)	*Ratio* R_c / W_{bkf}	Near-Bank Stress (NBS)

(3)

Pool Slope S_p	Average Slope S	*Ratio* S_p / S	Near-Bank Stress (NBS)

(4)

Pool Slope S_p	Riffle Slope S_{rif}	*Ratio* S_p / S_{rif}	Near-Bank Stress (NBS)

Method	
Dominant Near-Bank Stress	

Level III

(5)

Near-Bank Max Depth d_{nb} (ft)	Mean Depth d_{bkf} (ft)	*Ratio* d_{nb} / d_{bkf}	Near-Bank Stress (NBS)

(6)

Near-Bank Max Depth d_{nb} (ft)	Near-Bank Slope S_{nb}	Near-Bank Shear Stress τ_{nb} (lb/ft^2)	Mean Depth d_{bkf} (ft)	Average Slope S	Bankfull Shear Stress τ_{bkf} (lb/ft^2)	Ratio τ_{nb} / τ_{bkf}	Near-Bank Stress (NBS)

Level IV

(7)

Velocity Gradient (ft / sec / ft)	Near-Bank Stress (NBS)

Converting Values to a Near-Bank Stress (NBS) Rating

Near-Bank Stress (NBS) ratings	Method number (1)	(2)	(3)	(4)	(5)	(6)	(7)
Very Low	N / A	> 3.00	< 0.20	< 0.40	< 1.00	< 0.80	< 0.50
Low	N / A	2.21 – 3.00	0.20 – 0.40	0.41 – 0.60	1.00 – 1.50	0.80 – 1.05	0.50 – 1.00
Moderate	N / A	2.01 – 2.20	0.41 – 0.60	0.61 – 0.80	1.51 – 1.80	1.06 – 1.14	1.01 – 1.60
High	See	1.81 – 2.00	0.61 – 0.80	0.81 – 1.00	1.81 – 2.50	1.15 – 1.19	1.61 – 2.00
Very High	(1)	1.50 – 1.80	0.81 – 1.00	1.01 – 1.20	2.51 – 3.00	1.20 – 1.60	2.01 – 2.40
Extreme	Above	< 1.50	> 1.00	> 1.20	> 3.00	> 1.60	> 2.40
		Overall Near-Bank Stress (NBS) rating					

USFWS - SHARP
STREAM NAME - REACH IDENTIFICATION

BANK EROSION HAZARD INDEX

Stream:		**Observer(s):**		**Data:**		**QA/QC:**		**Total Score:**				
Reach:		**Comments:**										
Location:		**Bank Length**						**Total Score Values:**	**Very Low**	**Low**	**Moderate**	**High**	**Very High**	**Extreme**
Date:									5-10	10-20	20-30	30-40	40-45	45-50

Erodibility Variables					
Bank Height / Bankfull Height Ratio					
Bank Height	Bankfull Height	Value	Index	Bank Erosion Potental	Notes
Root Depth / Bank Height Ratio					
Root Depth	Bank Height	Value	Index	Bank Erosion Potental	Notes
Weighted Root Density					
Root Density (%)	Root Depth / Bank Height	Value	Index	Bank Erosion Potental	Notes
Bank Angle					
Bank Angle (°)			Index	Bank Erosion Potental	Notes
Surface Protection					
Surface Protection (%)			Index	Bank Erosion Potental	Notes
			Adjustment		Notes
Bank Materials					
			Adjustment		Notes
Bank Stratification					
		TOTAL SCORE			

Bank Erosion Potential

		Very Low	Low	Moderate	High	Very High	Extreme
Erodibility Variables							
Bank Height / Bankfull Height	Value	1.00-1.10	1.11-1.19	1.20-1.50	1.60-2.00	2.10-2.80	>2.80
	Index	1.0-1.9	2.0-3.9	4.0-5.9	6.0-7.9	8.0-9.0	10
Root Depth / Bank Height	Value	1.00-0.90	0.89-0.50	0.49-0.30	0.29-0.15	0.14-0.05	<0.05
	Index	1.0-1.9	2.0-3.9	4.0-5.9	6.0-7.9	8.0-9.0	10
Weighted Root Density	Value	100-80	79-55	54-30	29-15	14-5	<5
	Index	1.0-1.9	2.0-3.9	4.0-5.9	6.0-7.9	8.0-9.0	10
Bank Angle	Value	0-20	21-60	61-80	81-90	91-119	>119
	Index	1.0-1.9	2.0-3.9	4.0-5.9	6.0-7.9	8.0-9.0	10
Surface Protection	Value	100-80	79-55	54-30	29-15	14-10	<10
	Index	1.0-1.9	2.0-3.9	4.0-5.9	6.0-7.9	8.0-9.0	10

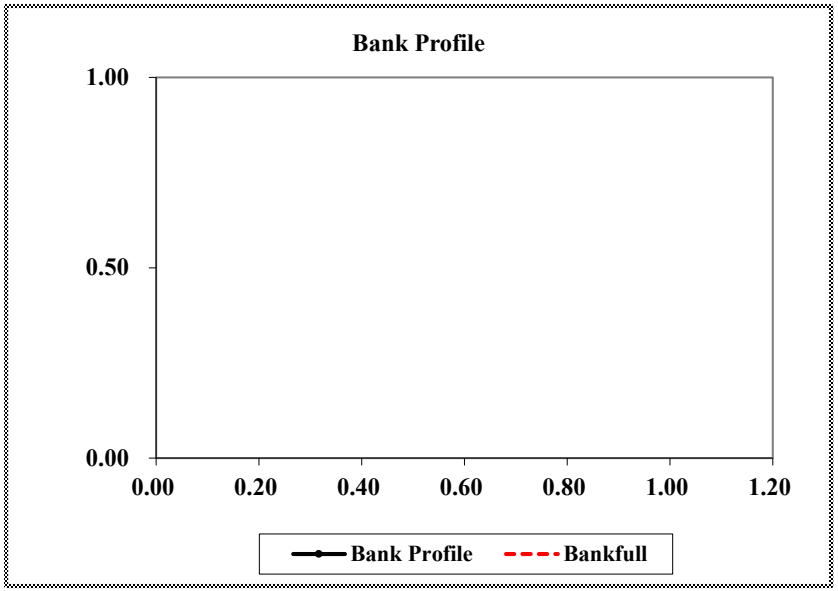
Adjustments

Bank Material	
Bedrock	Bedrock banks have a very low erosion potential.
Boulders	Boulder banks have a low erosion potential.
Cobble	Substract 10 points. No adjustment if sand/gravel compose greater than 50% of bank.
Clay/Silt Loam	Add 5 points.
Gravel	Add 5-10 points depending on percentage of bank material composed of sand.
Sand	Add 10 points.
Silt / Clay	No adjustment.

Stratification

Add 5-10 points depending on position of unstable layers in relation to bankfull stage.

Bank Profile		
Horizontal Distance	**Vertical Height**	**Notes**
Bankfull		
Horizontal Distance	**Vertical Height**	**Notes**



Worksheet 3-12. Various field methods of estimating Near-Bank Stress (NBS) risk ratings to calculate erosion rate.

