# Harborcreek Township Pollutant Reduction Plan



Prepared for Submittal with National Pollutant Discharge Elimination System (NPDES) Individual Permit to Discharge Stormwater from Small Municipal Separate Storm Sewer System (MS4) Application

### **Draft**

August 9, 2022

Harborcreek Township 5601 Buffalo Road Harborcreek, PA 16421

# Harborcreek Township, Pennsylvania Pollutant Reduction Plan

Draft - August 9, 2022

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# Harborcreek Township, Pennsylvania Pollutant Reduction Plan

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### Introduction

Harborcreek Township is located within Erie County in northwest Pennsylvania on the shore of Lake Erie. The Pennsylvania Department of Environmental Protection (DEP) has categorized one stream in Harborcreek Township as impaired due to siltation or sediment. This impairment is based on assessments of benthic macroinvertebrates (or aquatic insects) that were conducted in 2001. The impaired Unnamed Tributary to Lake Erie is identified locally as Five Mile Creek.

As part of its application for a new National Pollutant Discharge Elimination System (NPDES) Municipal Separate Storm Sewer System (MS4) permit, the Township is required to develop a Pollutant Reduction Plan (PRP) to reduce discharge of pollutants into local streams.

This PRP was prepared in accordance with guidance documents provided by DEP and others, including:

- "MS4 Requirements Table (Municipal)," revised November 18, 2019
- "PRP Instructions (3800-PM-BCW0100k)," revised March 2017
- "BMP Effectiveness Values (3800-PM-BCW0100m)," dated June 2018
- "PRP Development Process Summary," dated June 9, 2017
- "MS4 NPDES Permits Frequently Asked Questions (FAQ)," Version 1.4 revised April 20, 2022
- "Considerations of Stream Restoration Projects in Pennsylvania for eligibility as an MS4 Best Management Practice," dated May 11, 2018
- "MS4 Stream Restoration Eligibility Checklist" and "MS4 Stream Restoration Crediting Review Checklist – Expert Panel Protocols"
- "Recommendations of the Expert Panel to Define Removal Rates for Individual Stream Restoration Projects," dated September 8, 2014 and "Consensus Recommendations for Improving the Application of the Prevented Sediment Protocol for Urban Stream Restoration Projects Built for Pollutant Removal Credit", dated February, 27, 2020

### A. Public Participation

Harborcreek Township conducted a public comment period after initial review of the PRP by DEP as specified in the December 22, 2021 consent order.

Documentation of the public comment process, public comments, and the Township's responses will be provided in Appendix A.

### B. Map

Under the MS4 permit, Harborcreek Township is responsible for all areas draining to a stormwater outfall owned or operated by the Township that is located within the 2010 Census urbanized area. The Township has developed a map of its stormwater infrastructure based on visual inspections of above ground features and a map of the Township's stormwater infrastructure prepared by Erie County. This map was used as the basis for identifying regulated MS4 outfalls to determine the PRP planning area. The PRP planning area was adjusted to remove or parse areas that are operating as PennDOT roads. Facilities operating under an industrial stormwater permit (PAG03) were identified based on the list available on the DEP website. There were no industrial permitted facilities located within the Five Mile Creek watershed and no sites were removed from the PRP planning area. A portion of the watershed draining from Lawrence Park Township was parsed out of the planning area.

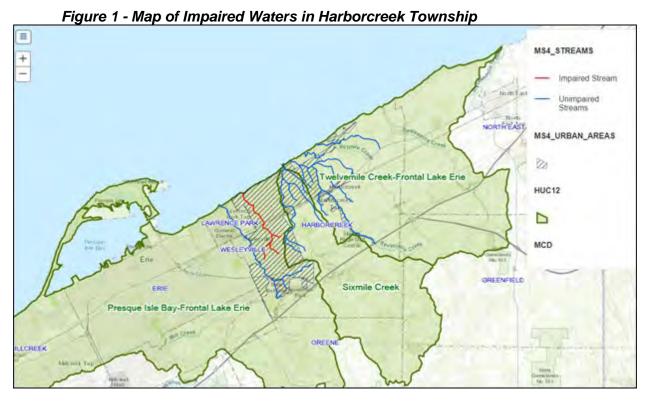
Artificial conveyances and natural drainage features were thoroughly reviewed in a GIS environment by engineers and planners in order to accurately account for storm sewer drainage areas and determine break points between the manmade and natural hydrologic systems. Drainage areas were delineated to each MS4 outfall and the PRP planning area reflects regulated drainage to Five Mile Creek. The drainage areas were delineated using the contours and DEM obtained from the Pennsylvania Geospatial Data Clearinghouse (PASDA) for Pennsylvania Western Lidar 2020 QL2 – North.

The Township evaluated impervious surfaces using detailed impervious cover data available through PASDA. Woolpert and Pennsylvania State University, using funding from the Pennsylvania Sea Grant, collaborated to produce highly detailed impervious surface data based on 2012 LiDAR. The 2012 impervious surface data was compared to the most recent satellite imagery available from PASDA (Erie County PEMA 2018) and was found to align very closely. Minor adjustments to the impervious surface were made to capture additional impervious surfaces.

A map of the planning area is provided in Appendix B. The watershed map shows the PRP planning area, MS4 outfalls and associated drainage areas, parsed areas, and the extent of the 2010 Census urbanized area. A draft of this map was submitted to DEP for review on February 4, 2022 as specified in the December 22, 2021 consent order.

### C. Pollutants of Concern

The MS4 Requirements Table (Municipal) developed by DEP, dated November 18, 2019, lists one stream in the Township that requires a PRP for siltation. The listed impaired water in the MS4 Requirements Table is Unnamed Tributary to Lake Erie. The Unnamed Tributary to Lake Erie is locally named Five Mile Creek. The location of this DEP-designated impaired water within Harborcreek Township is shown in Figure 1.



Five Mile Creek in Harborcreek was determined to be impaired based on DEP assessments of biological conditions in the streams through evaluations of benthic macroinvertebrates or aquatic insects conducted in 2001. More information about DEP's steam assessment program is available at the following webpage: <a href="https://www.depgis.state.pa.us/macroinvertebrate/index.html">https://www.depgis.state.pa.us/macroinvertebrate/index.html</a>. Per this website, Five Mile Creek has not been reassessed recently. Sediment or siltation is often considered a stressor that impacts the health of streams and benthic macroinvertebrates; however, DEP has not performed a Total Maximum Daily Load (TMDL) assessment for these streams to evaluate stressors and assign wasteload allocations.

Since all the impaired streams are listed for a siltation impairment the pollutant of concern for this PRP is sediment. In order to comply with its next MS4 permit, the Township is required to achieve a 10% sediment reduction as documented in the PRP Instructions (3800-PM-BCW0100k), dated March 2017.

### D. Determine Existing Loading for Pollutants of Concern

The existing loading for sediment in each of the impaired streams is based on the simplified method developed by DEP. The loading rate in pounds per acre per year for each land use type (impervious developed, pervious developed, and undeveloped lands) was taken from Attachment B of the PRP Instructions and is summarized in Table 1. These rates were then applied to the land use data for Harborcreek as summarized in Section B and Appendix B.

Table 1 - Existing Sediment Loading Rate Summary

Land Use	Sediment Loading Rate (lb/acre/year)
Impervious Developed	1,839
Pervious Developed	264.96
Undeveloped Land	234.6

The Township may take credit for existing Best Management Practices (BMPs) that are demonstrated to reduce the sediment loading. There were six private stormwater BMPs identified in the watershed – see the PRP map in Appendix B for locations. The Erie County Conservation District provided a review of the BMP sites and provided available documentation for five of the sites with permit applications in Appendix C and details summarized in Table 2.

Table 2 - Summary of Existing BMPs

Name	Permit No.	BMP Type	Latitude	Longitude	Year Constructed
Eastlake Woods	PAG02002511024	Detention Pond	42.164776	-80.008471	2012
(Affordable Senior		Rain garden	Unknown		2012
Housing)		Vegetated swales	Unkr	nown	2012
		Restoration: landscape	Unkr	nown	2012
		Rooftop disconnection	Unkr	nown	2012
Arneman Court	PAG02002512002	Wet pond	42.154197	-80.005370	2013
		Restoration buffers	Unknown		2013
		Protect Features	Unknown		2013
		WQ inserts	Unknown		2013
East Lake Road	PAG02002507008	Detention Basin	42.163259	-80.012072	2007
Alliance Church		Underground Detention	Unknown		2007
		Porous pavement	Unkr	nown	2007
		Vegetated filter swales			2007
Village of Foxwood	PAG02002505004	Detention basin 1 (North)	42.133390	-79.983653	2009
		Detention basin 2 (South)	42.129905	-79.987054	2009
		Vegetated filter swales	Unknown		2009

During field visits and desktop assessments of the watershed, the ponds were the only stormwater features that were located and therefor only these BMPs are included in credit calculations for existing BMPs. Drainage areas to the facilities were calculated based on the GIS data compiled for the watershed (see Section B). The total 10,198 pounds per year of sediment credit claimed is detailed in Table 3.

Table 3 - Summary of Existing BMP Reductions

Name	Pervious Acres	Impervious Acres	Undeveloped	TSS Load (lbs/yr)	Removal Efficiency*	Reduction in TSS Load (lbs/yr)
Eastlake Woods Detention Pond	0.49	0.65	0.00	1,325	10%	133
Arneman Court Wet Pond	4.73	3.16	0.00	7,065	60%	4,239
East Lake Road Alliance Church Detention Basin	1.91	1.19	0.00	2,694	10%	269
Foxwood North Detention Basin	40.94	17.85	0.00	43,674	10%	4,367
Foxwood South Detention Basin	11.60	4.80	0.00	11,901	10%	1,190
Total						10,198

<sup>\*</sup> Removal efficiency from BMP Effectiveness Values (3800-PM-BCW0100m)," dated June 2018

Table 4 summarizes the existing pollutant loading for Five Mile Creek and the total area calculated using the DEP simplified method.

Table 4 - Existing Sediment Loading Summary

Watershed	Full Sewershed (AC)	Parsed Area (AC)	Total Planning Area (AC)	Pervious (AC)	Impervious (AC)	Undeveloped (AC)	Sum of TSS Load (lbs/year)
Five Mile Creek	775.13	36.94	738.19	584.85	153.35	-	436,973
Credit for Existing Stormwater Management BMPs							- 10,198
	Adjusted Total Sediment Load						426,775
	Se	diment Redu	ction Goal (10% o	f Total Load	)		42,678

## E. Select BMPs to Achieve the Minimum Required Reductions in Pollutant Loading

The Township conducted an evaluation of BMP opportunities to achieve the minimum required 10% reduction of sediment. This minimum required sediment reduction is 42,678 pounds/year or 21.34 tons/year.

The following BMP is proposed to meet the required reduction in sediment. Additional information on the BMP and its associated sediment reduction is located in Appendix D.

### **Rolling Ridge Park Stream Restoration:**

This project was identified by a field assessment of streams in the watershed and potential opportunities on public land.

The Township proposes a restoration project spanning approximately 700 feet on a tributary to Five Mile Creek that flows through Rolling Ridge Park to address areas of high bank erosion and near bank stress. The main goals are to stabilize the banks and reconnect the stream to the

floodplain to dissipate energy during high flow events. Measurements of bank erosion rates and near stress indicators were taken in the field in May 2022. The approved methodology from Protocol 1 of the "Recommendations of the Expert Panel to Define Removal Rates for Individual Stream Restoration Projects" was used to compute sediment credit for this project. Using Protocol 1, the sediment reduction associated with this project was determined to be 71.6 tons per year or 143,200 pounds per year (see Appendix D for more detail about the sediment removal calculation).

Table 5 - Summary of Estimated Sediment Reduction

Project	Watershed	Estimated Sediment Load Reduction (lb/year)
Rolling Ridge Park Stream Restoration	Five Mile Creek	143,200

As demonstrated in Table 5, the proposed project exceeds the 10% sediment reduction goal of 42,678 pounds per year.

### F. Implementation Schedule

The Township intends to implement the identified stream restoration project during the five-year term of its next MS4 permit.

### G. Identify Funding Mechanisms

The Township intends to pursue a variety of grant opportunities to fund the proposed projects that may include:

- Growing Greener Watershed Protection Grants
- Coastal Zone Management Grant Program
- Nonpoint Source Implementation Program Grants (Section 319)
- Pennsylvania Infrastructure Investment Authority Clean Water State Revolving Fund
- Community Development Block Grants
- Watershed Restoration and Protection Program
- National Oceanic and Atmospheric Administration (NOAA) Great Lakes Restoration Initiative
- National Fish and Wildlife Foundation Sustain Our Great Lakes Program
- American Rescue Plan Act (ARPA)

The Township currently finances stormwater projects and grant matches through its general fund for MS4 permit compliance.

## H. Identify Responsible Parties for Operation and Maintenance of BMPs

The Township's Public Works Department will be responsible for managing the annual operation and maintenance of the proposed stream restoration project. Typical operation and maintenance activities for the stream restoration projects include:

- Post construction inspection to verify that vegetation is established;
- Inspection of vegetation and other stream restoration features after significant storm events:
- Replanting of vegetation, as necessary; and,
- Repair of stream restoration features, as necessary. If there is structural failure of a
  project feature, the Township will evaluate the cause of the failure and modify the design
  or construction methods if necessary.

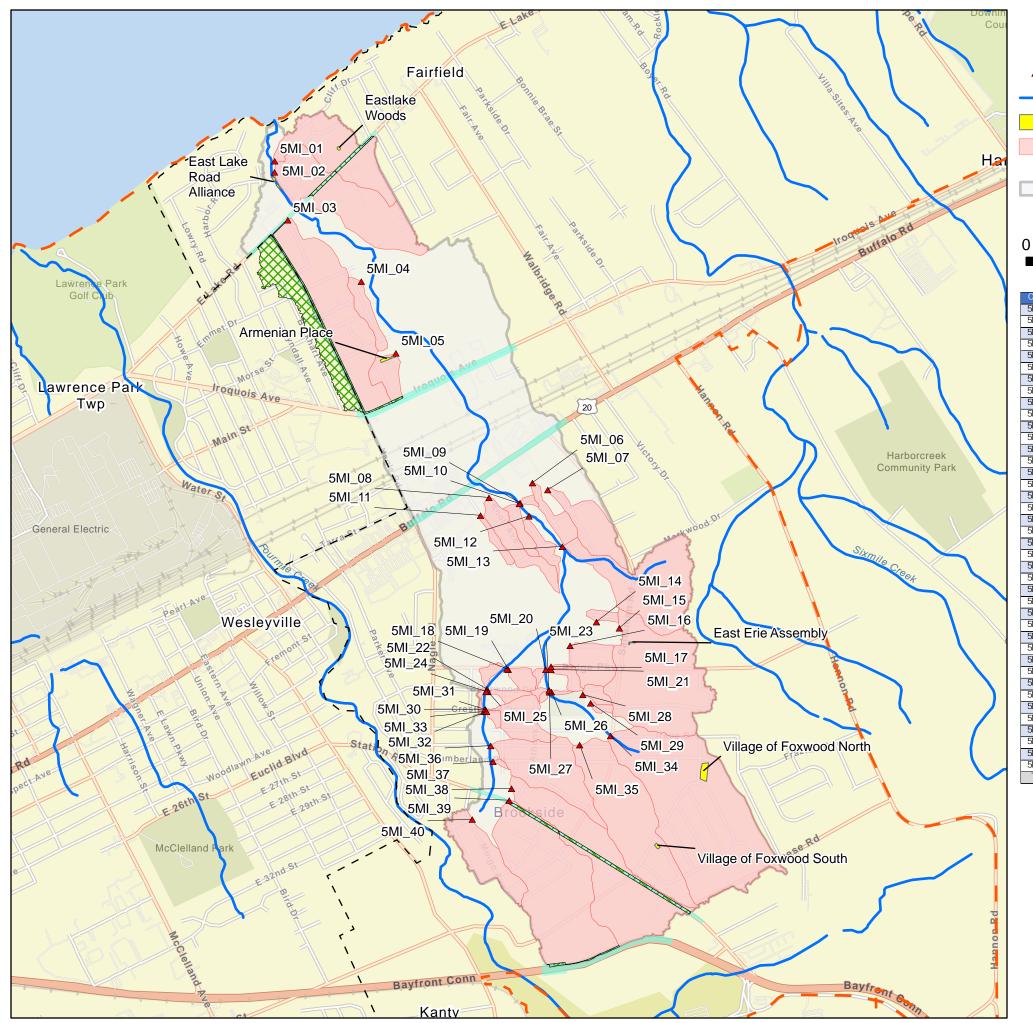
### Appendix A

### **Public Participation Documentation**

Harborcreek Township Pollutant Reduction Plan Draft – August 9, 2022

### Appendix B

### **Pollutant Reduction Plan Map**



## Pollution Reduction Plan Map

Township Outfalls Parsed Areas Stream River PennDOT Roads [ ] Harborcreek Boundary Existing Stormwater Facilities 2010 Census Urbanized Area

Five Mile Creek Watershed (Shaded areas are not draining to Township storm sewer infrastructure)

Township Planning Area

14/000	

Out all	Full Sewershed Area (ac)	Parsed Area (ac)	Total Planning Area (ac)	Pervious Planning Area (ac)	Impervious Planning Area (ac)
5MI_01	34.62	0.97	33.64	24.02	9.62
5MI_02	48.73	0.73	48.00	39.36	8.64
5MI_03	83.94	29.96	53.98	44.98	9.00
5MI_04	7.01	0.00	7.01	4.97	2.05
5MI_05	7.89	0.19	7.70	4.68	3.02
5MI_06	6.74	0.00	6.74	4.10	2.64
5MI_07	17.16	0.00	17.16	12.48	4.67
5MI_08	13.04	0.00	13.04	9.91	3.13
5MI_09	0.92	0.00	0.92	0.52	0.40
5MI_10	4.97	0.00	4.97	3.82	1.15
5MI_11	296	0.00	2%	1.99	0.97
5MI_12	5.04	0.00	5.04	296	2.08
5MI_13	47.24	0.00	47.24	41.65	5.60
5MI_14	2.27	0.00	2.27	1.24	1.03
5MI_15	69.75	0.00	69.75	56.48	13.26
5MI_16	12.65	0.00	12.65	9.29	3.36
5MI_17	0.55	0.00	0.55	0.35	0.20
5MI_18	2.23	0.00	2.23	1.55	0.68
5MI_19	3.83	0.00	3.83	292	0.91
5MI_20	1.02	0.00	1.02	0.62	0.40
5MI_21	2.87	0.00	287	209	0.78
5MI_22	0.10	0.00	0.10	0.04	0.06
5MI_23	0.76	0.00	0.76	0.47	0.28
5MI_24	0.59	0.00	0.59	0.43	0.16
5MI_25	2.42	0.00	2.42	1.66	0.77
5MI_26	0.48	0.00	0.48	0.11	0.38
5MI_27	0.60	0.00	0.60	0.43	0.16
5MI_28	2.95	0.00	295	1.81	1.14
5MI_29	1.27	0.00	1.27	0.63	0.64
5MI_30	0.02	0.00	0.02	0.01	0.01
5MI_31	12.84	0.00	12.84	9.31	3.53
5MI_32	1.32	0.00	1.32	0.98	0.34
5MI_33	0.15	0.00	0.15	0.08	0.07
5MI_34	115.25	0.00	115.25	88.07	27.18
5MI_35	59.43	0.00	59.43	50.00	9.43
5MI_36	32.38	0.00	32.38	23.44	8.94
5MI_37	0.53	0.00	0.53	0.36	0.17
5MI_38	65.58	3.19	62.39	54.89	7.50
5MI_39	81.59	1.90	79.69	66.26	13.43
5MI_40	21.43	0.00	21.43	15.88	5.55
Total	775.13	36.94	738.19	584.85	153.35

Pervious Sediment Load (lb/yr)	Impervious Sediment Load (lb/yr)
154,962	282,011

### **Appendix C**

### **Existing BMP Documentation**



#### **COMMONWEALTH OF PENNSYLVANIA** DEPARTMENT OF ENVIRONMENTAL PROTECTION **BUREAU OF WATERSHED MANAGEMENT**

OFFICI	AL USE ONLY
ID# <i>MG0Z</i>	2002511024
Date Received _	7/26/2011

### PERMIT APPLICATION NOTICE OF INTENT FOR COVERAGE **UNDER THE GENERAL (PAG-02) NPDES PERMIT**

### APPLICATION FOR AN INDIVIDUAL NPDES PERMIT FOR STORMWATER DISCHARGES ASSOCIATED WITH CONSTRUCTION ACTIVITIES

PLEASE READ THE PERMIT SUMMARY SHEET AND INSTRUCTIONS PROVIDED IN THIS PERMIT APPLICATION PACKAGE BEFORE COMPLETING THIS FORM. COMPLETE THE ATTACHED CHECKLIST AND APPROPRIATE WORKSHEETS ATTACHED AFTER APPENDIX C OF THIS PERMIT APPLICATION. COMPLETE ALL APPLICABLE WORKSHEETS REFERENCED IN THE APPLICATION CHECKLIST.

### PLEASE PRINT OR TYPE INFORMATION IN BLACK OR BLUE INK

CHECK APPROPRIATE BOX	GENEI	RAL 🗌	INDIVIDUAL [		
APPLICATION TYPE	NEW Z	RENEWAL [	MAJOR	MODIFICATION	PHASED [
	SE	ECTION A. APPLIC	ANT INFORMA	TION	
Applicant's Last Name		First Nam	ie MI	Phone 7	16 688-8640
CLUNIE		GAR		FAX	
Email Address	UNIE @	CLOULACONS		1 6004	
Organization Name or Reg	gistered Fictitiou	s Name		Phone	
AFFORDARLE	SENIOR	14005126	Opportu	UITIES FAX OF	ZIP + 4
Mailing Address		City	\$ \$'	State	ZIP + 4
**		3. 4.		NY	14221
348 HARRIS	Hicck	<u>CAO Willian</u>	ASUKLL	Employer ID (EIN)	
Co-Applicant's Last Name	(if applicable)	First Name		MI Phone	
				FAX	
Email Address					
Organization Name or Reg	istered Fictitious	s Name		Phone	
				FAX	
Mailing Address		City		State	ZIP + 4
					1
	SECTION	B. PROJECT INFORM	NATION AND SIT	E ANALYSIS	
	ARBORCREI		Housine		
2. Total Project Site (Acres):	9.1				
3. Total Disturbed Area (Acre	es): <u>1.8</u>	NAME OF THE OWNER OWNER OWNER OF THE OWNER OWNE			
4. Project Description					
☐ Residential Subdivisi	ion	☐ Sewerage/Wa	iter System	☐ Private	Road/Residence
Commercial/Industria		☐ Public Road	• , •	<u> </u>	ment Facility
☐ Utility Facility/Transn		☐ Recreational			iation/Restoration

5. Project Location or Physical Address (if available):										
	4400 EAST	LAKE ROAD - 1	TORMER HARBORS	CRER MALL S	ite					
6.	County	Municipality		City Boro	Twp					
	grandening S. 192	HARBORCRE			.⊠t					
	EREC	MARBORCRA								
7.	Latitude: 42 % 9	<u>"/ 33.5"</u> Lo	ongitude: <u>80°</u> /	0 4 48 41.1						
	Collection Method:   El	MAP 🗌 HGIS 🗌 G	ISDR 🗌 ITPMP 🚶	🛮 GPS 🗌 WAAS	LORAN					
	Check the horizontal reference datum (or projection datum) employed in the collection method. EMAP and HGIS (PNDI) have known datum and do not require checking here. ☐ NAD27 ☐ NAD83 ☐ WGS84 (GEO84)									
Ent	er the date of collection if the	lat and long coordinates we	re derived from GPS, WA	AS or LORAN. 🏸 mm	dd <u>2011</u>					
8.	U.S.G.S. Quad Map Name	ERIE NORTH	kuji							
9.	Existing and Previous Uses	of the Land Proposed for Co	onstruction (use separate	sheet if necessary):						
Exi	sting Land Uses: 🔲 Ag	griculture	odland 🔎 Barren	☐ Urban ☐ Brow	nfield					
De	scription: <u>Repeuc</u>	SOMENT SITE	MOST OF S	ITE CONSISTS C	F PAUCHENT					
	evious Land Uses:									
De	scription: Forme	R HARBONCREE	« MALL SITE							
	. Site Analysis									
	b. Identify naturally occurring geologic formations or soil conditions that may have the potential to cause pollution during earth disturbance activities and include BMPs to avoid or minimize potential pollution and its impacts from the formation.									
11.	. Potential Toxic or Hazardo provides a potential for cont	ous Pollutants: (Submit the aminated runoff from the pro	e following data if soil co	ontaminant, geology or pa Use additional sheets	ast or present land use if necessary.					
	Pollutant	Concentration w/Units	Source	Sample Type	Date(s) / Number of Samples					
	. Fill Material									
Ba rea	sed on a cut/fill analysis o ad the instructions before c	f the project site, will the ompleting this section. C	site need to import fill, lean Fill <u>can not</u> be place	export fill or will the site ed in or on waters of the	e balance? Be sure to Commonwealth.					
Ch	neck the appropriate box									
	fill imported to the site identify the operator(s)	or will, in most situations, b meets the department's defi responsibility and provide th	inition of clean fill. The plant the definition of Clean Fill a	an designer must include a and Environmental Due Dili	note on the drawings to gence.					
	determine that any fill e	nt is responsible for perform exported from the site will be	e certified as clean fill.		lication was submitted to					
	☐ Balance all cuts and fills with the amount of rock and soil available on the site.									

13. Estimated Tim	etable for Phased Project	s Build Out (Complete	for phased projects of	only)		
Phase No.	D	on a file of the state of	T-4.1.0	Disturbed	01-15	
or Name		pe of Activity	Total Area	Area	Start Date	End Date
gelio	DRUZLOP SIT	<u> </u>	7.1	7.8	9/2011	6/2012
14. Stormwater Di	scharges to nearest recei	ving stream (during co	enstruction) Check a	Il that annly:		
		inicipal Separate Storr	,	ite Storm Sewe	r 🗀 Non Sur	face Waters 🗌
	ers According to Category					_
			u vvater Quality Morii	toring and Asse	essment Report [	_
	npaired list type of impair	I				
Receiving Water/M		(Designated use)	g Water Classification	n: Existing Designate	`	erent from the
Fire Mic	e Creek			- 455,		
Name of Municipal	Storm Sewer Operator:	Name of Private Sto	WF JMP	Other (in	cluding off-site d	lischarges)
•			como: apa;aia;	3 (	oldanig on olda	noonargoo)
HARBORG	CRECK TOWNSHIP					
Will you meet CG-1	1? ☑Yes ☐ No					
•	•					
	d to use worksheets 11 th					
	FION C. E & S AND Positions of the state of					
and their app	ef summary of propose plication do not follow nual, provide documen	the guidelines ref	erenced in the Pa	a. Ērosion an	d Sediment P	ollution Control
E & S BMPs						
		anama Car	and the second and a			
reapor.	STABLLIZED (		Entarios 6	9	/ M	e
	AREA, COSCRETI	. Washing		QUIPINENT I	HATLEIAC	)TORAGE
	Concern					ment leap
I LEMA	LANDSCAPE R	ZSTORATION	STORMWATER	DETENTIO	o Pena, Ve	GETATED SW.
	SERDING, R.	PRAP, COS	CHAMBER	+ STR	KET SWE	EPINC
possible) or mi biological and	nformation - The PCSM nimize point source disch chemical qualities of the the Pa. Stormwater BMF	arges to surface water receiving surface wat	rs, preserve the integ er. <b>The DEP reco</b> m	rity of stream o	hannels, and pro	tect the physical.
Design standar	ds applied to develop the	PCSM Plan. Check t	hose that apply.			
the Munic	an - The attached PCSM cipal or County Engine s referenced in the applic	eer should be prov	ided with the appl	<b>lication.</b> Con	nplete and subr	nit all applicable
Complete the necessary)	following table for all a	pplicable approved A	ct 167 Stormwater	Management I	Plans. (use ad	ditional sheets if
ACT 167 P	Plan Name	Dat	e Adopted	Cons	istency Letter Inc	cluded 🗌
				Cons	istenc <b>y</b> Letter Pe	nding 🗌

		The attached PCSM plan is consistent with all apprendiction of the Discharge Stormwater Through a Municifrom the Municipal or County Engineer should worksheets referenced in the application checklist a	pal Separate Storm Sewer Syste be provided with the applicati	m) ordinances. A letter of consistency
		Complete the following table for all applicable Munic	cipalities. (use additional sheets if	necessary)
		Municipality Name	Ordinance Number	Consistency Letter Included
				Consistency Letter Pending
The	PC	SM Plan must satisfy either subparagraph A, B <u>or</u> C	below. Check those that apply.	
	A.	Act 167 Plan approved on or after January requirements pertaining to rate, volume, and DEP on or after January 2005.	2005 – The attached PCSM P water quality from an Act 167 St	lan, in its entirety, is consistent with all brimwater Management Plan approved by
	В.	Manager The PCSM Plan meets the standard design crit	eria from the PA Stormwater BMP	Manual.
	or			
	C.	☐ Alternative Design Standard – The attached Demonstrate/explain in the space provided h 102.8(g)(2) or will maintain and protect existing	now this standard will be either i	more protective than what is required in
3.	Rin	parian Buffers		
0,	-			wiffer as a next of this project?
	A.	Will you be protecting, converting or establishing a ☑ Yes ☐ No	npanan buner of a npanan lorest i	ouner as a part or this project?
	В.	If the regulations require a riparian buffer or ripa provisions in the Chapter 102 regulations, additional documentation to demonstrate reas	Section $102.14(d)(2)(i)-(vi)$ , t	hat you are requesting and provide
	C.	Will you be protecting, converting or establishing a	voluntary riparian forest buffer as	part of this project? ☐ Yes ☐ No
		If yes you must include a Riparian Forest Buffer Ma	anagement Plan as part of the PCS	SM plans.

4. Summary Table for Supporting Calculation and Measurement Data
Please reference the Stormwater Methodology used (Numbers generated in this table should be consistent with worksheets 1-5.)

	Pre-construction	Post Construction	Net Change
Design storm frequency 2 YEAR inches			
Impervious area (acres)	1 5.89	2 4.20	3-1.69
Volume of stormwater runoff  acre-feet or  cubic feet without planned stormwater BMPs (check appropriate box)	4 73,222	5 70,827	6 - 2,398
Volume of stormwater runoff  acre-feet or  cubic feet with planned stormwater BMPs (check appropriate box)		<sup>7</sup> 30,600	8 - 43,222
Stormwater peak discharge rate for the design frequency storm (cubic feet per second)	9 14.94	10	11 - 13.69

- **Box 1. Pre-construction impervious area**: The total acres of impervious area on the project site before construction activities begin, based on land use for five years preceding the planned project.
- Box 2. Post construction impervious area: The total acres of impervious area on the project site after construction activities have been completed.
- Box 3. Net change of impervious area: The difference between the acres of impervious area listed in Box 1 and Box 2. Zero or negative values are acceptable.
- **Box 4. Pre-construction stormwater runoff volume without planned BMPs**: The amount of stormwater runoff volume from the project site that would result from the design storm occurrence before construction activities begin, based on land use for five years preceding the project.
- Box 5. Post construction stormwater runoff volume without planned BMPs: The amount of stormwater runoff volume from the project site that would result from the design storm occurrence after construction activities have finished assuming that no stormwater infiltration or retention BMPs have been installed.
- **Box 6. Net change in stormwater volume without planned BMPs**: The difference between the amounts of stormwater runoff volume listed in Box 4 and Box 5.
- **Box 7. Post construction stormwater runoff volume with planned BMPs**: The amount of stormwater runoff volume from the project site that would result from the design storm occurrence after construction activities have finished and the planned stormwater infiltration or retention BMPs have been installed.
- Box 8. Net change in stormwater runoff volume with planned BMPs: The difference between the amounts of stormwater runoff volume listed in Box 4 and Box 7.
- Box 9. Pre-construction stormwater discharge rate: The stormwater runoff discharge rate for the design frequency storm as determined by the land use for the past five years.
- Box 10. Post construction stormwater discharge rate: The stormwater runoff discharge rate for the design frequency storm event after all planned stormwater BMPs are installed.
- **Box 11. Net change stormwater discharge rate**: The difference between the stormwater runoff discharge rates listed in Box 9 and Box 10.

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5. Summary Description of Post Construction Stormwater BMPs (consistent with the design or applicable worksheets)								
Key: RC = Rate Control	VC = Volume Control	WQ = Water	Quality					
In the lists below, check the BMPs identified in the may be checked for a BMP. List the stormwater PCSM Plan is not listed below, describe it in the specified by the second seco	volume and area of runoff to be							
ВМР	Function(s)	Volume of stormwater treated	Acres treated					
☐ Wet ponds	☐ VC ☐ RC ☐ WQ							
☐ Constructed wetlands	□ VC □ RC □ WQ							
☐ Retention basins	□ VC □ RC □ WQ							
☐ Detention basin	☐ VC 🔀 RC 🖾 WQ		7.9 ACRES					
Underground detention	□ VC □ RC □ WQ							
☐ Dry Extended detention basin	□ VC □ RC □ WQ							
☐ Sediment fore bay	□ VC □ RC □ WQ							
☐ Infiltration trench	☐ VC ☐ RC ☐ WQ							
☐ Infiltration Berm/Retentive Grading	☐ VC ☐ RC ☐ WQ							
☐ Subsurface Infiltration bed	□ VC □ RC □ WQ							
☐ Infiltration basin	□ VC □ RC □ WQ		:					
Pervious pavement	□ VC □ RC □ WQ							
☐ Dry well/Seepage pit	□ VC □ RC □ WQ							
☐ Bio-infiltration areas	☐ VC ☐ RC ☐ WQ							
Rain gardens/Bio-retention	□ VC X RC X WQ		1.1 AERRS					
☐ Vegetated swales	☑ VC ☑ RC ☑ WQ		O.8 ACRES					
☐ Constructed filters	□ VC □ RC □ WQ							
☐ Protect Sensitive & Special Value Features	☐ VC ☐ RC ☐ WQ							
☐ Protect/Convert/Establish Riparian buffers	☐ VC ☐ RC ☐ WQ							
Restoration: Buffers/ Landscape/Floodplain	VC RC WWQ		1.69 ACRES					
☐ Disconnection from storm sewers	☐ VC ☐ RC ☐ WQ		0.33 ACRES					
☐ Rooftop disconnection	U VC KRC WWQ		0.33 ACRES					
☐ Vegetated roofs	☐ VC ☐ RC ☐ WQ							
☐ Runoff capture/Reuse	☐ VC ☐ RC ☐ WQ							
Oil/grit separators	☐ WQ							
☐ Water quality inserts/inlets	☐ WQ							
☐ Street sweeping	₩Q		PAULO AREAS					
Other	☐ VC ☐ RC ☐ WQ							
Other	□ VC □ RC □ WQ							
6. Off Site Discharge Analysis								
Does the project propose any off-site disc	harges to areas other than	surface waters? 🗌 Ye	s No					
If yes, the applicant must have appropudischarge.	riate easement that provid	des the legal authorit	y for this off-site					
Applicant must provide a demonstration i erosion, damage, or nuisance to off-site pr		l plans that the discha	rge will not cause					

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7. Thermal Impa	cts A	nalv	'SIS
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Please explain how thermal impacts associated with this project were avoided, minimized, or mitigated.

THE SITE WILL BE LESS IMPERVIOUS AS PROPOSED AS THAN IT WAS AS HARBORCREEK MALL. ADDITIONALLY, AS MUCH BUILDING AS POSSIBLE WAS DISCONNECTED FROM THE STORM SKWER AND THE DETENTION POND IS OVER-SIZED TO STORE RUNOFF AS LONG AS POSSIBLE.

- 8. Identify the critical stages of implementation of the PCSM plan for which a licensed professional or designee shall be present on site:
  - . PRIOR TO CLEARING TO ENSURE PROPER INSTALLATION OF BMP'S
  - WEEKLY OR AFTER A O.S" RAINFALL EVENT
  - DURING INSTALLATION OF THE CDS CHAMBER AND CONSTRUCTION OF THE RAINES GARDEN.
  - AT FINAL GRADING PRIOR TO FINAL RESTORATION
  - AFTER ESTABLISHMENT OF VEGETATIVE GROUND COVER TO CKAT REMOVAL OF TEMPORARY BMP'S.

#### SECTION D. ANTIDEGRADATION ANALYSIS MODULE

This Section is to be completed for Special Protection Watershed Only. (HQ/EV and EV Wetlands)

#### PART 1 NON-DISCHARGE ALTERNATIVES EVALUATION

The applicant must consider and describe any and all non-discharge alternatives for the entire project area which are environmentally sound and will:

- Minimize accelerated erosion and sedimentation during the earth disturbance activity
- Achieve no net change from pre-development to post-development volume, rate and concentration of pollutants in water quality

Use Only	PCSM Plan	Official Use Only
	Check off the environmentally sound non-discharge Best Management Practices (BMPs) listed below to be used after construction that have been incorporated into your PCSM Plan based on your site analysis. For BMPs not checked, provide an explanation of why they were not utilized. (attach additional sheets if necessary)	
	Non-discharge BMPs	
	☐ Alternative Siting	
	<del></del>	
	Riparian Buffers (150 ft min)	
	Riparian Forest Buffer (150 ft min)	
	☐ Infiltration	
		Use Only  PCSM Plan  Check off the environmentally sound non-discharge Best Management Practices (BMPs) listed below to be used after construction that have been incorporated into your PCSM Plan based on your site analysis. For BMPs not checked, provide an explanation of why they were not utilized. (attach additional sheets if necessary)  Non-discharge BMPs  Alternative Siting  Alternative location  Alternative configuration  Alternative location of discharge  Low Impact Development (LID / BSD)  Riparian Buffers (150 ft min)  Riparian Forest Buffer (150 ft min)

#### Part 2 Antidegradation Best Available Combination of Technologies (ABACT)

If the net change in stormwater discharge from or after construction is not fully managed by non-discharge BMPs, the applicant must utilize ABACT BMPs to manage the difference. The Applicant must specify whether the discharge will occur during construction, post-construction or both, and identify the technologies that will be used to ensure that the discharge will be a non-degrading discharge. ABACT BMPs include but are not limited to:

		Official Use			Official Use
	E & S Plan	Only		PCSM Plan	Only
	Treatment BMPs:  Sediment basin with skimmer  Sediment basin ratio of 4:1 or greater (flow length to basin width)  Sediment basin with 4-7 day detention  Flocculants  Land disposal:  Vegetated filters  Riparian buffers <150ft.  Riparian Forest Buffer <150ft.  Immediate stabilization  Pollution prevention:			Treatment BMPs:  Infiltration Practices  Wet ponds Created wetland treatment systems Vegetated swales Manufactured devices Bio-retention/infiltration Green Roofs Land disposal: Vegetated filters Riparian Buffers <150ft. Riparian Forest Buffer <150ft.	
	<ul> <li>□ PPC Plans</li> <li>□ Street sweeping</li> <li>□ Channels, collectors and diversions lined with permanent vegetation, rock, geotextile or other non-erosive materials</li> <li>Stormwater reuse technologies:</li> <li>□ Sediment basin water for dust control</li> <li>□ Sediment basin water for irrigation</li> <li>Other</li> </ul>			□ Disconnection of roof drainage □ Bio-retention/bio-infiltration  Pollution prevention: □ Street sweeping □ Nutrient, pesticide, herbicide or other chemical application plan alternatives □ PPC Plans □ Non-structural Practices □ Land Preservation □ Restoration BMPs  Stormwater reuse technologies: □ Cisterns □ Rain barrels □ Dry hydrant with underground storage □ Spray/Drip Irrigation  Other	
Are the ABACT BMPs selected sufficient to minimize E & S discharges to the extent that existing or designated surface water uses are protected?  Yes No. If no, and the project is located in a HQ water, proceed to Part 3.			net o surfa Y	the ABACT BMPs selected sufficient to achieve no change to the extent that existing or designated ace water uses are protected?  Yes No. If no, and the project is located in a water, proceed to Part 3.	

#### Part 3 Social or Economic Justification (SEJ) (for projects in high quality waters only)

If the applicant cannot demonstrate that the net change in discharge will protect the existing quality of the receiving surface waters, for projects in HQ waters, the applicant may pursue the SEJ process for demonstrating that lowering water quality is necessary to accommodate important economic or social development in the area in which the waters are located, in accordance with Chapter 10 of the Water Quality Antidegradation Implementation Guidance Manual, DEP Document ID No. 391-0300-002.

SECTION E. CONSULTANT FOR THIS PROJECT							
Last Name	First Name	MI					
HOZFLER	Davaco )	T					
Title SENIOR PROJECT ENCINEER	Consulting Firm						
SENIOR PROJECT ENCINEER	WM SCHUM & ASSOCIATES						
	32-Conservation & C.						
	lear De						
Mailing Address							
37 CENTRAL AVENUE							
City	State ZIP+4						
CANCASTER	NY 14086						
Email	Phone 716 - 683 -53						
PHOEFLEKE WASCHUTT. COM	FAX 7/6-683-6	>169					
SECTION	F. COMPLIANCE HISTORY REVIEW						
Is/was the applicant(s) in violation of any permits	issued by DEP or any regulated activities wit	thin the past five years?					
☐ Yes     No							
If yes, list each permit or project that is/was in	violation and provide compliance status of	the activity (use additional sheets to					
provide information on all permits).		. ,					
Permit Program or Activity:	Permit Numbe	r (if applicable):					
Brief description of non-compliance:							
Steps taken to achieve compliance	Date(s) Compliance Act	nieved					
·	', '						
Current Compliance Status: 💹 In-Compliance	☐ In Non-Compliance						
If the applicant is not in compliance with any p	ermit requirement of DEP Regulations or	regulated activity, provide a narrative					
description of how the applicant will achieve comp compliance with appropriate milestones.	bilance with the permit requirement or activit	y, including the schedule for achieving					

		5	SECTION G. PERM	II COORDINATI	ON		40.00	
	es the applicant (own- litional planning requi	er and/or operator) havirements?	ve, have pending, o	r require any othe	er environmen	ital permits for t	:his project a	nd any
	Yes No If	yes, list each permit or	r approval, permit ու	umber, and descr	ription.			1
Co	ordination Questi	ons						
1.	Does the project in along, across, or pr	nvolve any of the follo rojecting into a water c	owing: Placement o course, floodway or l	of fill, excavation body of water (inc	within or a pl cluding wetlan	acement of a s	structure loca	ated in,
	☐ Yes   No	If yes, identify which	authorization under	Chapter 105 is a	applicable.			,
	☐ Joint Permit		☐ General Perm	nit		] Waiver		
2.	What is your 53 disturbance activ	37 Plan status? P vity.	lease note that	537 Plan appro	oval is requi	ired prior to	initiation of	earth
		•						
3.	Is your project as	ssociated with a Brov	wnfield's Remedia	tion? □ Yes	No If	yes, pleas	se indicate	any
J.	• • •	te with the Environmen			7 1	, , , , , , , , , , , , , , , , , , , ,		,
				4				
4.	Are there any ad	lditional permits or a	pprovals that may	be required for	this project?	Yes [	☐ No If ye	∋s,
	please list them.	ARBORCRECK	C D	Accessor				
	lown or t	1ARBORCREEK	DITE ILAN	/ IPPROVA S	te-			

#### SECTION H. CERTIFICATION

#### **Applicant Certification**

I certify under penalty of law that this application and all related attachments were prepared by me or under my direction or supervision by qualified personnel to properly gather and evaluate the information submitted. Based on my own knowledge and on inquiry of the person or persons directly responsible for gathering the information, the information submitted is, to the best of my knowledge and belief, true, accurate and complete. The responsible official's signature also verifies that the activity is eligible to participate in the NPDES permit, and that BMP's, E&S Plan, PPC Plan, PCSM Plan, and other controls are being or will be, implemented to ensure that water quality standards and effluent limits are attained. I am aware that there are significant penalties for submitting false information, including the possibility of fine and imprisonment or both for knowing violations pursuant to Section 309(c)(4) of the Clean Water Act and, 18 Pa. C.S. §§4903-4904.

4.
Co-Applicant (if applicable)
Print Name and Title of Person Signing
Telephone Number of Person Signing
Signature of Co-Applicant
Date Signed
S SOCIATES NY 14086 S) 683-0169
Commonwealth of Pennsylvania
County of
NOTARY
NOTARY SEAL



## COMMONWEALTH OF PENNSYLVANIA DEPARTMENT OF ENVIRONMENTAL PROTECTION BUREAU OF WATERSHED MANAGEMENT

# APPLICATION CHECKLIST GENERAL NPDES PERMIT FOR STORMWATER DISCHARGES ASSOCIATED WITH CONSTRUCTION ACTIVITIES

Please check the following list to make sure that you have included all the required information. Place a check mark in the column provided for all items completed and/or provided. Failure to provide all of the requested information will delay the processing of the application and may result in the application being placed ON HOLD with NO ACTION, or being considered withdrawn and the application file closed.

THIS CHECKLIST MUST BE COMPLETED AND ENCLOSED WITH YOUR GENERAL PERMIT APPLICATION FORM

	✓CHECKLIST FOR NEW GENERAL NPDES PERMIT APPLICATION				Official Use Only
1.	Fully completed, properly signed and notarized Notice 2 copies).	Included			
2.	Complete Erosion and Sediment Control Plans. (3 copies) Location: Drawings (D), Narrative (N).				
	Written Narrative (Must be labeled "E&S Plan" or "Erosion & Sediment Control Plan", be complete & legible, and be the final plan for construction)  Written Narrative Includes the following:	Location <u>N</u>	Page	Q	
	i. USGS map with outline of project site	Location <u>N</u>	Page <u>Fig. 1</u>	N	.0-
	ii. Soils information (including hydric soils) Types, depth, slope and locations of soils	Location <u>N</u>	Page App €	Ø	
	iii. Physical characteristics and limitations of soils	Location N	Page <u>A∞</u> €	囟	
	iv. Supporting calculations to show anticipated peak flows for the design storms	Location <u>N</u>	Page App I		
	v. Analysis of the impact that runoff from the project site will have on existing downstream watercourses resistance to erosion	Location <u>N</u>	Page Page		<u>/</u>
	vi. Provide supporting calculations, standard worksheet, and narrative description of the location for all proposed E&S Control BMPs used before, during and after earth disturbance including but not limited to the following:				
	A. Channels	Location N	Page		
	B. Sediment Basins	Location <u>N</u>	Page	_ □µ/L	
	C. Sediment Traps	Location <u>N</u>	Page		
	D. Filter Fabric Fencing	Location <u>N</u>	Page		
	E. Outlet Protection	Location N	Page		
	F. Other BMPs (Specify)	Location <u>N</u>	Page		
	/ TEMPORARY SOLL STOCKPILE CONCRETE				

WASHOUT PIT, EQUIPMENT / MATERIAL
STORAGE & TEMPORARY STABLUSED
-1-

Proposed Harborcreek Senior Apartments (T) Harborcreek — Erie County, PA 4400 East Lake Road



#### COMMONWEALTH OF PENNSYLVANIA DEPARTMENT OF ENVIRONMENTAL PROTECTION BUREAU OF WATERSHED MANAGEMENT

OFFICIAL I	USE ONLY
1D# 8A602	0025 12002
Date Received	2-10-12

# PERMIT APPLICATION NOTICE OF INTENT FOR COVERAGE UNDER THE GENERAL (PAG-02) NPDES PERMIT OR

### APPLICATION FOR AN INDIVIDUAL NPDES PERMIT FOR STORMWATER DISCHARGES ASSOCIATED WITH CONSTRUCTION ACTIVITIES

PLEASE READ THE PERMIT SUMMARY SHEET AND INSTRUCTIONS PROVIDED IN THIS PERMIT APPLICATION PACKAGE BEFORE COMPLETING THIS FORM. COMPLETE THE ATTACHED CHECKLIST AND APPROPRIATE WORKSHEETS ATTACHED AFTER APPENDIX C OF THIS PERMIT APPLICATION. COMPLETE ALL APPLICABLE WORKSHEETS REFERENCED IN THE APPLICATION CHECKLIST.

PLEASE PRINT OR TYPE INFORMATION IN BLACK OR BLUE INK

CHECK AF	PROPRIATE BOX	X GENERA	AL 🗵	INDIVIDUAL []		
APPLICAT	ION TYPE	NEW 🗵	RENEWAL	MAJOR MOD	IFICATION [	PHASED 🗌
		SEC	CTION A. APPLICA	NT INFORMATION		
Applica	ınt's Last Name		First Name	MI	Phone	614-396-3200
Coop	er, Jr.		David		FAX	614-396-3243
Email /	Address Dcooper	r@wodagroup.com				
Organi	zation Name or Re	egistered Fictitious	Name		Phone	614-396-3200
Arnem	an Place LP				FAX	
Mailing	Address		City		State	ZIP + 4
229 Hu	ber Village Road		Westerville		ОН	43081
				Empl	oyer ID (EIN)	
Co-App	olicant's Last Name	e (if applicable)	First Name	MI	Phone	
					FAX	
Email /	Address	-				
Organi	zation Name or Re	egistered Fictitious	Name		Phone	
					FAX	·
Mailing	Address		City		State	ZIP + 4
n estimati es que su establecia de establecia.						
		SECTION B	. PROJECT INFORMA	ATION AND SITE ANA	ALYSIS	
1. Projec	Name: Arnemai	n Place			2000	
2. Total P	roject Site (Acres)	: 12.2				
3. Total D	isturbed Area (Ac	res): <u>6.5</u>				
4. Project	Description					
			ovie theater. The pro Immunity center and			construction of 50
⊠ Re	sidential Subdivi	sion	☐ Sewerage/Wat	er System	☐ Private	e Road/Residence
□ Co	mmercial/Industi	rial	☐ Public Road		☐ Gover	nment Facility
☐ Uti	lity Facility/Trans	smission	Recreational		☐ Reme	diation/Restoration

	5. Project Location or Physical	Address (if available):		Na.000.00000000000000000000000000000000			
	The project is located on the	e North side of Iroquois Ave	nue (SR 0955) just east of	Nagle Road			
	6. County Erie	Municipality Harborcreek		City Boro	Twp ⊠		
	7. Latitude: 42 °/ 09  Collection Method: ⊠ E  Check the horizontal reference known datum and do not re  Enter the date of collection if the B. U.S.G.S. Quad Map Name	MAP	datum) employed in the c NAD27	O '/ 20 "  GPS	S DLORAN and HGIS (PNDI) have 84)		
	Existing and Previous Uses     Existing Land Uses:	of the Land Proposed for C griculture	· ·	sheet if necessary):	wnfield		
		griculture	oodland Barren	Urban Brov	wnfield 🛛 Other		
<ul> <li>a. Describe how Natural Resources features on the site (Worksheets 2 were considered in: Location and Design of the project, E &amp; S Plan necessary)</li> <li>The wetlands on-site that are to be mitigated has been minimized to that are to remain and the new wetlands are to be protected during corb.</li> <li>b. Identify naturally occurring geologic formations or soil conditions that disturbance activities and include BMPs to avoid or minimize potential N/A</li> </ul>				neest extent practical and ion and placed in a conse have the potential to cau on and its impacts from the	attach additional sheet if the the existing wetlands evation easement. use pollution during earth e formation.		
	11. Potential Toxic or Hazardo provides a potential for con	aminated runoff from the pr	e following data if soil co oject site) N/A   T	ontaminant, geology or p Use additional sheet	s if necessary.		
	Pollutant	Concentration w/Units	Source	Sample Type	Date(s) / Number of Samples		
	12. Fill Material  Based on a cut/fill analysis o read the instructions before c	f the project site, will the ompleting this section. C	site need to import fill, lean Fill <u>can not</u> be place	export fill or will the sit	te balance? Be sure to Commonwealth.		
	fill imported to the site	or will, in most situations, b meets the department's def responsibility and provide t	inition of clean fill. The pla	an designer must include :	a note on the drawings to		
	Export fill – the Applicant is responsible for performing environmental due diligence at the time this application was submitted to determine that any fill exported from the site will be certified as clean fill.						
☐ Balance all cuts and fills with the amount of rock and soil available on the site.							

Phase					Disturbed		
or Nar	me	Proposed Typ	pe of Activity	Total Area	Area	Start Date	End [
1		Development		12.2	6.5	04/12	10/13
			er en en antere en		- 1.1		
14. Storm	water Di	scharges to nearest receiv	ving stream (during co	nstruction). Check	all that apply:		
Water	s of the (	Commonwealth 🛛 Mu	ınicipal Separate Storn	n Sewer 🗍 Priv	ate Storm Sev	ver □ Non Su	rface Wate
		rs According to Category	•	-			
			<del>-</del>	vide dounty we	intoring and 710	occoment report	
		npaired list type of impairn	1				
-		/atershed Name:	Chapter 93 Receivin	g Water Classificati		Use (if diffented use)	erent fron
Five M	Mile Cree	<u>.</u>	(Designated use)		Designa	nea use)	
			CWF; MF				2·*****
	•	Storm Sewer Operator:	Name of Private Stor	rm Sewer Operator:	: Other:	including off-site (	discharges)
Harbo	rcreek T	ownship					
Will you me	eet CG-1	1? ⊠ Yes □ No	)	Saturda en la companya de la company			
•		d to use worksheets 11 th					
Trio, your	dieseyt Astronovicus	TION C. E & S AND PO					
watershed	d. de a bri	s involving multiple water	ed BMPs and their p	performance to m	anage E & S	for the project.	If E & S
1. Provide and the Program Manual E & S	de a britheir ap ram Mar ral. B BMPs		ed BMPs and their point the guidelines refutation to demonstra	performance to merenced in the Fite peformance ed	anage E & S	for the project. and Sediment F	If E & S Pollution C
1. Provide and the Program Manual E & S Non S Struct 2. PCSM possib biologic references	de a britheir apprant Marial.  S BMPs Structuratural - R  I Plan In ple) or midical and enced in	ef summary of propose plication do not follow nual, provide document al - Minimizing Disturbe	ed BMPs and their protection to demonstration demonstration to demonstration demonst	performance to merenced in the Fete performance enterprises of the performance enterprises of	anage E & S Pa. Erosion quivalent to, volume reduce	for the project. and Sediment F or better than, t	If E & S Pollution C he BMPs eliminate otect the pl
1. Provide and the Program Manual E & S Non S Struct  2. PCSM possib biologic reference Design	de a britheir appram Marial.  S BMPs Structuratural - R  I Plan In ble) or midical and enced in midal	ef summary of propose plication do not follow nual, provide document all - Minimizing Disturbed ock Construction Entrainmize point source discharge chemical qualities of the the Pa. Stormwater BMF rds applied to develop the	ed BMPs and their protection to demonstration demonstration demonstration demonstration demonstration demons	performance to merenced in the Fate performance enterprise to the performance to the performance enterprise to the performance enterprise enterprise to the performance enterprise ente	anage E & S Pa. Erosion quivalent to, volume reduce grity of strean mmends the	for the project. and Sediment F or better than, t  tion technologies, channels, and pr use of Control G	If E & S Pollution C he BMPs eliminate otect the planted
1. Provide and the Program Manual E & S Non S Struct  2. PCSM possib biologic refered Design	de a britheir appram Marial.  S BMPs Structuratural - R  I Plan Ir ble) or milical and enced in n standar	ef summary of propose plication do not follow nual, provide document al - Minimizing Disturbed ock Construction Entrainmize point source dischange point source	Plan should be desi arges to surface water receiving surface water PCSM Plan. Check to plan is consistent with eer should be prover the plan is consistent with eer should be prover the plan is consistent with eer should be prover the plan is consistent with eer should be prover the plan is consistent with eer should be prover the plan is consistent with eer should be prover the plan is consistent with eer should be prover the plan is consistent with eer should be prover the plan is consistent with eer should be prover the plan is consistent with ear should be plan in the plan is consistent with ear should be plan in the	gned to maximize rs, preserve the integer. The DEP recohis goal.  hose that apply.  an applicable apprided with the appreserve the apprided with the appreserve the apprided with the appreserve the appr	anage E & S Pa. Erosion quivalent to, volume reduce grity of strean mmends the oved Act 167 plication. C	for the project. and Sediment For better than, to better than, to better than, to be better than, to be better than, to be better than, to be better than better of complete and subsections.	eliminate otect the product all approximate all approximate all approximate the product th
1. Provide and the Program Manual E & S Non S Struct 2. PCSM possib biologic reference Design	de a britheir appram Marial.  B BMPs Structura tural - R  I Plan Ir ble) or mi ical and enced in n standar orksheet	ef summary of propose plication do not follow nual, provide document all - Minimizing Disturbed ock Construction Entrainmize point source dischanged in the Pa. Stormwater BMF and applied to develop the lan - The attached PCSM cipal or County Engine	ed BMPs and their proceed the guidelines reference to demonstration the demonstration to demonstration the process of the proce	performance to merenced in the Fite performance extends the performance extends the performance extends an applicable appropried with the apport the permit applicable appropried with the applicable appropried with the apport the permit applicable appropried with the a	anage E & S Pa. Erosion quivalent to,  volume reduce grity of strean mmends the  oved Act 167 plication. C ation for each	for the project. and Sediment For better than, to the sediment of the sediment	eliminate otect the plantal app
1. Provide and the Program Manual E & S Non S Struct    2. PCSM possibility po	de a britheir appram Marial.  S BMPs Structuratural - R  I Plan Ir ble) or mi ical and enced in n standar orksheet elete the sary)	ef summary of propose plication do not follow nual, provide document all - Minimizing Disturbed ock Construction Entrainmize point source dischanged entry and the Pa. Stormwater BMF ords applied to develop the lan - The attached PCSM cipal or County Engines referenced in the application.	ed BMPs and their proceed the guidelines reference to demonstration to demonstration to demonstration to demonstration to demonstration.  Plan should be designated to surface water receiving surface water receiving surface water PManual to achieve to PCSM Plan. Check to plan is consistent with the plan is con	performance to merenced in the Fite performance extends the performance extends the performance extends an applicable appropried with the apport the permit applicable appropried with the applicable appropried with the apport the permit applicable appropried with the a	volume reduced and the	for the project. and Sediment For better than, to the sediment of the sediment	eliminate otect the plantal applan.

		Permit to Discharge Stormwater Throughout the Municipal or County Engin	gh a Municipal Separate Storm Sewer Sy	agement ordinances, including MS4 (NPDES stem) ordinances. A letter of consistency cation. Complete and submit all applicable
		-	icable Municipalities. (use additional sheet	• •
		Municipality Name	Ordinance Number	Consistency Letter Included
*** -**		Harborcreek Township SWM Ordinance	1993	Consistency Letter Pending ⊠
The	∍ PC	SM Plan must satisfy either subparagrapl	h A, B or C below. Check those that apply	
	A.			Plan, in its entirety, is consistent with all Stormwater Management Plan approved by
	В.	□ The PCSM Plan meets the standard	d design criteria from the PA Stormwater B	MP Manual.
	OR	1		
	C.	Demonstrate/explain in the space	he attached PCSM plan was developed provided how this standard will be eithe tect existing water quality and existing and	using approaches other than 102.8(g)(2). er more protective than what is required in designated uses.
3.	Rip	parian Buffers		
	A.	Will you be protecting, converting or esta ☐ Yes ☐ No	ablishing a riparian buffer or a riparian fore:	st buffer as a part of this project?
	B.	provisions in the Chapter 102 reg	uffer or riparian forest buffer and you are gulations, Section 102.14(d)(2)( <i>i</i> )-( <i>vi</i> ), strate reasonable alternatives for comp	not providing one, please list the waiver, that you are requesting and provide liance with 102.14 requirements.
	C.	Will you be protecting, converting or esta	ablishing a voluntary riparian forest buffer a	as part of this project?   Yes   No
	0.	If you you must include a Dinarian Force	st Buffer Management Plan as part of the P	CSM plane

4. Summary Table for Supporting Calculation and Measurement Data
Please reference the Stormwater Methodology used (Numbers generated in this table should be consistent with worksheets 1-5.)
SCS

	Pre-construction	Post Construction	Net Change
Design storm frequency 2 yr  Rainfall amount 2.62 inches			
Impervious area (acres)	1 0	2 2.92	3 ÷2.92
Volume of stormwater runoff ☐ acre-feet or ☒ cubic feet without planned stormwater BMPs (check appropriate box)	4 19,063	5 35,048	6 +15,985
Volume of stormwater runoff ☐ acre-feet or ☒ cubic feet with planned stormwater BMPs (check appropriate box)		7 18,514	8 -549
Stormwater peak discharge rate for the design frequency storm (cubic feet per second)	9 6.6	10 2.4	11 -4.2

- **Box 1. Pre-construction impervious area**: The total acres of impervious area on the project site before construction activities begin, based on land use for five years preceding the planned project.
- **Box 2. Post construction impervious area**: The total acres of impervious area on the project site after construction activities have been completed.
- Box 3. Net change of impervious area: The difference between the acres of impervious area listed in Box 1 and Box 2. Zero or negative values are acceptable.
- **Box 4. Pre-construction stormwater runoff volume without planned BMPs**: The amount of stormwater runoff volume from the project site that would result from the design storm occurrence before construction activities begin, based on land use for five years preceding the project.
- Box 5. Post construction stormwater runoff volume without planned BMPs: The amount of stormwater runoff volume from the project site that would result from the design storm occurrence after construction activities have finished assuming that no stormwater infiltration or retention BMPs have been installed.
- Box 6. Net change in stormwater volume without planned BMPs: The difference between the amounts of stormwater runoff volume listed in Box 4 and Box 5.
- Box 7. Post construction stormwater runoff volume with planned BMPs: The amount of stormwater runoff volume from the project site that would result from the design storm occurrence after construction activities have finished and the planned stormwater infiltration or retention BMPs have been installed.
- Box 8. Net change in stormwater runoff volume with planned BMPs: The difference between the amounts of stormwater runoff volume listed in Box 4 and Box 7.
- **Box 9. Pre-construction stormwater discharge rate**: The stormwater runoff discharge rate for the design frequency storm as determined by the land use for the past five years.
- **Box 10. Post construction stormwater discharge rate**: The stormwater runoff discharge rate for the design frequency storm event after all planned stormwater BMPs are installed.
- **Box 11. Net change stormwater discharge rate**: The difference between the stormwater runoff discharge rates listed in Box 9 and Box 10.

<ul><li>Summary Description of Post Construction St</li><li>Key: RC = Rate Control</li></ul>	VC = Volume Control	WQ = Water	•
In the lists below, check the BMPs identified in the may be checked for a BMP. List the stormwater PCSM Plan is not listed below, describe it in the storms.	volume and area of runoff to b		
ВМР	Function(s)	Volume of stormwater treated	Acres treated
☑ Wet ponds	VC	16,492	5.03
Constructed wetlands	□ VC □ RC □ WQ	10,102	0.00
Retention basins	□ VC □ RC □ WQ		
Detention basin	□ VC □ RC □ WQ		
Underground detention	□ VC □ RC □ WQ		
Dry Extended detention basin	□ VC □ RC □ WQ		
Sediment fore bay	□ VC □ RC □ WQ		
Infiltration trench	☐ VC ☐ RC ☐ WQ		
Infiltration Berm/Retentive Grading	U VC □ RC □ WQ		
Subsurface Infiltration bed	□ VC □ RC □ WQ		
Infiltration basin	□ VC □ RC □ WQ		
Pervious pavement	VC RC WQ		4
Dry well/Seepage pit	□ VC □ RC □ WQ		
Bio-infiltration areas	□ VC □ RC □ WQ		
Rain gardens/Bio-retention	VC RC WQ		
Vegetated swales	VC RC WQ		
Constructed filters	□ VC □ RC □ WQ		
Protect Sensitive & Special Value Features	□ VC □ RC ☑ WQ		
Protect/Convert/Establish Riparian buffers	□ VC □ RC □ WQ		
Restoration: Buffers/ Landscape/Floodplain	□ VC □ RC ☑ WQ		
Disconnection from storm sewers	UVC RC WQ		
Rooftop disconnection	□ VC □ RC □ WQ		
Vegetated roofs	□ VC □ RC □ WQ		
Runoff capture/Reuse	□ VC □ RC □ WQ		•
Oil/grit separators			
∫ On/grit separators Ĵ Water quality inserts/inlets	U WQ ⊠ WQ		
Street sweeping	□ WQ		
Other	UVC □ RC □ WQ		
1 00	VC RC WQ	,	
Off Site Discharge Analysis  Does the project propose any off-site disc  If yes, the applicant must have approp discharge.  Applicant must provide a demonstration erosion, damage, or nuisance to off-site p	harges to areas other than riate easement that provi	des the legal authority	/ for this off-s

7.						
	Thermal Impacts Analysis					
	Please explain how thermal impacts associated with this project were avoided, minimized, or mitigated. As stated in various DEP references, the use of certain techniques can avoid, minimize and mitigate the effect of thermal impacts. Following are some examples of these techniques that have been incorporated into the site development design. These include: 1) reductions in the impervious footprint of the project 2) Planting Trees					
			M plan for which a licensed professional or designed Mitigation C. Pipe Trench Plugs in Wetland areas.	ee shall be		
	SECTION D. AN	TIDEGRAD	OATION ANALYSIS MODULE	,		
			ection Watershed Only. (HQ/EV and EV Wetland	s)		
PAR	RT 1 NON-DISCHARGE ALTERNATIVES EVA	ALUATION				
		and all non	-discharge alternatives for the entire project area	which are		
envi	ronmentally sound and will:	ماسال ممانيا	the endly disturbence activity			
	<ul> <li>Minimize accelerated erosion and sediment</li> <li>Achieve no net change from pre-development</li> <li>water quality</li> </ul>		g the earth disturbance activity t-development volume, rate and concentration of po	ollutants in		
		Official		Official		
	E & S Plan	Use	DOSM Blon	Use		
		Only	PCSM Plan	Only		
Best be u	ck off the environmentally sound non-discharge t Management Practices (BMPs) listed below to used prior to, during, and after earth disturbance vities that have been incorporated into your E & S to based on your site analysis. For BMPs not		Check off the environmentally sound non-discharge Best Management Practices (BMPs) listed below to be used after construction that have been incorporated into your PCSM Plan based on your site analysis. For BMPs not checked, provide an applicability of why they were not utilized.			
Plan	cked, provide an explanation of why they were utilized. (attach additional sheets if necessary)		explanation of why they were not utilized. (attach additional sheets if necessary)			

#### Antidegradation Best Available Combination of Technologies (ABACT) Part 2 If the net change in stormwater discharge from or after construction is not fully managed by non-discharge BMPs, the applicant must utilize ABACT BMPs to manage the difference. The Applicant must specify whether the discharge will occur during construction, postconstruction or both, and identify the technologies that will be used to ensure that the discharge will be a non-degrading discharge. ABACT BMPs include but are not limited to: Official Official Use Use **PCSM Plan** Only E & S Plan Only Treatment BMPs: Treatment BMPs: Infiltration Practices Sediment basin with skimmer Sediment basin ratio of 4:1 or greater (flow Wet ponds length to basin width) Created wetland treatment systems Sediment basin with 4-7 day detention Vegetated swales Flocculants Manufactured devices Land disposal: Bio-retention/infiltration Vegetated filters Green Roofs Riparian buffers <150ft. Land disposal: Riparian Forest Buffer <150ft. Vegetated filters Immediate stabilization Riparian Buffers <150ft. □ Pollution prevention: Riparian Forest Buffer <150ft. **PPC Plans** Disconnection of roof drainage Street sweeping Bio-retention/bio-infiltration Channels, collectors and diversions lined with Pollution prevention: permanent vegetation, rock, geotextile or other Street sweeping non-erosive materials Nutrient, pesticide, herbicide or other chemical ☐ Stormwater reuse technologies: application plan alternatives Sediment basin water for dust control **PPC Plans** Sediment basin water for irrigation Non-structural Practices Other \_ Land Preservation $\Box$ Restoration BMPs Stormwater reuse technologies: Cisterns Rain barrels Dry hydrant with underground storage Spray/Drip Irrigation Other Are the ABACT BMPs selected sufficient to achieve no Are the ABACT BMPs selected sufficient to minimize net change to the extent that existing or designated E & S discharges to the extent that existing or designated surface water uses are protected? surface water uses are protected? Yes No. If no, and the project is located in a If no, and the project is located ☐ No. in a HQ water, proceed to Part 3. HQ water, proceed to Part 3. Part 3 Social or Economic Justification (SEJ) (for projects in high quality waters only)

If the applicant cannot demonstrate that the net change in discharge will protect the existing quality of the receiving surface waters, for projects in HQ waters, the applicant may pursue the SEJ process for demonstrating that lowering water quality is necessary to accommodate important economic or social development in the area in which the waters are located, in accordance with Chapter 10 of the Water Quality Antidegradation Implementation Guidance Manual, DEP Document ID No. 391-0300-002.

Last Name	First Nan	ie		MI		
Sanford	Michael			G		
Title	Consultir	g Firm				
President		Surveying & Er	ngineering			
	P.C.			and the second s		
A. W. A. A.	WALLES OF THE STATE OF THE STAT			MARKE COST OF THE STATE OF THE		
Mailing Address						
4721 Atlantic Avenue	Chata	710 . 4				
City	State PA	ZIP+4				
Erie Email	PA	16506 Phone	814-835-0010	Ext		
		FAX	814-835-0010	EXI		
msanford@sanfordsurvey.com						
SE	ECTION F. COMPLIAN	ICE HISTORY	REVIEW			
☐ Yes ☒ No  If yes, list each permit or project that is provide information on all permits).	/was in violation and p	provide compli	ance status of the	activity (use additional she		
If yes, list each permit or project that is	/was in violation and p		ance status of the			
If yes, list each permit or project that is provide information on all permits).  Permit Program or Activity:	/was in violation and p					
If yes, list each permit or project that is provide information on all permits).  Permit Program or Activity:	/was in violation and p			applicable):		
If yes, list each permit or project that is provide information on all permits).  Permit Program or Activity:  Brief description of non-compliance:	/was in violation and p		Permit Number (if a	applicable):		
If yes, list each permit or project that is provide information on all permits).  Permit Program or Activity:  Brief description of non-compliance:	/was in violation and p		Permit Number (if a	applicable):		
If yes, list each permit or project that is provide information on all permits).  Permit Program or Activity:  Brief description of non-compliance:	/was in violation and p		Permit Number (if a	applicable):		
If yes, list each permit or project that is provide information on all permits).  Permit Program or Activity:  Brief description of non-compliance:			Permit Number (if a	applicable):		
If yes, list each permit or project that is provide information on all permits).  Permit Program or Activity:  Brief description of non-compliance:  Steps taken to achieve compliance	npliance □ In	Date(s) C	Permit Number (if a	applicable): ed		
If yes, list each permit or project that is provide information on all permits).  Permit Program or Activity: Brief description of non-compliance:  Steps taken to achieve compliance  Current Compliance Status:   In-Compliance with description of how the applicant will achie	npliance □ In	Date(s) C	Permit Number (if a	applicable): ed		

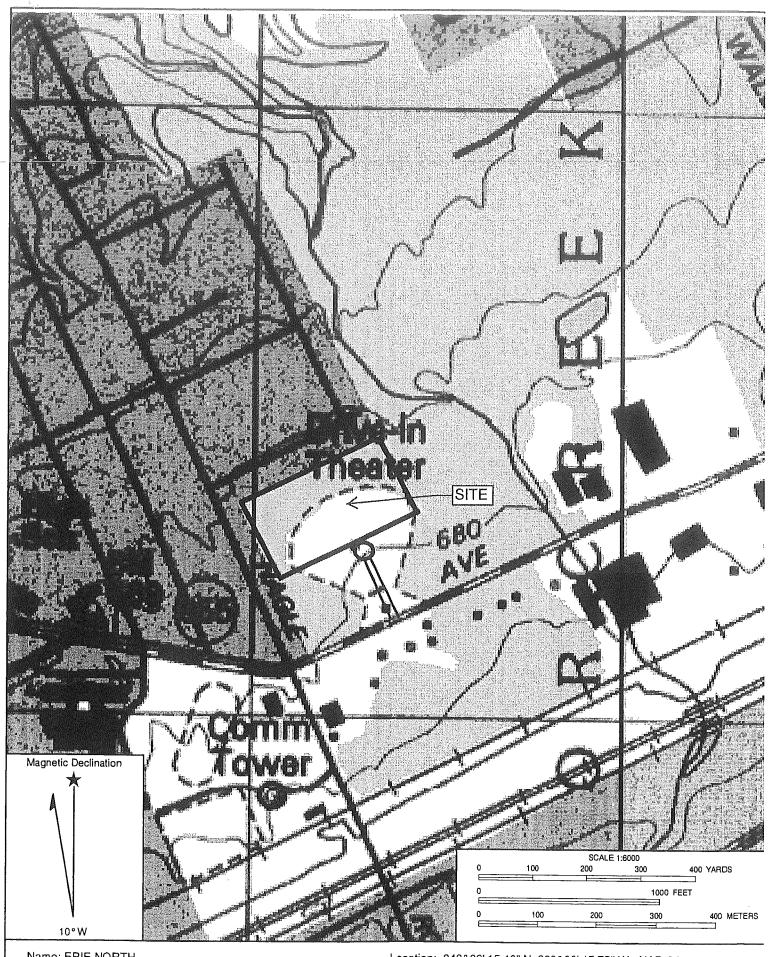
			SECTION G. PER	MIT COORDINATIO	ИС		
	Does the applicant (owner and/or operator) have, have pending, or require any other environmental permits for this project and any additional planning requirements?						
	☐ Yes ☑ No If yes, list each permit or approval, permit number, and description.						
		and the control of the second		and the second of the second o	e same a second contract of the		
Co	ordination Quest	tions					
1.			following: Placement	of fill, excavation	within or a placem	nent of a structure located in,	
			er course, floodway o				
	⊠ Yes ☐ No	If yes, identify wh	ich authorization unde	er Chapter 105 is ap	oplicable.		
			☐ General Per	mit	☐ Wa	iver	
2.	What is your 5 disturbance active Pending		Please note that	537 Plan appro	val is required	prior to initiation of earth	
						· ·	
3.	Is your project a	ssociated with a E	Brownfield's Remed	ation? 🗌 Yes 🏻 [	⊠ No If ye:	s, please indicate any	
	coordination to da	ate with the Environn	nental Cleanup Progra	am (Act 2 or Superfi	und).		
4.			r approvals that ma	y be required for t	this project?	Yes 🛛 No If yes,	
	please list them.	•					

### SECTION H. CERTIFICATION

## **Applicant Certification**

I certify under penalty of law that this application and all related attachments were prepared by me or under my direction or supervision by qualified personnel to properly gather and evaluate the information submitted. Based on my own knowledge and on inquiry of the person or persons directly responsible for gathering the information, the information submitted is, to the best of my knowledge and belief, true, accurate and complete. The responsible official's signature also verifies that the activity is eligible to participate in the NPDES permit, and that BMP's, E&S Plan, PPC Plan, PCSM Plan, and other controls are being or will be, implemented to ensure that water quality standards and effluent limits are attained. I am aware that there are significant penalties for submitting false information, including the possibility of fine and imprisonment or both for knowing violations pursuant to Section 309(c)(4) of the Clean Water Act and, 18 Pa. C.S. §§4903-4904.