Estimating Near-Bank Stress (NBS)

Stream: Location:

Station: Stream Type: Valley Type:

Observers: Date:

Methods for Estimating Near-Bank Stress (NBS)

(1) Channel pattern, transverse bar or split channel/central bar creating NBS	Level I	Reconaissance
(2) Ratio of radius of curvature to bankfull width (R_c / W_{bkf})	Level II	General prediction
(3) Ratio of pool slope to average water surface slope (S_p / S)	Level II	General prediction
(4) Ratio of pool slope to riffle slope (S_p / S_{rif})	Level II	General prediction
(5) Ratio of near-bank maximum depth to bankfull mean depth (d_{nb} / d_{bkf})	Level III	Detailed prediction
(6) Ratio of near-bank shear stress to bankfull shear stress (τ_{nb} / τ_{bkf})	Level III	Detailed prediction
(7) Velocity profiles / Isovels / Velocity gradient	Level IV	Validation

Level I

(1)

Transverse and/or central bars-short and/or discontinuous…… ……..…NBS = High / Very High

Extensive deposition (continuous, cross-channel)……..…… ……...NBS = Extreme

Chute cutoffs, down-valley meander migration, converging flow…… ……..…NBS = Extreme

Level II

(2)

Radius of Curvature R_c (ft)	Bankfull Width W_{bkf} (ft)	*Ratio* R_c / W_{bkf}	Near-Bank Stress (NBS)

(3)

Pool Slope S_p	Average Slope S	*Ratio* S_p / S	Near-Bank Stress (NBS)

(4)

Pool Slope S_p	Riffle Slope S_{rif}	*Ratio* S_p / S_{rif}	Near-Bank Stress (NBS)

Method	
Dominant Near-Bank Stress	

Level III

(5)

Near-Bank Max Depth d_{nb} (ft)	Mean Depth d_{bkf} (ft)	*Ratio* d_{nb} / d_{bkf}	Near-Bank Stress (NBS)

(6)

Near-Bank Max Depth d_{nb} (ft)	Near-Bank Slope S_{nb}	Near-Bank Shear Stress τ_{nb} (lb/ft^2)	Mean Depth d_{bkf} (ft)	Average Slope S	Bankfull Shear Stress τ_{bkf} (lb/ft^2)	Ratio τ_{nb} / τ_{bkf}	Near-Bank Stress (NBS)

Level IV

(7)

Velocity Gradient (ft / sec / ft)	Near-Bank Stress (NBS)

Converting Values to a Near-Bank Stress (NBS) Rating

Near-Bank Stress (NBS) ratings	Method number (1)	(2)	(3)	(4)	(5)	(6)	(7)
Very Low	N / A	> 3.00	< 0.20	< 0.40	< 1.00	< 0.80	< 0.50
Low	N / A	2.21 – 3.00	0.20 – 0.40	0.41 – 0.60	1.00 – 1.50	0.80 – 1.05	0.50 – 1.00
Moderate	N / A	2.01 – 2.20	0.41 – 0.60	0.61 – 0.80	1.51 – 1.80	1.06 – 1.14	1.01 – 1.60
High	See	1.81 – 2.00	0.61 – 0.80	0.81 – 1.00	1.81 – 2.50	1.15 – 1.19	1.61 – 2.00
Very High	(1)	1.50 – 1.80	0.81 – 1.00	1.01 – 1.20	2.51 – 3.00	1.20 – 1.60	2.01 – 2.40
Extreme	Above	< 1.50	> 1.00	> 1.20	> 3.00	> 1.60	> 2.40
		Overall Near-Bank Stress (NBS) rating					

USFWS - SHARP
STREAM NAME - REACH IDENTIFICATION

BANK EROSION HAZARD INDEX

Stream:		**Observer(s):**		**Data:**		**QA/QC:**		**Total Score:**				
Reach:		**Comments:**										
Location:		**Bank Length**						**Total Score Values:**	**Very Low**	**Low**	**Moderate**	**High**	**Very High**	**Extreme**
Date:									5-10	10-20	20-30	30-40	40-45	45-50

Erodibility Variables					
Bank Height / Bankfull Height Ratio					
Bank Height	Bankfull Height	Value	Index	Bank Erosion Potental	Notes
Root Depth / Bank Height Ratio					
Root Depth	Bank Height	Value	Index	Bank Erosion Potental	Notes
Weighted Root Density					
Root Density (%)	Root Depth / Bank Height	Value	Index	Bank Erosion Potental	Notes
Bank Angle					
Bank Angle (°)			Index	Bank Erosion Potental	Notes
Surface Protection					
Surface Protection (%)			Index	Bank Erosion Potental	Notes
			Adjustment		Notes
Bank Materials					
			Adjustment		Notes
Bank Stratification					
		TOTAL SCORE			

Bank Erosion Potential

		Very Low	Low	Moderate	High	Very High	Extreme
Erodibility Variables							
Bank Height / Bankfull Height	Value	1.00-1.10	1.11-1.19	1.20-1.50	1.60-2.00	2.10-2.80	>2.80
	Index	1.0-1.9	2.0-3.9	4.0-5.9	6.0-7.9	8.0-9.0	10
Root Depth / Bank Height	Value	1.00-0.90	0.89-0.50	0.49-0.30	0.29-0.15	0.14-0.05	<0.05
	Index	1.0-1.9	2.0-3.9	4.0-5.9	6.0-7.9	8.0-9.0	10
Weighted Root Density	Value	100-80	79-55	54-30	29-15	14-5	<5
	Index	1.0-1.9	2.0-3.9	4.0-5.9	6.0-7.9	8.0-9.0	10
Bank Angle	Value	0-20	21-60	61-80	81-90	91-119	>119
	Index	1.0-1.9	2.0-3.9	4.0-5.9	6.0-7.9	8.0-9.0	10
Surface Protection	Value	100-80	79-55	54-30	29-15	14-10	<10
	Index	1.0-1.9	2.0-3.9	4.0-5.9	6.0-7.9	8.0-9.0	10

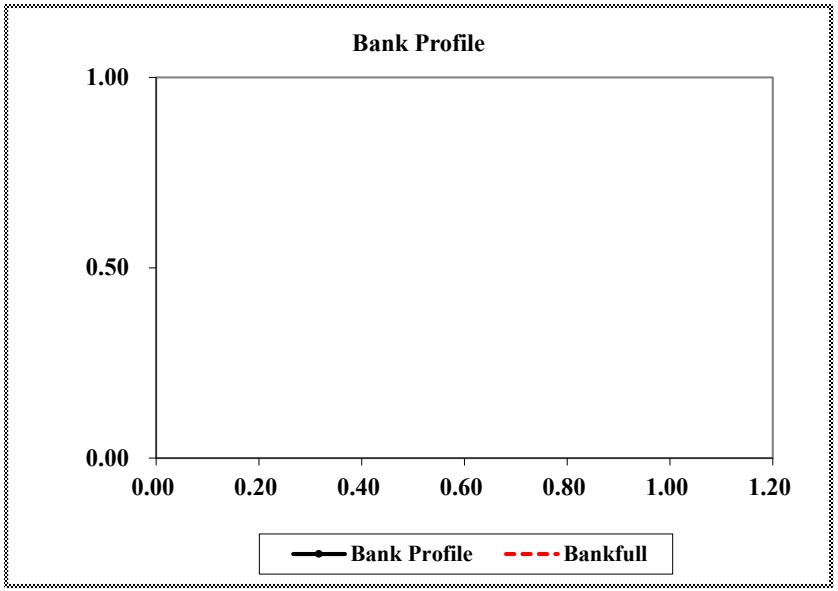
Adjustments

Bank Material	
Bedrock	Bedrock banks have a very low erosion potential.
Boulders	Boulder banks have a low erosion potential.
Cobble	Substract 10 points. No adjustment if sand/gravel compose greater than 50% of bank.
Clay/Silt Loam	Add 5 points.
Gravel	Add 5-10 points depending on percentage of bank material composed of sand.
Sand	Add 10 points.
Silt / Clay	No adjustment.

Stratification

Add 5-10 points depending on position of unstable layers in relation to bankfull stage.

Bank Profile		
Horizontal Distance	**Vertical Height**	**Notes**
Bankfull		
Horizontal Distance	**Vertical Height**	**Notes**



Worksheet 3-12. Various field methods of estimating Near-Bank Stress (NBS) risk ratings to calculate erosion rate.