Applicant	Co-Applicant (if applicable)
David Cooper, Jr. Member/General Counsel	
Print Name and Title of Person Signing	Print Name and Title of Person Signing
(614) 396-3200	
Telephone Number of Person Signing	Telephone Number of Person Signing
Signature of Applicant February 8, 2012	Signature of Co-Applicant
Date Signed	Date Signed
Please note below the name, address and telephone number of the individual th	·
Address:	
Telephone: () FAX: (	
Notarization:	Commonwealth of Pennsylvania
	County of Franklin
Sworn to and Subscribed to Before Me This	NOTARY
	SEAL SHAUNTEE SLONECKER NOTARY PUBLIC STATE OF OHIO Comm. Expires March 25, 2015 Recorded in Franklin County
Notary-Public	My Commission Expires: <u>March</u> 25, 2015



Name: ERIE NORTH

Date: 11/8/2011 Scale: 1 inch equals 500 feet

Location: 042.° 09' 15.40" N 080.° 00' 17.75" W NAD 27 Caption: Arneman Place

3930-PM-WM0035 Rev. 1/2006



# COMMONWEALTH OF PENNSYLVANIA DEPARTMENT OF ENVIRONMENTAL PROTECTION BUREAU OF WATERSHED MANAGEMENT

OFFICIAL USE ONLY
ID # PAG2002507008  Date Received 6/5/07

## NOTICE OF INTENT FOR COVERAGE UNDER THE GENERAL (PAG-2) NPDES PERMIT OR

APPLICATION FOR AN INDIVIDUAL NPDES PERMIT FOR STORMWATER DISCHARGES ASSOCIATED WITH CONSTRUCTION ACTIVITIES

RE	READ THE STEP-BY-STEP INSTRUCTIONS PROVIDED IN THIS PERMIT APPLICATION PACKAGE BEFORE COMPLETING THIS FORM.									
X	1 acre to less than 5 acres of disturbance with a point source discharge 5 acres or larger disturbance									
PL	EASE PRINT OF	TYPE INF	ORMATION	IN BLA	CK OR BL	UE INK.				
СН	IECK APPROPRIA	те вох	GENERA	L X		INDIVIDUA	AL [			
AP	PLICATION TYPE		NEW 🛚			RENEWAL			REVISED [	
	SECTION A. E&S PLANNING REQUIREMENTS									
1.	1. Total Project Area (Acres): 4.48 +/- Total Disturbed Area (Acres): 2.9 +/-					_				
2.	Project Name E	East La	ike Roa	d Al	liance	Churcl	า			
3.	3. Project Description Addition of an 8910 square foot addition to existing building with approx. 42600 sf of parking.									
	☐ Residential S	Bubdivision		□ S∈	ewerage/Wa	ater System		□P	rivate Road/Re	sidence
	▼ Commercial/	Industrial		☐ Public Road			□ G	overnment Fac	ility	
	Utility Facility	//Transmiss	ion	□ R€	ecreational			□R	emediation/Res	storation
4.	Please provide th and seconds (dd description of the	mm ss.ss) Cl	neck the collect	rdinates tion met	s for the cent shod used to	er of the proje determine the	ct. The lat an	e coordinate d long coord	s should be in de inates. See the i	grees, minutes nstructions for a
-	Latitude: <u>42</u>	<u>°</u> / <u>10</u>	<u>y 31.1 "</u>		Longitude:	<u>79 °</u> /	_59	y <u>08.4</u>	<del></del>	
	Collection Method	I: EMA	√P ☐ HGIS	s 🗆	GISDR	ITPMP		GPS [	] WAAS	] LORAN
	Check the horizor known datum and	ital reference do not requi	datum (or proj re checking he	jection or re. [	datum) empl ▼ NAD27	oyed in the co	llectior 3 3	n method. El ☐ W GS	MAP and HGIS (F 84 (GEO84)	PNDI) have
Ent	ter the date of colle	ction if the la	t and long coor	dinates	were derive	d from GPS, V	VAAS	or LORAN.	mm	dd yyyy
5.	U.S.G.S. Quad M	ap Name <u></u>	<u> Harborcre</u>	<u>ek, P</u>	A		_		,	
6.	Estimated Timeta	ole for Major	Construction A	ctivities	: (Phased p	rojects only)	NA	- no ph	asing is pro	posed
	Phase No. or Name		Description	1		Total Area		Disturbed Area	Start Date	End Date
-		· · · · · · · · · · · · · · · · · · ·	·							
<u> </u>					****					

Rev: 5/10/07

7. Existing and Previous Uses of the L Existing Land Uses: ☐ Agricultur Description: Lawn, building &	e 🗌 Forest/Wo		te sheet if necess	eary):	☐ Other
Previous Land Uses: Agricultur  Description: Field woodlot		odland 🔲 Barren	☐ Urban	☐ Brownfield	X Other
Potential Pollutants: (Submit the force contaminated runoff from the project)	ollowing data if soil t site) N/A 🔀	contaminant, geology of Use additional sheets	or past or presens if necessary.	nt land use provid	es a potential for
Pollutant	Concentration w/Units	Source	Sample	Type Da	ate(s) / Number of Samples
(1)					
(2)					
Clearly indicate the source/location of the in the E&S plan narrative what measure for pollution to surface waters of the Con	s are proposed to n	(s) on the Erosion and S nanage and control disc	ediment Control harges of these	L (E&S) Plan drawir pollutants to elimii	ngs, and describe nate the potential
9. Describe the type, source and locati Clean Fill is uncontaminated, non-water material, used asphalt, and brick, block recognizable as such. The term does authorized.  Check the appropriate box  All of the fill material placed on, diligence, was found to have no material and the results of anal owner of the property receiving	soluble, non-decome or concrete from control include mater or removed from the tabeen affected by a placed on, or remove. Any person placytical testing to quarter or concrete the control of the control	apposable, inert, solid matconstruction and demoliticials placed in or on the project site is Clean F spill or release of a region of the project site ing this fill on a property alify the material as cleans	terial. The term ion activities that e waters of the ill, that, upon the ulated substance te is Clean Fill the must use form Fan fill. A copy of	includes soil, rock is separate from Commonwealth performance of elements in the commonwealth in the commo	c, stone, dredged other waste and unless otherwise over the over the control of the fill o
<ol> <li>Summary of E&amp;S Control BMPs as of</li> <li>Silt fence</li> <li>Rock construction entrance</li> <li>Erosion Control Blanket Ch</li> </ol>	)	ed E&S Plan:			
11. Stormwater Discharges to (during co	,				
Waters of the Commonwealth [ 12. Receiving Water/Watershed Name: Unnamed tributary to Sixmile Cre	Name of Muni	pal Separate Storm Sev cipal Storm Sewer Oper	1	Private Storm Se	
13. Chapter 93 Receiving Water Classification:	Secondary Wa		Other:		

SECTION E	3. APPLICANT INFORMA	TION	
Applicant's Last Name	First Name	MI	Phone 814/898-2771
Rubeis	Richard	NA	fax <b>NA</b>
Organization Name or Registered Fictitious Name			Phone 814/898-2771
East Lake Road Alliance Church			fax <b>NA</b>
Mailing Address	City		State ZIP + 4
4500 East Lake Road	Erie		PA 16511
Co-Applicant's Last Name	First Name	MI	Phone
NA			FAX
Organization Name or Registered Fictitious Name			Phone
NA			FAX
Mailing Address	City		State ZIP + 4
NA			
SECTIO	ON C. SITE INFORMATION	٧	•
Site Name			
East Lake Road Alliance Church	<u> </u>		
Site Location			
4500 East Lake Road			
Site Location City	State ZIP+4		
Erie (Harborcreek Township)	PA 16511		
Detailed Written Directions to Site			
From US Route 5(East Lake R	oad) & PA Route	956 (	Iroquois Avenue)
<ul> <li>Intersection, proceed east on F</li> </ul>	Route 5 approxim	rately 2	2.44 miles to
site on left (north).			
,			
			. 1
County Municipality			City Boro Twp
Erie Harborcreek			
SECTION D. OTHER POLLUTANTS; PREP	AREDNESS PREVENTIO	N AND C	ONTINGENCY (PPC) PLAN
<ol> <li>Will chemicals, solvents, other hazardous waste of disturbance activities be used or stored on site?</li> </ol>			ause accidental pollution during earth n is required)

SECTION E. POST CONSTRUCTION STORMWATER MANAGEMENT (PCSM) PLAN  See the Attached Instructions on how to Complete This Section
All PCSM plans should be designed to maximize infiltration technology, eliminate or minimize point source discharges to surface waters, preserve the integrity of stream channels, and protect the physical, chemical and biological qualities of the receiving water. In addition to these water quality design features, all PCSM plans must comply with local water quantity or flood control requirements.
Check those that apply:
☐ The attached PCSM plan was developed to be consistent with an Act 167 Stormwater Management Plan approved by the Department after July 2001.
☐ The attached PCSM plan was developed to be consistent with existing local ordinances that satisfy the requirements of an MS4 (NPDES Permit to Discharge Stormwater Through a Municipal Separate Storm Sewer System) permit.
The attached PCSM plan was developed to employ water quality design features and BMPs that will manage any net increase in stormwater runoff volume resulting from the DEP recommended 2-year/24-hour frequency storm.
Please include the following as part of the PCSM plan:
a. A written narrative.
b. Plan drawings including construction details.
<ul><li>c. Identification and location of post construction stormwater management BMPs. Such BMPs should address:</li><li>• Infiltration</li></ul>
Volume and rate control
Water quality treatment
d. Operation and maintenance procedures.
e. Supporting calculations. (Supporting calculations and measurements are not required if the disturbed areas will be revegetated or otherwise stabilized with pervious material.)
2. Explain how post construction stormwater runoff volume will be managed if BMPs will not infiltrate the total net increase in stormwater runoff volume. (Net increase volume = Post construction runoff volume minus Pre-construction runoff volume):
N/A (check N/A only if BMPs will infiltrate all of the Net Change in Runoff)
3. Are there existing post construction stormwater management (PCSM) BMPs at this location/site? X YES  NO  Do you plan to use or expand any of these existing PCSM BMPs? YES X NO
List the existing PCSM BMPs that will be used or expanded.
List the existing PCSW BMPs that will be used or expanded.

Rev: 6/7/07

SUMMARY TABLE FOR SUPPORTING CALCULATION AND MEASUREMENT DATA  See the Instructions on how to Complete This Section							
Check this box if supporting calculations and measurements are NOT required in accordance with Section E.1.e on the preceding page.							
Design storm frequency 2-year/24-hour Rainfall amount 2,62 inches		Post Construction	Net Change				
Impervious area (acres)		0.8	2	2.06	+1.241		
Volume of stormwater runoff (acre-feet) without	ıt	0.31	 36	0.4808	÷0.1622		
planned stormwater BMPs Volume of stormwater runoff (acre-feet) with							
planned stormwater BMPs	= -			0.3186	+ 0.0		
Stormwater discharge rate for the design frequency storm (Cubic feet per second -cfs)		3.39	)	1.74	- 2.65		
	RIDTION			UCTION STORMWATER BMPs	12.		
5. In the lists below, check the BMPs ide function detention/retention; checking Il function may be checked for a BMP. Lis the PCSM Plan is not listed below, described to the process of	ntified in for infi	the PCS ltration/red mwater vo	M Plan. In charge; or colume and a	dicate the function(s) of the BMP checking <b>WQ</b> for water quality tre rea of runoff to be treated by each	atment. More than on e		
ВМР		Function	(s)	Volume of stormwater treated	Acres treated		
☐ Wet ponds	☐ DR	☐ IF	☐ WQ				
☐ Constructed wetlands	☐ DR	☐ IF	□ WQ				
☐ Retention basins	☐ DR	☐ IF	☐ WQ				
□ Detention basin	X DR	☐ IF	☐ WQ	0.3395	4.2		
★ Underground detention	X DR	🗶 IF	X WQ	0.2353	1.44		
☐ Extended detention basin	☐ DR	□ IF	□ WQ				
☐ Water quality fore bay	☐ DR	IF	☐ WQ				
☐ Infiltration trench	☐ DR	□ IF	□ wa				
☐ Infiltration bed	☐ DR	☐ IF	□ WQ				
☐ Infiltration basin	☐ DR	□ IF	□ wa				
Porous pavement	X DR	X IF	□ wa	0.2353	1.44		
☐ Dry well	☐ DR	☐ IF	□ WQ				
☐ Bio-infiltration areas	☐ DR	☐ IF	□ WQ				
Rain gardens/Bio-retention	☐ DR	☐ IF	□ wa				
X Vegetated filter swales	DR		X WQ	0.3188	1.44		
Sand/organic filters	DR	☐ IF	☐ WQ				
☐ Natural area conservation	☐ DR	☐ IF	□ wa				
Filter/buffer strips	☐ DR	☐ IF	□ wa				
Surfaces drain to vegetated areas	☐ DR	☐ IF	□ WQ				
☐ Downspouts to vegetated areas	☐ DR	☐ IF	□ WQ				
☐ Green roofs	☐ DR	□ IF	☐ WQ				
Cisterns/rain barrels	☐ DR	☐ IF	□ WQ				
Oil/grit separators	DR		□ wa				
Water quality inserts/inlets	DR	☐ IF	□ wa				
Street sweeping	☐ DR	☐ IF	□ wa				
Other	☐ DR	☐ IF	□ wa				
☐ Other	☐ DR	□ WQ					

Rev: 6/7/07

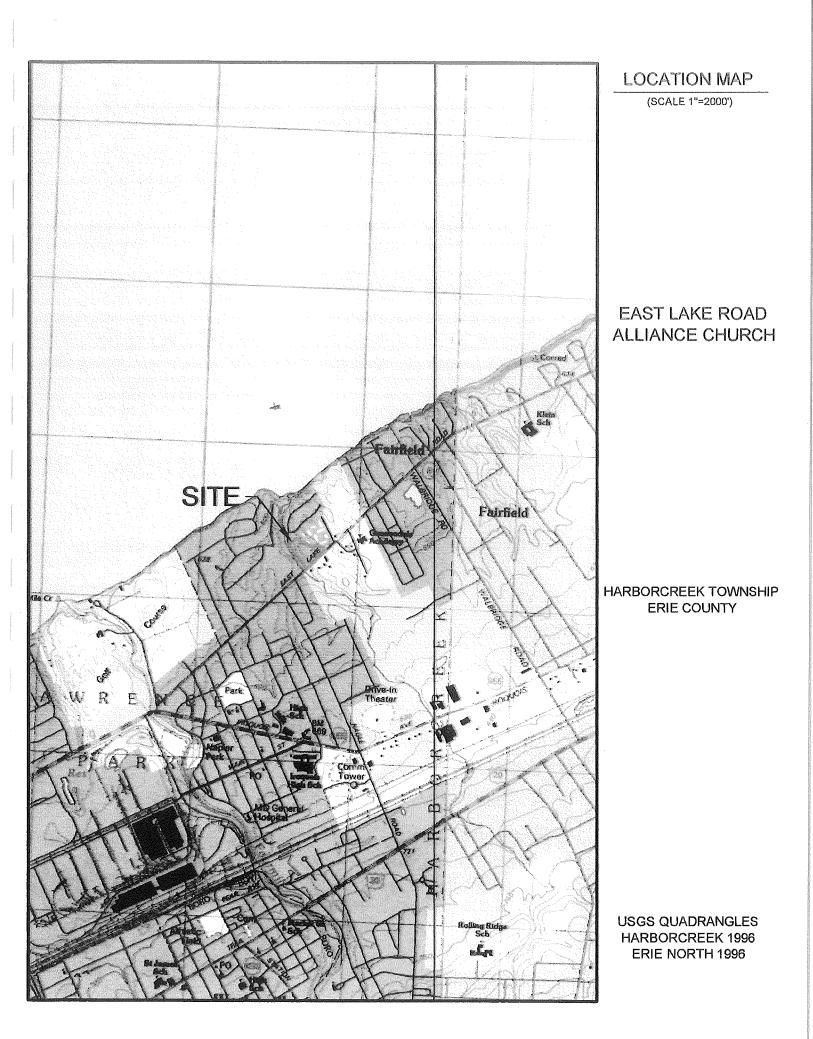
SECTION	VF. CONSULTAN	IT FOR THIS PROJECT	
Last Name	First Nam	e .	MI
Patterson	John K		
Title	Consulting		
Project Engineer	Lake Eng	lineering	
Mailing Address 140 Meadville Street			
City	State	ZIP+4	
Edinboro	PA	16412-2508	
Email		Phone 814/734-1414 E	Ext 02
john@lake-eng.com		FAX 814/734-4339	
SECTION G. PE	RMIT COORDINATION	ON AND COMPLIANCE REVIEW	
Does the applicant (owner and/or operator) hat IX Yes ☐ No If yes, list each permit		her Department permit or approval for umber, and description.	this project?
GP-4 Outfall			
·			
•			
Compliance History Review:			
Is/was applicant in violation of any permits iss	ued by DEP?	Yes X No	
If yes, list each permit that is/was in violation provide information on all permits).	on and provide com	pliance status of the permitted activi	ty (use additional sheets to
Permit Program:			
Permit Number:			
	•		
Brief description of Non-Compliance:			
Steps taken to achieve compliance and date(	s) compliance achiev	ved:	
			,
Current Compliance Status:		on-Compliance	
If the applicant is not in compliance with an Department, provide a narrative description or	ny environmental law f how the applicant w	w or regulation, permit, order or sch vill achieve compliance including the a	edule of compliance of the ppropriate milestones.
•			

SECTION	₩.	CERTIFICATION
---------	----	---------------

### **Applicant Certification**

I certify under penalty of law that this application and all related attachments were prepared by me or under my direction or supervision by qualified personnel to properly gather and evaluate the information submitted. Based on my own knowledge and on inquiry of the person or persons directly responsible for gathering the information, the information submitted is, to the best of my knowledge and belief, true, accurate and complete. The responsible official's signature also verifies that the activity is eligible to participate in the NPDES permit, and that BMP's, E&S Plan, PPC Plan, PCSM Plan, and other controls are being or will be, implemented to ensure that water quality standards and effluent limits are attained. I am aware that there are significant penalties for submitting false information, including the possibility of fine and imprisonment or both for knowing violations pursuant to Section 309(c)(4) of the Clean Water Act and, 18 Pa. C.S. §§4903-4904.

Applicant		Co-Applicant (i	f applicable)
Richard Rubeis, Pastor		NA	
Print Name and Title of Person Signing		Print Name and Title	e of Person Signing
(814) 898-2771	()		
Telephone Number of Person Signing		Telephone Number	of Person Signing
Signature of Applicant		Signature of 0	Co-Applicant
3/22/07			
Date Signed		Date S	igned
Please note below the name, address and telephone number of me: John K Patterson, PE - Lake Engagness:  140 Meadville Street, Edinbor	neering , PA 16412		additional information is required.
me: John K Patterson, PE - Lake Eng	neering , PA 16412 FAX: <u>(814)</u> 73	34-4339	
me: John K Patterson, PE - Lake Eng dress: 140 Meadville Street, Edinbor ephone: (814) 734-1414 x 02	neering , PA 16412 FAX: <u>(814)</u> 7:	34-4339 nonwealth of Pennsy	
me: John K Patterson, PE - Lake Eng dress: 140 Meadville Street, Edinbor ephone: (814) 734-1414 x 02	neering , PA 16412 FAX: <u>(814)</u> 7:	34-4339	
me: John K Patterson, PE - Lake Engagnes:  140 Meadville Street, Edinbor  Bephone: (814) 734-1414 x 02  Notarization:	neering , PA 16412 FAX: <u>(814)</u> 7:	34-4339 nonwealth of Pennsy ty of Erie	





# COMMONWEALTH OF PENNSYLVANIA DEPARTMENT OF ENVIRONMENTAL PROTECTION BUREAU OF WATERSHED MANAGEMENT

OFFICIAL USE ONLY					
ID# PAG 2002505004					
Date Received ///2/04					

# NOTICE OF INTENT FOR COVERAGE UNDER THE GENERAL (PAG-2) NPDES PERMIT OR

# APPLICATION FOR AN INDIVIDUAL NPDES PERMIT FOR STORMWATER DISCHARGES ASSOCIATED WITH CONSTRUCTION ACTIVITIES

Read the step-by-step instructions provided in this Permit Application Package before completing this form.								
□ 1 acre to less than 5 acres of disturbance with a point source discharge ⊠ 5 acres or larger disturbance								
PLEASE PRIN	T OR TYPE INFO	RMATION IN BLACK OR BI	_UE INK.					
CHECK APPRO	CHECK APPROPRIATE BOX GENERAL ⊠ INDIVIDUAL □							
APPLICATION TYPE NEW ☐ RENEWAL ☑ REVISED ☐						]		
SECTION A. E&S PLANNING REQUIREMENTS								
1. Total Project	t Acres: <u>68.90</u>		Total Disturbed	Acres: <u>12.99</u>				
2. Project Nan	ne							
VILLAGE (	OF FOXWOOD -	SECTION 7 & 8						
3. Project Des	cription							
CONSTRU	ICTION OF 48 SIN	GLE-FAMILY RESIDENTIAL	LOTS					
⊠ Resider	ntial Subdivision	☐ Sewerage/W	ater System	□ P	rivate Road/Re	sidence		
☐ Comme	rcial/Industrial	☐ Public Road			Sovernment Fac	cility		
Utility F	acility/Transmissio	n 🔲 Recreational		□R	emediation/Re	storation		
and seconds	de the latitude and los (dd mm ss.ss) Che of the collection meth	ongitude coordinates for the cer ck the collection method used to lods.	nter of the project. o determine the la	The coordinate	es should be in d dinates. See the	egrees, minutes instructions for a		
Latitude: 4	<u>2 °/ 07 '</u> /	49 " Longitude	: <u>79 °</u> / <u>59</u>	<u>'</u> / <u>05</u>	11			
Collection M	ethod: 🗌 EMAP	☐ HGIS 🏻 GISDR	☐ ITPMP [	☐ GPS [	☐ WAAS [	LORAN		
Check the h known datur	orizontal reference d n and do not require	atum (or projection datum) emp checking here.   NAD27	loyed in the collection	ction method. E		(PNDI) have		
Enter the date of	collection if the lat a	nd long coordinates were derive	ed from GPS, WA	AS or LORAN.	mm	dd yyyy		
	ad Map Name <u>HAR</u>							
6. Estimated Ti	metable for Major Co	onstruction Activities: (Phased	projects only)					
Phase No. or Name		Description	Total Acres	Disturbed Acres	Start Date	End Date		
PHASE 1	SUBDIVISION #7		7.39	4.71	JAN 05	JUNE 07		
PHASE 2	SUBDIVISION #8	3	8.69	8.28	JUNE 07	DEC 09		

7. Existing and Previous Uses of the L	and Proposed for 0	Constructio	on (use separate	sheet if neces	sary):		
Existing Land Uses: Agricultur	e ⊠ Forest/W	oodland	Barren	☐ Urban	☐ Brown	nfield 🗌 Other	
Description:							
Previous Land Uses: Agricultur	e 🛛 Forest/W	oodland	Barren	☐ Urban	☐ Brown	nfield	
Description:							
Potential Pollutants: (Submit the contaminated runoff from the project.)	following data if so t site) N/A ⊠	oil properti Use a	es, geology or p	past or preser if necessary.	nt land use p	rovides a potential	for
Pollutant	oncentration w/Units		Source	Sample	Туре	Date(s) / Number of Samples	r
(1)					Ī		
(2)							
Clearly indicate the source/location of th in the E&S plan narrative what measure for pollution to surface waters of the Cor	s are proposed to	t(s) on the manage a	Erosion and Se nd control discha	diment Contro arges of these	l (E&S) Plan pollutants to	drawings, and descri	be tial
9. Describe the type, source and locati	on of any fill mater	ials: Be s	ure to read the i	instructions b	efore comp	leting this section.	
<u>Clean Fill</u> is uncontaminated, non-water material, used asphalt, and brick, block recognizable as such. The term does authorized.	or concrete from	constructio	n and demolitio	n activities tha	it is separate	from other waste a	nd
Check the appropriate box							
All of the fill material placed on,	or removed from the	ne project	site is Clean Fill,	, that, upon the	e performanc	e of environmental d	ue
diligence, was found to <u>have no</u>	<u>t been</u> affected by	a spill or re	elease of a regul	ated substanc	e.		
Some or all of the fill material release of a regulated substance material and the results of ana owner of the property receiving	e. Any person pla ytical testing to qu	cing this fil alify the m	ll on a property n naterial as clean	nust use form fill. A copy o	FP-001 to ce	rtify the origin of the	fill
	` '			,.			
<ol> <li>Summary of E&amp;S Control BMPs as of FILTER FABRIC FENCE</li> </ol>	letailed in the attac	hed E&S F	Plan:				
GRASS-LINED SWALES							
STONE & CONCRETE BLOCK INLE	T PROTECTION						
SEDIMENT EMBANKMENT TRAPS							
11. Stormwater Discharges to (during co	nstruction):						
Waters of the Commonwealth [	☑ Munio	ipal Separ	ate Storm Sewe	r 🛛	Private	Storm Sewer 🔲	
12. Receiving Water/Watershed Name: UNT SIX MILE CREEK	Name of Mun		n Sewer Operate	or: Name of	Private Stor	m Sewer Operator:	
13. Chapter 93 Receiving Water Classification:  CWF, MF	Secondary W UNT SIX MILE			Other:			

	SECTION B.	APPLICAN	IT INFORMA	TION			
Applicant's Last Name		First Name		MI	Phone	e 8	14-899-7561
SHAFER		TIM			FAX		
Organization Name or Registe	red Fictitious Name				Phone	е	
TIM SHAFER & SONS CONST	FRUCTION				FAX		
Mailing Address		City			State	Z	IP + 4
211 PRESTON AVE,		ERIE			PA	16	3511
Co-Applicant's Last Name		First Name		MI	Phone	Э	
					FAX		
Organization Name or Registe	red Fictitious Name				Phone	9	
					FAX		
Mailing Address		City			State	ZI	P + 4
	SECTION	C. SITE IN	IFORMATIO	N			
Site Name							A STATE OF THE STA
VILLAGE OF FOXWOOD							
Site Location							
EAST SIDE OF ROUTE 430 JU	JST SOUTH OF COOPER R	OAD					
Site Location City		State	ZIP+4				
HARBORCREEK TWP ERI	E	PA					
Detailed Written Directions to S	Site						
I-90 TO EXIT 32 - NORTH ON THE EAST SIDE OF RT 430.	RT.430 / STATION ROAD AF	PROXIMAT	ELY 1.6 MILE:	S. VILLAC	GE OF F	oxwo	OD IS LOCATED ON
County	Municipality				City	Boro	Twp
ERIE	HARBORCREEK						$\boxtimes$
SECTION D. OTHER	POLLUTANTS; PREPAR	REDNESS	PREVENTIO	N AND C	ONTIN	GENC	Y (PPC) PLAN
1. Will chemicals, solvents	, other hazardous waste or r used or stored on site? Ye	materials tha	it_have the pot		cause a	ccident	ranningan kanpan kandingan berasa ambangsia malaysi in salah

# SECTION E. POST CONSTRUCTION STORMWATER MANAGEMENT (PCSM) PLAN See the Attached Instructions on how to Complete This Section

19990	See the Attached Instructions on now to Complete This Section					
pre	PCSM plans should be designed to maximize infiltration technology, eliminate or minimize point source discharges to surface waters, serve the integrity of stream channels, and protect the physical, chemical and biological qualities of the receiving water. In addition hese water quality design features, all PCSM plans must comply with local water quantity or flood control requirements.					
Che	eck those that apply:					
$\boxtimes$	The attached PCSM plan was developed to be consistent with existing local ordinances enacted under an Act 167 Stormwater Management Plan approved by the Department after July 2001.					
	The attached PCSM plan was developed to be consistent with existing local ordinances that satisfy the requirements of an MS4 (NPDES Permit to Discharge Stormwater Through a Municipal Separate Storm Sewer System) permit.					
	The attached PCSM plan was developed to employ water quality design features and BMPs that will manage any net increase in stormwater runoff volume resulting from a 2-year/ 24-hour frequency storm.					
1.	Please include the following as part of the PCSM plan:					
	a. A written narrative.					
	b. Plan drawings including construction details.					
	<ul><li>c. Identification and location of post construction stormwater management BMPs. Such BMPs should address:</li><li>• Infiltration</li></ul>					
	Volume and rate control					
	Water quality treatment					
	d. Operation and maintenance procedures.					
	e. Supporting calculations. (Supporting calculations and measurements are not required if the disturbed areas will be revegetated or otherwise stabilized with pervious material.)					
2.	Explain how post construction stormwater runoff volume will be managed if BMPs will not infiltrate the total net increase in stormwater runoff volume. (Net increase volume = Post construction runoff volume minus Pre-construction runoff volume):					
	☐ N/A (check N/A only if BMPs will infiltrate all of the Net Change in Runoff)					
	STORMWATER RUNOFF WILL BE DIRECTED TO GRASS-LINED SWALES ALONG THE REAR YARDS OF THE PPROPOSED LOTS. THESE SWALES WILL DIRECT RUNOFF TO THE EXISTING & PROPOSED STORM SEWER WHICH CONVEYS THE RUNOFF TO THE STORMWATER DETENTION POND.					
3.	Are there existing post construction stormwater management (PCSM) BMPs at this location/site?   YES  NO					
	Do you plan to use or expand any of these existing PCSM BMPs? XES NO					
	List the existing PCSM BMPs that will be used or expanded.					
	STORMWATER MANAGAMENT POND					
	EXISTING STORM SEWER FROM SECTIONS 3 & 4.					

				JLATION AND MEASUREMENT Complete This Section	T DATA
Check this box if supporting calculation page.	s and mea	asuremer	nts are NOT	required in accordance with Sectio	n E.1.e on the preceding
Design storm frequency Rainfall amount 2.62inches		Pre-con:	struction	Post Construction	Net Change
Impervious area (acres)		(	)	5.08	5.08
Volume of stormwater runoff (acre-feet) without	ut	1.1	19	0	1,119
planned stormwater BMPs Volume of stormwater runoff (acre-feet) with					
planned stormwater BMPs				1.378	1.378
Stormwater discharge rate for the design frequency storm		10.	.13	6.53	-3.6
SUMMARY DESC	RIPTION	OF POS	T CONSTR	UCTION STORMWATER BMPs	
5. In the lists below, check the BMPs idention detention/retention; checking I function may be checked for a BMP. List the PCSM Plan is not listed below, described by the PCSM Plan is not listed below.	F for infilest the stor	tration/ re mwater v	echarge; or olume and a	checking WQ for water quality tre area of runoff to be treated by each	atment. More than one
ВМР		Function	ı(s)	Volume of stormwater treated	Acres treated
☐ Wet ponds	☐ DR		☐ WQ		
☐ Constructed wetlands	☐ DR		☐ WQ		
Retention basins	☐ DR				
☑ Detention basin	□ DR				61.06
☐ Underground detention	☐ DR				
Extended detention basin	DR		☐ WQ		
☐ Water quality fore bay	☐ DR		☐ WQ		
☐ Infiltration trench	☐ DR	□ IF	☐ WQ		
☐ Infiltration bed	☐ DR	□ IF	☐ WQ		
☐ Infiltration basin	☐ DR	☐ IF	☐ WQ		
☐ Porous pavement	☐ DR	□ IF			
☐ Dry well	☐ DR	☐ IF			
☐ Bio-infiltration areas	☐ DR	☐ IF	□ WQ		
☐ Rain gardens/Bio-retention	☐ DR		☐ WQ		
		⊠ IF	⊠ WQ		3.87
☐ Sand/organic filters		☐ IF	□ WQ		
☐ Natural area conservation	☐ DR	☐ IF	☐ WQ		
☐ Filter/buffer strips	☐ DR	□ IF	☐ WQ		
☐ Surfaces drain to vegetated areas	☐ DR	□ IF	□ WQ		
☐ Downspouts to vegetated areas	☐ DR	□ IF	☐ WQ		
☐ Green roofs	☐ DR		□ WQ		
Cisterns/rain barrels	☐ DR				
Oil/grit separators			☐ WQ		
☐ Water quality inserts/inlets			□ WQ		
☐ Street sweeping			□ WQ		
Other	☐ DR	□ IF	□ WQ		
Other	☐ DR	□ IF	□ WQ		

	SECTION F. CONSULTAN	T FOR THE	S PROJECT	
Last Name	First Name	Э		MI
WELKA	JAMES		T.	
Title	Consulting	j Firm		
PRESIDENT	HENRY T.	WELKA AS	SOCIATES	
Mailing Address				
3200 WEST 32 <sup>ND</sup> STREET				
City	State	ZIP+4		
ERIE	PA	16506		
Email		Phone	8148333900	Ext
		FAX	8148339550	
SECTIO	N G. PERMIT COORDINATION	ON AND COI	VIPLIANCE REVIE	W
☐ Yes ⊠ No If yes, list eac	ch permit or approval, permit n	ambor, and	assonption.	
Compliance History Review: Is/was applicant in violation of any p If yes, list each permit that is/was provide information on all permits). Permit Program: Permit Number:	·		⊠ No s of the permitted	activity (use additional sheets to
Brief description of Non-Compliance	e .			
Steps taken to achieve compliance a	and date(s) compliance achiev	/ed:		
Current Compliance Status:	e with any environmental law	on-Complian v or regulatio vill achieve co	on, permit, order o	r schedule of compliance of the

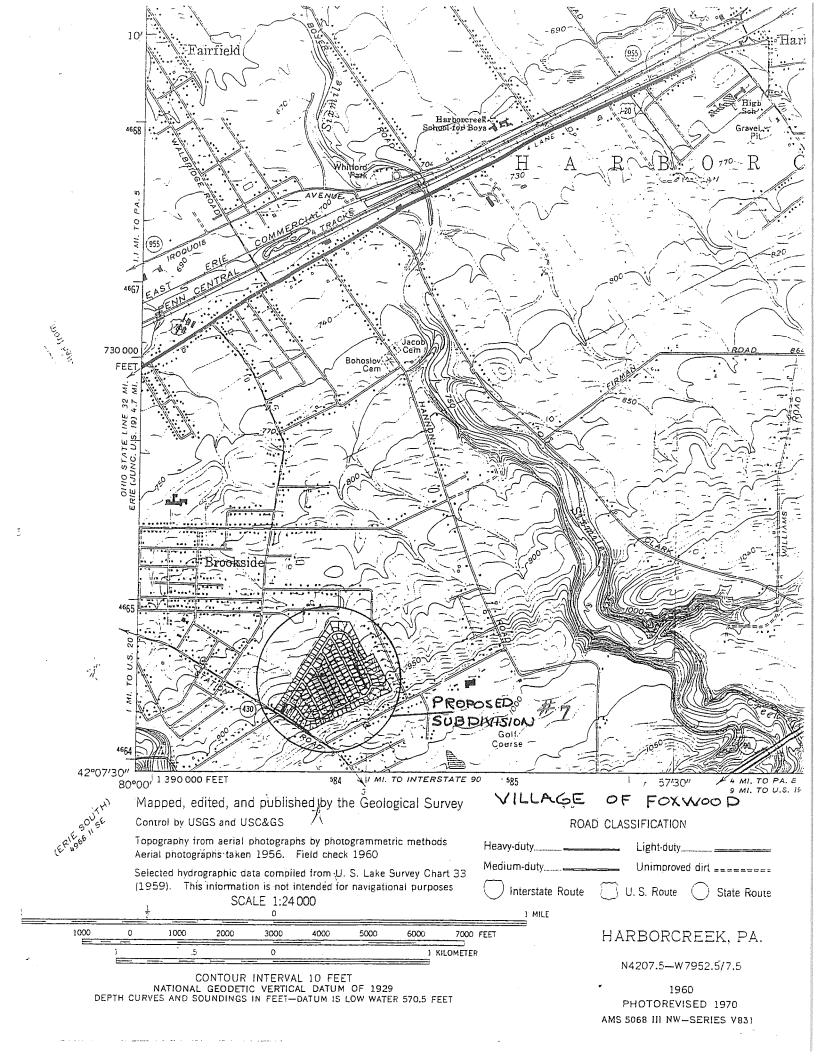
Notary Public

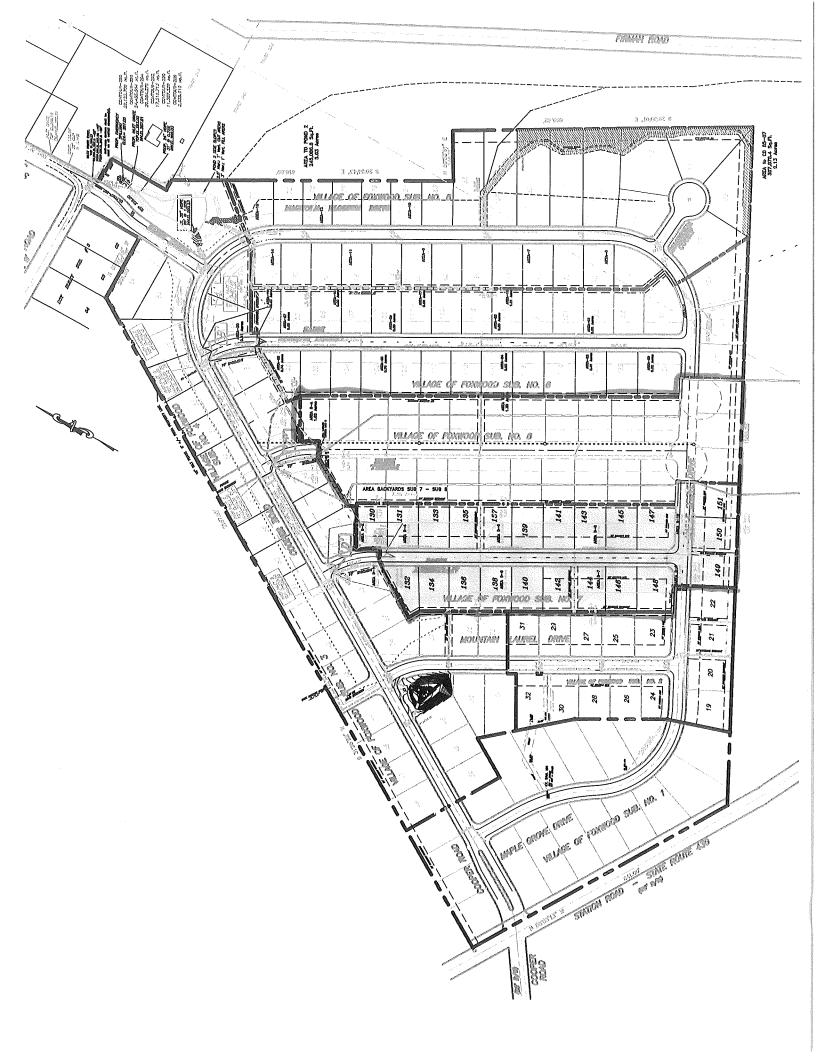
SECTION	H. CERTIFICATION
supervision by qualified personnel to properly gather and inquiry of the person or persons directly responsible for knowledge and belief, true, accurate and complete. The participate in the NPDES permit, and that BMP's, E&S implemented to ensure that water quality standards and experience.	all related attachments were prepared by me or under my direction or evaluate the information submitted. Based on my own knowledge and on gathering the information, the information submitted is, to the best of my responsible official's signature also verifies that the activity is eligible to Plan, PPC Plan, PCSM Plan, and other controls are being or will be effluent limits are attained. I am aware that there are significant penalties y of fine and imprisonment or both for knowing violations pursuant to \$\\$4903-4904.
Applicant	Co-Applicant (if applicable)
TIM SHAFER	
Print Name and Title of Person Signing	Print Name and Title of Person Signing
(814) 899-756/	()
Telephone Number of Person Signing	Telephone Number of Person Signing
Signature of Applicant	
Signature of Applicant	Signature of Co-Applicant
11-3-04	
Date Signed	Date Signed
Please note below the name, address and telephone number of the Name: HENRY To WEST 32ND. ST.	individual that should be contacted in the event additional information is required.
Telephone: (814) 833-3900	FAX: (8/4) B33-9550
Notarization:	Commonwealth of Pennsylvania  County of
Sworn to and Subscribed to Before Me This	
3 Day of /lovernier_, 2	0 0 4 NOTARY

SEAL

My Commission Expires:

NOTARIAL SEAL MARY LEE CHELLI, NOTARY PUBLIC ERIE, ERIE COUNTY, PENNA. MY COMMISSION EXPIRES MARCH 19, 2006





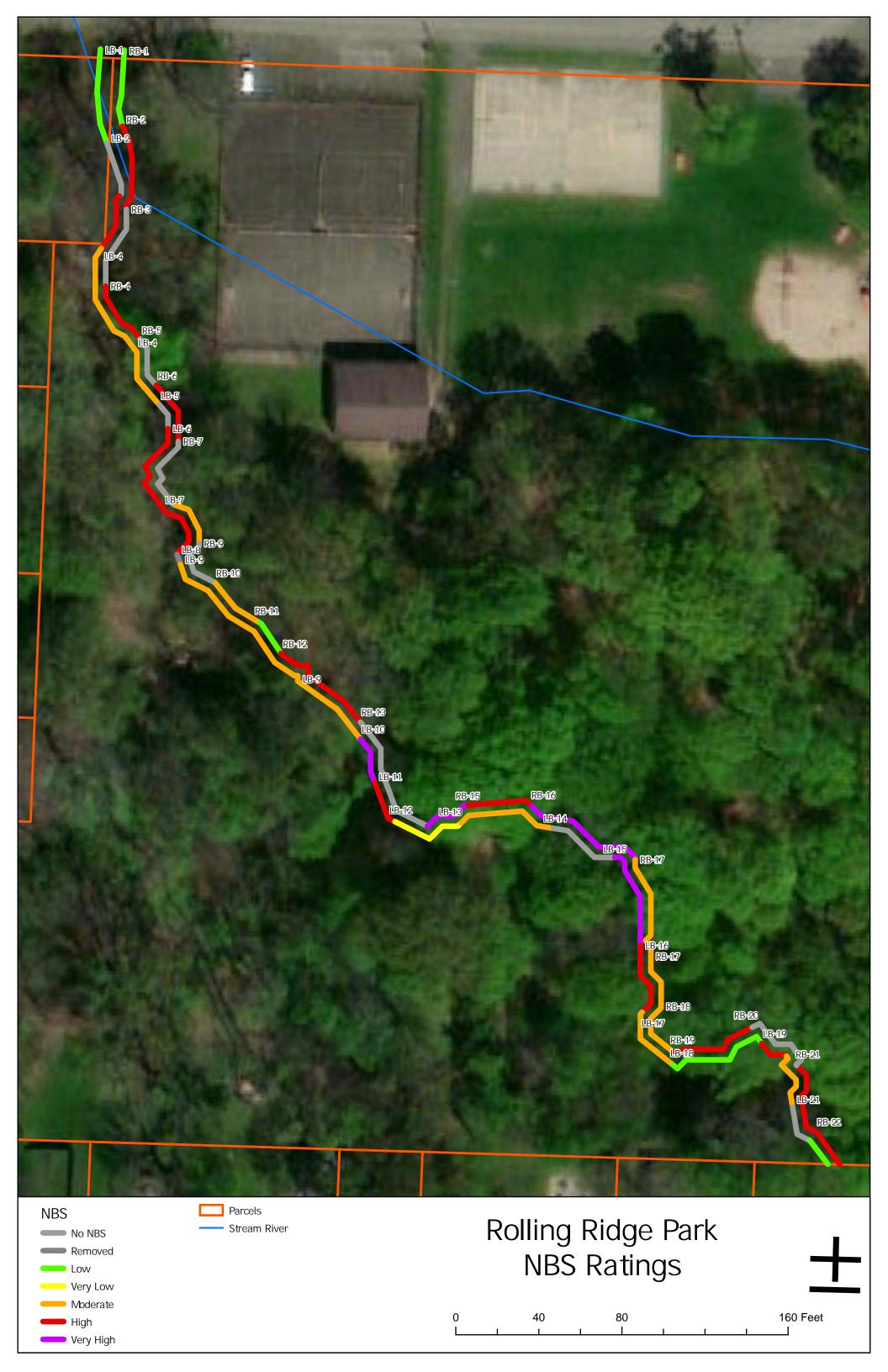
# Appendix D

# **Proposed BMP Documentation**

	Default Value	Site- Specific Value	Units
Bulk Density (average of			
samples in stream reach)	N/A	66.6	lb/ft <sup>3</sup>
Restoration Efficiency	50	50	%

Project Name						Tribut	ary to Five Mile					
Feature	Lat/Lor Start	ng End	Length, ft	Height, ft	DEIII D. C.	NIDG D. C.	Predicted Rate of Bank	Predicted Erosion	Predicted Erosion	Predicted	Estimated	
Feature I.D. (Bank., Headcut or Deposition I.D.)	Headcut Location or Start of Bank/Deposition	For Banks or Deposition only	(Bank or deposition)	(Bank or Headcut)	BEHI Rating	NBS Rating	Erosion	Amount	Amount	Erosion Rate (tons/year/ft)	TSS (tons/yr) Reduction	Comments
LB-1	42.13754	42.13741	46.0	4.3	High	Low	(ft/year) 0.40	(ft³/year) 79.12	(tons/year)	0.06	1.32	
	-79.99424 42.13741	-79.99422 42.13735			Tilgii	Low	0.40	77.12	2.03	0.00	1.52	
LB-2	-79.99422	-79.99420	27.0	0.0								Removed - Deposition
LB-3	42.13735 -79.99420	42.13728 -79.99423	28.0	4.7	Very High	High	1.00	131.60	4.38	0.16	2.19	
LB-4	42.13728	42.13707	88.0	3.7	High	Moderate	0.64	208.38	6.94	0.08	3.47	
	-79.99423 42.13707	-79.99412 42.13704			8	1110001010	0,0.	200.00			3111	
LB-5	-79.99412	-79.99410	13.0	0.0								Removed - Deposition
LB-6	42.13704 -79.99410	42.13693 -79.99411	48.0	4.0	Very High	High	1.00	192.00	6.39	0.13	3.20	
LB-7	42.13693	42.13687	31.0	0.5	Moderate	High	0.80	12.40	0.41	0.01	0.21	Ocular Estimate
ID 0	-79.99411 42.13687	-79.99408 42.13686	5.0	0.0								December 17.15
LB-8	-79.99408 42.13686	-79.99407 42.13664	5.0	0.0								Removed - Unnamed Tributary
LB-9	-79.99407	-79.99375	125.0	0.0	High	Moderate	0.64	0.00	0.00	0.00	0.00	Ocular Estimate
LB-10	42.13664	42.13658	23.0	4.0	Very High	Very High	1.75	161.00	5.36	0.23	2.68	
I D 11	-79.99375 42.13658	-79.99372 42.13653	22.0	2.7	TT' 1	TT' 1	1.00	01.40	0.71	0.12	1.26	
LB-11	-79.99372	-79.99368 42.13653	22.0	3.7	High	High	1.00	81.40	2.71	0.12	1.36	Ocular Estimate
LB-12	42.13653 -79.99368	-79.99356	37.0	3.3	High	Very Low	0.25	30.53	1.02	0.03	0.51	
LB-13	42.13653 -79.99356	42.13652 -79.99340	49.0	3.6	Moderate	Moderate	0.30	52.92	1.76	0.04	0.88	Ocular Estimate
LB-14	42.13652	42.13649	35.0	0.0								Removed - Deposition
	-79.99340 42.13649	-79.99329 42.13637										-
LB-15	-79.99329	-79.99324	48.0	4.4	Extreme	Very High	3.50	739.20	24.62	0.51	12.31	Ocular Estimate
LB-16	42.13637 -79.99324	42.13628 -79.99323	36.0	10.0	Moderate	High	0.80	288.00	9.59	0.27	4.80	Ocular Estimate
LB-17	42.13628	42.13622	22.0	1.9	High	High	1.00	62.70	2.09	0.06	1.04	Ocular Estimate
	-79.99323 42.13622	-79.99318 42.13625										
LB-18	-79.99318 42.13625	-79.99302		1.3	High	Low	0.40	27.04	0.90	0.02	0.45	Ocular Estimate
LB-19	-79.99302	42.13623 -79.99298	15.0	2.6	High	High	1.00	39.00	1.30	0.09	0.65	Ocular Estimate
LB-20	42.13623 -79.99298	42.13617 -79.99296	28.0	3.0	Moderate	Moderate	0.30	25.20	0.84	0.03	0.42	Ocular Estimate
LB-21	42.13617	42.13612	22.0	0.0								Removed - Deposition
	-79.99296 42.13612	-79.99293 42.13609										-
LB-22	-79.99293	-79.99290	14.0	1.8	Moderate	Low	0.13	3.15	0.10	0.01	0.05	Ocular Estimate
RB-1	42.13754 -79.99420	42.13744 -79.99420	37.0	2.1	High	Low	0.40	31.08	1.03	0.03	0.52	
RB-2	42.13744	42.13733	42.0	4.5	High	High	1.00	189.00	6.29	0.15	3.15	
DD 2	-79.99420 42.13733	-79.99419 42.13723		0.0								Removed Denseition
RB-3	-79.99419 42.13723	-79.99422 42.13716	40.0	0.0								Removed - Deposition
RB-4	-79.99422	-79.99416	32.0	1.7	Very High	High	1.00	54.40	1.81	0.06	0.91	
RB-5	42.13716 -79.99416	42.13710 -79.99413	25.0	0.0								Removed - Deposition
RB-6	42.13710	42.13702	31.0	2.8	High	High	1.00	86.80	2.89	0.09	1.45	
	-79.99413 42.13702	-79.99408 42.13694						3333	2.07	0.005		
RB-7	-79.99408	-79.99409	//////	0.0								Removed - Deposition
RB-8	42.13694 -79.99409	42.13689 -79.99404	24.0	1.1	High	Moderate	0.64	16.90	0.56	0.02	0.28	
RB-9	42.13689 -79.99404	42.13684 -79.99401	28.0	0.0								Removed - Deposition
RB-10	42.13684	42.13679	29.0	1.8	High	Moderate	0.64	33.41	1.11	0.04	0.56	
	-79.99401 42.13679	-79.99393 42.13675										
RB-11	-79.99393	-79.99389	18.0	0.5	Moderate	Low	0.13	1.13	0.04	0.00	0.02	Ocular Estimate
RB-12	42.13675 -79.99389	42.13666 -79.99375	54.0	4.1	Very High	High	1.00	221.40	7.37	0.14	3.69	
RB-13	42.13666	42.13652	64.0	0.0								Removed - Deposition
	-79.99375 42.13652	-79.99362 42.13655			Magnetti 1	Marrie 1	1.75	210.00	600	0.20	2.50	-
RB-14	-79.99362 42.13655	-79.99355 42.13655	24.0	5.0	Very High	Very High	1.75	210.00	6.99	0.29	3.50	Ocular Estimate
RB-15	-79.99355	-79.99344	32.0	4.4	High	High	1.00	140.80	4.69	0.15	2.34	Ocular Estimate
RB-16	42.13655 -79.99344	42.13649 -79.99325	60.0	5.0	Very High	Very High	1.75	525.00	17.48	0.29	8.74	Ocular Estimate
RB-17	42.13649	42.13629	77.0	3.5	High	Moderate	0.64	172.48	5.74	0.07	2.87	Ocular Estimate
	-79.99325 42.13629	-79.99320 42.13623										
RB-18	-79.99320	-79.99318	29.0	2.1	High	Moderate	0.64	38.98	1.30	0.04	0.65	
RB-19	42.13623 -79.99318	42.13627 -79.99304	44.0	6.0	Very High	High	1.00	264.00	8.79	0.20	4.40	Ocular Estimate
RB-20	42.13627	42.13622	37.0	0.0								Removed - Deposition
	-79.99304 42.13622	-79.99296 42.13613			LUch	LUch	1.00	92.60	2.79	0.07	1.20	-
RB-21	-79.99296	-79.99292	38.0	2.2	High	High	1.00	83.60	2.78	0.07	1.39	Ocular Estimate
RB-22	42.13613 -79.99292	42.13609 -79.99288	19.0	5.2	Very High	High	1.00	98.80	3.29	0.17	1.65	Ocular Estimate
TOTAL	OF ALL GRIDS		1649.0	N/A	N/A	N/A	N/A	4301.4	143.2	N/A	71.6	





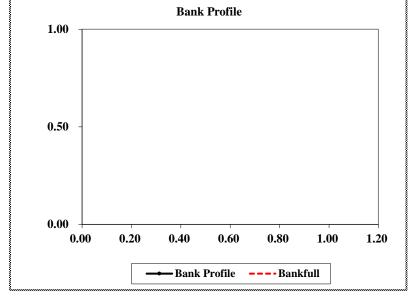
### BANK EROSION HAZARD INDEX

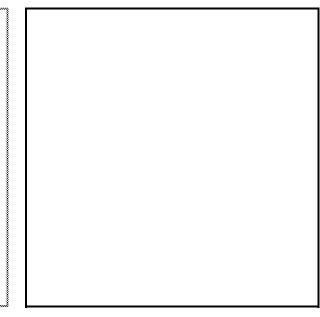
Stream:	Tributary to Five Mile Creek	Observer(s):	IT RS Data: IT QA/QC: RS T					Total Score:		32.64	32.64					
Reach:		Comments:							High							
Location:	LB-1	Bank Length	46				Total Score	Very Low	Low	Moderate	High	Very High	Extreme			
Date:	5/24/2022						Values:	5-10	10-20	20-30	30-40	40-45	45-50			

		E	rodibility Variabl	les						
Bank Height / Bankf	ull Height Ratio		rodibiney variable							
Bank Height	Bankfull Height	Value	Index	Bank Erosion Potental	Notes					
4.30	0.40	10.75	10.00	Extreme						
Root Depth / Bank H	eight Ratio									
Root Depth	Bank Height	Value	Index	Bank Erosion Potental	Notes					
2.00	4.30	0.47	4.25	Moderate						
Weighted Root Density										
Root Density (%)	Root Depth / Bank Height	Value	Index	Bank Erosion Potental	Notes					
30.00	0.47	13.95	8.01	Very High						
Bank Angle										
Bank Angle ( °)			Index	Bank Erosion Potental	Notes					
45.00			3.17	Low						
Surface Protection										
Surface Protection (%)			Index	Bank Erosion Potental	Notes					
20.00			7.22	High						
			Adjustment		Notes					
Bank Materials			0.00							
			Adjustment		Notes					
Bank Stratification			0.00							
	тот	AL SCORE	32.64							

	Bank Erosion Potential													
			Very Low	Low	Moderate	High	Very High	Extreme						
	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						
səle	Bank Height / Bankiuli Height	Index	1.0-1.9	2.0-3.9	4.0-5.9	6.0-7.9	8.0-9.0	10						
Variables	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						
	Root Deptil / Bank Height	Index	1.0-1.9	2.0-3.9	4.0-5.9	6.0-7.9	8.0-9.0	10						
ility	Weighted Root Density	Value	100-80	79-55	54-30	29-15	14-5	<5						
Erodibility	Weighted Root Density	Index	1.0-1.9	2.0-3.9	4.0-5.9	6.0-7.9	8.0-9.0	10						
Erc	Bank Angle	Value	0-20	21-60	61-80	81-90	91-119	>119						
	Dank Angie	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						
	Surface I Totection	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 lo	w erosion pot	tential.									
	Boulders	Boulder banks	have a low ere	osion potentia	l.									
a	Cobble	Substract 10 po	oints. No adjus	tment if sand	gravel compo	se greater that	n 50% of bank							
teri	Clay/Silt Loam	Add 5 points.												
Ma	Gravel	Add 5-10 point	s depending of	n percentage	of bank mater	ial composed	of sand.							
Bank Material	Sand	Add 10 points.	•		•	•		•						
B	Silt / Clay	No adjustment.						·						
			Strat	ification	•	•								
	Add 5-10 p	oints depending	on position of	unstable laye	rs in relation t	o bankfull sta	ge.							

	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 )											
			Estim	ating Nea	r-Bank St	ress ( NBS	3)				
Stream:	Tributa	ary to Five	Mile Creek		Location:	Rolling Ri	dge Park				
Station:	LB-1			S	tream Type:		\	Valley Type:			
Observe	rs:	IT RS						Date:	5/24/2022		
			Methods fo	or Estimati	ng Near-Ba	ank Stress	(NBS)				
( <b>1</b> ) Chanr	nel pattern	, transverse bar	or split channe	l/central bar cre	eating NBS		Level I	Recona	nissance		
( <b>2</b> ) Ratio	of radius o	f curvature to b	ankfull width (F	R <sub>c</sub> / W <sub>bkf</sub> )			Level II	General	prediction		
( <b>3</b> ) Ratio	of pool slo	pe to average v	ater surface slo	ope (S <sub>p</sub> /S)			Level II	General	prediction		
( <b>4</b> ) Ratio	of pool slo	pe to riffle slope	e (S <sub>p</sub> /S <sub>rif</sub> )				Level II	General	prediction		
( <b>5</b> ) Ratio	of near-ba	nk maximum de	pth to bankfull	mean depth ( d	nb / d <sub>bkf</sub> )		Level III	Detailed	prediction		
( <b>6</b> ) Ratio	of near-ba	nk shear stress	to bankfull she	ar stress ( τ <sub>nb</sub> /	τ <sub>bkf</sub> )		Level III	Detailed	prediction		
(7) Veloci	ty profiles	/ Isovels / Veloc	city gradient				Level IV	Valid	lation		
=											
Level	(1)										
ٽ	NI	3S = Extreme									
		Radius of Curvature	Bankfull Width W <sub>bkf</sub>	Ratio R <sub>c</sub> /	Near-Bank						
	(2)	R <sub>c</sub> (ft)	(ft)	W <sub>bkf</sub>	Stress (NBS)						
				2							
_					Near-Bank		Method	1			
el II	(2)	Pool Slope	Average		Stress			inant			
Level II	(3)	S <sub>p</sub>	Slope S	Ratio S <sub>p</sub> / S	(NBS)	1	Near-Bar	nk Stress			
						]	Lo	ow			
					Near-Bank						
	(4)	Pool Slope	Riffle Slope	Ratio S <sub>p</sub> / S <sub>rif</sub>	Stress						
		S <sub>p</sub>	S <sub>rif</sub>	O <sub>rif</sub>	(NBS)						
		Near Dools									
		Near-Bank Max Depth	Mean Depth	Ratio d <sub>nb</sub> /	Near-Bank Stress						
	(5)	d <sub>nb</sub> (ft)	d <sub>bkf</sub> (ft)	d <sub>bkf</sub>	(NBS)						
≡											
Level III				Near-Bank			Bankfull				
Ľ	(0)	Near-Bank	Near-Bank	Shear			Shear	Potio = /	Near-Bank		
	(6)	Max Depth d <sub>nb</sub> (ft)	Slope S <sub>nb</sub>	Stress τ <sub>nb</sub> (	Mean Depth d <sub>bkf</sub> (ft)	Average Slope S	Stress τ <sub>bkf</sub> (		Stress (NBS <b>)</b>		
		unb (II)	Ciopo CIID	10/11	u <sub>bkf</sub> (11)	Slope S	10/11	$ au_{ m bkf}$	(NDO)		
				Many David							
Level IV	/=·	Velocity Grad	dient (ft / sec	Near-Bank Stress							
eve	(7)	/ f		(NBS)	i						
7											
		Coi	nverting Va	alues to a N	Near-Bank	Stress (NE	SS) Rating				
Near-B		ess (NBS)			M	ethod numb					
	ratings (1) (2)			(2)	(3)	(4)	(5)	(6)	(7)		
	Very Lo		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		
		<b>oderate</b> N/A 2.01 – 2.2			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 Hi	_	(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		
	Extren	ne	Above	< 1.50	> 1.00	> 1.20	> 3.00	> 1.60	> 2.40		
				Overall N	ear-Bank \$	Stress (NB	S) rating	Lo	ow		

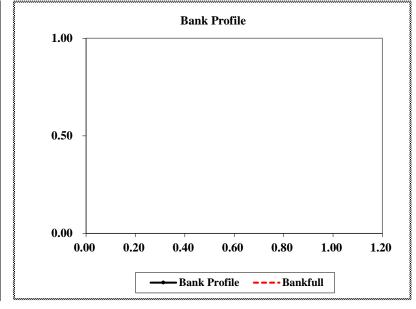
## BANK EROSION HAZARD INDEX

Stream:	Tributary to Five Mile Creek	Observer(s):	IT RS Data: IT QA/QC: RS T					Total Score:						
Reach:		Comments:												
Location:	LB-2	Bank Length	27					Very Low	Low	Moderate	High	Very High	Extreme	
Date:	5/24/2022							Values:	5-10	10-20	20-30	30-40	40-45	45-50

		E	rodibility Variabl	los.	
D 1 II : 14 / D 16	HIT : 1 / D /	E	rodibility variabl	les	
Bank Height / Bankf	· · · · · · · · · · · · · · · · · · ·				
Bank Height	Bankfull Height	Value	Index	Bank Erosion Potental	Notes
Root Depth / Bank H	leight Ratio				
Root Depth	Bank Height	Value	Index	Bank Erosion Potental	Notes
Weighted Root Densi	ity				
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					
	тот	AL SCORE			

			Bank Eros	sion Potential				
			Very Low	Low	Moderate	High	Very High	Extreme
	Pouls Height / Poulsfull Height	Value	1.00-1.10	1.11-1.19	1.20-1.50	1.60-2.00	2.10-2.80	>2.80
oles	Bank Height / Bankiuli Height	Index	1.0-1.9	2.0-3.9	4.0-5.9	6.0-7.9	8.0-9.0	10
Variables	Poot Donth / Pouls Height	Value	1.00-0.90	0.89-0.50	0.49-0.30	0.29-0.15	0.14-0.05	< 0.05
	Root Deptil / Bank Height	Index	1.0-1.9	2.0-3.9	4.0-5.9	6.0-7.9	00 2.10-2.80 0 8.0-9.0 5 0.14-0.05 0 8.0-9.0 14-5 0 8.0-9.0 91-119 0 8.0-9.0 14-10 0 8.0-9.0 14-1	10
Erodibility	Weighted Poet Density	Value	100-80	79-55	54-30	29-15	14-5	<5
dik	Weighted Root Density	Index	1.0-1.9	2.0-3.9	4.0-5.9	6.0-7.9	8.0-9.0	10
뎔	Rank Angle	Value	0-20	21-60	61-80	81-90	91-119	>119
	Dank Angk	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   1.00-1.10   1.11-1.19   1.20-1.50   1.60-2.00	14-10	<10				
	Surface Frotection	Index	1.0-1.9	2.0-3.9	4.0-5.9	6.0-7.9	8.0-9.0	10
			Adju	stments				
	Bedrock	Bedrock banks	have a very lo	ow erosion pot	tential.			
	Boulders	Boulder banks	have a low ere	osion potentia	l.			
ਾਫ਼	Cobble	Substract 10 po	oints. No adjus	stment if sand	gravel compo	se greater that	n 50% of bank	
Material	Clay/Silt Loam	Add 5 points.						
Ma	Gravel	Add 5-10 point	s depending o	n percentage	of bank mater	ial composed	of sand.	
Bank	Sand	Add 10 points.						
B	Silt / Clay	No adjustment.						
			Strat	ification				
	Add 5-10 p	oints depending	on position of	f unstable laye	rs in relation t	to bankfull sta	ge.	

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



Removed due to deposition

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

erosion	rate.									
			Estim	ating Nea	r-Bank St	ress ( NBS	<b>S</b> )			
Stream:	Tributa	ary to Five	Mile Creek		Location:	Rolling Ri	dge Park			
Station:	LB-2			S	tream Type:		,	Valley Type:		
Observe	rs:	IT RS						Date:	5/24/2022	
			Methods fo	or Estimati	ng Near-Ba	ank Stress	(NBS)			
(1) Chanr	nel pattern	, transverse bai	or split channe	l/central bar cre	eating NBS		Level I	Recona	nissance	
	· ·	of curvature to b	·				Level II	General	prediction	
( <b>3</b> ) Ratio	of pool slo	pe to average v	ater surface slo	ope(S <sub>p</sub> /S)			Level II	General	prediction	
(4) Ratio	of pool slo	pe to riffle slope	e (S <sub>p</sub> /S <sub>rif</sub> )	<u> </u>			Level II	General	prediction	
		nk maximum de		mean depth ( d	nb / d <sub>bkf</sub> )		Level III	Detailed	prediction	
		nk shear stress					Level III	Detailed	prediction	
		/ Isovels / Veloc					Level IV	Valid	lation	
		Transverse a	nd/or central b		or discontinuo			NBS = Hig	jh / Very High	
Level	(1)									
Ľ		Chute cutoffs	, down-valley	meander mig	ration, conver	ging flow		NI	BS = Extreme	
		Radius of	Bankfull	Potio P /	Near-Bank					
	(2)	Curvature R <sub>c</sub> (ft)	Width W <sub>bkf</sub> (ft)	Ratio R <sub>c</sub> / W <sub>bkf</sub>	Stress (NBS)					
		1 10 (11)	(,	DKI	(1.126)					
					Near-Bank	l	Method			
Level II	(0)	Pool Slope	Average		Stress		Dom	inant		
-ev	(3)	S <sub>p</sub>	Slope S	Ratio S <sub>p</sub> / S	(NBS)	1	Near-Bar	nk Stress		
					Near-Bank	•	=		-	
	(4)	Pool Slope	Riffle Slope	Ratio S <sub>p</sub> /	Stress					
	( ' )	S <sub>p</sub>	S <sub>rif</sub>	S <sub>rif</sub>	(NBS)					
		Near-Bank Max Depth	Mean Depth	<i>Ratio</i> d <sub>nb</sub> /	Near-Bank					
	(5)	d <sub>nb</sub> (ft)	d <sub>bkf</sub> (ft)	d <sub>bkf</sub>	Stress (NBS)					
=		112 ( )	Dia ( )	Div.						
Level III				Near-Bank			Bankfull			
Le		Near-Bank		Shear			Shear		Near-Bank	
	(6)	Max Depth	Near-Bank	Stress τ <sub>nb</sub> (	Mean Depth	Average		Ratio τ <sub>nb</sub> /	Stress	
		d <sub>nb</sub> (ft)	Slope S <sub>nb</sub>	lb/ft <sup>2</sup> )	d <sub>bkf</sub> (ft)	Slope S	lb/ft <sup>2</sup> )	$ au_{ m bkf}$	(NBS)	
2		Velocity Cro	dient (ft / sec	Near-Bank Stress						
Level IV	(7)		t)	(NBS)						
Le			,							
		C	avorting V	duon to a	loor Pont	Ctross (NF	C) Detine			
Near-F	ank Str		iverung va	aiues to a f	Near-Bank Me	Stress (NE ethod numb				
	Near-Bank Stress (NBS) ratings (1) (2)				(3)	(4)	(5)	(6)	(7)	
	Very L		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	
	Modera	ate	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	1	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 H	igh	(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	
	Extren	ne	Above	< 1.50	> 1.00	> 1.20	> 3.00	> 1.60	> 2.40	
				Overall N	lear-Bank S	Stress (NB	S) rating			
			Overall Near-Bank Stress (NBS) rating							

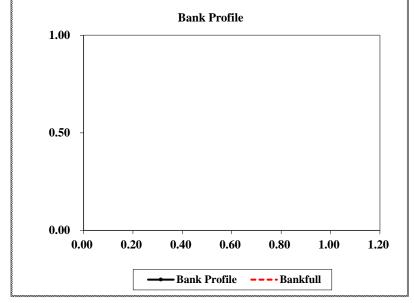
### BANK EROSION HAZARD INDEX

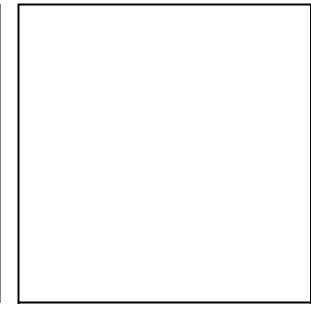
Stream:	Tributary to Five Mile Creek	Observer(s):	IT RS Data: IT QA/QC: RS T					Total Score:		40.86	40.86					
Reach:		Comments:								Very Hi	Very High					
Location:	LB-3	Bank Length	28				Total Score	Very Low	Low	Moderate	High	Very High	Extreme			
Date:	5/24/2022						Values:	5-10	10-20	20-30	30-40	40-45	45-50			

Erodibility Variables								
Bank Height / Bankfull Height Ratio								
Bank Height Bankfull Height Value		Index	Bank Erosion Potental	Notes				
4.70	4.70 0.40 11.75		10.00	Extreme				
Root Depth / Bank H	eight Ratio							
Root Depth Bank Height Value		Index	Bank Erosion Potental	Notes				
2.30	4.70 0.49		4.01	Moderate				
Weighted Root Densi	ity							
Root Density (%)	Root Depth / Bank Height	Value	Index	Bank Erosion Potental	Notes			
60.00	60.00 0.49 29.36		5.95	Moderate				
Bank Angle								
Bank Angle (°)			Index	Bank Erosion Potental	Notes			
120.00	120.00			Extreme				
Surface Protection								
Surface Protection (%)			Index	Bank Erosion Potental	Notes			
30.00			5.90	Moderate				
			Adjustment		Notes			
Bank Materials			0.00					
			Adjustment		Notes			
Bank Stratification			5.00					
	тот	AL SCORE	40.86					

	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	
	bank neight / bankiun neight	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	
	Root Deptil / Bank Height	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	
	Weighted Root Density	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	
	Dank Angie	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	
	Surface Frotection	Index	1.0-1.9	2.0-3.9	4.0-5.9	6.0-7.9	8.0-9.0	10	
			Adju	stments					
	Bedrock	Bedrock banks have a very low erosion potential.							
	Boulders	Boulder banks have a low erosion potential.							
a	Cobble	Substract 10 points. No adjustment if sand/gravel compose greater than 50% of bank.							
teri	Clay/Silt Loam	Add 5 points.							
Bank Material	Gravel	Add 5-10 points depending on percentage of bank material composed of sand.							
ank	Sand	Add 10 points.							
B	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.