Estimating Near-Bank Stress (NBS)

Stream: Location:

Station: Stream Type: Valley Type:

Observers: Date:

Methods for Estimating Near-Bank Stress (NBS)

(1) Channel pattern, transverse bar or split channel/central bar creating NBS	Level I	Reconaissance
(2) Ratio of radius of curvature to bankfull width (R_c / W_{bkf})	Level II	General prediction
(3) Ratio of pool slope to average water surface slope (S_p / S)	Level II	General prediction
(4) Ratio of pool slope to riffle slope (S_p / S_{rif})	Level II	General prediction
(5) Ratio of near-bank maximum depth to bankfull mean depth (d_{nb} / d_{bkf})	Level III	Detailed prediction
(6) Ratio of near-bank shear stress to bankfull shear stress (τ_{nb} / τ_{bkf})	Level III	Detailed prediction
(7) Velocity profiles / Isovels / Velocity gradient	Level IV	Validation

Level I

(1)

Transverse and/or central bars-short and/or discontinuous…… ……..…NBS = High / Very High

Extensive deposition (continuous, cross-channel)……..…… ……...NBS = Extreme

Chute cutoffs, down-valley meander migration, converging flow…… ……..…NBS = Extreme

Level II

(2)

Radius of Curvature R_c (ft)	Bankfull Width W_{bkf} (ft)	*Ratio* R_c / W_{bkf}	Near-Bank Stress (NBS)

(3)

Pool Slope S_p	Average Slope S	*Ratio* S_p / S	Near-Bank Stress (NBS)

(4)

Pool Slope S_p	Riffle Slope S_{rif}	*Ratio* S_p / S_{rif}	Near-Bank Stress (NBS)

Method	
Dominant Near-Bank Stress	

Level III

(5)

Near-Bank Max Depth d_{nb} (ft)	Mean Depth d_{bkf} (ft)	*Ratio* d_{nb} / d_{bkf}	Near-Bank Stress (NBS)

(6)

Near-Bank Max Depth d_{nb} (ft)	Near-Bank Slope S_{nb}	Near-Bank Shear Stress τ_{nb} (lb/ft^2)	Mean Depth d_{bkf} (ft)	Average Slope S	Bankfull Shear Stress τ_{bkf} (lb/ft^2)	Ratio τ_{nb} / τ_{bkf}	Near-Bank Stress (NBS)

Level IV

(7)

Velocity Gradient (ft / sec / ft)	Near-Bank Stress (NBS)

Converting Values to a Near-Bank Stress (NBS) Rating

Near-Bank Stress (NBS) ratings	Method number (1)	(2)	(3)	(4)	(5)	(6)	(7)
Very Low	N / A	> 3.00	< 0.20	< 0.40	< 1.00	< 0.80	< 0.50
Low	N / A	2.21 – 3.00	0.20 – 0.40	0.41 – 0.60	1.00 – 1.50	0.80 – 1.05	0.50 – 1.00
Moderate	N / A	2.01 – 2.20	0.41 – 0.60	0.61 – 0.80	1.51 – 1.80	1.06 – 1.14	1.01 – 1.60
High	See	1.81 – 2.00	0.61 – 0.80	0.81 – 1.00	1.81 – 2.50	1.15 – 1.19	1.61 – 2.00
Very High	(1)	1.50 – 1.80	0.81 – 1.00	1.01 – 1.20	2.51 – 3.00	1.20 – 1.60	2.01 – 2.40
Extreme	Above	< 1.50	> 1.00	> 1.20	> 3.00	> 1.60	> 2.40
		Overall Near-Bank Stress (NBS) rating					

USFWS - SHARP
STREAM NAME - REACH IDENTIFICATION

BANK EROSION HAZARD INDEX

Stream:		**Observer(s):**		**Data:**		**QA/QC:**		**Total Score:**				
Reach:		**Comments:**										
Location:		**Bank Length**						**Total Score Values:**	**Very Low**	**Low**	**Moderate**	**High**	**Very High**	**Extreme**
Date:									5-10	10-20	20-30	30-40	40-45	45-50

Erodibility Variables					
Bank Height / Bankfull Height Ratio					
Bank Height	Bankfull Height	Value	Index	Bank Erosion Potental	Notes
Root Depth / Bank Height Ratio					
Root Depth	Bank Height	Value	Index	Bank Erosion Potental	Notes
Weighted Root Density					
Root Density (%)	Root Depth / Bank Height	Value	Index	Bank Erosion Potental	Notes
Bank Angle					
Bank Angle (°)			Index	Bank Erosion Potental	Notes
Surface Protection					
Surface Protection (%)			Index	Bank Erosion Potental	Notes
			Adjustment		Notes
Bank Materials					
			Adjustment		Notes
Bank Stratification					
		TOTAL SCORE			

Bank Erosion Potential

		Very Low	Low	Moderate	High	Very High	Extreme
Erodibility Variables							
Bank Height / Bankfull Height	Value	1.00-1.10	1.11-1.19	1.20-1.50	1.60-2.00	2.10-2.80	>2.80
	Index	1.0-1.9	2.0-3.9	4.0-5.9	6.0-7.9	8.0-9.0	10
Root Depth / Bank Height	Value	1.00-0.90	0.89-0.50	0.49-0.30	0.29-0.15	0.14-0.05	<0.05
	Index	1.0-1.9	2.0-3.9	4.0-5.9	6.0-7.9	8.0-9.0	10
Weighted Root Density	Value	100-80	79-55	54-30	29-15	14-5	<5
	Index	1.0-1.9	2.0-3.9	4.0-5.9	6.0-7.9	8.0-9.0	10
Bank Angle	Value	0-20	21-60	61-80	81-90	91-119	>119
	Index	1.0-1.9	2.0-3.9	4.0-5.9	6.0-7.9	8.0-9.0	10
Surface Protection	Value	100-80	79-55	54-30	29-15	14-10	<10
	Index	1.0-1.9	2.0-3.9	4.0-5.9	6.0-7.9	8.0-9.0	10

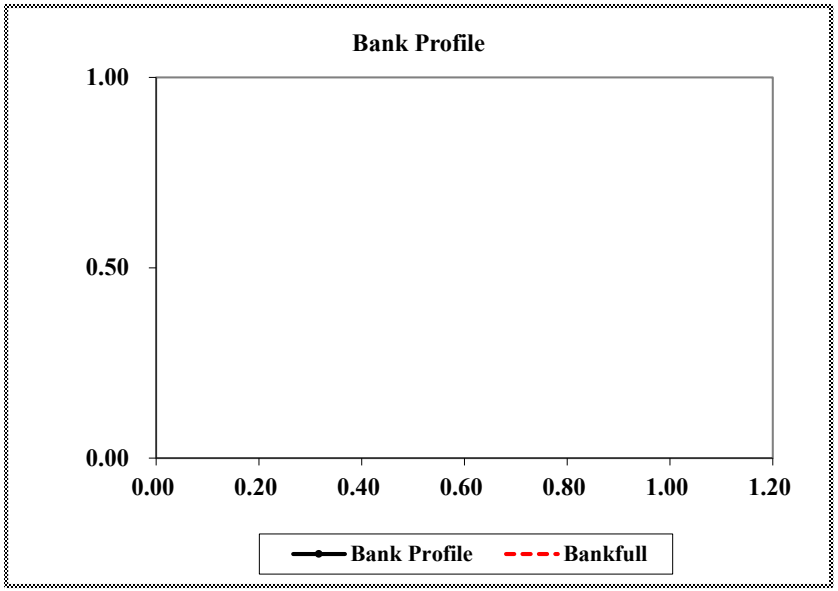
Adjustments

Bank Material	
Bedrock	Bedrock banks have a very low erosion potential.
Boulders	Boulder banks have a low erosion potential.
Cobble	Substract 10 points. No adjustment if sand/gravel compose greater than 50% of bank.
Clay/Silt Loam	Add 5 points.
Gravel	Add 5-10 points depending on percentage of bank material composed of sand.
Sand	Add 10 points.
Silt / Clay	No adjustment.