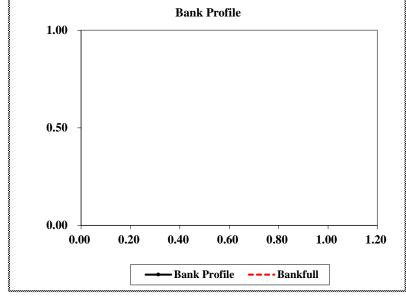
CIOSIOII											
			Estim	ating Nea	r-Bank St	ress ( NBS	S)				
Stream:	Tributa	ry to Five	Mile Creek		Location:	Rolling Ri	dge Park				
Station:	LB-3			S	tream Type:		1	Valley Type:			
Observe	rs:	IT RS						Date:	5/24/2022		
			Methods fo	or Estimati	ng Near-Ba	ank Stress	(NBS)				
(1) Channel pattern, transverse bar or split channel/central bar creating NBS							Level I	Recona	aissance		
(2) Ratio of radius of curvature to bankfull width ( R <sub>c</sub> / W <sub>bkf</sub> )							Level II	General	prediction		
( <b>3</b> ) Ratio	of pool slo	pe to average v	ater surface sl	ope(S <sub>p</sub> /S)			Level II General prediction				
( <b>4</b> ) Ratio	of pool slo	pe to riffle slope	e (S <sub>p</sub> /S <sub>rif</sub> )				Level II General prediction				
( <b>5</b> ) Ratio	of near-ba	nk maximum de	pth to bankfull	mean depth ( d	<sub>nb</sub> / d <sub>bkf</sub> )		Level III	Detailed	Detailed prediction		
( <b>6</b> ) Ratio	of near-ba	nk shear stress	to bankfull she	ar stress ( τ <sub>nb</sub> /	τ <sub>bkf</sub> )		Level III	Detailed prediction			
(7) Veloci	ty profiles	/ Isovels / Veloc	city gradient				Level IV	Valid	dation		
=					or discontinuo			,	, , ,		
Levell	(1)				channel)						
<u> </u>				meander mig	ration, conver	ging flow		N	BS = Extreme		
		Radius of Curvature	Bankfull Width W <sub>bkf</sub>	Ratio R <sub>c</sub> /	Near-Bank Stress						
	(2)	R <sub>c</sub> (ft)	(ft)	W <sub>bkf</sub>	(NBS)						
_					Near-Bank	l	Method	1			
Level II	(2)	Pool Slope	Average		Stress			inant			
Lev	(3)	S <sub>p</sub>	Slope S	Ratio S <sub>p</sub> / S	(NBS)	1		nk Stress			
							Hi	gh			
				Datia O /	Near-Bank						
	(4)	Pool Slope S <sub>p</sub>	Riffle Slope S <sub>rif</sub>	Ratio S <sub>p</sub> / S <sub>rif</sub>	Stress (NBS)						
		- Op	Orif	Orif	(NDO)						
		Near-Bank			Naar Dard	l					
	(5)	Max Depth	Mean Depth	Ratio d <sub>nb</sub> /	Near-Bank Stress						
		d <sub>nb</sub> (ft)	d <sub>bkf</sub> (ft)	d <sub>bkf</sub>	(NBS)	1					
≡											
Level III	(6)			Near-Bank Shear			Bankfull Shear				
		Near-Bank Max Depth	Near-Bank	Stress τ <sub>nb</sub> (	Moon Donth	A., a. a. a. a.	Stress τ <sub>bkf</sub> (	Ratio τ <sub>nb</sub> /	Near-Bank		
	(6)	d <sub>nb</sub> (ft)	Slope S <sub>nb</sub>	Ib/ft <sup>2</sup> )	Mean Depth d <sub>bkf</sub> (ft)	Average Slope S	lb/ft <sup>2</sup> )	$ au_{\mathrm{bkf}}$	Stress (NBS <b>)</b>		
				ŕ			,				
				Near-Bank							
Level IV	(7)	-	dient (ft/sec	Stress							
ě	(7)	/ f	t )	(NBS)	 						
_											
		Coi	nverting Va	alues to a l	Near-Bank	Stress (NE	SS) Rating				
Near-B		ess (NBS)				ethod numb					
ratings			(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 N	lear-Bank S	Stress (NB	S) rating	Hi	gh		

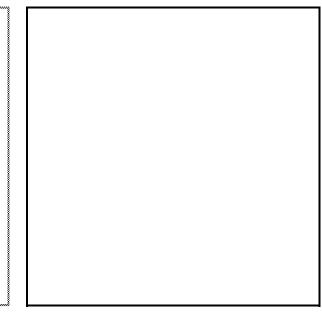
Stream:	Tributary to Five Mile Creek	Observer(s):	IT RS Data: IT QA/QC: RS			Total Score:		32.58	32.58					
Reach:		Comments:						High	High					
Location:	LB-4	Bank Length	88			Total Score	Very Low	Low	Moderate	High	Very High	Extreme		
Date:	5/24/2022							Values:	5-10	10-20	20-30	30-40	40-45	45-50

		T	121-2124 372-1-1		
		E	rodibility Variabl	les	
Bank Height / Bankft	· · ·				
Bank Height	Bankfull Height	Value	Index	Bank Erosion Potental	Notes
3.70	0.40	9.25	10.00	Extreme	
Root Depth / Bank H	eight Ratio				
Root Depth	Bank Height	Value	Index	Bank Erosion Potental	Notes
1.80	3.70	0.49	4.04	Moderate	
Weighted Root Densi	ity				
Root Density (%)	Root Depth / Bank Height	Value	Index	Bank Erosion Potental	Notes
15.00	0.49	7.30	8.74	Very High	
Bank Angle					
Bank Angle ( °)			Index	Bank Erosion Potental	Notes
60.00			3.90	Low	
Surface Protection					
Surface Protection (%)			Index	Bank Erosion Potental	Notes
30.00			5.90	Moderate	
			Adjustment		Notes
Bank Materials			0.00		
			Adjustment		Notes
Bank Stratification			0.00		
	тот	AL SCORE	32.58		

			Bank Eros	ion Potential				
			Very Low	Low	Moderate	High	Very High	Extreme
	Pouls Height / Poulsfull Height	Value	1.00-1.10	1.11-1.19	1.20-1.50	1.60-2.00	2.10-2.80	>2.80
səle	Bank Height / Bankfull Height	Index	1.0-1.9	2.0-3.9	4.0-5.9	6.0-7.9	8.0-9.0	10
Variables	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
	Root Deptil / Bank Height	Index	1.0-1.9	2.0-3.9	4.0-5.9	6.0-7.9	8.0-9.0	10
Erodibility	Weighted Root Density	Value	100-80	79-55	54-30	29-15	14-5	<5
dib	Weighted Root Density	Index	1.0-1.9	2.0-3.9	4.0-5.9	6.0-7.9	8.0-9.0	10
Erc	Bank Angle	Value	0-20	21-60	61-80	81-90	91-119	>119
	Dank Angle	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
	Surface I Totection	Index	1.0-1.9	2.0-3.9	4.0-5.9	6.0-7.9	8.0-9.0	10
			Adju	stments				
	Bedrock	Bedrock banks	have a very lo	w erosion pot	tential.			
	Boulders	Boulder banks	have a low ere	osion potentia	l.			
ਢ	Cobble	Substract 10 po	ints. No adjus	tment if sand	gravel compo	se greater that	n 50% of bank	
Material	Clay/Silt Loam	Add 5 points.						
Ma	Gravel	Add 5-10 point	s depending o	n percentage	of bank mater	ial composed	of sand.	
Bank	Sand	Add 10 points.						
B	Silt / Clay	No adjustment.						
			Strat	fication				
	Add 5-10 p	oints depending	on position of	unstable laye	rs in relation t	to bankfull sta	ge.	

	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.

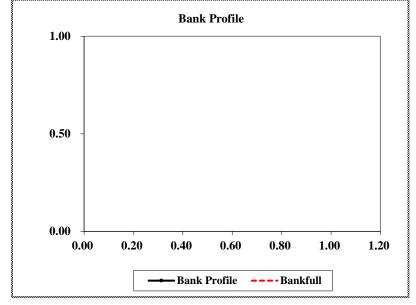
	Estimating Near-Bank Stress (NBS)											
			Estim	ating Nea	r-Bank St	ress ( NBS	S)					
Stream:	Tributa	ry to Five	Mile Creek		Location:	Rolling Ri	dge Park					
Station:	LB-4			S	tream Type:		,	Valley Type:				
Observe	rs:	IT RS						Date:	5/24/2022			
			Methods fo	or Estimati	ng Near-B	ank Stress	(NBS)					
(1) Chanr	nel pattern	, transverse bar	or split channe	l/central bar cre	eating NBS		Level I	Recona	aissance			
(2) Ratio	of radius o	f curvature to b	ankfull width (F	R <sub>c</sub> / W <sub>bkf</sub> )			Level II General prediction					
(3) Ratio	of pool slo	pe to average w	vater surface slo	ppe (S <sub>p</sub> /S)			Level II	General prediction				
(4) Ratio	of pool slo	pe to riffle slope	e (S <sub>p</sub> /S <sub>rif</sub> )				Level II	General	prediction			
( <b>5</b> ) Ratio	of near-ba	nk maximum de	epth to bankfull	mean depth ( d	<sub>nb</sub> / d <sub>bkf</sub> )		Level III	Detailed prediction				
( <b>6</b> ) Ratio	of near-ba	nk shear stress	to bankfull she	ar stress (τ <sub>nb</sub> /	$\tau_{ m bkf}$ )		Level III	Detailed	prediction			
(7) Veloci	ity profiles	/ Isovels / Veloc	city gradient				Level IV	Valid	dation			
=									, , ,			
Levell	(1)											
				meander mig	ration, conver	ging flow		NI	BS = Extreme			
		Radius of Curvature	Bankfull Width W <sub>bkf</sub>	Ratio R <sub>c</sub> /	Near-Bank Stress							
	(2)	R <sub>c</sub> (ft)	(ft)	W <sub>bkf</sub>	(NBS)							
_					Near-Bank		Method	1				
Level II	(3)	Pool Slope	Average		Stress			inant				
Lev	(3)	S <sub>p</sub>	Slope S	Ratio S <sub>p</sub> / S	(NBS)	1		nk Stress				
							Mod	erate				
				D-#- 0 /	Near-Bank							
	(4)	Pool Slope S <sub>p</sub>	Riffle Slope S <sub>rif</sub>	Ratio S <sub>p</sub> / S <sub>rif</sub>	Stress (NBS)							
		- Op	Orif	Orif	(NDO)	]						
		Near-Bank			Naar Dard	l						
	(5)	Max Depth	Mean Depth	Ratio d <sub>nb</sub> /	Near-Bank Stress							
	(5)	d <sub>nb</sub> (ft)	d <sub>bkf</sub> (ft)	d <sub>bkf</sub>	(NBS)	1						
							T		1			
Level III				Near-Bank Shear			Bankfull Shear					
_	(6)	Near-Bank Max Depth	Near-Bank	Stress τ <sub>nb</sub> (	Mean Depth	Average	Stress τ <sub>bkf</sub> (	Ratio τ <sub>nb</sub> /	Near-Bank Stress			
	(6)	d <sub>nb</sub> (ft)	Slope S <sub>nb</sub>	lb/ft <sup>2</sup> )	d <sub>bkf</sub> (ft)	Slope S	lb/ft <sup>2</sup> )	$ au_{bkf}$	(NBS)			
>				Near-Bank								
Level IV	(7)	-	dient (ft/sec	Stress								
Lev	(.,	/ f	t )	(NBS)	1							
			nverting Va	lues to a l	Near-Bank	Stress (NE	SS) Rating					
Near-E		ess (NBS)	44)	(0)		ethod numb		(0)				
	rating		<b>(1)</b>	(2)	(3)	(4)	(5)	(6)	(7)			
	Very Low		N/A 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			
	Modera		See	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		(1)	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 Hi Extren	_	Above	1.50 – 1.80	0.81 – 1.00	1.01 – 1.20	2.51 – 3.00	1.20 – 1.60	2.01 – 2.40			
	LAUGII	16	710000	< 1.50	> 1.00	> 1.20	> 3.00	> 1.60	> 2.40			
				Overali N	lear-Bank \$	otress (NB	S) rating	Mod	erate			

Stream:	Tributary to Five Mile Creek	Observer(s):	IT RS Data: IT QA/QC: RS			Total Score:								
Reach:		Comments:												
Location:	LB-5	Bank Length		13			Total Score	Very Low	Low	Moderate	High	Very High	Extreme	
Date:	5/24/2022							Values:	5-10	10-20	20-30	30-40	40-45	45-50

		E	rodibility Variabl	les	
Bank Height / Bankf	ull Height Ratio		Toursely (uran)		
Bank Height	Bankfull Height	Value	Index	Bank Erosion Potental	Notes
Root Depth / Bank H	eight Ratio				
Root Depth	Bank Height	Value	Index	Bank Erosion Potental	Notes
Weighted Root Densi	ity				
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					
	TOT	AL SCORE			

			Bank Eros	ion Potential				
			Very Low	Low	Moderate	High	Very High	Extreme
	D	Value	1.00-1.10	1.11-1.19	1.20-1.50	1.60-2.00	2.10-2.80	>2.80
səle	Bank Height / Bankfull Height	Index	1.0-1.9	2.0-3.9	4.0-5.9	6.0-7.9	8.0-9.0	10
Variables	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
	Root Deptil / Bank Height	Index	1.0-1.9	2.0-3.9	4.0-5.9	6.0-7.9	8.0-9.0	10
Erodibility	Weighted Root Density	Value	100-80	79-55	54-30	29-15	14-5	<5
dib	Weighted Root Density	Index	1.0-1.9	2.0-3.9	4.0-5.9	6.0-7.9	8.0-9.0	10
Ere	Bank Angle	Value	0-20	21-60	61-80	81-90	91-119	>119
	Dank Angle	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
	Surface I Totection	Index	1.0-1.9	2.0-3.9	4.0-5.9	6.0-7.9	8.0-9.0	10
			Adju	stments				
	Bedrock	Bedrock banks	have a very lo	w erosion po	tential.			
	Boulders	Boulder banks	have a low ere	osion potentia	l.			
ਾਫ	Cobble	Substract 10 po	oints. No adjus	stment if sand	gravel compo	se greater that	n 50% of bank	
iteri	Clay/Silt Loam	Add 5 points.						
Ma	Gravel	Add 5-10 point	s depending of	n percentage	of bank mater	ial composed	of sand.	
Bank Material	Sand	Add 10 points.						
B	Silt / Clay	No adjustment.						
			Strat	ification				
	Add 5-10 p	oints depending	on position of	unstable laye	rs in relation t	to bankfull sta	ge.	

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



Removed due to deposition

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

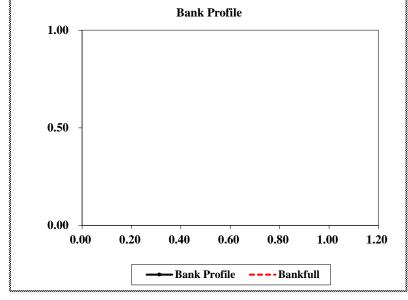
erosioi	rosion rate.									
			Estim	ating Nea	r-Bank St	ress ( NBS	S)			
Stream	Tributa	ary to Five	Mile Creek		Location:	Rolling Ri	dge Park			
Station:	LB-5			S	tream Type:		,	Valley Type:		
Observ	ers:	IT RS						Date:	5/24/2022	
			Methods for	or Estimati	ng Near-B	ank Stress	(NBS)			
( <b>1</b> ) Chai	nnel pattern	, transverse bai	or split channe	el/central bar cre	eating NBS		Level I	Recona	aissance	
( <b>2</b> ) Ratio	o of radius o	of curvature to b	ankfull width (F	R <sub>c</sub> / W <sub>bkf</sub> )			Level II	General	prediction	
( <b>3</b> ) Ratio	o of pool slo	pe to average v	vater surface slo	ope (S <sub>p</sub> /S)			Level II	General	prediction	
( <b>4</b> ) Ratio	of pool slo	pe to riffle slope	e ( S <sub>p</sub> / S <sub>rif</sub> )	·			Level II	General	prediction	
( <b>5</b> ) Ratio	of near-ba	nk maximum de	epth to bankfull	mean depth ( d	<sub>nb</sub> / d <sub>bkf</sub> )		Level III	Detailed	prediction	
( <b>6</b> ) Ratio	of near-ba	nk shear stress	to bankfull she	ar stress ( τ <sub>nb</sub> /	$\tau_{bkf}$ )		Level III	Detailed	prediction	
( <b>7</b> ) Velo	city profiles	/ Isovels / Veloc	city gradient				Level IV	Valid	lation	
=		Transverse a	nd/or central b	ars-short and/	or discontinuo	us		NBS = Hig	jh / Very High	
Level	(1)									
تّ		Chute cutoffs	, down-valley	meander mig	ration, conver	ging flow		NI	3S = Extreme	
		Radius of	Bankfull	Ratio R <sub>c</sub> /	Near-Bank					
	(2)	Curvature R <sub>c</sub> (ft)	Width W <sub>bkf</sub> (ft)	W <sub>bkf</sub>	Stress (NBS)					
	-				Near-Bank		Method			
II le	(0)	Pool Slope	Average		Stress		Dom	inant		
Pool Slope Slope S Ratio Sp / S (NBS)							Near-Bar	nk Stress		
1										
					Near-Bank	'			-	
	(4)	Pool Slope	Riffle Slope	Ratio S <sub>p</sub> /	Stress					
	( ',	S <sub>p</sub>	S <sub>rif</sub>	S <sub>rif</sub>	(NBS)	1				
		Near-Bank Max Depth	Maan Danth	Ratio d <sub>nb</sub> /	Near-Bank					
	(5)	d <sub>nb</sub> (ft)	Mean Depth d <sub>bkf</sub> (ft)	d <sub>bkf</sub>	Stress (NBS)					
=		TID ( )	Did ( )	Ditt						
Level III				Near-Bank			Bankfull			
Le		Near-Bank		Shear			Shear		Near-Bank	
	(6)	Max Depth	Near-Bank	Stress τ <sub>nb</sub> (	Mean Depth			Ratio τ <sub>nb</sub> /	Stress	
		d <sub>nb</sub> (ft)	Slope S <sub>nb</sub>	lb/ft <sup>2</sup> )	d <sub>bkf</sub> (ft)	Slope S	lb/ft <sup>2</sup> )	$ au_{bkf}$	(NBS)	
≥		Valerity O	diant / # /	Near-Bank						
Level IV	(7)		dient (ft/sec ft)	Stress (NBS)						
Le		,	- /	(	İ					
					<u> </u>	01	0) 5 4			
Noor	Bank Str	ess (NBS)	nverting Va	alues to a l		Stress (NE ethod numb				
iveai-	rating		(1)	(2)	(3)	(4)	(5)	(6)	(7)	
	Very L		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	
	Modera		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 S				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			1.50 – 1.80	0.81 – 1.00	1.01 – 1.20	2.51 – 3.00	1.20 – 1.60	2.01 – 2.40	
	Extrer		(1) Above	< 1.50	> 1.00	> 1.20	> 3.00	> 1.60	> 2.40	
				-	-					
				Overall N	lear-Bank \$	Strace /NP	S) rating			

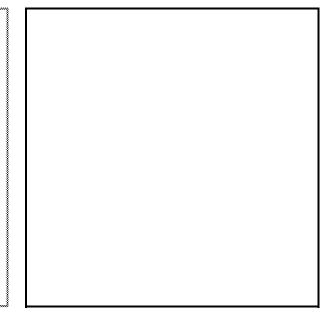
Stream:	Tributary to Five Mile Creek	Observer(s):	IT RS Data: IT QA/QC: RS			Total Score:		42.90	42.90					
Reach:		Comments:						Very Hi	Very High					
Location:	LB-6	Bank Length		48			Total Score	Very Low	Low	Moderate	High	Very High	Extreme	
Date:	5/24/2022							Values:	5-10	10-20	20-30	30-40	40-45	45-50

		Tr.	rodibility Variabl		
D 1 17 1 1 1 / D 1 0	### 1 1 . B . I	E	rodibility variabl	ies	
Bank Height / Bankf				•	
Bank Height	Bankfull Height	Value	Index	Bank Erosion Potental	Notes
4.00	0.40	10.00	10.00	Extreme	
Root Depth / Bank H	eight Ratio				
Root Depth	Bank Height	Value	Index	Bank Erosion Potental	Notes
2.00	4.00	0.50	3.90	Low	
Weighted Root Densi	ity				
Root Density (%)	Root Depth / Bank Height	Value	Index	Bank Erosion Potental	Notes
10.00	0.50	5.00	9.00	Very High	
Bank Angle					
Bank Angle ( °)			Index	Bank Erosion Potental	Notes
120.00			10.00	Extreme	
Surface Protection					
Surface Protection (%)			Index	Bank Erosion Potental	Notes
5.00			10.00	Extreme	
			Adjustment		Notes
Bank Materials			0.00		
			Adjustment		Notes
Bank Stratification			0.00		
	тот	AL SCORE	42.90		

			Bank Eros	ion Potential						
			Very Low	Low	Moderate	High	Very High	Extreme		
	D	Value	1.00-1.10	1.11-1.19	1.20-1.50	1.60-2.00	2.10-2.80	>2.80		
les	Bank Height / Bankfull Height	Index	1.0-1.9	2.0-3.9	4.0-5.9	6.0-7.9	8.0-9.0	10		
Variables	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		
	Root Deptil / Balik Height	Index	1.0-1.9	2.0-3.9	4.0-5.9	6.0-7.9	8.0-9.0	10		
Erodibility	Weighted Root Density	Value	100-80	79-55	54-30	29-15	14-5	<5		
dib	Weighted Root Delisity	Index	1.0-1.9	2.0-3.9	4.0-5.9	6.0-7.9	8.0-9.0	10		
Ere	Bank Angle	Value	0-20	21-60	61-80	81-90	91-119	>119		
	Dank Angic	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		
	Surface Frotection	Index	1.0-1.9	2.0-3.9	4.0-5.9	6.0-7.9	8.0-9.0	10		
			Adju	stments						
	Bedrock	Bedrock banks	have a very lo	w erosion po	tential.					
	Boulders	Boulder banks	have a low ere	osion potentia	l.					
ਾਫ	Cobble	Substract 10 po	oints. No adjus	stment if sand	gravel compo	se greater that	n 50% of bank			
iteri	Clay/Silt Loam	Add 5 points.								
Ma	Gravel	Add 5-10 point	Add 5-10 points depending on percentage of bank material composed of sand.							
Bank Material	Sand	Add 10 points.								
B	Silt / Clay	No adjustment.								
			Strati	ification						
	Add 5-10 p	oints depending	on position of	funstable laye	rs in relation t	o bankfull sta	ge.			

	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.

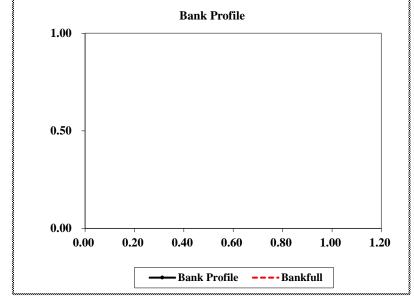
01001011	Estimating Near-Bank Stress ( NBS )								
			Estim	ating Nea	r-Bank St	ress ( NBS	S)		
Stream:	Tributa	ry to Five	Mile Creek		Location:	Rolling Ri	dge Park		
Station:	LB-6			S	tream Type:		,	Valley Type:	
Observe	rs:	IT RS						Date:	5/24/2022
			Methods fo	or Estimati	ng Near-B	ank Stress	(NBS)		
(1) Chanr	nel pattern,	transverse bar	or split channe	l/central bar cre	eating NBS		Level I	Recona	aissance
( <b>2</b> ) Ratio	of radius o	f curvature to b	ankfull width ( F	R <sub>c</sub> / W <sub>bkf</sub> )			Level II	General	prediction
( <b>3</b> ) Ratio	of pool slop	pe to average w	ater surface slo	ope (S <sub>p</sub> /S)			Level II	General	prediction
( <b>4</b> ) Ratio	of pool slop	pe to riffle slope	e (S <sub>p</sub> /S <sub>rif</sub> )	·			Level II	General	prediction
(5) Ratio of near-bank maximum depth to bankfull mean depth ( d <sub>nb</sub> / d <sub>bkf</sub> )							Level III	Detailed	prediction
(6) Ratio of near-bank shear stress to bankfull shear stress ( $\tau_{nb}/\tau_{bkf}$ )							Level III	Detailed	prediction
(7) Veloci	ty profiles	/ Isovels / Veloc	city gradient				Level IV	Valid	lation
=									, , ,
Levell	(1)								
ٽ		Chute cutoffs	, down-valley	meander mig	ration, conver	ging flow		NI	3S = Extreme
		Radius of Curvature	Bankfull Width W	Ratio R <sub>c</sub> /	Near-Bank				
	(2)	R <sub>c</sub> (ft)	Width W <sub>bkf</sub> (ft)	W <sub>bkf</sub>	Stress (NBS)				
		3 ( )		S.C.					
					Near-Bank	l	Method	1	
Level II	(2)	Pool Slope	Average		Stress		Dom	inant	
_ev	(3)	$S_p$	Slope S	Ratio S <sub>p</sub> / S	(NBS)	1	Near-Bar	nk Stress	
_							Hi	gh	
					Near-Bank				
	(4)	Pool Slope	Riffle Slope	Ratio S <sub>p</sub> /	Stress				
	, ,	S <sub>p</sub>	S <sub>rif</sub>	S <sub>rif</sub>	(NBS)				
		Many David				l			
		Near-Bank Max Depth	Mean Depth	Ratio d <sub>nb</sub> /	Near-Bank Stress				
	(5)	d <sub>nb</sub> (ft)	d <sub>bkf</sub> (ft)	d <sub>bkf</sub>	(NBS)				
≡									
Level III				Near-Bank			Bankfull		
ĭ	(0)	Near-Bank	Near-Bank	Shear Stress $\tau_{nb}$ (	5 //	_	Shear Stress τ <sub>bkf</sub> (	Ratio τ <sub>nb</sub> /	Near-Bank
	(6)	Max Depth d <sub>nb</sub> (ft)	Slope S <sub>nb</sub>	Ib/ft <sup>2</sup> )	Mean Depth d <sub>bkf</sub> (ft)	Average Slope S	lb/ft <sup>2</sup> )	$\tau_{\rm bkf}$	Stress (NBS <b>)</b>
		- 110 ( -)	1 110	, (	-DKI (1-7)	Ciopo C	1.5/11	*DKI	(1.126)
				Near-Bank					
Level IV	/ <del>7</del> \	Velocity Grad	dient (ft/sec	Stress					
e v	(7)	/ f	t )	(NBS)	1				
_									
		Coi	nverting Va	alues to a l	Near-Bank	Stress (NE	SS) Rating		
Near-B	ank Str	ess (NBS)				ethod numb			
	rating	s	(1)	(2)	(3)	(4)	(5)	(6)	(7)
	Very Lo	ow	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
	Modera		N/A See	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			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 Hi		(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
	Extren	ne	Above	< 1.50	> 1.00	> 1.20	> 3.00	> 1.60	> 2.40
				Overall N	lear-Bank \$	Stress (NB	S) rating	Hi	gh

Stream:	Tributary to Five Mile Creek	Observer(s):	IT RS	TT RS Data: IT QA/QC: RS T			Total Score:		NA	NA				
Reach:		Comments:							Modera	te				
Location:	LB-7	Bank Length			31			Total Score	Very Low	Low	Moderate	High	Very High	Extreme
Date:	5/24/2022							Values:	5-10	10-20	20-30	30-40	40-45	45-50

		T	3:1.:11:4 37		
		E	rodibility Variabl	es	
Bank Height / Bankf	· · ·				
Bank Height	Bankfull Height	Value	Index	Bank Erosion Potental	Notes
0.50					
Root Depth / Bank H	eight Ratio				
Root Depth	Bank Height	Value	Index	Bank Erosion Potental	Notes
Weighted Root Densi	ity				
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					
	тот	AL SCORE	Moderate		

			Bank Eros	ion Potential				
			Very Low	Low	Moderate	High	Very High	Extreme
	D1- II-1-1-4 / D1-6-11 II-1-1-4	Value	1.00-1.10	1.11-1.19	1.20-1.50	1.60-2.00	2.10-2.80	>2.80
səle	Bank Height / Bankfull Height	Index	1.0-1.9	2.0-3.9	4.0-5.9	6.0-7.9	8.0-9.0	10
Variables	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
	Root Deptil / Bank Height	Index	1.0-1.9	2.0-3.9	4.0-5.9	6.0-7.9	8.0-9.0	10
Erodibility	Weighted Root Density	Value	100-80	79-55	54-30	29-15	14-5	<5
dib	Weighted Root Density	Index	1.0-1.9	2.0-3.9	4.0-5.9	6.0-7.9	8.0-9.0	10
Erc	Bank Angle	Value	0-20	21-60	61-80	81-90	91-119	>119
	Dank Angie	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
	Surface Protection	Index	1.0-1.9	2.0-3.9	4.0-5.9	6.0-7.9	8.0-9.0	10
			Adju	stments				
	Bedrock	Bedrock banks	have a very lo	w erosion por	tential.			
	Boulders	Boulder banks	have a low ere	osion potentia	l.			
ਢ	Cobble	Substract 10 po	oints. No adjus	tment if sand	gravel compo	se greater that	n 50% of bank	
teri	Clay/Silt Loam	Add 5 points.						
Ma	Gravel	Add 5-10 point	s depending of	n percentage	of bank mater	ial composed	of sand.	
Bank Material	Sand	Add 10 points.						
B	Silt / Clay	No adjustment.	•			•	•	•
			Strat	fication				
	Add 5-10 p	oints depending	on position of	unstable laye	rs in relation t	to bankfull sta	ge.	

	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.

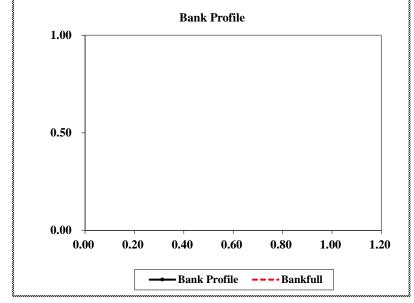
	Estimating Near-Bank Stress ( NBS )								
			Estim	ating Nea	r-Bank St	ress ( NBS	<b>S</b> )		
Stream:	Tributa	ry to Five	Mile Creek		Location:	Rolling Ri	dge Park		
Station:	LB-7			S	tream Type:		,	Valley Type:	
Observe	rs:	IT RS						Date:	5/24/2022
			Methods fo	or Estimati	ng Near-B	ank Stress	(NBS)		
(1) Chanr	nel pattern,	transverse bar	or split channe	l/central bar cre	eating NBS		Level I	Recona	aissance
( <b>2</b> ) Ratio	of radius o	f curvature to b	ankfull width ( F	R <sub>c</sub> / W <sub>bkf</sub> )			Level II	General	prediction
( <b>3</b> ) Ratio	of pool slop	pe to average w	ater surface slo	ope (S <sub>p</sub> /S)			Level II	General	prediction
( <b>4</b> ) Ratio	of pool slop	pe to riffle slope	e (S <sub>p</sub> /S <sub>rif</sub> )	·			Level II	General	prediction
(5) Ratio of near-bank maximum depth to bankfull mean depth ( d <sub>nb</sub> / d <sub>bkf</sub> )							Level III	Detailed	prediction
(6) Ratio of near-bank shear stress to bankfull shear stress ( $\tau_{nb}/\tau_{bkf}$ )							Level III	Detailed	prediction
(7) Veloci	ty profiles	/ Isovels / Veloc	city gradient				Level IV	Valid	dation
=									, , ,
Levell	(1)								
Chute cutoffs, down-valley meander migration, conv						ging flow		NI	BS = Extreme
		Radius of	Bankfull	Ratio R <sub>c</sub> /	Near-Bank				
	(2)	Curvature R <sub>c</sub> (ft)	Width W <sub>bkf</sub> (ft)	W <sub>bkf</sub>	Stress (NBS)				
		0 ( )	(1-7)	DKI	(**===)				
					Near-Bank	l	Method	1	Ĩ
Level II	(2)	Pool Slope	Average		Stress			inant	1
- ev	(3)	Sp	Slope S	Ratio S <sub>p</sub> / S	(NBS)	1	Near-Bai	nk Stress	
_							Hi	gh	
					Near-Bank		=		
	(4)	Pool Slope	Riffle Slope	Ratio S <sub>p</sub> /	Stress				
	` ,	S <sub>p</sub>	S <sub>rif</sub>	S <sub>rif</sub>	(NBS)	1			
		Mara Davi							
		Near-Bank Max Depth	Mean Depth	Ratio d <sub>nb</sub> /	Near-Bank Stress				
	(5)	d <sub>nb</sub> (ft)	d <sub>bkf</sub> (ft)	d <sub>bkf</sub>	(NBS)				
=									
Level III				Near-Bank			Bankfull		
ت	(0)	Near-Bank	Near-Bank	Shear			Shear	Ratio τ <sub>nb</sub> /	Near-Bank
	(6)	Max Depth d <sub>nb</sub> (ft)	Slope S <sub>nb</sub>	Stress $\tau_{nb}$ ( $lb/ft^2$ )	Mean Depth d <sub>bkf</sub> (ft)	Average Slope S	Stress $\tau_{bkf}$ ( lb/ft <sup>2</sup> )		Stress (NBS)
		unb (It)	Ciopo CIID	10/11	u <sub>bkf</sub> (11)	Slope S	10/11	$ au_{ m bkf}$	(NDO)
				Many David					
Level IV	<b>/-</b> >	Velocity Grad	dient (ft/sec	Near-Bank Stress					
eve	(7)	/ f	•	(NBS)					
		Col	nverting Va	dues to a N	lear-Bank	Stress (NF	S) Rating		
Near-B	ank Str	ess (NBS)	Troiting to			ethod numb			
	rating	s	(1)	(2)	(3)	(4)	(5)	(6)	(7)
	Very Lo	ow	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
	Modera	ate	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			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 Hi	gh	(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
	Extren	ne	Above	< 1.50	> 1.00	> 1.20	> 3.00	> 1.60	> 2.40
				Overall N	lear-Bank \$	Stress (NB	S) rating	Hi	gh
						•			

Stream:	Tributary to Five Mile Creek	Observer(s):	IT RS	TRS Data: IT QA/QC: RS To		Total Score:							
Reach:		Comments:											
Location:	LB-8	Bank Length			5		Total Score	Very Low	Low	Moderate	High	Very High	Extreme
Date:	5/24/2022						Values:	5-10	10-20	20-30	30-40	40-45	45-50

		E	rodibility Variabl	les	
Bank Height / Bankf	ull Height Ratio		Toursely (uran)		
Bank Height	Bankfull Height	Value	Index	Bank Erosion Potental	Notes
Root Depth / Bank H	eight Ratio				
Root Depth	Bank Height	Value	Index	Bank Erosion Potental	Notes
Weighted Root Densi	ity				
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					
	TOT	AL SCORE			

			Bank Eros	ion Potential						
			Very Low	Low	Moderate	High	Very High	Extreme		
	D1- II-1-1-4 / D1-6-11 II-1-1-4	Value	1.00-1.10	1.11-1.19	1.20-1.50	1.60-2.00	2.10-2.80	>2.80		
les	Bank Height / Bankfull Height	Index	1.0-1.9	2.0-3.9	4.0-5.9	6.0-7.9	8.0-9.0	10		
Variables	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		
	Root Deptil / Bank Height	Index	1.0-1.9	2.0-3.9	4.0-5.9	6.0-7.9	8.0-9.0	10		
Erodibility	Weighted Root Density	Value	100-80	79-55	54-30	29-15	14-5	<5		
dib	Weighted Root Density	Index	1.0-1.9	2.0-3.9	4.0-5.9	6.0-7.9	8.0-9.0	10		
Ere	Bank Angle	Value	0-20	21-60	61-80	81-90	91-119	>119		
	Dank Angle	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		
	Surface 1 Totection	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 lo	w erosion pot	tential.					
	Boulders	Boulder banks	oulder banks have a low erosion potential.							
ਾਫ	Cobble	Substract 10 po	oints. No adjus	tment if sand	gravel compo	se greater that	n 50% of bank			
teri	Clay/Silt Loam	Add 5 points.								
Gravel Add 5-10 points depending on percentage of bank material composed										
Bank Material	Sand	Add 10 points.								
B	Silt / Clay	No adjustment.								
Stratification										
	Add 5-10 p	oints depending	on position of	unstable laye	rs in relation t	to bankfull sta	ge.			

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



Removed - Unnamed Tributary

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

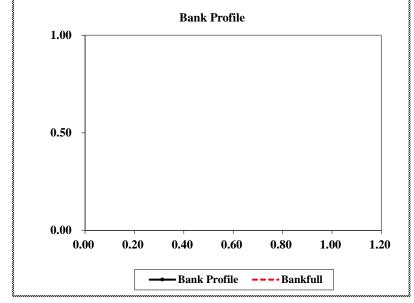
erosior	n rate.									
			Estim	ating Nea	r-Bank St	ress ( NBS	3)			
Stream	Tributa	ary to Five	Mile Creek	,	Location:	Rolling Ri	dge Park			
Station:	LB-8			S	tream Type:			Valley Type:		
Observ	ers:	IT RS						Date:	5/24/2022	
			Methods for	or Estimati	ng Near-Ba	ank Stress	(NBS)			
( <b>1</b> ) Char	nnel pattern	, transverse bar	or split channe	l/central bar cre	eating NBS		Level I	Recona	aissance	
( <b>2</b> ) Ratio	o of radius o	of curvature to b	ankfull width ( F	R <sub>c</sub> / W <sub>bkf</sub> )			Level II	General	prediction	
( <b>3</b> ) Ratio	of pool slo	pe to average v	vater surface slo	ope (S <sub>p</sub> /S)			Level II	General	prediction	
( <b>4</b> ) Ratio	of pool slo	pe to riffle slope					Level II	General	prediction	
( <b>5</b> ) Ratio	of near-ba	ınk maximum de	epth to bankfull	mean depth ( d	nb / d <sub>bkf</sub> )		Level III	Detailed	prediction	
( <b>6</b> ) Ratio	of near-ba	ınk shear stress	to bankfull she	ar stress ( τ <sub>nb</sub> /	$\tau_{bkf}$ )		Level III	Detailed	prediction	
( <b>7</b> ) Velo	city profiles	/ Isovels / Veloc	city gradient				Level IV	Valid	lation	
=		Transverse a	nd/or central b	ars-short and/	or discontinuo	us		NBS = Hig	jh / Very High	
Level	(1)									
تّ		Chute cutoffs	, down-valley	meander mig	ration, conver	ging flow		NE	3S = Extreme	
		Radius of	Bankfull	Ratio R <sub>c</sub> /	Near-Bank					
	(2)	Curvature $R_c$ (ft)	Width W <sub>bkf</sub> (ft)	W <sub>bkf</sub>	Stress (NBS)					
		1 10 (11)	(11)	DKI	(1.126)					
	-				Near-Bank	1	Method			
e	(0)	Pool Slope	Average		Stress			inant		
Level II	(3)	S <sub>p</sub>	Slope S	Ratio S <sub>p</sub> / S	(NBS)		Near-Bar	nk Stress		
1										
					Near-Bank				•	
	(4)	Pool Slope	Riffle Slope	Ratio S <sub>p</sub> /	Stress					
	(4)	S <sub>p</sub>	S <sub>rif</sub>	S <sub>rif</sub>	(NBS)					
		Near-Bank		Dotio d /	Near-Bank					
	(5)	Max Depth d <sub>nb</sub> (ft)	Mean Depth d <sub>bkf</sub> (ft)	Ratio d <sub>nb</sub> / d <sub>bkf</sub>	Stress (NBS)					
=		110 ( )	S-DKI (1-7)	-DKI	(1126)					
Level III				Near-Bank		<del>                                     </del>	Bankfull			
Le		Near-Bank		Shear		ļ	Shear		Near-Bank	
	(6)	Max Depth	Near-Bank	Stress τ <sub>nb</sub> (	Mean Depth		Stress τ <sub>bkf</sub> (	Ratio τ <sub>nb</sub> /	Stress	
		d <sub>nb</sub> (ft)	Slope S <sub>nb</sub>	lb/ft <sup>2</sup> )	d <sub>bkf</sub> (ft)	Slope S	lb/ft <sup>2</sup> )	$ au_{bkf}$	(NBS)	
≥		V-1	P 1 / ft /	Near-Bank						
Level IV	(7)		dient (ft / sec	Stress (NBS)						
Le		/	- /	(.123)	Ì					
Nass	Ponk Cr		nverting Va	alues to a N						
near-		ess (NBS) Is	(1)	(2)	(3)	ethod numb (4)	(5)	(6)	(7)	
ratings         (1)         (2)           Very Low         N/A         > 3.0					< 0.20	< 0.40	< 1.00	< 0.80	< 0.50	
Low N/A 2.21 –					0.20 - 0.40	0.41 – 0.60	1.00 – 1.50	0.80 – 1.05	0.50 – 1.00	
	Modera		N/A	2.01 – 2.20	0.41 - 0.60	0.41 - 0.80	1.51 – 1.80	1.06 – 1.14	1.01 – 1.60	
<b>High</b> See 1.81 – 2.0					0.41 - 0.80	0.81 – 1.00	1.81 – 2.50	1.15 – 1.19	1.61 – 2.00	
	Very H		(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					> 1.20	> 3.00	> 1.60	> 2.40	
					> 1.00	0				
				Overall N	lear-Bank S	Strace (NID	S) rating			

Stream:	Tributary to Five Mile Creek	Observer(s):	IT RS Data: IT QA/QC: RS T					Total Score:		NA	NA				
Reach:		Comments:							High	High					
Location:	LB-9	Bank Length	125				Total Score	Very Low	Low	Moderate	High	Very High	Extreme		
Date:	5/24/2022						Values:	5-10	10-20	20-30	30-40	40-45	45-50		

			19199 37 1 1		
		E	rodibility Variabl	ies	
Bank Height / Bankf	· · ·				
Bank Height	Bankfull Height	Value	Index	Bank Erosion Potental	Notes
Root Depth / Bank H	eight Ratio				
Root Depth	Bank Height	Value	Index	Bank Erosion Potental	Notes
Weighted Root Densi	ity				
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					
	тот	AL SCORE	High		

			Bank Eros	ion Potential									
			Very Low	Low	Moderate	High	Very High	Extreme					
	D	Value	1.00-1.10	1.11-1.19	1.20-1.50	1.60-2.00	2.10-2.80	>2.80					
les	Bank Height / Bankfull Height	Index	1.0-1.9	2.0-3.9	4.0-5.9	6.0-7.9	8.0-9.0	10					
Variables	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					
	Root Deptil / Balik Height	Index	1.0-1.9	2.0-3.9	4.0-5.9	6.0-7.9	8.0-9.0	10					
Erodibility	Weighted Root Density	Value	100-80	79-55	54-30	29-15	14-5	<5					
dib	Weighted Root Density	Index	1.0-1.9	2.0-3.9	4.0-5.9	6.0-7.9	8.0-9.0	10					
Ere	Bank Angle	Value	0-20	21-60	61-80	81-90	91-119	>119					
	Dank Angic	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					
	Surface Frotection	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	drock banks have a very low erosion potential.										
	Boulders	Boulder banks	have a low ere	osion potentia	l.								
ਾਫ	Cobble	Substract 10 po	oints. No adjus	stment if sand	gravel compo	se greater that	n 50% of bank						
iteri	Clay/Silt Loam	Add 5 points.											
Ma	Gravel	Add 5-10 point	s depending o	n percentage	of bank mater	ial composed	of sand.						
Bank Material	Sand	Add 10 points.											
B	Silt / Clay No adjustment.												
			Strat	ification									
	Add 5-10 p	oints depending	on position of	funstable laye	rs in relation t	o bankfull sta	ge.						

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



Occular estimate - High

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

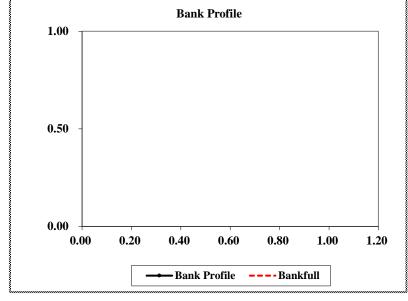
Patio of pool slope to average water surface slope ( $S_p/S$ )  Level II  General prediction  Ratio of pool slope to riffle slope ( $S_p/S_{rif}$ )  Level II  General prediction  Ratio of near-bank maximum depth to bankfull mean depth ( $d_{nb}/d_{bkf}$ )  Level III  Detailed prediction  Ratio of near-bank shear stress to bankfull shear stress ( $\tau_{nb}/\tau_{bkf}$ )  Level III  Detailed prediction	erosion rate.											
Stream Type:   Valley Type:   Date: \$1/24/2022				Estim	ating Nea	r-Bank St	ress ( NBS	3)				
Description	Stream:	Tributa	ry to Five	Mile Creek		Location:	Rolling Ri	dge Park				
Channel pattern, transverse bar or split channel/central bar creating NBS	Station:	LB-9			S	tream Type:		,	√alley Type:			
Channel pattern, transverse bar or split channel/central bar creating NBS	Observe	rs:	IT RS						Date:	5/24/2022		
Ratio of radius of curvature to bankfull width ( R <sub>c</sub> / W <sub>tat</sub> )   Level II   General prediction   Ratio of pool slope to average water surface slope ( S <sub>p</sub> / S <sub>tr</sub> )   Level II   General prediction   Ratio of pool slope to riffle slope ( S <sub>p</sub> / S <sub>tr</sub> )   Level II   General prediction   Ratio of pool slope to riffle slope ( S <sub>p</sub> / S <sub>tr</sub> )   Level II   Detailed prediction   Ratio of near-bank maximum depth to bankfull mean depth ( d <sub>to</sub> / d <sub>tot</sub> )   Level III   Detailed prediction   Ratio of near-bank shear stress to bankfull shear stress ( T <sub>Co</sub> / T <sub>Sut</sub> )   Level III   Detailed prediction   Ratio of near-bank shear stress to bankfull shear stress ( T <sub>Co</sub> / T <sub>Sut</sub> )   Level III   Detailed prediction   Validation   Validat				Methods fo	or Estimati	ng Near-B	ank Stress	(NBS)				
Ratio of pool slope to average water surface slope (S <sub>p</sub> / S <sub>n</sub> )   Level II   General prediction	(1) Chann	el pattern	, transverse bar	or split channe	l/central bar cre	eating NBS		Level I	aissance			
Ratio of pool slope to riftle slope (S <sub>p</sub> / S <sub>str</sub> )   Ratio of near-bank maximum depth to bankfull mean depth (d <sub>tb</sub> / d <sub>bbt</sub> )   Level III   Detailed prediction	( <b>2</b> ) Ratio	of radius o	f curvature to b	ankfull width (F	R <sub>c</sub> / W <sub>bkf</sub> )			Level II				
Ratio of near-bank maximum depth to bankfull mean depth ( dn <sub>D</sub> / d <sub>bel</sub> )   Level III   Detailed prediction	( <b>3</b> ) Ratio	of pool slo	pe to average w	vater surface slo	ope (S <sub>p</sub> /S)			Level II	General	prediction		
Ratio of near-bank maximum depth to bankfull mean depth (\$d_{nb}/d_{bat}')   Level III   Detailed prediction	( <b>4</b> ) Ratio	of pool slo	pe to riffle slope	e (S <sub>p</sub> /S <sub>rif</sub> )	·			Level II	General	prediction		
Velocity profiles / Isovels / Velocity gradient   Velo	( <b>5</b> ) Ratio	of near-ba	nk maximum de	epth to bankfull	<sub>nb</sub> / d <sub>bkf</sub> )		Level III	Detailed	prediction			
1	( <b>6</b> ) Ratio	of near-ba	nk shear stress	to bankfull she	ar stress ( $\tau_{nb}$ /	$\tau_{bkf}$ )		Level III	Detailed	prediction		
California   Converting   California   Cal	(7) Veloci	ty profiles	/ Isovels / Veloc	city gradient				Level IV	Valid	lation		
Radius of Curvature   Width Wold   Wales   W	=		Transverse a	nd/or central b	ars-short and/	or discontinuo	us		NBS = Hig	jh / Very High		
Radius of Curvature   Width Wold   Wales   W	eve	(1)										
California   Cal	ت		Chute cutoffs	, down-valley	meander mig	ration, conver	ging flow		NE	BS = Extreme		
(3)					Potio P /							
Companies   Comp		(2)			-							
Companies   Comp			110 (11)	(11)	V V DKT	(NBC)						
Companies   Comp						Near Book	l	Method	1			
(4)	=		Pool Slope	Average								
(4)	eve	(3)		•	Ratio S <sub>p</sub> / S			Near-Bar	nk Stress			
(4)   Pool Slope   S <sub>p</sub>   Riffle Slope   S <sub>rif</sub>   Stress   (NBS)	_							Mode	erate			
(4)   Pool Slope   S <sub>p</sub>   Riffle Slope   S <sub>rif</sub>   Stress   (NBS)						Near-Bank	•					
Sp		(4)		Riffle Slope								
(5)   Max Depth   d <sub>bkf</sub> (ft)   Mean Depth   d <sub>bkf</sub> (ft)   Mean Depth   d <sub>bkf</sub> (ft)   Mean Depth   Stress (NBS)		(+)	S <sub>p</sub>	S <sub>rif</sub>	S <sub>rif</sub>	(NBS)	1					
(5)   Max Depth   d <sub>bkf</sub> (ft)   Mean Depth   d <sub>bkf</sub> (ft)   Mean Depth   d <sub>bkf</sub> (ft)   Mean Depth   Stress (NBS)												
Converting Values to a Near-Bank Stress (NBS)   Converting Values to a Near					Datia d /							
Near-Bank   Near-Bank   Stress τ <sub>nb</sub> (   Ib/ft² )   Mean Depth   Average   Stress τ <sub>bkf</sub> (   Ib/ft² )   Near-Bank   Stress τ <sub>nb</sub> (   Ib/ft² )   Near-Bank   Stress τ <sub>nb</sub> (   Ib/ft² )   Near-Bank   Stress τ <sub>nb</sub> (   Ib/ft² )   Near-Bank   Stress (NBS)		(5)										
(6)   Max Depth   Close S   Near-Bank   Slope S   Slope S   Slope S   Near-Bank   Stress τ <sub>nb</sub> (   Ib/ft²)   Mean Depth   Close S   Slope S   Slope S   Near-Bank   Stress (NBS)	=		Shb (11)	ODKI (11)	<b>⇔</b> DKT	(NBC)						
(6)   Max Depth   Close S   Near-Bank   Slope S   Slope S   Slope S   Near-Bank   Stress τ <sub>nb</sub> (   Ib/ft²)   Mean Depth   Close S   Slope S   Slope S   Near-Bank   Stress (NBS)	l lə/				Near-Bank			Bankfull				
Max Depth dnb (ft)   Near-Bank Slope Snb   Stress τnb ( lb/ft²)   Mean Depth dbkf (ft)   Average Slope S   Stress τbkf ( lb/ft²)   Tbkf (	Le		Near-Bank					Shear		Near-Bank		
Converting Values to a Near-Bank Stress (NBS) Rating   Near-Bank Stress (NBS)		(6)			Stress $\tau_{nb}$ (	Mean Depth	Average		Ratio $\tau_{nb}$ /			
Converting Values to a Near-Bank Stress (NBS) Rating   Near-Bank Stress (NBS)   Method number   ratings   (1)   (2)   (3)   (4)   (5)   (6)   (7)   (7)   (1)   (2)   (3)   (4)   (5)   (6)   (7)   (1)   (1)   (2)   (3)   (4)   (5)   (6)   (7)   (7)   (1)			d <sub>nb</sub> (ft)	Slope S <sub>nb</sub>	lb/ft <sup>2</sup> )	d <sub>bkf</sub> (ft)	Slope S	lb/ft <sup>2</sup> )	$ au_{bkf}$	(NBS)		
Converting Values to a Near-Bank Stress (NBS) Rating   Near-Bank Stress (NBS)   Method number   ratings   (1)   (2)   (3)   (4)   (5)   (6)   (7)   (7)   (1)   (2)   (3)   (4)   (5)   (6)   (7)   (1)   (1)   (2)   (3)   (4)   (5)   (6)   (7)   (7)   (1)												
Converting Values to a Near-Bank Stress (NBS) Rating   Near-Bank Stress (NBS)	≥											
Converting Values to a Near-Bank Stress (NBS) Rating   Near-Bank Stress (NBS)	vel	(7)										
Near-Bank Stress (NBS)	Le		, 1	.,	(NDO)							
Near-Bank Stress (NBS)												
ratings         (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	Ni	and Ct		nverting Va	alues to a l		•					
Very Low         N / A         > 3.00         < 0.20	Near-B		•	(1)	(2)				(6)	(7)		
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												
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												
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												
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												
Extreme Above < 1.50 > 1.00 > 1.20 > 3.00 > 1.60 > 2.40	g.:											
2.110			_									
Overall Near-Dank Stress (NBS) rating   MODERATE												
					Overall N	ear-Dank S	วแ <i>ย</i> รร (NB	o) rating	IVIO	erate		

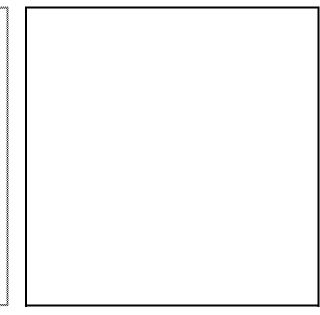
Stream:	Tributary to Five Mile Creek	Observer(s):	IT RS Data: IT QA/QC: RS T				Total Score:		43.66	43.66					
Reach:		Comments:							Very Hi	Very High					
Location:	LB-10	Bank Length		23				Total Score	Very Low	Low	Moderate	High	Very High	Extreme	
Date:	5/24/2022						Values:	5-10	10-20	20-30	30-40	40-45	45-50		

			**********		
		E	rodibility Variabl	es	
Bank Height / Bankf	· · ·				
Bank Height	Bankfull Height	Value	Index	Bank Erosion Potental	Notes
4.00	0.40	10.00	10.00	Extreme	
Root Depth / Bank H	eight Ratio				
Root Depth	Bank Height	Value	Index	Bank Erosion Potental	Notes
1.30	1.30 4.00 0.33		5.65	Moderate	
Weighted Root Densi	ity				
Root Density (%)	Root Depth / Bank Height	Value	Index	Bank Erosion Potental	Notes
40.00	0.33	13.00	8.11	Very High	
Bank Angle					
Bank Angle ( °)			Index	Bank Erosion Potental	Notes
80.00			5.90	Moderate	
Surface Protection					
Surface Protection (%)			Index	Bank Erosion Potental	Notes
10.00			9.00	Very High	
			Adjustment		Notes
Bank Materials			0.00		
			Adjustment		Notes
Bank Stratification			5.00		
	тот	AL SCORE	43.66		

			Bank Eros	sion Potential								
			Very Low	Low	Moderate	High	Very High	Extreme				
	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				
səlc	Dank Height / Danktun Height	Index	1.0-1.9	2.0-3.9	4.0-5.9	6.0-7.9	8.0-9.0	10				
Variables	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				
	Root Deptil / Bank Height	Index	1.0-1.9	2.0-3.9	4.0-5.9	6.0-7.9	8.0-9.0	10				
Erodibility	Weighted Root Density	Value	100-80	79-55	54-30	29-15	14-5	<5				
odit	Weighted Root Density	Index	1.0-1.9	2.0-3.9	4.0-5.9	6.0-7.9	8.0-9.0	10				
Er	Bank Angle	Value	0-20	21-60	61-80	81-90	91-119	>119				
	Dank Angk	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				
	Surface 1 Totection	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 lo	ow erosion pot	tential.							
	Boulders	Boulder banks	have a low er	osion potentia	l.							
ਢ	Cobble	Substract 10 po	oints. No adjus	stment if sand	gravel compo	se greater that	n 50% of bank					
Material	Clay/Silt Loam	Add 5 points.										
Ma	Gravel	Add 5-10 point	s depending of	n percentage	of bank mater	ial composed	of sand.					
Bank	Sand	Add 10 points.										
B	Silt / Clay	No adjustment.										
	Stratification											
	Add 5-10 p	oints depending	on position of	f unstable laye	rs in relation t	to bankfull sta	ge.	•				

	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.

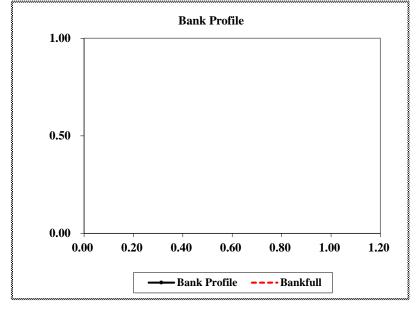
erosion rate.												
			Estim	ating Nea	r-Bank St	ress ( NBS	S)					
Stream:	Tributa	ary to Five	Mile Creek		Location:	<b>Rolling Ri</b>	dge Park					
Station:	LB-10			S	tream Type:		•	√alley Type:				
Observe	rs:	IT RS						Date:	5/24/2022			
			Methods fo	or Estimati	ng Near-B	ank Stress	(NBS)					
(1) Chanr	nel pattern	, transverse bar	or split channe	l/central bar cre	eating NBS		Level I	Reconaissance				
	•	f curvature to b	·				Level II	General prediction				
		pe to average v					Level II		prediction			
		pe to riffle slope		- · · · ·			Level II	General	prediction			
		nk maximum de		mean depth ( d	<sub>nh</sub> / d <sub>hkf</sub> )		Level III		prediction			
		nk shear stress					Level III		prediction			
		/ Isovels / Veloc		ar on ooo ( v <sub>nb</sub> /	*DKI /		Level IV		lation			
_	., p.o			ars-short and/	or discontinuo	us						
Level	(1)							-				
Le		Chute cutoffs	, down-valley	meander mig	ration, conver	ging flow		NE	BS = Extreme			
		Radius of	Bankfull		Near-Bank							
	(2)	Curvature	Width W <sub>bkf</sub>	Ratio R <sub>c</sub> /	Stress							
	` ,	R <sub>c</sub> (ft)	(ft)	W <sub>bkf</sub>	(NBS)	1						
							Method	1				
=		Pool Slope	Average		Near-Bank Stress			inant				
Level II	(3)	S <sub>p</sub>	Slope S	Ratio S <sub>p</sub> / S	(NBS)			nk Stress				
Ľ		P	-	P			Very High					
					Near-Bank		10.7	9				
	(4)	Pool Slope	Riffle Slope	Ratio S <sub>p</sub> /	Stress							
	(4)	S <sub>p</sub>	S <sub>rif</sub>	S <sub>rif</sub>	(NBS)	1						
		Near-Bank			Near-Bank							
	(5)	Max Depth	Mean Depth	Ratio d <sub>nb</sub> /	Stress							
_	( )	d <sub>nb</sub> (ft)	d <sub>bkf</sub> (ft)	d <sub>bkf</sub>	(NBS)	1						
Level III				Near-Bank			Bankfull					
Lev		Near-Bank		Shear			Shear		Near Dools			
	(6)	Max Depth	Near-Bank	Stress $\tau_{\text{nb}}$ (	Mean Depth	Average	Stress $\tau_{bkf}$ (	Ratio τ <sub>nb</sub> /	Near-Bank Stress			
	(-)	d <sub>nb</sub> (ft)	Slope S <sub>nb</sub>	lb/ft <sup>2</sup> )	d <sub>bkf</sub> (ft)	Slope S	lb/ft <sup>2</sup> )	$ au_{bkf}$	(NBS)			
>				Near-Bank								
Level IV	(7)		dient (ft/sec	Stress								
Lev	(- )	/ f	t )	(NBS)	l							
					<u> </u>							
_			nverting Va	alues to a N								
Near-E		ess (NBS)			(3)	ethod numb						
	ratings (1) (2)					(4)	(5)	(6)	(7)			
	Very Lo		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	0.41 – 0.60	1.00 – 1.50	0.80 – 1.05	0.50 – 1.00			
	Moderate N/A 2.01 – 2.2					0.61 – 0.80	1.51 – 1.80	1.06 – 1.14	1.01 – 1.60			
High See 1.81 – 2.0					0.61 – 0.80	0.81 – 1.00	1.81 – 2.50	1.15 – 1.19	1.61 – 2.00			
	Very Hi		(1) Abovo	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 N	all Near-Bank Stress (NBS) rating Very High							
								_				

Stream:	Tributary to Five Mile Creek	Observer(s):	IT RS Data: IT QA/QC: RS					Total Score:		NA	NA				
Reach:		Comments:							High	High					
Location:	LB-11	Bank Length	22				Total Score	Very Low	Low	Moderate	High	Very High	Extreme		
Date:	5/24/2022							Values:	5-10	10-20	20-30	30-40	40-45	45-50	

		T	3:1.:11:4 37		
		E	rodibility Variabl	es	
Bank Height / Bankf	· · ·				
Bank Height	Bankfull Height	Value	Index	Bank Erosion Potental	Notes
3.70					
Root Depth / Bank H	eight Ratio				
Root Depth	Bank Height	Value	Index	Bank Erosion Potental	Notes
	3.70				
Weighted Root Densi	ity				
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					
	тот	AL SCORE	High		

			Bank Eros	sion Potential							
			Very Low	Low	Moderate	High	Very High	Extreme			
	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			
səle	Bank Height / Bankiuli Height	Index	1.0-1.9	2.0-3.9	4.0-5.9	6.0-7.9	8.0-9.0	10			
Variables	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			
	Root Deptil / Bank Height	Index	1.0-1.9	2.0-3.9	4.0-5.9	6.0-7.9	8.0-9.0	10			
ility	Weighted Root Density	Value	100-80	79-55	54-30	29-15	14-5	<5			
Erodibility	Weighted Root Density	Index	1.0-1.9	2.0-3.9	4.0-5.9	6.0-7.9	8.0-9.0	10			
Erc	Bank Angle	Value	0-20	21-60	61-80	81-90	91-119	>119			
	Dank Angie	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			
	Surface I Totection	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 lo	w erosion po	tential.						
	Boulders	Boulder banks	have a low ere	osion potentia	l.						
a	Cobble	Substract 10 po	oints. No adjus	stment if sand	gravel compo	se greater that	n 50% of bank				
teri	Clay/Silt Loam	Add 5 points.									
Ma	Gravel	Add 5-10 point	s depending of	n percentage	of bank mater	ial composed	of sand.	•			
Bank Material	Sand	Add 10 points.	•				•	•			
B	Silt / Clay	No adjustment.						•			
			Strat	ification			•	·			
	Add 5-10 p	oints depending	on position of	funstable laye	rs in relation t	o bankfull sta	ge.				

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



Occular estimate - High

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

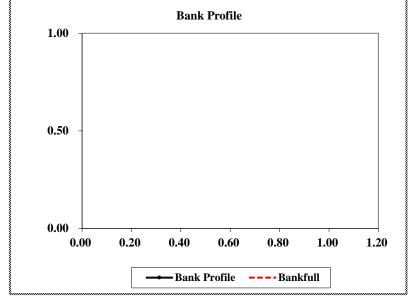
erosion	rate.												
			Estim	ating Nea	r-Bank St	ress ( NBS	S)						
Stream:	Tributa	ry to Five	Mile Creek		Location:	Rolling Ri	dge Park						
Station:	LB-11			S	tream Type:		,	Valley Type:					
Observe	ers:	IT RS						Date:	5/24/2022				
			Methods fo	or Estimati	ng Near-B	ank Stress	(NBS)						
( <b>1</b> ) Chan	nel pattern	, transverse bar	or split channe	l/central bar cre	eating NBS		Level I	Recona	aissance				
(2) Ratio	of radius o	f curvature to b	ankfull width (F	R <sub>c</sub> / W <sub>bkf</sub> )			Level II	General	prediction				
(3) Ratio	of pool slo	pe to average w	vater surface slo	ope (S <sub>p</sub> /S)			Level II	General	prediction				
(4) Ratio	of pool slo	pe to riffle slope	e ( S <sub>p</sub> / S <sub>rif</sub> )				Level II	General	prediction				
( <b>5</b> ) Ratio	of near-ba	nk maximum de	epth to bankfull	mean depth ( d	<sub>nb</sub> / d <sub>bkf</sub> )		Level III	Detailed	prediction				
			to bankfull she				Level III	Detailed	prediction				
		/ Isovels / Veloc		, 110	DIG 7		Level IV		lation				
=		Transverse a	nd/or central b	ars-short and/	or discontinuo	us		NBS = Hig	jh / Very High				
Level	(1)												
۳		Chute cutoffs	, down-valley	meander mig	ration, conver	ging flow		NE	BS = Extreme				
		Radius of	Bankfull	Datio D /	Near-Bank								
	(2)	Curvature R <sub>c</sub> (ft)	Width W <sub>bkf</sub> (ft)	Ratio R <sub>c</sub> / W <sub>bkf</sub>	Stress (NBS)								
		110 (11)	(11)	• • DKT	(NDO)								
					Near Book	or Rank Method 1							
=	(0)	Pool Slope	Average		Near-Bank Stress	IN .							
Level II	(3)	Sp	Slope S	Ratio S <sub>p</sub> / S	(NBS)								
_							Hi	gh					
					Near-Bank	•	_						
	(4)	Pool Slope	Riffle Slope	Ratio S <sub>p</sub> /	Stress								
	(-,	Sp	S <sub>rif</sub>	S <sub>rif</sub>	(NBS)	ì							
						ļ							
		Near-Bank	5 //	Potio d /	Near-Bank								
	(5)	Max Depth d <sub>nb</sub> (ft)	Mean Depth d <sub>bkf</sub> (ft)	Ratio d <sub>nb</sub> / d <sub>bkf</sub>	Stress (NBS)								
=		* HD ( *)	S-DKI (1-7)	- DKI	(1.126)								
Level III				Near-Bank			Bankfull						
Le		Near-Bank		Shear			Shear		Near-Bank				
	(6)	Max Depth	Near-Bank	Stress τ <sub>nb</sub> (	Mean Depth			Ratio τ <sub>nb</sub> /	Stress				
		d <sub>nb</sub> (ft)	Slope S <sub>nb</sub>	lb/ft <sup>2</sup> )	d <sub>bkf</sub> (ft)	Slope S	lb/ft <sup>2</sup> )	$ au_{bkf}$	(NBS)				
≥		\/ala=:t= 0=	diant / ft /	Near-Bank									
Level IV	(7)		dient (ft/sec t)	Stress (NBS)									
Le			- /	(**===)									
					<u> </u>	04	10) 5 4						
Noor I	Rank Ct-		nverting Va	liues to a l		•							
ivear-t	rating	ess (NBS) s	(1)	(2)	(3)	ethod numb (4)	(5)	(6)	(7)				
	Very Lo		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				
	Modera	ate	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 Hi		(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				
	Extren	_	Above	< 1.50	> 1.00	> 1.20	> 3.00	> 1.60	> 2.40				
Overall Near-Bank Stress (NBS) rating High							9''						

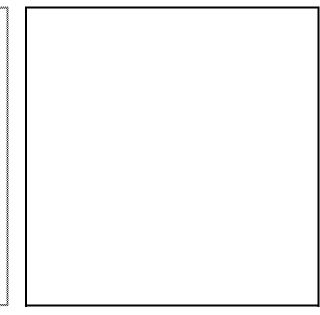
Stream:	Tributary to Five Mile Creek	Observer(s):	IT RS	TT RS Data: IT QA/QC: RS To			Total Score:		36.45	36.45				
Reach:		Comments:								High				
Location:	LB-12	Bank Length			37			Total Score	Very Low	Low	Moderate	High	Very High	Extreme
Date:	5/24/2022							Values:	5-10	10-20	20-30	30-40	40-45	45-50

		E	rodibility Variabl	les	
Bank Height / Bankfo	ull Height Ratio				
Bank Height	Bankfull Height	Value	Index	Bank Erosion Potental	Notes
3.30	0.40	8.25	10.00	Extreme	
Root Depth / Bank H	eight Ratio				
Root Depth	Bank Height	Value	Index	Bank Erosion Potental	Notes
0.80	3.30	0.24	6.65	High	
Weighted Root Densi	ity				
Root Density (%)	Root Depth / Bank Height	Value	Index	Bank Erosion Potental	Notes
20.00	0.24	4.85	10.00	Extreme	
Bank Angle					
Bank Angle ( °)			Index	Bank Erosion Potental	Notes
60.00			3.90	Low	
Surface Protection					
Surface Protection (%)			Index	Bank Erosion Potental	Notes
30.00			5.90	Moderate	
			Adjustment		Notes
Bank Materials			0.00		
			Adjustment		Notes
Bank Stratification			0.00		
	тот	AL SCORE	36.45		

			Bank Eros	ion Potential				
			Very Low	Low	Moderate	High	Very High	Extreme
	D	Value	1.00-1.10	1.11-1.19	1.20-1.50	1.60-2.00	2.10-2.80	>2.80
les	Bank Height / Bankfull Height	Index	1.0-1.9	2.0-3.9	4.0-5.9	6.0-7.9	8.0-9.0	10
Variables	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
	Root Deptil / Balik Height	Index	1.0-1.9	2.0-3.9	4.0-5.9	6.0-7.9	8.0-9.0	10
Erodibility	Weighted Root Density	Value	100-80	79-55	54-30	29-15	14-5	<5
dib	Weighted Root Density	Index	1.0-1.9	2.0-3.9	4.0-5.9	6.0-7.9	8.0-9.0	10
Ere	Bank Angle	Value	0-20	21-60	21-60 61-80		91-119	>119
	Dank Angic	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
	Surface Frotection	Index	1.0-1.9	2.0-3.9	4.0-5.9	6.0-7.9	8.0-9.0	10
			Adju	stments				
	Bedrock	Bedrock banks	have a very lo	w erosion po	tential.			
	Boulders	Boulder banks	have a low ere	osion potentia	l.			
ਾਫ	Cobble	Substract 10 po	oints. No adjus	stment if sand	gravel compo	se greater that	n 50% of bank	
iteri	Clay/Silt Loam	Add 5 points.						
Ma	Gravel	Add 5-10 point	s depending o	n percentage	of bank mater	ial composed	of sand.	
Bank Material	Sand	Add 10 points.						
B	Silt / Clay	No adjustment.						
			Strat	ification				
	Add 5-10 p	oints depending	on position of	funstable laye	rs in relation t	o bankfull sta	ge.	

	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.