Stratification

Add 5-10 points depending on position of unstable layers in relation to bankfull stage.

Bank Profile		
Horizontal Distance	**Vertical Height**	**Notes**
Bankfull		
Horizontal Distance	**Vertical Height**	**Notes**



Worksheet 3-12. Various field methods of estimating Near-Bank Stress (NBS) risk ratings to calculate erosion rate.

Estimating Near-Bank Stress (NBS)

Stream: Location:

Station: Stream Type: Valley Type:

Observers: Date:

Methods for Estimating Near-Bank Stress (NBS)

(1) Channel pattern, transverse bar or split channel/central bar creating NBS	Level I	Reconaissance
(2) Ratio of radius of curvature to bankfull width (R_c / W_{bkf})	Level II	General prediction
(3) Ratio of pool slope to average water surface slope (S_p / S)	Level II	General prediction
(4) Ratio of pool slope to riffle slope (S_p / S_{rif})	Level II	General prediction
(5) Ratio of near-bank maximum depth to bankfull mean depth (d_{nb} / d_{bkf})	Level III	Detailed prediction
(6) Ratio of near-bank shear stress to bankfull shear stress (τ_{nb} / τ_{bkf})	Level III	Detailed prediction
(7) Velocity profiles / Isovels / Velocity gradient	Level IV	Validation

Level I

(1)

Transverse and/or central bars-short and/or discontinuous…… ……..…NBS = High / Very High

Extensive deposition (continuous, cross-channel)……..…… ……...NBS = Extreme

Chute cutoffs, down-valley meander migration, converging flow…… ……..…NBS = Extreme

Level II

(2)

Radius of Curvature R_c (ft)	Bankfull Width W_{bkf} (ft)	*Ratio* R_c / W_{bkf}	Near-Bank Stress (NBS)

(3)

Pool Slope S_p	Average Slope S	*Ratio* S_p / S	Near-Bank Stress (NBS)

(4)

Pool Slope S_p	Riffle Slope S_{rif}	*Ratio* S_p / S_{rif}	Near-Bank Stress (NBS)

Method	
Dominant Near-Bank Stress	

Level III

(5)

Near-Bank Max Depth d_{nb} (ft)	Mean Depth d_{bkf} (ft)	*Ratio* d_{nb} / d_{bkf}	Near-Bank Stress (NBS)

(6)

Near-Bank Max Depth d_{nb} (ft)	Near-Bank Slope S_{nb}	Near-Bank Shear Stress τ_{nb} (lb/ft^2)	Mean Depth d_{bkf} (ft)	Average Slope S	Bankfull Shear Stress τ_{bkf} (lb/ft^2)	Ratio τ_{nb} / τ_{bkf}	Near-Bank Stress (NBS)

Level IV

(7)

Velocity Gradient (ft / sec / ft)	Near-Bank Stress (NBS)

Converting Values to a Near-Bank Stress (NBS) Rating

Near-Bank Stress (NBS) ratings	Method number (1)	(2)	(3)	(4)	(5)	(6)	(7)
Very Low	N / A	> 3.00	< 0.20	< 0.40	< 1.00	< 0.80	< 0.50
Low	N / A	2.21 – 3.00	0.20 – 0.40	0.41 – 0.60	1.00 – 1.50	0.80 – 1.05	0.50 – 1.00
Moderate	N / A	2.01 – 2.20	0.41 – 0.60	0.61 – 0.80	1.51 – 1.80	1.06 – 1.14	1.01 – 1.60
High	See	1.81 – 2.00	0.61 – 0.80	0.81 – 1.00	1.81 – 2.50	1.15 – 1.19	1.61 – 2.00
Very High	(1)	1.50 – 1.80	0.81 – 1.00	1.01 – 1.20	2.51 – 3.00	1.20 – 1.60	2.01 – 2.40
Extreme	Above	< 1.50	> 1.00	> 1.20	> 3.00	> 1.60	> 2.40
		Overall Near-Bank Stress (NBS) rating					

USFWS - SHARP
STREAM NAME - REACH IDENTIFICATION

BANK EROSION HAZARD INDEX

Stream:		**Observer(s):**		**Data:**		**QA/QC:**		**Total Score:**				
Reach:		**Comments:**										
Location:		**Bank Length**						**Total Score Values:**	**Very Low**	**Low**	**Moderate**	**High**	**Very High**	**Extreme**
Date:									5-10	10-20	20-30	30-40	40-45	45-50

Erodibility Variables					
Bank Height / Bankfull Height Ratio					
Bank Height	Bankfull Height	Value	Index	Bank Erosion Potental	Notes
Root Depth / Bank Height Ratio					
Root Depth	Bank Height	Value	Index	Bank Erosion Potental	Notes
Weighted Root Density					
Root Density (%)	Root Depth / Bank Height	Value	Index	Bank Erosion Potental	Notes
Bank Angle					
Bank Angle (°)			Index	Bank Erosion Potental	Notes
Surface Protection					
Surface Protection (%)			Index	Bank Erosion Potental	Notes
			Adjustment		Notes
Bank Materials					
			Adjustment		Notes
Bank Stratification					
		TOTAL SCORE			

Bank Erosion Potential

		Very Low	Low	Moderate	High	Very High	Extreme
Erodibility Variables							
Bank Height / Bankfull Height	Value	1.00-1.10	1.11-1.19	1.20-1.50	1.60-2.00	2.10-2.80	>2.80
	Index	1.0-1.9	2.0-3.9	4.0-5.9	6.0-7.9	8.0-9.0	10
Root Depth / Bank Height	Value	1.00-0.90	0.89-0.50	0.49-0.30	0.29-0.15	0.14-0.05	<0.05
	Index	1.0-1.9	2.0-3.9	4.0-5.9	6.0-7.9	8.0-9.0	10
Weighted Root Density	Value	100-80	79-55	54-30	29-15	14-5	<5
	Index	1.0-1.9	2.0-3.9	4.0-5.9	6.0-7.9	8.0-9.0	10
Bank Angle	Value	0-20	21-60	61-80	81-90	91-119	>119
	Index	1.0-1.9	2.0-3.9	4.0-5.9	6.0-7.9	8.0-9.0	10
Surface Protection	Value	100-80	79-55	54-30	29-15	14-10	<10
	Index	1.0-1.9	2.0-3.9	4.0-5.9	6.0-7.9	8.0-9.0	10

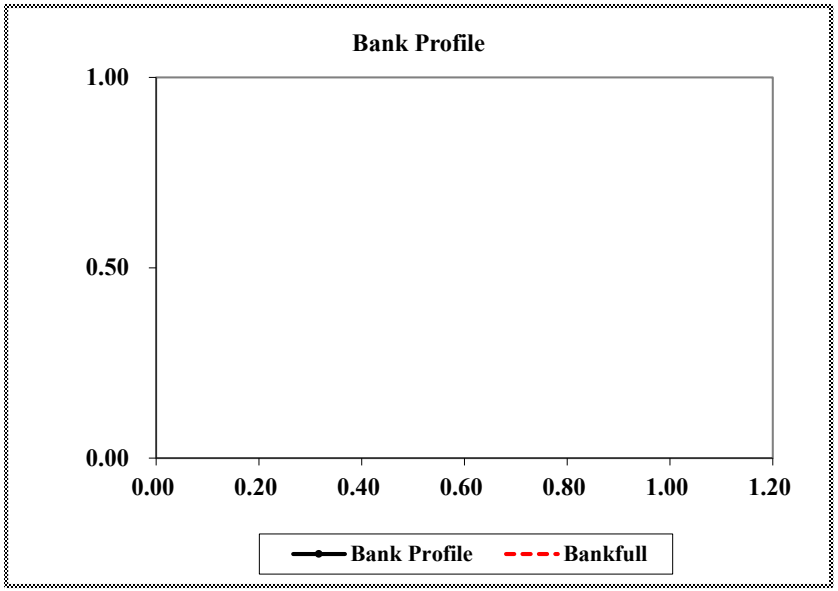
Adjustments

Bank Material	
Bedrock	Bedrock banks have a very low erosion potential.
Boulders	Boulder banks have a low erosion potential.
Cobble	Substract 10 points. No adjustment if sand/gravel compose greater than 50% of bank.
Clay/Silt Loam	Add 5 points.
Gravel	Add 5-10 points depending on percentage of bank material composed of sand.
Sand	Add 10 points.
Silt / Clay	No adjustment.

Stratification

Add 5-10 points depending on position of unstable layers in relation to bankfull stage.

Bank Profile		
Horizontal Distance	**Vertical Height**	**Notes**
Bankfull		
Horizontal Distance	**Vertical Height**	**Notes**



Worksheet 3-12. Various field methods of estimating Near-Bank Stress (NBS) risk ratings to calculate erosion rate.

Estimating Near-Bank Stress (NBS)

Stream: Location:

Station: Stream Type: Valley Type:

Observers: Date:

Methods for Estimating Near-Bank Stress (NBS)

(1) Channel pattern, transverse bar or split channel/central bar creating NBS	Level I	Reconaissance
(2) Ratio of radius of curvature to bankfull width (R_c / W_{bkf})	Level II	General prediction
(3) Ratio of pool slope to average water surface slope (S_p / S)	Level II	General prediction
(4) Ratio of pool slope to riffle slope (S_p / S_{rif})	Level II	General prediction
(5) Ratio of near-bank maximum depth to bankfull mean depth (d_{nb} / d_{bkf})	Level III	Detailed prediction
(6) Ratio of near-bank shear stress to bankfull shear stress (τ_{nb} / τ_{bkf})	Level III	Detailed prediction
(7) Velocity profiles / Isovels / Velocity gradient	Level IV	Validation

Level I

(1)

Transverse and/or central bars-short and/or discontinuous…… ……..…NBS = High / Very High

Extensive deposition (continuous, cross-channel)……..…… ……...NBS = Extreme

Chute cutoffs, down-valley meander migration, converging flow…… ……..…NBS = Extreme

Level II

(2)

Radius of Curvature R_c (ft)	Bankfull Width W_{bkf} (ft)	*Ratio* R_c / W_{bkf}	Near-Bank Stress (NBS)

(3)

Pool Slope S_p	Average Slope S	*Ratio* S_p / S	Near-Bank Stress (NBS)

(4)

Pool Slope S_p	Riffle Slope S_{rif}	*Ratio* S_p / S_{rif}	Near-Bank Stress (NBS)

Method	
Dominant Near-Bank Stress	

Level III

(5)

Near-Bank Max Depth d_{nb} (ft)	Mean Depth d_{bkf} (ft)	*Ratio* d_{nb} / d_{bkf}	Near-Bank Stress (NBS)

(6)

Near-Bank Max Depth d_{nb} (ft)	Near-Bank Slope S_{nb}	Near-Bank Shear Stress τ_{nb} (lb/ft^2)	Mean Depth d_{bkf} (ft)	Average Slope S	Bankfull Shear Stress τ_{bkf} (lb/ft^2)	Ratio τ_{nb} / τ_{bkf}	Near-Bank Stress (NBS)

Level IV

(7)

Velocity Gradient (ft / sec / ft)	Near-Bank Stress (NBS)

Converting Values to a Near-Bank Stress (NBS) Rating

Near-Bank Stress (NBS) ratings	Method number (1)	(2)	(3)	(4)	(5)	(6)	(7)
Very Low	N / A	> 3.00	< 0.20	< 0.40	< 1.00	< 0.80	< 0.50
Low	N / A	2.21 – 3.00	0.20 – 0.40	0.41 – 0.60	1.00 – 1.50	0.80 – 1.05	0.50 – 1.00
Moderate	N / A	2.01 – 2.20	0.41 – 0.60	0.61 – 0.80	1.51 – 1.80	1.06 – 1.14	1.01 – 1.60
High	See	1.81 – 2.00	0.61 – 0.80	0.81 – 1.00	1.81 – 2.50	1.15 – 1.19	1.61 – 2.00
Very High	(1)	1.50 – 1.80	0.81 – 1.00	1.01 – 1.20	2.51 – 3.00	1.20 – 1.60	2.01 – 2.40
Extreme	Above	< 1.50	> 1.00	> 1.20	> 3.00	> 1.60	> 2.40
		Overall Near-Bank Stress (NBS) rating					

USFWS - SHARP
STREAM NAME - REACH IDENTIFICATION

BANK EROSION HAZARD INDEX

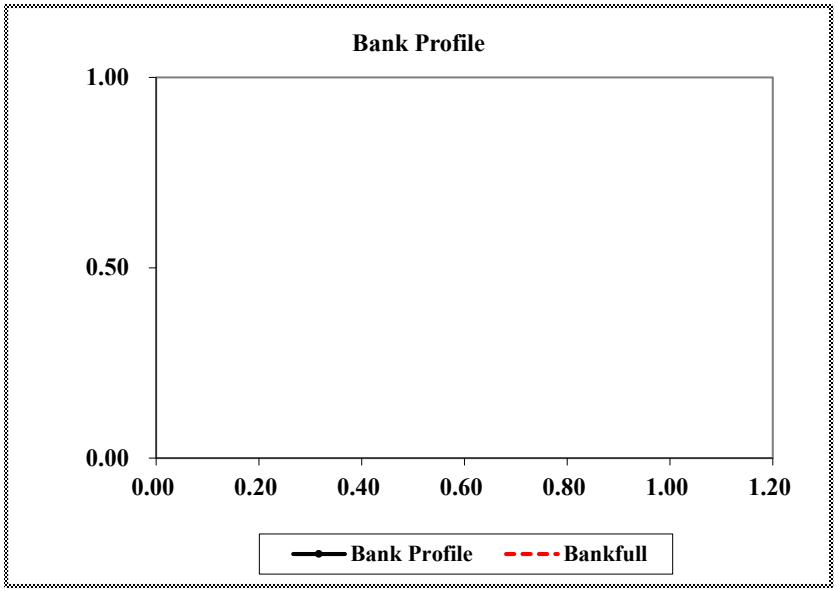
Stream:		**Observer(s):**		**Data:**		**QA/QC:**		**Total Score:**				
Reach:		**Comments:**										
Location:		**Bank Length**						**Total Score Values:**	**Very Low**	**Low**	**Moderate**	**High**	**Very High**	**Extreme**
Date:									5-10	10-20	20-30	30-40	40-45	45-50

Erodibility Variables					
Bank Height / Bankfull Height Ratio					
Bank Height	Bankfull Height	Value	Index	Bank Erosion Potental	Notes
Root Depth / Bank Height Ratio					
Root Depth	Bank Height	Value	Index	Bank Erosion Potental	Notes
Weighted Root Density					
Root Density (%)	Root Depth / Bank Height	Value	Index	Bank Erosion Potental	Notes
Bank Angle					
Bank Angle (°)			Index	Bank Erosion Potental	Notes
Surface Protection					
Surface Protection (%)			Index	Bank Erosion Potental	Notes
			Adjustment		Notes
Bank Materials					
			Adjustment		Notes
Bank Stratification					
		TOTAL SCORE			