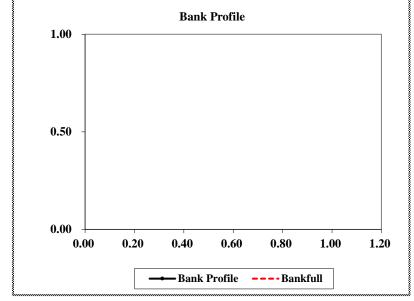
Ratio of pool slope to average water surface slope ( $S_p/S$ )  Level II  General prediction  Ratio of pool slope to riffle slope ( $S_p/S_{rif}$ )  Level II  General prediction  Ratio of near-bank maximum depth to bankfull mean depth ( $d_{nb}/d_{bkf}$ )  Level III  Detailed prediction  Ratio of near-bank shear stress to bankfull shear stress ( $\tau_{nb}/\tau_{bkf}$ )  Level III  Detailed prediction	erosion	rate.								
Desire				Estim	ating Nea	r-Bank St	ress ( NBS	3)		
Diservers:   IT RS	Stream:	Tributa	ry to Five	Mile Creek		Location:	Rolling Ri	dge Park		
	Station:	LB-12			S	tream Type:		•	Valley Type:	
Channel pattern, transverse bar or split channel/central bar creating NBS	Observe	rs:	IT RS						Date:	5/24/2022
2   Ratio of radius of curvature to bankfull width (R <sub>c</sub> / W <sub>sat</sub> )   Level II   General prediction				Methods fo	or Estimati	ng Near-B	ank Stress	(NBS)		
Ratio of pool slope to average water surface slope (S <sub>p</sub> / S)   Level III   General prediction   General prediction   General prediction   Level III   General prediction   Level III   Detailed prediction   Level III   Detailed prediction   General prediction   Level III   Detailed prediction   Level III   Le	(1) Chanr	el pattern	, transverse bar	or split channe	l/central bar cre	eating NBS		Level I	Recona	issance
Ratio of pool slope to riffie slope   Sp / Sn     Ratio of near-bank maximum depth to bankfull mean depth (dne/doid)   Level III   Detailed prediction	( <b>2</b> ) Ratio	of radius o	f curvature to b	ankfull width (F	R <sub>c</sub> / W <sub>bkf</sub> )			Level II	General	prediction
Pation of near-bank maximum depth to bankfull mean depth (d <sub>nb</sub> / d <sub>baf</sub> )   Level III   Detailed prediction   Detailed prediction   Detailed prediction   Detailed prediction   Detailed prediction   Pation   P	( <b>3</b> ) Ratio	of pool slo	pe to average w	vater surface slo	ope (S <sub>p</sub> /S)			Level II	General	prediction
Detailed prediction   NBS = Extreme   NBS = Ex	( <b>4</b> ) Ratio	of pool slo	pe to riffle slope	e ( S <sub>p</sub> / S <sub>rif</sub> )	·			Level II	General	prediction
Velocity profiles / Isovels / Velocity gradient	( <b>5</b> ) Ratio	of near-ba	nk maximum de	epth to bankfull	mean depth ( d	<sub>nb</sub> / d <sub>bkf</sub> )		Level III	Detailed	prediction
Transverse and/or central bars-short and/or discontinuous	( <b>6</b> ) Ratio	of near-ba	nk shear stress	to bankfull she	ar stress ( $\tau_{nb}$ /	$\tau_{bkf}$ )		Level III	Detailed	prediction
Canal	(7) Veloci	ty profiles	/ Isovels / Veloc	city gradient				Level IV	Valid	lation
Radius of Curvature   Width Wood   Ratio R <sub>c</sub> / (ht)   Wood   Wood   Ratio R <sub>c</sub> / (ht)   Ratio R <sub>c</sub> / (h	=		Transverse a	nd/or central b	ars-short and/	or discontinuo	us		NBS = Hig	jh / Very High
Radius of Curvature   Width Wood   Ratio R <sub>c</sub> / (ht)   Wood   Wood   Ratio R <sub>c</sub> / (ht)   Ratio R <sub>c</sub> / (h	eve.	(1)								
Campaigness	ت			, down-valley	meander mig	ration, conver	ging flow		NE	BS = Extreme
California					Potio P /					
Method   1   Dominant   Near-Bank   Stress   Near		(2)			_					
Companies   Comp			( )	(11)	* * DKI	(NBC)				
Companies   Comp						Near Book	l	Method	1	
Color   Colo	=		Pool Slope	Average						
Color   Colo	eve.	(3)		•	Ratio S <sub>p</sub> / S			Near-Bai	nk Stress	
(4)   Pool Slope   S <sub>p</sub>   Riffle Slope   S <sub>rif</sub>   Ratio S <sub>p</sub> / Stress (NBS)	_							Very	Low	
(4)   Pool Slope   S <sub>p</sub>   Riffle Slope   S <sub>rif</sub>   Ratio S <sub>p</sub> / Stress (NBS)						Near-Bank	•	_		
Near-Bank   Near-Bank   Near-Bank   Near-Bank   Stress (NBS)		(4)								
(5)   Max Depth   Mean Depth   Abkf (ft)   Mean Depth   Abkf (ft)   Mean Depth   Abkf (ft)   Mean Depth   Abkf (ft)   Mean Depth   Average   Shear   Stress τ <sub>bkf</sub> ( Ib/ft²)   Near-Bank   Stress τ <sub>τb</sub> ( Ib/ft²)   Near-Bank   Stress τ <sub>τb</sub> ( Ib/ft²)   Near-Bank   Stress τ <sub>τb</sub> (Ib/ft²)   Near-Bank   Stress τ <sub>τb</sub> (Ib/ft²)   Near-Bank   Stress τ <sub>τb</sub> (Ib/ft²)   Near-Bank   Stress (NBS)   Near-Bank   Near-Bank   Stress (NBS)   Near-Bank   Near-Bank   Stress (NBS)   Near-Bank   Near-B		(-)	S <sub>p</sub>	S <sub>rif</sub>	S <sub>rif</sub>	(NBS)				
(5)   Max Depth   Mean Depth   Abkf (ft)   Mean Depth   Abkf (ft)   Mean Depth   Abkf (ft)   Mean Depth   Abkf (ft)   Mean Depth   Average   Shear   Stress τ <sub>bkf</sub> ( Ib/ft²)   Near-Bank   Stress τ <sub>τb</sub> ( Ib/ft²)   Near-Bank   Stress τ <sub>τb</sub> ( Ib/ft²)   Near-Bank   Stress τ <sub>τb</sub> (Ib/ft²)   Near-Bank   Stress τ <sub>τb</sub> (Ib/ft²)   Near-Bank   Stress τ <sub>τb</sub> (Ib/ft²)   Near-Bank   Stress (NBS)   Near-Bank   Near-Bank   Stress (NBS)   Near-Bank   Near-Bank   Stress (NBS)   Near-Bank   Near-B										
Converting Values to a Near-Bank Stress (NBS)   Converting Values to a Near					Datio d /					
Near-Bank   Near-Bank   Near-Bank   Stress \( This in the content of the		(5)				1. 1. 1. 2. 1				
Converting Values to a Near-Bank Stress (NBS)   Converting Values to a Near-	=		* HD ( *)	S-DKI (1-7)	-DKI	(1.126)				
Converting Values to a Near-Bank Stress (NBS)   Converting Values to a Near-	le Ve				Near-Bank			Bankfull		
(6)   Max Depth   Glope S   Stress τ <sub>nb</sub> (   Ib/ft²)   Mean Depth   Average   Slope S   Stress τ <sub>bbf</sub> (   Ib/ft²)   Stress (NBS)	Le		Near-Bank							Near-Bank
Velocity Gradient ( ft / sec		(6)			Stress $\tau_{nb}$ (				Ratio τ <sub>nb</sub> /	Stress
Converting Values to a Near-Bank Stress (NBS) Rating   Near-Bank Stress (NBS)			d <sub>nb</sub> (ft)	Slope S <sub>nb</sub>	lb/ft²)	d <sub>bkf</sub> (ft)	Slope S	lb/ft <sup>2</sup> )	$ au_{ m bkf}$	(NBS)
Converting Values to a Near-Bank Stress (NBS) Rating   Near-Bank Stress (NBS)										
Converting Values to a Near-Bank Stress (NBS) Rating   Near-Bank Stress (NBS)   Rating   (1)   (2)   (3)   (4)   (5)   (6)   (7)   (7)   (7)   (8)   (1)	≥		V-1	P 1 / ft /						
Converting Values to a Near-Bank Stress (NBS) Rating   Near-Bank Stress (NBS)   Rating   (1)   (2)   (3)   (4)   (5)   (6)   (7)   (7)   (7)   (8)   (1)	_ e	(7)								
Near-Bank Stress (NBS)	Fe		, .	.,	(NBC)					
Near-Bank Stress (NBS)										
ratings         (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	Ni	and Ct		nverting Va	alues to a l					
Very Low         N/A         > 3.00         < 0.20	Near-B			(1)	(2)				(6)	(7)
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										
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										
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										
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										
Extreme Above <1.50 >1.00 >1.20 >3.00 >1.60 >2.40										
2.100 2.100 2.100 2.100			_							
Overall Near-Dalik Stress (NBS) rating Very Low				-						
					Overall N	ear-Dank S	วแ <i>ย</i> รร (NB	o) rating	very	LOW

Stream:	Tributary to Five Mile Creek	Observer(s):	IT RS	IT RS Data: IT QA/QC: RS To			Total Score:	NA	NA					
Reach:		Comments:						Moderate						
Location:	LB-13	Bank Length		49		Total Score	Very Low	Low	Moderate	High	Very High	Extreme		
Date:	5/24/2022							Values:	5-10	10-20	20-30	30-40	40-45	45-50

		-			
		E	rodibility Variabl	les	
Bank Height / Bankf	ull Height Ratio				
Bank Height	Bankfull Height	Value	Index	Bank Erosion Potental	Notes
3.60					
Root Depth / Bank H	eight Ratio				
Root Depth	Bank Height	Value	Index	Bank Erosion Potental	Notes
	3.60				
Weighted Root Densi	ity				
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					
	тот	AL SCORE	Moderate		

			Bank Eros	ion Potential				
			Very Low	Low	Moderate	High	Very High	Extreme
	D	Value	1.00-1.10	1.11-1.19	1.20-1.50	1.60-2.00	2.10-2.80	>2.80
les	Bank Height / Bankfull Height	Index	1.0-1.9	2.0-3.9	4.0-5.9	6.0-7.9	8.0-9.0	10
Variables	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
	Root Deptil / Balik Height	Index	1.0-1.9	2.0-3.9	4.0-5.9	6.0-7.9	8.0-9.0	10
Erodibility	Weighted Root Density	Value	100-80	79-55	54-30	29-15	14-5	<5
gib	Weighted Root Delisity	Index	1.0-1.9	2.0-3.9	4.0-5.9	6.0-7.9	8.0-9.0	10
Ere	Bank Angle	Value	0-20	21-60	21-60 61-80		91-119	>119
	Dank Angic	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
	Surface Frotection	Index	1.0-1.9	2.0-3.9	4.0-5.9	6.0-7.9	8.0-9.0	10
			Adju	stments				
	Bedrock	Bedrock banks	have a very lo	w erosion po	tential.			
	Boulders	Boulder banks	have a low ere	osion potentia	l.			
ਾਫ	Cobble	Substract 10 po	oints. No adjus	stment if sand	gravel compo	se greater that	n 50% of bank	
iteri	Clay/Silt Loam	Add 5 points.						
Ma	Gravel	Add 5-10 point	s depending o	n percentage	of bank mater	ial composed	of sand.	
Bank Material	Sand	Add 10 points.						
B	Silt / Clay	No adjustment.						
			Strati	ification				
	Add 5-10 p	oints depending	on position of	funstable laye	rs in relation t	o bankfull sta	ge.	

	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.

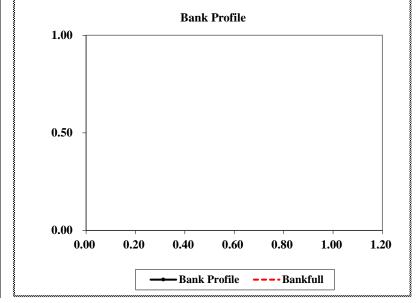
Patio of pool slope to average water surface slope ( $S_p/S$ )  Level II  General prediction  Ratio of pool slope to riffle slope ( $S_p/S_{rif}$ )  Level II  General prediction  Ratio of near-bank maximum depth to bankfull mean depth ( $d_{nb}/d_{bkf}$ )  Level III  Detailed prediction  Ratio of near-bank shear stress to bankfull shear stress ( $\tau_{nb}/\tau_{bkf}$ )  Level III  Detailed prediction	erosion	rate.										
Stream Type:   Valley Type:   Date: 5/24/2022				Estim	ating Nea	r-Bank St	ress ( NBS	3)				
Description	Stream:	Tributa	ary to Five	Mile Creek		Location:	Rolling Ri	dge Park				
Channel patern, transverse bar or split channel/central bar creating NBS	Station:	LB-13			S	tream Type:		,	√alley Type:			
Channel pattern, transverse bar or split channel/central bar creating NBS	Observe	rs:	IT RS						Date:	5/24/2022		
Ratio of radius of curvature to bankfull width ( R <sub>c</sub> / W <sub>sat</sub> )   Level II   General prediction   Ratio of pool slope to average water surface slope ( S <sub>p</sub> / S <sub>H</sub> )   Level II   General prediction   Ratio of pool slope to riffle slope ( S <sub>p</sub> / S <sub>H</sub> )   Level III   General prediction   Ratio of pool slope to riffle slope ( S <sub>p</sub> / S <sub>H</sub> )   Level III   Detailed prediction   Ratio of near-bank maximum depth to bankfull mean depth ( d <sub>to</sub> / d <sub>bat</sub> )   Level III   Detailed prediction   Ratio of near-bank shear stress to bankfull shear stress ( T <sub>cac</sub> / T <sub>cac</sub> )   Level III   Detailed prediction   Velocity profiles / Velocity gradient   Level III   Detailed prediction   Velocity profiles / Velocity gradient   Level III   Detailed prediction   NBS = High / Vel Ptiph   Velocity profiles   Near-Bank   Near				Methods fo	or Estimati	ng Near-Ba	ank Stress	(NBS)				
Ratio of pool slope to average water surface slope (S <sub>p</sub> /S <sub>s</sub> )   Level II   General prediction	(1) Chanr	nel pattern	, transverse bar	or split channe	l/central bar cre	eating NBS		Level I	Recona	issance		
Ratio of pool slope to riffle slope (S p / Srift)   Ratio of pool slope to riffle slope (S p / Srift)   Ratio of near-bank maximum depth to bankfull hear stress (T m/ State)   Level III   Detailed prediction	( <b>2</b> ) Ratio	of radius o	f curvature to b	ankfull width (F	R <sub>c</sub> / W <sub>bkf</sub> )		Level II	General	prediction			
Ratio of near-bank maximum depth to bankfull mean depth (d <sub>nb</sub> / d <sub>beld</sub> )   Level III   Detailed prediction	( <b>3</b> ) Ratio	of pool slo	pe to average w	vater surface slo	ope (S <sub>p</sub> /S)			Level II	General	prediction		
Ratio of near-bank shear stress to bankfull shear stress ( \( \frac{T_{th}}{T_{bac}} \)   Velocity profiles / Isovels / Velocity gradient   Level IIV   Validation   Validat	( <b>4</b> ) Ratio	of pool slo	pe to riffle slope	e (S <sub>p</sub> /S <sub>rif</sub> )	·	Level II	General	prediction				
Velocity profiles / Isovels / Velocity gradient	( <b>5</b> ) Ratio	of near-ba	nk maximum de	epth to bankfull	mean depth ( d	<sub>nb</sub> / d <sub>bkf</sub> )		Level III	Detailed	prediction		
Transverse and/or central bars-short and/or discontinuous	( <b>6</b> ) Ratio	of near-ba	nk shear stress	to bankfull she	ar stress ( τ <sub>nb</sub> /	$\tau_{bkf}$ )		Level III	Detailed	prediction		
California   Cal	(7) Veloci	ty profiles	/ Isovels / Veloc	city gradient				Level IV	Valid	lation		
Radius of Curvature (right)   Ratio R <sub>c</sub> / (right)   Ratio R <sub>c</sub> / (right)   Ratio R <sub>c</sub> / (right)   Ratio S <sub>p</sub> /	=		Transverse a	nd/or central b	ars-short and/	or discontinuo	us		NBS = Hig	jh / Very High		
Radius of Curvature (right)   Ratio R <sub>c</sub> / (right)   Ratio R <sub>c</sub> / (right)   Ratio R <sub>c</sub> / (right)   Ratio S <sub>p</sub> /	eve.	(1)										
Carry atture   Carr	ت		Chute cutoffs	, down-valley	meander mig	ration, conver	ging flow		NE	BS = Extreme		
(2)   R <sub>c</sub> (ft)   (ft)   (ft)   W <sub>bot</sub>   (NBS)   (NBS)					Potio P /							
Converting Values to a Near-Bank Stress (NBS)   Near-Bank Stress (NBS)   Near-Bank Stress (NBS)		(2)										
Companies   Comp			()	(,	DKI	(1.126)	Ì					
Companies   Comp						Noor Ponk	J	Method	1			
Converting Values to a Near-Bank Stress (NBS)   Near-Bank Stress (NBS	=	(0)	Pool Slope	Average					inant			
Converting Values to a Near-Bank Stress (NBS)   Near-Bank Stress (NBS	eve.	(3)		Slope S	Ratio S <sub>p</sub> / S	(NBS)		Near-Bar	nk Stress			
(4)   Pool Slope   S <sub>p</sub>   Riffle Slope   S <sub>rif</sub>   Stress   (NBS)	_							Mode	erate			
(4) S <sub>p</sub> S <sub>rif</sub> S <sub>rif</sub> (NBS)  (5) Near-Bank Max Depth d <sub>nb</sub> (ft) d <sub>bM</sub> (ft) d						Near-Bank						
Sp		(4)			•	Stress						
(5)   Max Depth   d <sub>bkf</sub> (ft)   Mean Depth   d <sub>bkf</sub> (ft)   d <sub>bkf</sub> (ft		(-)	S <sub>p</sub>	S <sub>rif</sub>	S <sub>rif</sub>	(NBS)						
(5)   Max Depth   d <sub>bkf</sub> (ft)   Mean Depth   d <sub>bkf</sub> (ft)   d <sub>bkf</sub> (ft							ļ					
Converting Values to a Near-Bank Stress (NBS)   Converting Values to a Near					Datio d /							
Near-Bank   Near-Bank   Stress τ <sub>nb</sub> (   Ib/ft² )   Near-Bank   Stress (NBS)   Ib/ft² )   Near-Bank   Stress (NBS)   Ib/ft² )   Near-Bank   Stress (NBS)   Near-Bank   Near-Bank   Stress (NBS)   Near-Bank   Near-Bank   Stress (NBS)   Near-Bank   Near-Ban		(5)										
(6)   Max Depth   And Depth	=		* HD ( *)	S-DKI (1-7)	- DKI	(1120)						
(6)   Max Depth   And Depth	<u>vel</u>				Near-Bank			Bankfull				
Max Depth dnb (ft)   Near-Bank Stress τnb (lb/ft²)   Mean Depth dbkf (ft)   Average Slope S   Stress τbkf (lb/ft²)   Stress (NBS)	Le		Near-Bank							Near-Bank		
Converting Values to a Near-Bank Stress (NBS) Rating   Near-Bank Stress (NBS)		(6)			Stress $\tau_{nb}$ (				Ratio τ <sub>nb</sub> /	Stress		
Converting Values to a Near-Bank Stress (NBS) Rating   Near-Bank Stress (NBS)			d <sub>nb</sub> (ft)	Slope S <sub>nb</sub>	lb/ft²)	d <sub>bkf</sub> (ft)	Slope S	lb/ft <sup>2</sup> )	$ au_{bkf}$	(NBS)		
Converting Values to a Near-Bank Stress (NBS) Rating   Near-Bank Stress (NBS)												
Converting Values to a Near-Bank Stress (NBS) Rating   Near-Bank Stress (NBS)	≥		V-1	P 1 / ft /								
Converting Values to a Near-Bank Stress (NBS) Rating   Near-Bank Stress (NBS)	   	(7)										
Near-Bank Stress (NBS)	Fe		, ,	.,	(NBC)							
Near-Bank Stress (NBS)												
ratings         (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	Ni			nverting Va	alues to a l		•					
Very Low         N/A         > 3.00         < 0.20	Near-B		•	(1)	(2)				(6)	(7)		
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												
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												
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												
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												
Extreme Above <1.50 >1.00 >1.20 >3.00 >1.60 >2.40												
2.110												
Overall Near-Dank Stress (NBS) rating Wioderate			·		7 1100 7 1120 7 0100 7 1100 7 2110							
					Overall N	edi-Dank S	วแ <i>ย</i> รร (NB	o) rating	IVIO	erale		

Stream:	Tributary to Five Mile Creek	Observer(s):	IT RS	Data:	IT	QA/QC:	RS	Total Score:						
Reach:		Comments:												
Location:	LB-14	Bank Length			35				Very Low	Low	Moderate	High	Very High	Extreme
Date:	5/24/2022							Values:	5-10	10-20	20-30	30-40	40-45	45-50

		E	rodibility Variabl	les	
Bank Height / Bankf	ull Height Ratio				
Bank Height	Bankfull Height	Value	Index	Bank Erosion Potental	Notes
Root Depth / Bank H	leight Ratio				
Root Depth	Bank Height	Value	Index	Bank Erosion Potental	Notes
Weighted Root Dens	ity				
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					
	TOT	AL SCORE			

			Bank Eros	sion Potential						
			Very Low	Low	Moderate	High	Very High	Extreme		
	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		
səle	Bank Height / Bankiun Height	Index	1.0-1.9	2.0-3.9	4.0-5.9	6.0-7.9	8.0-9.0	10		
Variables	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		
	Root Deptil / Bank Height	Index	1.0-1.9	2.0-3.9	4.0-5.9	6.0-7.9	8.0-9.0	10		
Erodibility	Weighted Root Density	Value	100-80	79-55	54-30	29-15	14-5	<5		
lgil.	Weighted Root Density	Index	1.0-1.9	2.0-3.9	4.0-5.9	6.0-7.9	8.0-9.0	10		
豆	Bank Angle	Value	0-20	21-60	61-80	81-90	91-119	>119		
	Dank Angk	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		
	Surface 1 Totection	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 lo	ow erosion por	tential.					
	Boulders	Boulder banks	have a low er	osion potentia	l.					
ਢ	Cobble	Substract 10 po	oints. No adjus	stment if sand	gravel compo	se greater that	n 50% of bank			
Material	Clay/Silt Loam	Add 5 points.								
Ma	Gravel	Add 5-10 point	s depending of	n percentage	of bank mater	ial composed	of sand.			
Bank	Sand	Add 10 points.								
B	Silt / Clay	No adjustment.								
			Strat	ification	•		•	•		
	Add 5-10 p	oints depending	on position of	f unstable laye	rs in relation t	o bankfull sta	ge.			

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



Removed due to deposition

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

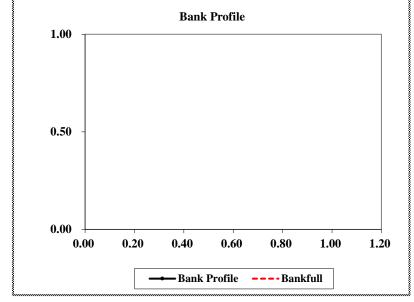
Ratio of pool slope to average water surface slope ( $S_p/S$ )  Level II  General prediction  Ratio of pool slope to riffle slope ( $S_p/S_{rif}$ )  Level II  General prediction  Ratio of near-bank maximum depth to bankfull mean depth ( $d_{nb}/d_{bkf}$ )  Level III  Detailed prediction  Ratio of near-bank shear stress to bankfull shear stress ( $\tau_{nb}/\tau_{bkf}$ )  Level III  Detailed prediction	erosion	rate.										
Deservers:   IT RS				Estim	ating Nea	`						
Diservers:   IT RS	Stream:	Tributa	ry to Five	Mile Creek		Location:	Rolling Ri	dge Park				
	Station:	LB-14			S	tream Type:		,	√alley Type:			
Channel pattern, transverse bar or split channel/central bar creating NBS	Observe	rs:	IT RS						Date:	5/24/2022		
2   Ratio of radius of curvature to bankfull width (R <sub>c</sub> / W <sub>hat</sub> )   Level II   General prediction   General pr				Methods fo	or Estimati	ng Near-B	ank Stress	(NBS)				
Ratio of pool slope to average water surface slope (S <sub>p</sub> / S)   Level II   General prediction   General prediction   General prediction   Level III   General prediction   Gene	(1) Chann	nel pattern	, transverse bar	or split channe	l/central bar cre	eating NBS		Level I	Recona	issance		
Ratio of pool slope to riffie slope   Sp / Sn     Ratio of near-bank maximum depth to bankfull mean depth (dne/dbit)   Level III   Detailed prediction	( <b>2</b> ) Ratio	of radius o	f curvature to b	ankfull width (F	R <sub>c</sub> / W <sub>bkf</sub> )			Level II	General	prediction		
Pation of near-bank maximum depth to bankfull mean depth (d <sub>nb</sub> / d <sub>bal</sub> )   Level III   Detailed prediction   Detailed prediction   Detailed prediction   Detailed prediction   Detailed prediction   Velocity profiles / Isovels / Velocity Gradient ( It / Sec / Its) / Isovels	( <b>3</b> ) Ratio	of pool slo	pe to average w	vater surface slo	ope (S <sub>p</sub> /S)	Level II	General	prediction				
Transverse and/or central bars-short and/or discontinuous	( <b>4</b> ) Ratio	of pool slo	pe to riffle slope	e (S <sub>p</sub> /S <sub>rif</sub> )	·			Level II	General	prediction		
Velocity profiles / Isovels / Velocity gradient   Cevel IV   Validation	( <b>5</b> ) Ratio	of near-ba	nk maximum de	epth to bankfull	mean depth ( d	<sub>nb</sub> / d <sub>bkf</sub> )		Level III	Detailed	prediction		
Transverse and/or central bars-short and/or discontinuous	( <b>6</b> ) Ratio	of near-ba	nk shear stress	to bankfull she	ar stress ( τ <sub>nb</sub> /	$\tau_{ m bkf}$ )		Level III	Detailed	prediction		
Canal	(7) Veloci	ty profiles	/ Isovels / Veloc	city gradient				Level IV	Valid	lation		
Radius of Curvature   Width Wood   Ratio R <sub>c</sub> / Word   Wood   W	=		Transverse a	nd/or central b	ars-short and/	or discontinuo	us		NBS = Hig	jh / Very High		
Radius of Curvature   Width Wood   Ratio R <sub>c</sub> / Word   Wood   W	eve.	(1)		•								
Campaigness	ני			, down-valley	meander mig	ration, conver	ging flow		NE	3S = Extreme		
California   Cal					Potio P /							
Companies   Comp		(2)			-							
			( )	(11)	* * DKI	(NBC)						
						Near Book	l	Method				
Color   Pool Slope   Riffle Slope   Specified Stress   Near-Bank   Near-Bank   Near-Bank   Stress   Near-Bank   Stress   Near-Bank   Stress   Near-Bank   Near-Bank   Near-Bank   Near-Bank   Stress   Near-Bank   Near-Bank   Near-Bank   Stress   Near-Bank	=	(0)	Pool Slope	Average					inant			
Color   Pool Slope   Riffle Slope   Specified Stress   Near-Bank   Near-Bank   Near-Bank   Stress   Near-Bank   Stress   Near-Bank   Stress   Near-Bank   Near-Bank   Near-Bank   Near-Bank   Stress   Near-Bank   Near-Bank   Near-Bank   Stress   Near-Bank	eve	(3)		•	Ratio S <sub>p</sub> / S			Near-Bar	nk Stress			
(4)   Pool Slope   S <sub>p</sub>   Riffle Slope   S <sub>rif</sub>   Ratio S <sub>p</sub> / S <sub>rif</sub>   Stress (NBS)	_											
(4)   Pool Slope   S <sub>p</sub>   Riffle Slope   S <sub>rif</sub>   Ratio S <sub>p</sub> / S <sub>rif</sub>   Stress (NBS)						Near-Bank	•					
Near-Bank   Max Depth   Above   Near-Bank   Stress (NBS)   Near-Bank   Near-Bank   Stress (NBS)   Near-Bank   Near-Bank   Stress (NBS)   Near-Bank   Near-Bank   Stress (NBS)   Near-Bank   Near-		(4)										
(5)   Max Depth   Mean Depth   Abkf (ft)   Mean Depth   Abkf (ft)   Mean Depth   Abkf (ft)   Mean Depth   Abkf (ft)   Mean Depth   Average   Shear   Stress τ <sub>bkf</sub> (    Bh/ft²)   Near-Bank   Shear   Stress τ <sub>nb</sub> (    Bh/ft²)   Near-Bank   Stress ( NBS)   Near-Bank   Near-Bank   Stress ( NBS)   Near-Bank   Stress ( NBS)   Near-Bank   Stress ( NBS)   Near-Bank   Near-Bank   Stress ( NBS)   Near-Bank   Near-Bank   Near-Bank   Near-Bank   Stress ( NBS)   Near-Bank   N		(+)	S <sub>p</sub>	S <sub>rif</sub>	S <sub>rif</sub>	(NBS)	1					
(5)   Max Depth   Mean Depth   Abkf (ft)   Mean Depth   Abkf (ft)   Mean Depth   Abkf (ft)   Mean Depth   Abkf (ft)   Mean Depth   Average   Shear   Stress τ <sub>bkf</sub> (    Bh/ft²)   Near-Bank   Shear   Stress τ <sub>nb</sub> (    Bh/ft²)   Near-Bank   Stress ( NBS)   Near-Bank   Near-Bank   Stress ( NBS)   Near-Bank   Stress ( NBS)   Near-Bank   Stress ( NBS)   Near-Bank   Near-Bank   Stress ( NBS)   Near-Bank   Near-Bank   Near-Bank   Near-Bank   Stress ( NBS)   Near-Bank   N												
Converting Values to a Near-Bank Stress (NBS)   Rating   Converting Values to a Near-Bank Stress (NBS)   Converting Values to a Near-Bank Stress (N					Datia d /							
Near-Bank   Near-Bank   Near-Bank   Stress \tau_{nb} (ft)   Near-Bank   Stress (NBS)   Near-Bank   Near-Bank   Stress (NBS)   Near-Bank		(5)				1. 1. 1. 2. 1						
(6)   Max Depth dnb (ft)   Near-Bank Slope S nb   Stress τnb (lb/ft²)   Mean Depth db (lb/ft²)   Average Slope S   Stress τb (lb/ft²)   Stress (NBS)	=		Shb (11)	ODKI (11)	<b>⇔</b> DKT	(NBC)						
(6)   Max Depth dnb (ft)   Near-Bank Slope S nb   Stress τnb (lb/ft²)   Mean Depth db (lb/ft²)   Average Slope S   Stress τb (lb/ft²)   Stress (NBS)	vell				Near-Bank			Bankfull				
Converting Values to a Near-Bank Stress (NBS)   Converting Values to a Near-	Le		Near-Bank		Shear			Shear		Near-Bank		
Velocity Gradient ( ft / sec		(6)			Stress $\tau_{nb}$ (		Average		Ratio $\tau_{nb}$ /			
Converting Values to a Near-Bank Stress (NBS) Rating   Near-Bank Stress (NBS)			d <sub>nb</sub> (ft)	Slope S <sub>nb</sub>	lb/ft <sup>2</sup> )	d <sub>bkf</sub> (ft)	Slope S	lb/ft <sup>2</sup> )	$ au_{bkf}$	(NBS)		
Converting Values to a Near-Bank Stress (NBS) Rating   Near-Bank Stress (NBS)												
Converting Values to a Near-Bank Stress (NBS) Rating   Near-Bank Stress (NBS)   Tatings   (1)   (2)   (3)   (4)   (5)   (6)   (7)   (7)	≥											
Converting Values to a Near-Bank Stress (NBS) Rating   Near-Bank Stress (NBS)   Tatings   (1)   (2)   (3)   (4)   (5)   (6)   (7)   (7)	vel	(7)										
Near-Bank Stress (NBS)	Le		, 1	.,	(NDO)							
Near-Bank Stress (NBS)												
ratings         (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	NI	and Of		nverting Va	alues to a l							
Very Low         N/A         > 3.00         < 0.20	Near-B			(1)	(2)				(6)	(7)		
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												
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												
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												
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												
Extreme Above < 1.50 > 1.00 > 1.20 > 3.00 > 1.60 > 2.40												
2.100 2.100 2.100 2.100 2.100			_									
Overall Near-Dalik Stress (NBS) rating	<u> </u>			-	7 1100 7 1120 7 0100 7 1100 7 2110							
					Overall N	ear-Dank S	วแ <i>ย</i> รร (NB	o) rating				

Stream:	Tributary to Five Mile Creek	Observer(s):	IT RS	TRS Data: IT QA/QC: RS To			Total Score:	NA	NA					
Reach:		Comments:					Extren			treme				
Location:	LB-15	Bank Length		48			Total Score	Very Low	Low	Moderate	High	Very High	Extreme	
Date:	5/24/2022							Values:	5-10	10-20	20-30	30-40	40-45	45-50

		-			
		Е	rodibility Variabl	es	
Bank Height / Bankf	ull Height Ratio				
Bank Height	Bankfull Height	Value	Index	Bank Erosion Potental	Notes
4.40					
Root Depth / Bank H	eight Ratio				
Root Depth	Bank Height	Value	Index	Bank Erosion Potental	Notes
	4.40				
Weighted Root Densi	ity				
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					
	тот	AL SCORE	Extreme		

			Bank Eros	ion Potential							
			Very Low	Low	Moderate	High	Very High	Extreme			
	B	Value	1.00-1.10	1.11-1.19	1.20-1.50	1.60-2.00	2.10-2.80	>2.80			
les	Bank Height / Bankfull Height	Index	1.0-1.9	2.0-3.9	4.0-5.9	6.0-7.9	8.0-9.0	10			
Variables	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			
	Root Deptn / Bank Height	Index	1.0-1.9	2.0-3.9	4.0-5.9	6.0-7.9	8.0-9.0	10			
Erodibility	Weighted Root Density	Value	100-80	79-55	54-30	29-15	14-5	<5			
dib	Weighted Root Density	Index	1.0-1.9	2.0-3.9	4.0-5.9	6.0-7.9	8.0-9.0	10			
Ere	Value         0-20         21-60         61-80         81-90         91-119										
	Dank Angie	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			
	Surface Frotection	Index	1.0-1.9	2.0-3.9	4.0-5.9	6.0-7.9	8.0-9.0	10			
			Adju	stments							
	Bedrock	Bedrock banks	have a very lo	w erosion pot	tential.						
	Boulders	Boulder banks	have a low ere	osion potentia	l.						
а	Cobble	Substract 10 po	oints. No adjus	tment if sand	gravel compo	se greater that	n 50% of bank				
teri	Clay/Silt Loam	Add 5 points.									
Ma	Gravel	Add 5-10 point	s depending o	n percentage	of bank mater	ial composed	of sand.				
Bank Material	Sand	Add 10 points.	•				•				
B	Silt / Clay	No adjustment.			·	·					
			Strat	fication							
	Add 5-10 p	oints depending	on position of	unstable laye	rs in relation t	o bankfull sta	ge.				

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



Occular estimate - Extreme

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

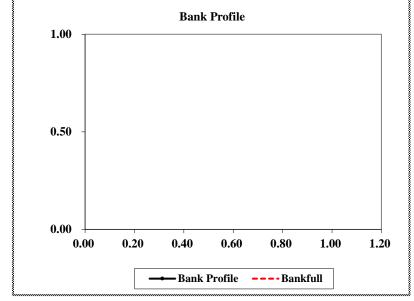
erosion	Tale.								
			Estim	ating Nea	r-Bank St	ress ( NBS	S)		
Stream:	Tributa	ary to Five	Mile Creek		Location:	Rolling Ri	dge Park		
Station:	LB-15			S	tream Type:		•	Valley Type:	
Observe	rs:	IT RS						Date:	5/24/2022
			Methods fo	or Estimati	ng Near-B	ank Stress	(NBS)		
(1) Chanr	nel pattern	, transverse bar	or split channe	l/central bar cre	eating NBS		Level I	Recona	issance
	•	f curvature to b	·				Level II	General	prediction
		pe to average v					Level II		prediction
		pe to riffle slope		- · · · ·			Level II	General	prediction
		nk maximum de		mean depth ( d	<sub>nh</sub> / d <sub>hkf</sub> )		Level III		prediction
		nk shear stress					Level III		prediction
		/ Isovels / Veloc		ar on ooo ( v <sub>nb</sub> /	*DKI /		Level IV		lation
_	., p.o			ars-short and/	or discontinuo	us			
Level	(1)							-	
Le		Chute cutoffs	, down-valley	meander mig	ration, conver	ging flow		NE	BS = Extreme
		Radius of	Bankfull		Near-Bank				
	(2)	Curvature	Width W <sub>bkf</sub>	Ratio R <sub>c</sub> /	Stress				
	` ,	R <sub>c</sub> (ft)	(ft)	W <sub>bkf</sub>	(NBS)	1			
							Method	1	
Ξ		Pool Slope	Average		Near-Bank Stress			inant	
Level II	(3)	S <sub>p</sub>	Slope S	Ratio S <sub>p</sub> / S	(NBS)		_	nk Stress	
Ľ		Р		P			Verv	High	
					Near Book		10.7		
	(4)	Pool Slope	Riffle Slope	Ratio S <sub>p</sub> /	Near-Bank Stress				
	(4)	S <sub>p</sub>	S <sub>rif</sub>	S <sub>rif</sub>	(NBS)				
		Near-Bank			Near-Bank				
	(5)	Max Depth	Mean Depth	Ratio d <sub>nb</sub> /	Stress				
_	(-)	d <sub>nb</sub> (ft)	d <sub>bkf</sub> (ft)	d <sub>bkf</sub>	(NBS)				
Level III				Near-Bank			Bankfull		
-ev		Near-Bank		Shear			Shear		Naar Dank
_	(6)	Max Depth	Near-Bank	Stress $\tau_{nb}$ (	Mean Depth	Average	Stress $\tau_{bkf}$ (	Ratio τ <sub>nb</sub> /	Near-Bank Stress
	(-)	d <sub>nb</sub> (ft)	Slope S <sub>nb</sub>	lb/ft <sup>2</sup> )	d <sub>bkf</sub> (ft)	Slope S	lb/ft <sup>2</sup> )	$ au_{bkf}$	(NBS)
>			·	Near-Bank					
Level IV	(7)		dient (ft/sec	Stress					
Lev	(.,	/ f	t )	(NBS)	1				
_									
		Соі	nverting Va	alues to a N	Near-Bank	Stress (NE	SS) Rating		
Near-E		ess (NBS)	_			ethod numb			
	rating		(1)	(2)	(3)	(4)	(5)	(6)	(7)
	Very Lo		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
	Modera		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 Hi		(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
	Extren	ne	Above	< 1.50	> 1.00	> 1.20	> 3.00	> 1.60	> 2.40
				Overall N	lear-Bank \$	Stress (NB	S) rating	Very	High

Stream:	Tributary to Five Mile Creek	Observer(s):	IT RS Data: IT QA/QC: RS T			Total Score:		NA	NA					
Reach:		Comments:							Modera	Moderate				
Location:	LB-16	Bank Length		36			Total Score	Very Low	Low	Moderate	High	Very High	Extreme	
Date:	5/24/2022							Values:	5-10	10-20	20-30	30-40	40-45	45-50

		-			
		E	rodibility Variabl	les	
Bank Height / Bankf	ull Height Ratio				
Bank Height	Bankfull Height	Value	Index	Bank Erosion Potental	Notes
10.00					
Root Depth / Bank H	eight Ratio				
Root Depth	Bank Height	Value	Index	Bank Erosion Potental	Notes
	10.00				
Weighted Root Densi	ity				
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					
	тот	AL SCORE	Moderate		

			Bank Eros	ion Potential						
			Very Low	Low	Moderate	High	Very High	Extreme		
	Pouls Height / Poulsfull Height	Value	1.00-1.10	1.11-1.19	1.20-1.50	1.60-2.00	2.10-2.80	>2.80		
səle	Bank Height / Bankfull Height	Index	1.0-1.9	2.0-3.9	4.0-5.9	6.0-7.9	8.0-9.0	10		
Variables	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		
	Root Deptil / Bank Height	Index	1.0-1.9	2.0-3.9	4.0-5.9	6.0-7.9	8.0-9.0	10		
Erodibility	Weighted Root Density	Value	100-80	79-55	54-30	29-15	14-5	<5		
dib	Weighted Root Density	Index	1.0-1.9	2.0-3.9	4.0-5.9	6.0-7.9	8.0-9.0	10		
Erc	Bank Angle	Value	0-20	21-60	61-80	81-90	91-119	>119		
	Dank Angie	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		
	Surface I Totection	Index	1.0-1.9	2.0-3.9	4.0-5.9	6.0-7.9	8.0-9.0	10		
			Adju	stments						
	Bedrock	Bedrock banks	have a very lo	w erosion pot	tential.					
	Boulders	Boulder banks	have a low ere	osion potentia	l.					
ਢ	Cobble	Substract 10 po	ints. No adjus	tment if sand	gravel compo	se greater that	n 50% of bank			
Material	Clay/Silt Loam	Add 5 points.								
Ma	Gravel	Add 5-10 point	s depending o	n percentage	of bank mater	ial composed	of sand.			
Bank	Sand	Add 10 points.								
B	Silt / Clay	No adjustment.								
			Strat	fication						
	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.