Bank Erosion Potential							
		Very Low	Low	Moderate	High	Very High	Extreme
Erodibility Variables							
Bank Height / Bankfull Height	Value	1.00-1.10	1.11-1.19	1.20-1.50	1.60-2.00	2.10-2.80	>2.80
	Index	1.0-1.9	2.0-3.9	4.0-5.9	6.0-7.9	8.0-9.0	10
Root Depth / Bank Height	Value	1.00-0.90	0.89-0.50	0.49-0.30	0.29-0.15	0.14-0.05	<0.05
	Index	1.0-1.9	2.0-3.9	4.0-5.9	6.0-7.9	8.0-9.0	10
Weighted Root Density	Value	100-80	79-55	54-30	29-15	14-5	<5
	Index	1.0-1.9	2.0-3.9	4.0-5.9	6.0-7.9	8.0-9.0	10
Bank Angle	Value	0-20	21-60	61-80	81-90	91-119	>119
	Index	1.0-1.9	2.0-3.9	4.0-5.9	6.0-7.9	8.0-9.0	10
Surface Protection	Value	100-80	79-55	54-30	29-15	14-10	<10
	Index	1.0-1.9	2.0-3.9	4.0-5.9	6.0-7.9	8.0-9.0	10

Adjustments	
Bank Material	
Bedrock	Bedrock banks have a very low erosion potential.
Boulders	Boulder banks have a low erosion potential.
Cobble	Substract 10 points. No adjustment if sand/gravel compose greater than 50% of bank.
Clay/Silt Loam	Add 5 points.
Gravel	Add 5-10 points depending on percentage of bank material composed of sand.
Sand	Add 10 points.
Silt / Clay	No adjustment.
Stratification	
Add 5-10 points depending on position of unstable layers in relation to bankfull stage.	

Bank Profile		
Horizontal Distance	**Vertical Height**	**Notes**
Bankfull		
Horizontal Distance	**Vertical Height**	**Notes**



Worksheet 3-12. Various field methods of estimating Near-Bank Stress (NBS) risk ratings to calculate erosion rate.

Estimating Near-Bank Stress (NBS)

Stream: Location:

Station: Stream Type: Valley Type:

Observers: Date:

Methods for Estimating Near-Bank Stress (NBS)

(1) Channel pattern, transverse bar or split channel/central bar creating NBS	Level I	Reconaissance
(2) Ratio of radius of curvature to bankfull width (R_c / W_{bkf})	Level II	General prediction
(3) Ratio of pool slope to average water surface slope (S_p / S)	Level II	General prediction
(4) Ratio of pool slope to riffle slope (S_p / S_{rif})	Level II	General prediction
(5) Ratio of near-bank maximum depth to bankfull mean depth (d_{nb} / d_{bkf})	Level III	Detailed prediction
(6) Ratio of near-bank shear stress to bankfull shear stress (τ_{nb} / τ_{bkf})	Level III	Detailed prediction
(7) Velocity profiles / Isovels / Velocity gradient	Level IV	Validation

Level I

(1)

Transverse and/or central bars-short and/or discontinuous…… ……..…NBS = High / Very High

Extensive deposition (continuous, cross-channel)……..…… ……...NBS = Extreme

Chute cutoffs, down-valley meander migration, converging flow…… ……..…NBS = Extreme

Level II

(2)

Radius of Curvature R_c (ft)	Bankfull Width W_{bkf} (ft)	*Ratio* R_c / W_{bkf}	Near-Bank Stress (NBS)

(3)

Pool Slope S_p	Average Slope S	*Ratio* S_p / S	Near-Bank Stress (NBS)

(4)

Pool Slope S_p	Riffle Slope S_{rif}	*Ratio* S_p / S_{rif}	Near-Bank Stress (NBS)

Method	
Dominant Near-Bank Stress	

Level III

(5)

Near-Bank Max Depth d_{nb} (ft)	Mean Depth d_{bkf} (ft)	*Ratio* d_{nb} / d_{bkf}	Near-Bank Stress (NBS)

(6)

Near-Bank Max Depth d_{nb} (ft)	Near-Bank Slope S_{nb}	Near-Bank Shear Stress τ_{nb} (lb/ft^2)	Mean Depth d_{bkf} (ft)	Average Slope S	Bankfull Shear Stress τ_{bkf} (lb/ft^2)	Ratio τ_{nb} / τ_{bkf}	Near-Bank Stress (NBS)

Level IV

(7)

Velocity Gradient (ft / sec / ft)	Near-Bank Stress (NBS)

Converting Values to a Near-Bank Stress (NBS) Rating

Near-Bank Stress (NBS) ratings	Method number (1)	(2)	(3)	(4)	(5)	(6)	(7)
Very Low	N / A	> 3.00	< 0.20	< 0.40	< 1.00	< 0.80	< 0.50
Low	N / A	2.21 – 3.00	0.20 – 0.40	0.41 – 0.60	1.00 – 1.50	0.80 – 1.05	0.50 – 1.00
Moderate	N / A	2.01 – 2.20	0.41 – 0.60	0.61 – 0.80	1.51 – 1.80	1.06 – 1.14	1.01 – 1.60
High	See	1.81 – 2.00	0.61 – 0.80	0.81 – 1.00	1.81 – 2.50	1.15 – 1.19	1.61 – 2.00
Very High	(1)	1.50 – 1.80	0.81 – 1.00	1.01 – 1.20	2.51 – 3.00	1.20 – 1.60	2.01 – 2.40
Extreme	Above	< 1.50	> 1.00	> 1.20	> 3.00	> 1.60	> 2.40
		Overall Near-Bank Stress (NBS) rating					

USFWS - SHARP
STREAM NAME - REACH IDENTIFICATION

BANK EROSION HAZARD INDEX

Stream:		**Observer(s):**		**Data:**		**QA/QC:**		**Total Score:**				
Reach:		**Comments:**										
Location:		**Bank Length**						**Total Score Values:**	**Very Low**	**Low**	**Moderate**	**High**	**Very High**	**Extreme**
Date:									5-10	10-20	20-30	30-40	40-45	45-50

Erodibility Variables					
Bank Height / Bankfull Height Ratio					
Bank Height	Bankfull Height	Value	Index	Bank Erosion Potental	Notes
Root Depth / Bank Height Ratio					
Root Depth	Bank Height	Value	Index	Bank Erosion Potental	Notes
Weighted Root Density					
Root Density (%)	Root Depth / Bank Height	Value	Index	Bank Erosion Potental	Notes
Bank Angle					
Bank Angle (°)			Index	Bank Erosion Potental	Notes
Surface Protection					
Surface Protection (%)			Index	Bank Erosion Potental	Notes
			Adjustment		Notes
Bank Materials					
			Adjustment		Notes
Bank Stratification					
		TOTAL SCORE			

Bank Erosion Potential

		Very Low	Low	Moderate	High	Very High	Extreme
Erodibility Variables							
Bank Height / Bankfull Height	Value	1.00-1.10	1.11-1.19	1.20-1.50	1.60-2.00	2.10-2.80	>2.80
	Index	1.0-1.9	2.0-3.9	4.0-5.9	6.0-7.9	8.0-9.0	10
Root Depth / Bank Height	Value	1.00-0.90	0.89-0.50	0.49-0.30	0.29-0.15	0.14-0.05	<0.05
	Index	1.0-1.9	2.0-3.9	4.0-5.9	6.0-7.9	8.0-9.0	10
Weighted Root Density	Value	100-80	79-55	54-30	29-15	14-5	<5
	Index	1.0-1.9	2.0-3.9	4.0-5.9	6.0-7.9	8.0-9.0	10
Bank Angle	Value	0-20	21-60	61-80	81-90	91-119	>119
	Index	1.0-1.9	2.0-3.9	4.0-5.9	6.0-7.9	8.0-9.0	10
Surface Protection	Value	100-80	79-55	54-30	29-15	14-10	<10
	Index	1.0-1.9	2.0-3.9	4.0-5.9	6.0-7.9	8.0-9.0	10

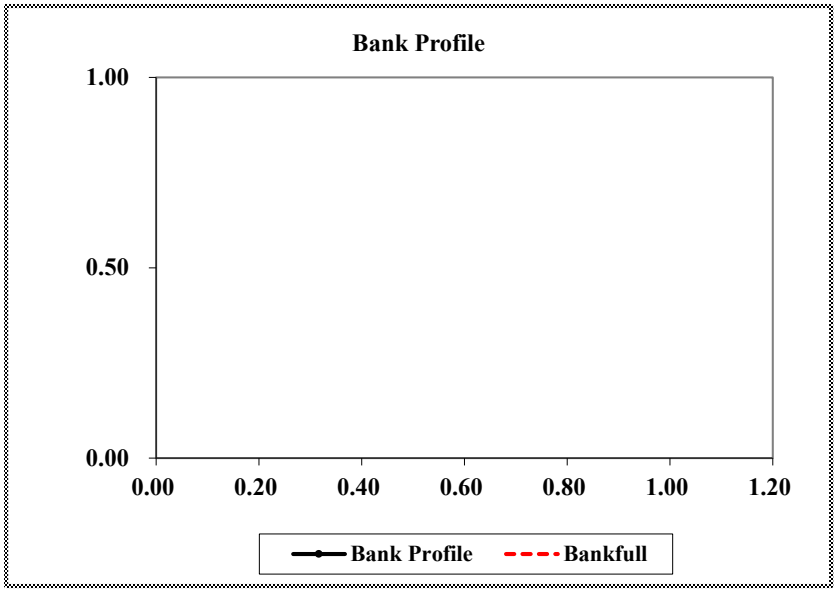
Adjustments

Bank Material	
Bedrock	Bedrock banks have a very low erosion potential.
Boulders	Boulder banks have a low erosion potential.
Cobble	Substract 10 points. No adjustment if sand/gravel compose greater than 50% of bank.
Clay/Silt Loam	Add 5 points.
Gravel	Add 5-10 points depending on percentage of bank material composed of sand.
Sand	Add 10 points.
Silt / Clay	No adjustment.

Stratification

Add 5-10 points depending on position of unstable layers in relation to bankfull stage.

Bank Profile		
Horizontal Distance	**Vertical Height**	**Notes**
Bankfull		
Horizontal Distance	**Vertical Height**	**Notes**



Worksheet 3-12. Various field methods of estimating Near-Bank Stress (NBS) risk ratings to calculate erosion rate.

Estimating Near-Bank Stress (NBS)

Stream: Location:

Station: Stream Type: Valley Type:

Observers: Date:

Methods for Estimating Near-Bank Stress (NBS)

(1) Channel pattern, transverse bar or split channel/central bar creating NBS	Level I	Reconaissance
(2) Ratio of radius of curvature to bankfull width (R_c / W_{bkf})	Level II	General prediction
(3) Ratio of pool slope to average water surface slope (S_p / S)	Level II	General prediction
(4) Ratio of pool slope to riffle slope (S_p / S_{rif})	Level II	General prediction
(5) Ratio of near-bank maximum depth to bankfull mean depth (d_{nb} / d_{bkf})	Level III	Detailed prediction
(6) Ratio of near-bank shear stress to bankfull shear stress (τ_{nb} / τ_{bkf})	Level III	Detailed prediction
(7) Velocity profiles / Isovels / Velocity gradient	Level IV	Validation

Level I

(1)

Transverse and/or central bars-short and/or discontinuous…… ……..…NBS = High / Very High

Extensive deposition (continuous, cross-channel)……..…… ……...NBS = Extreme

Chute cutoffs, down-valley meander migration, converging flow…… ……..…NBS = Extreme

Level II

(2)

Radius of Curvature R_c (ft)	Bankfull Width W_{bkf} (ft)	*Ratio* R_c / W_{bkf}	Near-Bank Stress (NBS)

(3)

Pool Slope S_p	Average Slope S	*Ratio* S_p / S	Near-Bank Stress (NBS)

(4)

Pool Slope S_p	Riffle Slope S_{rif}	*Ratio* S_p / S_{rif}	Near-Bank Stress (NBS)

Method	
Dominant Near-Bank Stress	

Level III

(5)

Near-Bank Max Depth d_{nb} (ft)	Mean Depth d_{bkf} (ft)	*Ratio* d_{nb} / d_{bkf}	Near-Bank Stress (NBS)

(6)

Near-Bank Max Depth d_{nb} (ft)	Near-Bank Slope S_{nb}	Near-Bank Shear Stress τ_{nb} (lb/ft^2)	Mean Depth d_{bkf} (ft)	Average Slope S	Bankfull Shear Stress τ_{bkf} (lb/ft^2)	Ratio τ_{nb} / τ_{bkf}	Near-Bank Stress (NBS)

Level IV

(7)

Velocity Gradient (ft / sec / ft)	Near-Bank Stress (NBS)

Converting Values to a Near-Bank Stress (NBS) Rating

Near-Bank Stress (NBS) ratings	Method number (1)	(2)	(3)	(4)	(5)	(6)	(7)
Very Low	N / A	> 3.00	< 0.20	< 0.40	< 1.00	< 0.80	< 0.50
Low	N / A	2.21 – 3.00	0.20 – 0.40	0.41 – 0.60	1.00 – 1.50	0.80 – 1.05	0.50 – 1.00
Moderate	N / A	2.01 – 2.20	0.41 – 0.60	0.61 – 0.80	1.51 – 1.80	1.06 – 1.14	1.01 – 1.60
High	See	1.81 – 2.00	0.61 – 0.80	0.81 – 1.00	1.81 – 2.50	1.15 – 1.19	1.61 – 2.00
Very High	(1)	1.50 – 1.80	0.81 – 1.00	1.01 – 1.20	2.51 – 3.00	1.20 – 1.60	2.01 – 2.40
Extreme	Above	< 1.50	> 1.00	> 1.20	> 3.00	> 1.60	> 2.40
		Overall Near-Bank Stress (NBS) rating					

USFWS - SHARP
STREAM NAME - REACH IDENTIFICATION

BANK EROSION HAZARD INDEX

Stream:		**Observer(s):**		**Data:**		**QA/QC:**		**Total Score:**				
Reach:		**Comments:**										
Location:		**Bank Length**						**Total Score Values:**	**Very Low**	**Low**	**Moderate**	**High**	**Very High**	**Extreme**
Date:									5-10	10-20	20-30	30-40	40-45	45-50

Erodibility Variables					
Bank Height / Bankfull Height Ratio					
Bank Height	Bankfull Height	Value	Index	Bank Erosion Potental	Notes
Root Depth / Bank Height Ratio					
Root Depth	Bank Height	Value	Index	Bank Erosion Potental	Notes
Weighted Root Density					
Root Density (%)	Root Depth / Bank Height	Value	Index	Bank Erosion Potental	Notes
Bank Angle					
Bank Angle (°)			Index	Bank Erosion Potental	Notes
Surface Protection					
Surface Protection (%)			Index	Bank Erosion Potental	Notes
			Adjustment		Notes
Bank Materials					
			Adjustment		Notes
Bank Stratification					
		TOTAL SCORE			

Bank Erosion Potential

		Very Low	Low	Moderate	High	Very High	Extreme
Erodibility Variables							
Bank Height / Bankfull Height	Value	1.00-1.10	1.11-1.19	1.20-1.50	1.60-2.00	2.10-2.80	>2.80
	Index	1.0-1.9	2.0-3.9	4.0-5.9	6.0-7.9	8.0-9.0	10
Root Depth / Bank Height	Value	1.00-0.90	0.89-0.50	0.49-0.30	0.29-0.15	0.14-0.05	<0.05
	Index	1.0-1.9	2.0-3.9	4.0-5.9	6.0-7.9	8.0-9.0	10
Weighted Root Density	Value	100-80	79-55	54-30	29-15	14-5	<5
	Index	1.0-1.9	2.0-3.9	4.0-5.9	6.0-7.9	8.0-9.0	10
Bank Angle	Value	0-20	21-60	61-80	81-90	91-119	>119
	Index	1.0-1.9	2.0-3.9	4.0-5.9	6.0-7.9	8.0-9.0	10
Surface Protection	Value	100-80	79-55	54-30	29-15	14-10	<10
	Index	1.0-1.9	2.0-3.9	4.0-5.9	6.0-7.9	8.0-9.0	10

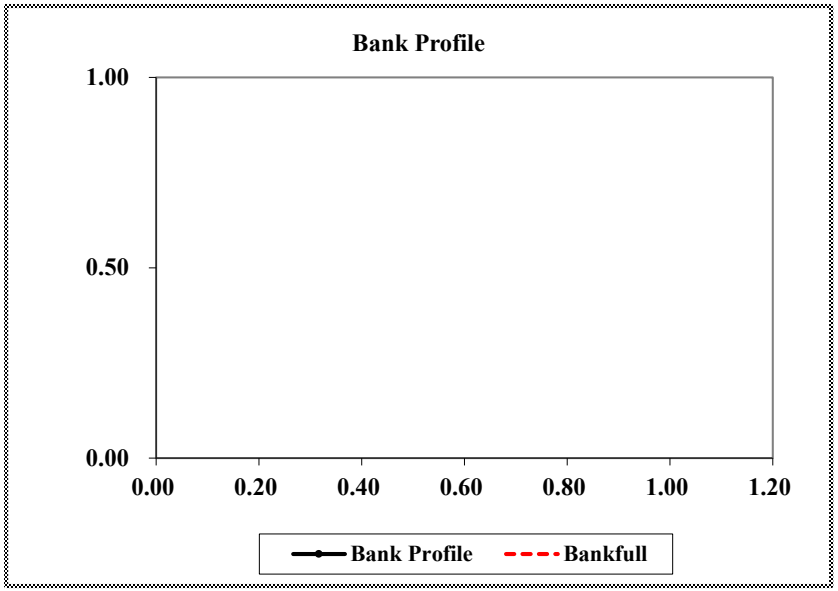
Adjustments

Bank Material	
Bedrock	Bedrock banks have a very low erosion potential.
Boulders	Boulder banks have a low erosion potential.
Cobble	Substract 10 points. No adjustment if sand/gravel compose greater than 50% of bank.
Clay/Silt Loam	Add 5 points.
Gravel	Add 5-10 points depending on percentage of bank material composed of sand.
Sand	Add 10 points.
Silt / Clay	No adjustment.

Stratification

Add 5-10 points depending on position of unstable layers in relation to bankfull stage.

Bank Profile		
Horizontal Distance	**Vertical Height**	**Notes**
Bankfull		
Horizontal Distance	**Vertical Height**	**Notes**



Worksheet 3-12. Various field methods of estimating Near-Bank Stress (NBS) risk ratings to calculate erosion rate.

Estimating Near-Bank Stress (NBS)

Stream: Location:

Station: Stream Type: Valley Type:

Observers: Date:

Methods for Estimating Near-Bank Stress (NBS)

(1) Channel pattern, transverse bar or split channel/central bar creating NBS	Level I	Reconaissance
(2) Ratio of radius of curvature to bankfull width (R_c / W_{bkf})	Level II	General prediction
(3) Ratio of pool slope to average water surface slope (S_p / S)	Level II	General prediction
(4) Ratio of pool slope to riffle slope (S_p / S_{rif})	Level II	General prediction
(5) Ratio of near-bank maximum depth to bankfull mean depth (d_{nb} / d_{bkf})	Level III	Detailed prediction
(6) Ratio of near-bank shear stress to bankfull shear stress (τ_{nb} / τ_{bkf})	Level III	Detailed prediction
(7) Velocity profiles / Isovels / Velocity gradient	Level IV	Validation

Level I

(1)

Transverse and/or central bars-short and/or discontinuous…… ……..…NBS = High / Very High

Extensive deposition (continuous, cross-channel)……..…… ……...NBS = Extreme

Chute cutoffs, down-valley meander migration, converging flow…… ……..…NBS = Extreme

Level II

(2)

Radius of Curvature R_c (ft)	Bankfull Width W_{bkf} (ft)	*Ratio* R_c / W_{bkf}	Near-Bank Stress (NBS)

(3)

Pool Slope S_p	Average Slope S	*Ratio* S_p / S	Near-Bank Stress (NBS)

(4)

Pool Slope S_p	Riffle Slope S_{rif}	*Ratio* S_p / S_{rif}	Near-Bank Stress (NBS)

Method	
Dominant Near-Bank Stress	

Level III

(5)

Near-Bank Max Depth d_{nb} (ft)	Mean Depth d_{bkf} (ft)	*Ratio* d_{nb} / d_{bkf}	Near-Bank Stress (NBS)

(6)

Near-Bank Max Depth d_{nb} (ft)	Near-Bank Slope S_{nb}	Near-Bank Shear Stress τ_{nb} (lb/ft^2)	Mean Depth d_{bkf} (ft)	Average Slope S	Bankfull Shear Stress τ_{bkf} (lb/ft^2)	Ratio τ_{nb} / τ_{bkf}	Near-Bank Stress (NBS)

Level IV

(7)

Velocity Gradient (ft / sec / ft)	Near-Bank Stress (NBS)

Converting Values to a Near-Bank Stress (NBS) Rating

Near-Bank Stress (NBS) ratings	Method number (1)	(2)	(3)	(4)	(5)	(6)	(7)
Very Low	N / A	> 3.00	< 0.20	< 0.40	< 1.00	< 0.80	< 0.50
Low	N / A	2.21 – 3.00	0.20 – 0.40	0.41 – 0.60	1.00 – 1.50	0.80 – 1.05	0.50 – 1.00
Moderate	N / A	2.01 – 2.20	0.41 – 0.60	0.61 – 0.80	1.51 – 1.80	1.06 – 1.14	1.01 – 1.60
High	See	1.81 – 2.00	0.61 – 0.80	0.81 – 1.00	1.81 – 2.50	1.15 – 1.19	1.61 – 2.00
Very High	(1)	1.50 – 1.80	0.81 – 1.00	1.01 – 1.20	2.51 – 3.00	1.20 – 1.60	2.01 – 2.40
Extreme	Above	< 1.50	> 1.00	> 1.20	> 3.00	> 1.60	> 2.40
		Overall Near-Bank Stress (NBS) rating					

BEHI	NBS	Rate
low	very low	0.017
low	low	0.020
low	moderate	0.090
low	high	0.160
low	very high	0.325
low	extreme	0.6
moderate	very low	0.09
moderate	low	0.125
moderate	moderate	0.300
moderate	high	0.800
moderate	very high	0.700
moderate	extreme	1.200
high	very low	0.250
high	low	0.400
high	moderate	0.640
high	high	1.000
high	very high	1.750
high	extreme	2.500
very high	very low	0.250
very high	low	0.400
very high	moderate	0.640
very high	high	1.000
very high	very high	1.750
very high	extreme	2.500
extreme	very low	0.15
extreme	low	1.300
extreme	moderate	1.750
extreme	high	2.500
extreme	very high	3.500
extreme	extreme	4.500

Non-highlighted rates from USFWS Bank Erosion Rate Curve
Yellow Highlighted rates from Rosgen Colorado Bank Erosion Rate **Blue Highlighted rates are interpolated from Rosgen Colorado Bank Erosion Rate**