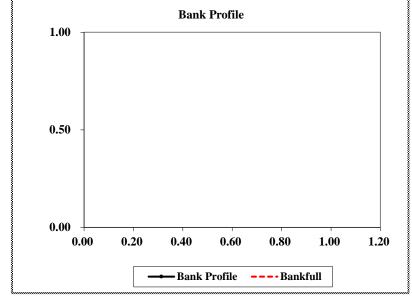
erosion	rosion rate.									
			Estim	ating Nea	r-Bank St	ress ( NBS	3)			
Stream:	Tributa	ary to Five	Mile Creek		Location:	Rolling Ri	dge Park			
Station:	LB-16			S	tream Type:		,	Valley Type:		
Observe	rs:	IT RS						Date:	5/24/2022	
			Methods fo	or Estimati	ng Near-Ba	ank Stress	(NBS)			
(1) Chanr	nel pattern	, transverse bai	or split channe	l/central bar cre	eating NBS		Level I	Recona	issance	
( <b>2</b> ) Ratio	of radius c	of curvature to b	ankfull width (F	R <sub>c</sub> / W <sub>bkf</sub> )			Level II	General	prediction	
( <b>3</b> ) Ratio	of pool slo	pe to average v	ater surface sl	ope (S <sub>p</sub> /S)			Level II	General	prediction	
( <b>4</b> ) Ratio	of pool slo	pe to riffle slope	e (S <sub>p</sub> /S <sub>rif</sub> )				Level II	General	prediction	
( <b>5</b> ) Ratio	of near-ba	nk maximum de	pth to bankfull	mean depth ( d	<sub>nb</sub> / d <sub>bkf</sub> )		Level III	Detailed	prediction	
( <b>6</b> ) Ratio	of near-ba	nk shear stress	to bankfull she	ar stress ( τ <sub>nb</sub> /	τ <sub>bkf</sub> )		Level III	Detailed	prediction	
(7) Veloci	ty profiles	/ Isovels / Velo	city gradient				Level IV	Valid	lation	
=					or discontinuo			-		
Level	(1)				channel)					
				meander mig	ration, conver	ging flow		NI	oo = Extreme	
		Radius of Curvature	Bankfull Width W <sub>bkf</sub>	Ratio R <sub>c</sub> /	Near-Bank Stress					
	(2)	R <sub>c</sub> (ft)	(ft)	W <sub>bkf</sub>	(NBS)					
_					Near-Bank		Method	1		
Level II	(3)	Pool Slope	Average		Stress			inant		
Lev	(3)	S <sub>p</sub>	Slope S	Ratio S <sub>p</sub> / S	(NBS)	1		nk Stress		
							Hi	gh		
			5.44. 61	Datia C /	Near-Bank					
	(4)	Pool Slope S <sub>p</sub>	Riffle Slope S <sub>rif</sub>	Ratio S <sub>p</sub> / S <sub>rif</sub>	Stress (NBS)					
		Ор	On	On	(NBC)					
		Near-Bank			Naar Dard	l				
	(5)	Max Depth	Mean Depth	Ratio d <sub>nb</sub> /	Near-Bank Stress					
	(5)	d <sub>nb</sub> (ft)	d <sub>bkf</sub> (ft)	d <sub>bkf</sub>	(NBS)	1				
≡										
Level III				Near-Bank Shear			Bankfull Shear			
_	(6)	Near-Bank Max Depth	Near-Bank		Mean Depth	A		Ratio τ <sub>nb</sub> /	Near-Bank	
	(6)	d <sub>nb</sub> (ft)	Slope S <sub>nb</sub>	Ib/ft <sup>2</sup> )	d <sub>bkf</sub> (ft)	Average Slope S	lb/ft <sup>2</sup> )	$\tau_{\rm bkf}$	Stress (NBS <b>)</b>	
				,	Dia ( )		,	Sit.		
,				Near-Bank						
Level IV	(7)	Velocity Grad	dient (ft/sec	Stress						
-ev	(1)	/ f	t )	(NBS)	 					
		Col	nverting Va	alues to a l	Near-Bank	Stress (NE	SS) Rating			
Near-B		ess (NBS)			Me	ethod numb	er			
	rating		(1)	(2)	(3)	(4)	(5)	(6)	(7)	
	Very Lo		N/A	> 3.00	< 0.20	< 0.40	< 1.00	< 0.80	< 0.50	
	Low		N/A 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			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			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	
	Extren	ne	Above	< 1.50	> 1.00	> 1.20	> 3.00	> 1.60	> 2.40	
				Overall N	lear-Bank S	Stress (NB	S) rating	Hi	gh	
				-						

Stream:	Tributary to Five Mile Creek	Observer(s):	IT RS Data: IT QA/QC: RS T			Total Score:		NA	NA					
Reach:		Comments:							High	High				
Location:	LB-17	Bank Length		33			Total Score	Very Low	Low	Moderate	High	Very High	Extreme	
Date:	5/24/2022							Values:	5-10	10-20	20-30	30-40	40-45	45-50

		-			
		E	rodibility Variabl	es	
Bank Height / Bankf	ull Height Ratio				
Bank Height	Bankfull Height	Value	Index	Bank Erosion Potental	Notes
1.90					
Root Depth / Bank H	leight Ratio				
Root Depth	Bank Height	Value	Index	Bank Erosion Potental	Notes
	1.90				
Weighted Root Densi	ity				
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					
	тот	AL SCORE	High		

			Bank Eros	ion Potential							
			Very Low	Low	Moderate	High	Very High	Extreme			
	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			
səle	Bank Height / Bankiuli Height	Index	1.0-1.9	2.0-3.9	4.0-5.9	6.0-7.9	8.0-9.0	10			
Variables	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			
	Root Deptil / Bank Height	Index	1.0-1.9	2.0-3.9	4.0-5.9	6.0-7.9	8.0-9.0	10			
Erodibility	Weighted Root Density	Value	100-80	79-55	54-30	29-15	14-5	<5			
gib	Weighted Root Delisity	Index	1.0-1.9	2.0-3.9	4.0-5.9	6.0-7.9	8.0-9.0	10			
Σī	Bank Angle	Value	0-20	21-60	61-80	81-90	91-119	>119			
	Dank Angk	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			
	Surface I Totection	Index	1.0-1.9	2.0-3.9	4.0-5.9	6.0-7.9	8.0-9.0	10			
			Adju	stments							
	Bedrock	Bedrock banks	have a very lo	w erosion pot	tential.						
	Boulders	Boulder banks	have a low ere	osion potentia	l.						
a	Cobble	Substract 10 po	ints. No adjus	stment if sand	gravel compo	se greater that	n 50% of bank				
Material	Clay/Silt Loam	Add 5 points.									
Ma	Gravel Add 5-10 points depending on percentage of bank material composed of sand.										
Bank	Sand	Add 10 points.		•				•			
B	Silt / Clay	No adjustment.									
			Strat	ification							
	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



Occular estimate - High

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

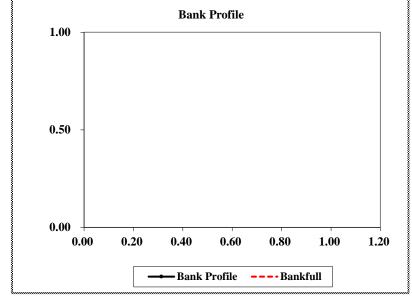
erosion	rosion rate.										
			Estim	ating Nea	r-Bank St	ress ( NBS	S)				
Stream:	Tributa	ary to Five	Mile Creek		Location:	Rolling Ri	dge Park				
Station:	LB-17			S	tream Type:		,	Valley Type:			
Observe	ers:	IT RS						Date:	5/24/2022		
			Methods for	or Estimati	ng Near-B	ank Stress	(NBS)				
( <b>1</b> ) Chan	nel pattern	, transverse bar	or split channe	l/central bar cre	eating NBS		Level I	Recona	aissance		
( <b>2</b> ) Ratio	of radius o	f curvature to b	ankfull width (F	R <sub>c</sub> / W <sub>bkf</sub> )			Level II	General	prediction		
(3) Ratio	of pool slo	pe to average v	vater surface slo	ope (S <sub>p</sub> /S)			Level II	General	prediction		
(4) Ratio	of pool slo	pe to riffle slope	e (S <sub>p</sub> /S <sub>rif</sub> )				Level II	General	prediction		
( <b>5</b> ) Ratio	of near-ba	nk maximum de	epth to bankfull	mean depth ( d	<sub>nb</sub> / d <sub>bkf</sub> )		Level III	Detailed	prediction		
(6) Ratio	of near-ba	nk shear stress	to bankfull she	ar stress ( τ <sub>nb</sub> /	τ <sub>bkf</sub> )		Level III	Detailed	prediction		
(7) Veloc	ity profiles	/ Isovels / Veloc	city gradient				Level IV	Valid	dation		
=			nd/or central b					_	, ,		
Level	(1)		position (conti								
			, down-valley	meander mig		ging flow		NI	55 = Extreme		
		Radius of Curvature	Bankfull Width W <sub>bkf</sub>	Ratio R <sub>c</sub> /	Near-Bank Stress						
	(2)	R <sub>c</sub> (ft)	(ft)	W <sub>bkf</sub>	(NBS)						
						Ī					
_					Near-Bank		Method	1			
Level II	(3)	Pool Slope	Average		Stress			inant			
Lev	(5)	S <sub>p</sub>	Slope S	Ratio S <sub>p</sub> / S	(NBS)	 		nk Stress			
		High									
			5.41 6.	Datia C /	Near-Bank						
	(4)	Pool Slope S <sub>p</sub>	Riffle Slope S <sub>rif</sub>	Ratio S <sub>p</sub> / S <sub>rif</sub>	Stress (NBS)						
		Ор	O <sub>III</sub>	O <sub>III</sub>	(NEC)						
		Near-Bank			Near-Bank						
	<i>(E</i> )	Max Depth	Mean Depth	Ratio d <sub>nb</sub> /	Stress						
	(5)	d <sub>nb</sub> (ft)	d <sub>bkf</sub> (ft)	d <sub>bkf</sub>	(NBS)						
<b>=</b>							_				
Level III				Near-Bank Shear			Bankfull Shear				
_	(6)	Near-Bank Max Depth	Near-Bank		Mean Depth	A.,		Ratio τ <sub>nb</sub> /	Near-Bank		
	(6)	d <sub>nb</sub> (ft)	Slope S <sub>nb</sub>	lb/ft <sup>2</sup> )	d <sub>bkf</sub> (ft)	Average Slope S	lb/ft <sup>2</sup> )	$ au_{\mathrm{bkf}}$	Stress (NBS <b>)</b>		
				,							
				Near-Bank							
Level IV	(7)	Velocity Grad	dient (ft/sec	Stress							
- e	(')	/ f	t)	(NBS)	 						
_											
		Coi	nverting Va	alues to a N	Near-Bank	Stress (NE	SS) Rating				
Near-E		ess (NBS)				ethod numb					
	rating		(1)	(2)	(3)	(4)	(5)	(6)	(7)		
	Very Lo		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 See	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)	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 Extreme		(1) Above	1.50 – 1.80	0.81 – 1.00	1.01 – 1.20	2.51 – 3.00	1.20 – 1.60	2.01 – 2.40			
	LAUGI	iic	7.0000	< 1.50	> 1.00	> 1.20	> 3.00	> 1.60	> 2.40		
				Overall N	lear-Bank \$	otress (NB	ع) rating	Hi	gh		
								· · · · · · · · · · · · · · · · · · ·	· · · · · · · · · · · · · · · · · · ·		

Stream:	Tributary to Five Mile Creek	Observer(s):	IT RS Data: IT QA/QC: RS			Total Score:		NA	NA					
Reach:		Comments:							High	High				
Location:	LB-18	Bank Length		52			Total Score	Very Low	Low	Moderate	High	Very High	Extreme	
Date:	5/24/2022							Values:	5-10	10-20	20-30	30-40	40-45	45-50

		-			
		E	rodibility Variabl	les	
Bank Height / Bankf	ull Height Ratio				
Bank Height	Bankfull Height	Value	Index	Bank Erosion Potental	Notes
1.30					
Root Depth / Bank H	eight Ratio				
Root Depth	Bank Height	Value	Index	Bank Erosion Potental	Notes
	1.30				
Weighted Root Densi	ity				
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					
	тот	AL SCORE	Moderate		

			Bank Eros	ion Potential				
			Very Low	Low	Moderate	High	Very High	Extreme
	Pouls Height / Poulsfull Height	Value	1.00-1.10	1.11-1.19	1.20-1.50	1.60-2.00	2.10-2.80	>2.80
səle	Bank Height / Bankfull Height	Index	1.0-1.9	2.0-3.9	4.0-5.9	6.0-7.9	8.0-9.0	10
Variables	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
	Root Deptil / Bank Height	Index	1.0-1.9	2.0-3.9	4.0-5.9	6.0-7.9	8.0-9.0	10
Erodibility	Weighted Root Density	Value	100-80	79-55	54-30	29-15	14-5	<5
dib	Weighted Root Density	Index	1.0-1.9	2.0-3.9	4.0-5.9	6.0-7.9	8.0-9.0	10
Erc	Bank Angle	Value	0-20	21-60	61-80	81-90	91-119	>119
	Dank Angle	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
	Surface I Totection	Index	1.0-1.9	2.0-3.9	4.0-5.9	6.0-7.9	8.0-9.0	10
			Adju	stments				
	Bedrock	Bedrock banks	have a very lo	w erosion pot	tential.			
	Boulders	Boulder banks	have a low ere	osion potentia	l.			
ਢ	Cobble	Substract 10 po	ints. No adjus	tment if sand	gravel compo	se greater that	n 50% of bank	
Material	Clay/Silt Loam	Add 5 points.						
Ma	Gravel	Add 5-10 point	s depending o	n percentage	of bank mater	ial composed	of sand.	
Bank	Sand	Add 10 points.						
B	Silt / Clay	No adjustment.						
			Strat	fication				
	Add 5-10 p	oints depending	on position of	unstable laye	rs in relation t	to bankfull sta	ge.	

	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.

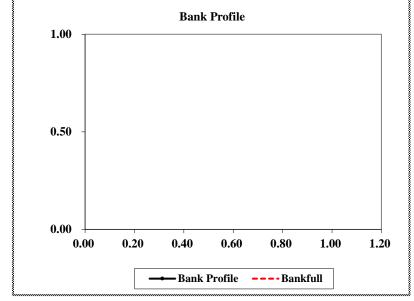
		erosion rate.										
	Estimating Near-Bank Stress (NBS)  Stream: Tributary to Five Mile Creek Location: Rolling Ridge Park											
Station	n: <b>Tribu</b>	tary to Five	Mile Creek		Location:	Rolling Ri	dge Park					
	n: <b>LB-1</b>	3		S	tream Type:		1	Valley Type:				
Obser	vers:	IT RS						Date:	5/24/2022			
			Methods for	or Estimati	ng Near-Ba	ank Stress	(NBS)					
( <b>1</b> ) Cha	annel patte	rn, transverse ba	r or split channe	l/central bar cre	eating NBS		Level I	Recona	issance			
( <b>2</b> ) Rat	io of radiu	of curvature to b	ankfull width (F	R <sub>c</sub> / W <sub>bkf</sub> )			Level II	General	prediction			
( <b>3</b> ) Rat	io of pool :	lope to average v	water surface slo	ope (S <sub>p</sub> /S)			Level II	General	prediction			
( <b>4</b> ) Rat	io of pool :	lope to riffle slope	e (S <sub>p</sub> /S <sub>rif</sub> )	·			Level II	General	prediction			
( <b>5</b> ) Rat	io of near-	oank maximum d	epth to bankfull	mean depth ( d	nb / d <sub>bkf</sub> )		Level III	Detailed	prediction			
( <b>6</b> ) Rat	io of near-	oank shear stress	to bankfull she	ar stress ( $\tau_{nb}$ /	τ <sub>bkf</sub> )		Level III	Detailed	prediction			
( <b>7</b> ) Vel	ocity profile	es / Isovels / Velo	city gradient		·		Level IV	Valid	lation			
=		Transverse a	and/or central b	ars-short and/	or discontinuo	us		NBS = Hig	ıh / Very High			
Level	(1)		position (conti									
تّ			s, down-valley	meander mig	ration, conver	ging flow		NE	BS = Extreme			
		Radius of	Bankfull	Potio P /	Near-Bank							
	(2)	Curvature R <sub>c</sub> (ft)	Width W <sub>bkf</sub> (ft)	<i>Ratio</i> R <sub>c</sub> / W <sub>bkf</sub>	Stress (NBS)							
			(11)	* * DKI	(HBG)							
	<b>-</b>				Near Book	ļ	Method	1				
= 16		Pool Slope	Average		Near-Bank Stress			inant				
Level II	(3)	Sp	Slope S	Ratio S <sub>p</sub> / S	(NBS)		Near-Bar	nk Stress				
1							Lo	w				
					Near-Bank		_		•			
	(4)	Pool Slope	Riffle Slope	Ratio S <sub>p</sub> /	Stress							
	(-)	S <sub>p</sub>	S <sub>rif</sub>	S <sub>rif</sub>	(NBS)							
						ļ						
		Near-Bank		<i>Ratio</i> d <sub>nb</sub> /	Near-Bank							
		May Donth		Nauo u <sub>nb</sub> /	Stress							
	(5)	Max Depth	Mean Depth		1. 1. 1. 1. 1. 1.							
=	(5)	Max Depth d <sub>nb</sub> (ft)	Mean Depth d <sub>bkf</sub> (ft)	d <sub>bkf</sub>	(NBS)	]						
vel III	(5)		•		1. 1. 1. 1. 1. 1.		Bankfull					
Level III	(5)	d <sub>nb</sub> (ft)	d <sub>bkf</sub> (ft)	d <sub>bkf</sub> Near-Bank Shear	(NBS)		Shear		Near-Bank			
Level III	(5)	d <sub>nb</sub> (ft)  Near-Bank Max Depth	d <sub>bkf</sub> (ft)	d <sub>bkf</sub> Near-Bank Shear Stress τ <sub>nb</sub> (	(NBS)  Mean Depth		Shear Stress $\tau_{\text{bkf}}$ (	Ratio τ <sub>nb</sub> /	Stress			
Level III		d <sub>nb</sub> (ft)	d <sub>bkf</sub> (ft)	d <sub>bkf</sub> Near-Bank Shear	(NBS)	Average Slope S	Shear	Ratio $ au_{\sf nb}$ / $ au_{\sf bkf}$				
Level III		d <sub>nb</sub> (ft)  Near-Bank Max Depth	d <sub>bkf</sub> (ft)	d <sub>bkf</sub> Near-Bank Shear Stress τ <sub>nb</sub> (	(NBS)  Mean Depth		Shear Stress $\tau_{\text{bkf}}$ (		Stress			
		Near-Bank Max Depth d <sub>nb</sub> (ft)	d <sub>bkf</sub> (ft)  Near-Bank Slope S <sub>nb</sub>	$\frac{d_{bkf}}{Near\text{-}Bank}$ $\frac{Shear}{Stress}\tau_{nb}(\frac{lb/ft^2}{})$ $\frac{Near\text{-}Bank}{Near\text{-}Bank}$	(NBS)  Mean Depth		Shear Stress $\tau_{\text{bkf}}$ (		Stress			
		Near-Bank Max Depth d <sub>nb</sub> (ft)	d <sub>bkf</sub> (ft)  Near-Bank Slope S <sub>nb</sub>	$\frac{d_{bkf}}{Near\text{-}Bank}$ Shear Stress $\tau_{nb}$ ( $lb/ft^2$ )  Near-Bank Stress	(NBS)  Mean Depth		Shear Stress $\tau_{\text{bkf}}$ (		Stress			
Level IV Level III	(6)	Near-Bank Max Depth d <sub>nb</sub> (ft)	d <sub>bkf</sub> (ft)  Near-Bank Slope S <sub>nb</sub>	$\frac{d_{bkf}}{Near\text{-}Bank}$ $\frac{Shear}{Stress}\tau_{nb}(\frac{lb/ft^2}{})$ $\frac{Near\text{-}Bank}{Near\text{-}Bank}$	(NBS)  Mean Depth		Shear Stress $\tau_{\text{bkf}}$ (		Stress			
	(6)	Near-Bank Max Depth d <sub>nb</sub> (ft)	Near-Bank Slope S <sub>nb</sub>	d <sub>bkf</sub> Near-Bank Shear Stress τ <sub>nb</sub> ( Ib/ft²)  Near-Bank Stress (NBS)	Mean Depth d <sub>bkf</sub> (ft)	Slope S	Shear Stress τ <sub>bkf</sub> ( Ib/ft²)		Stress			
Level IV	(6)	d <sub>nb</sub> (ft)  Near-Bank Max Depth d <sub>nb</sub> (ft)  Velocity Gra	d <sub>bkf</sub> (ft)  Near-Bank Slope S <sub>nb</sub>	d <sub>bkf</sub> Near-Bank Shear Stress τ <sub>nb</sub> ( Ib/ft²)  Near-Bank Stress (NBS)	Mean Depth dbkf (ft)	Slope S Stress (NE	Shear Stress τ <sub>bkf</sub> ( lb/ft <sup>2</sup> )		Stress			
Level IV	(6)	d <sub>nb</sub> (ft)  Near-Bank Max Depth d <sub>nb</sub> (ft)  Velocity Gra	d <sub>bkf</sub> (ft)  Near-Bank Slope S <sub>nb</sub> dient ( ft / sec ft )	d <sub>bkf</sub> Near-Bank Shear Stress τ <sub>nb</sub> ( Ib/ft²)  Near-Bank Stress (NBS)	Mean Depth d <sub>bkf</sub> (ft)	Slope S  Stress (NE ethod number	Shear Stress τ <sub>bkf</sub> (  Ib/ft²)  3S) Rating	T <sub>bkf</sub>	Stress (NBS)			
Level IV	(6) (7) -Bank S	d <sub>nb</sub> (ft)  Near-Bank Max Depth d <sub>nb</sub> (ft)  Velocity Gra	Near-Bank Slope Snb  dient (ft / sec ft )	d <sub>bkf</sub> Near-Bank Shear Stress τ <sub>nb</sub> ( Ib/ft²)  Near-Bank Stress (NBS)	Mean Depth d <sub>bkf</sub> (ft)	Stress (NE ethod numb	Shear Stress $\tau_{bkf}$ (  Ib/ft²)   BS) Rating  per (5)	τ <sub>bkf</sub> (6)	Stress (NBS)			
Level IV	(6) (7) -Bank S ratii	Near-Bank Max Depth dnb (ft)  Velocity Gra //  //  Co tress (NBS) ngs	Near-Bank Slope S <sub>nb</sub> dient ( ft / sec ft )	d <sub>bkf</sub> Near-Bank Shear Stress τ <sub>nb</sub> ( Ib/ft²)  Near-Bank Stress (NBS)  alues to a N  (2)  > 3.00	Mean Depth d <sub>bkf</sub> (ft)  Near-Bank M (3) < 0.20	Stress (NE ethod numb	Shear Stress $\tau_{bkf}$ ( $ b/ft^2 $ )  3S) Rating  er  (5)  < 1.00	τ <sub>bkf</sub> (6) < 0.80	(7) < 0.50			
Level IV	(6) (7) -Bank S ratii Very Lo	d <sub>nb</sub> (ft)  Near-Bank Max Depth d <sub>nb</sub> (ft)  Velocity Gra  /  Co  tress (NBS) ngs	d <sub>bkf</sub> (ft)  Near-Bank Slope S <sub>nb</sub> dient ( ft / sec ft )  nverting Va  (1)  N/A  N/A	$\begin{array}{c} d_{bkf} \\ \hline \\ Near-Bank \\ Shear \\ Stress \tau_{nb} \left( \\ lb/ft^2 \right) \\ \hline \\ Near-Bank \\ Stress \\ (NBS) \\ \hline \\ \textbf{Alues to a N} \\ \hline \\ \textbf{(2)} \\ \hline \\ > 3.00 \\ \hline \\ 2.21 - 3.00 \\ \hline \end{array}$	Mean Depth d <sub>bkf</sub> (ft)  Near-Bank M (3) < 0.20 0.20 - 0.40	Stress (NE ethod numb (4) < 0.40 0.41 - 0.60	Shear Stress τ <sub>bkf</sub> (  b/tt²)  3S) Rating per (5) < 1.00 1.00 – 1.50	τ <sub>bkf</sub> (6) < 0.80 0.80 – 1.05	(7) < 0.50 0.50 – 1.00			
Level IV	(6) (7) -Bank S ratii Very Lo	d <sub>nb</sub> (ft)  Near-Bank Max Depth d <sub>nb</sub> (ft)  Velocity Gra /  tress (NBS) ags Low werate	Near-Bank Slope S <sub>nb</sub> dient ( ft / sec ft )	$\begin{array}{c} d_{bkf} \\ \hline \\ Near-Bank \\ Shear \\ Stress \tau_{nb} \left( \\ lb/ft^2 \right) \\ \hline \\ Near-Bank \\ Stress \\ (NBS) \\ \hline \\ alues to a N \\ \hline \\ (2) \\ \hline \\ > 3.00 \\ \hline \\ 2.21 - 3.00 \\ \hline \\ 2.01 - 2.20 \\ \hline \end{array}$	(NBS)  Mean Depth d <sub>bkf</sub> (ft)  Near-Bank (3)  < 0.20  0.20 - 0.40  0.41 - 0.60	Stress (NE ethod numb (4) < 0.40	Shear Stress τ <sub>bkf</sub> (  b/ft² )  SS) Rating ter (5) < 1.00 1.50 – 1.50 1.51 – 1.80	τ <sub>bkf</sub> (6) < 0.80 0.80 – 1.05 1.06 – 1.14	(7) < 0.50 0.50 – 1.00 1.01 – 1.60			
Level IV	(6) (7) -Bank S ratii Very Lo Mode	Near-Bank Max Depth dnb (ft)  Velocity Gra //  //  Co tress (NBS) ngs Low werate	d <sub>bkf</sub> (ft)  Near-Bank Slope S <sub>nb</sub> dient ( ft / sec ft )  nverting Va  (1)  N/A  N/A  N/A  See	$\begin{array}{c} d_{bkf} \\ \hline \\ Near-Bank \\ Shear \\ Stress \tau_{nb} \left( \\ lb/ft^2 \right) \\ \hline \\ Near-Bank \\ Stress \\ (NBS) \\ \hline \\ alues to a \\ \hline \\ & > 3.00 \\ \hline \\ & 2.21 - 3.00 \\ \hline \\ & 2.01 - 2.20 \\ \hline \\ & 1.81 - 2.00 \\ \hline \end{array}$	(NBS)  Mean Depth d <sub>bkf</sub> (ft)  Near-Bank  (3)  < 0.20 0.20 - 0.40 0.41 - 0.60 0.61 - 0.80	Stress (NE ethod numb (4) < 0.40 0.41 - 0.60 0.61 - 0.80 0.81 - 1.00	Shear Stress τ <sub>bkf</sub> (  b/ft²)  3S) Rating er (5) <1.00 1.00 – 1.50 1.51 – 1.80 1.81 – 2.50	τ <sub>bkf</sub> (6) < 0.80 0.80 - 1.05 1.06 - 1.14 1.15 - 1.19	(7) < 0.50 0.50 - 1.00 1.01 - 1.60 1.61 - 2.00			
Level IV	(6) (7) -Bank S ratii Very Lo Mode Hit	d <sub>nb</sub> (ft)  Near-Bank Max Depth d <sub>nb</sub> (ft)  Velocity Gra  /   Co  tress (NBS)  gs  Low  werate gh  High	d <sub>bkf</sub> (ft)  Near-Bank Slope S <sub>nb</sub> dient ( ft / sec ft )  nverting Va  (1)  N/A  N/A	d <sub>bkf</sub> Near-Bank Shear Stress τ <sub>nb</sub> ( Ib/ft²)  Near-Bank Stress (NBS)  (2)  > 3.00  2.21 – 3.00  2.01 – 2.20  1.81 – 2.00  1.50 – 1.80	(NBS)  Mean Depth d <sub>bkf</sub> (ft)  Near-Bank (3) < 0.20 0.20 - 0.40 0.41 - 0.60 0.61 - 0.80 0.81 - 1.00	Slope S  Stress (NE ethod numb (4)  < 0.40  0.41 – 0.60  0.61 – 0.80  0.81 – 1.00  1.01 – 1.20	Shear Stress τ <sub>bkf</sub> (  b/ft²)  3S) Rating per (5) <1.00 1.00 – 1.50 1.51 – 1.80 1.81 – 2.50 2.51 – 3.00	τ <sub>bkf</sub> (6) < 0.80 0.80 – 1.05 1.06 – 1.14 1.15 – 1.19 1.20 – 1.60	(7) < 0.50 0.50 – 1.00 1.01 – 1.60 1.61 – 2.00 2.01 – 2.40			
Level IV	(6) (7) -Bank S ratii Very Lo Mode	d <sub>nb</sub> (ft)  Near-Bank Max Depth d <sub>nb</sub> (ft)  Velocity Gra  /   Co  tress (NBS)  gs  Low  werate gh  High	d <sub>bkf</sub> (ft)  Near-Bank Slope S <sub>nb</sub> dient ( ft / sec ft )  nverting Va  (1)  N/A  N/A  N/A  See  (1)	$\begin{array}{c} d_{bkf} \\ \hline \\ Near-Bank \\ Shear \\ Stress \tau_{nb} \left( \\ Ib/ft^2 \right) \\ \hline \\ Near-Bank \\ Stress \\ (NBS) \\ \hline \\ Alues to a \\ \hline \\ (2) \\ \hline \\ > 3.00 \\ \hline \\ 2.21 - 3.00 \\ \hline \\ 2.01 - 2.20 \\ \hline \\ 1.81 - 2.00 \\ \hline \\ 1.50 - 1.80 \\ \hline \\ < 1.50 \\ \hline \end{array}$	(NBS)  Mean Depth d <sub>bkf</sub> (ft)  Near-Bank  (3)  < 0.20 0.20 - 0.40 0.41 - 0.60 0.61 - 0.80	Stress (NE ethod numb (4) < 0.40	Shear Stress $\tau_{bkf}$ ( $lb/ft^2$ )  SS) Rating ter  (5)  < 1.00  1.51 – 1.80  1.81 – 2.50  2.51 – 3.00  > 3.00	$\begin{array}{c} \tau_{bkf} \\ \hline \\ \textbf{(6)} \\ \textbf{<} 0.80 \\ 0.80 - 1.05 \\ 1.06 - 1.14 \\ 1.15 - 1.19 \\ 1.20 - 1.60 \\ \textbf{>} 1.60 \\ \hline \end{array}$	(7) < 0.50 0.50 - 1.00 1.01 - 1.60 1.61 - 2.00			

Stream:	Tributary to Five Mile Creek	Observer(s):	IT RS Data: IT QA/QC: RS T			Total Score:		NA	NA				
Reach:		Comments:							High				
Location:	LB-19	Bank Length			15		Total Score	Very Low	Low	Moderate	High	Very High	Extreme
Date:	5/24/2022						Values:	5-10	10-20	20-30	30-40	40-45	45-50

			111 111 37 1 1 1		
		E	rodibility Variabl	ies	
Bank Height / Bankft					
Bank Height	Bankfull Height	Value	Index	Bank Erosion Potental	Notes
2.60					
Root Depth / Bank H	eight Ratio				
Root Depth	Bank Height	Value	Index	Bank Erosion Potental	Notes
	2.60				
Weighted Root Densi	ty				
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					
	ТОТ	AL SCORE	High		

			Bank Eros	ion Potential				
			Very Low	Low	Moderate	High	Very High	Extreme
	B	Value	1.00-1.10	1.11-1.19	1.20-1.50	1.60-2.00	2.10-2.80	>2.80
les	Bank Height / Bankfull Height	Index	1.0-1.9	2.0-3.9	4.0-5.9	6.0-7.9	8.0-9.0	10
Variables	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
	Root Deptn / Bank Height	Index	1.0-1.9	2.0-3.9	4.0-5.9	6.0-7.9	8.0-9.0	10
Erodibility	Weighted Root Density	Value	100-80	79-55	54-30	29-15	14-5	<5
dib	Weighted Root Density	Index	1.0-1.9	2.0-3.9	4.0-5.9	6.0-7.9	8.0-9.0	10
Ere	Bank Angle	Value	0-20	21-60	61-80	81-90	91-119	>119
	Dank Angie	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
	Surface Frotection	Index	1.0-1.9	2.0-3.9	4.0-5.9	6.0-7.9	8.0-9.0	10
			Adju	stments				
	Bedrock	Bedrock banks	have a very lo	w erosion pot	tential.			
	Boulders	Boulder banks	have a low ere	osion potentia	l.			
а	Cobble	Substract 10 po	oints. No adjus	tment if sand	gravel compo	se greater that	n 50% of bank	
teri	Clay/Silt Loam	Add 5 points.						
Ma	Gravel	Add 5-10 point	s depending o	n percentage	of bank mater	ial composed	of sand.	
Bank Material	Sand	Add 10 points.	•				•	
B	Silt / Clay	No adjustment.			·	·		
			Strat	fication				
	Add 5-10 p	oints depending	on position of	unstable laye	rs in relation t	o bankfull sta	ge.	

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



Ocular estimate - High

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

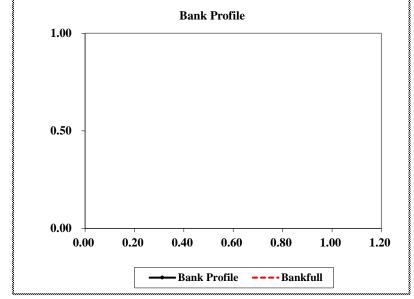
erosion	erosion rate.										
			Estim	ating Nea	r-Bank St	ress ( NBS	3)				
Stream:	Tributa	ary to Five	Mile Creek		Location:	Rolling Ri	dge Park				
Station:	LB-19			S	tream Type:		,	Valley Type:			
Observe	rs:	IT RS						Date:	5/24/2022		
			Methods fo	or Estimati	ng Near-Ba	ank Stress	(NBS)				
(1) Chanr	nel pattern	, transverse baı	or split channe	l/central bar cre	eating NBS		Level I	Recona	issance		
( <b>2</b> ) Ratio	of radius o	of curvature to b	ankfull width (F	R <sub>c</sub> / W <sub>bkf</sub> )			Level II	General	prediction		
( <b>3</b> ) Ratio	of pool slo	pe to average w	vater surface slo	ope (S <sub>p</sub> /S)			Level II	General	prediction		
(4) Ratio	of pool slo	pe to riffle slope	e (S <sub>p</sub> /S <sub>rif</sub> )	·			Level II	General	prediction		
( <b>5</b> ) Ratio	of near-ba	nk maximum de	epth to bankfull	mean depth ( d	nb / d <sub>bkf</sub> )		Level III	Detailed	prediction		
( <b>6</b> ) Ratio	of near-ba	nk shear stress	to bankfull she	ar stress ( τ <sub>nb</sub> /	τ <sub>bkf</sub> )		Level III	Detailed	prediction		
		/ Isovels / Veloc			·		Level IV	Valid	lation		
=		Transverse a	nd/or central b	ars-short and/	or discontinuo	us		NBS = Hig	ıh / Very High		
Level	(1)				channel)						
Ľ			, down-valley	meander mig	ration, conver	ging flow		NE	BS = Extreme		
		Radius of	Bankfull	Ratio R <sub>c</sub> /	Near-Bank						
	(2)	Curvature R <sub>c</sub> (ft)	Width W <sub>bkf</sub> (ft)	W <sub>bkf</sub>	Stress (NBS)						
		1 10 (11)	()	DKI	(1.126)						
					Near-Bank		Method	1			
= =	(0)	Pool Slope	Average		Stress			inant			
Level II	(3)	S <sub>p</sub>	Slope S	Ratio S <sub>p</sub> / S	(NBS)		Near-Bar	nk Stress			
_							Hi	gh			
					Near-Bank	'			-		
	(4)	Pool Slope	Riffle Slope	Ratio S <sub>p</sub> /	Stress						
	( - /	S <sub>p</sub>	S <sub>rif</sub>	S <sub>rif</sub>	(NBS)	1					
		Near-Bank Max Depth	Maan Danth	<i>Ratio</i> d <sub>nb</sub> /	Near-Bank						
	(5)	d <sub>nb</sub> (ft)	Mean Depth d <sub>bkf</sub> (ft)	d <sub>bkf</sub>	Stress (NBS)						
=		TID ( )	- DRI ( ·)	- DKI	(1123)						
Level III				Near-Bank			Bankfull				
Le		Near-Bank		Shear			Shear		Near-Bank		
	(6)	Max Depth	Near-Bank	Stress τ <sub>nb</sub> (	Mean Depth		Stress $\tau_{bkf}$ (		Stress		
		d <sub>nb</sub> (ft)	Slope S <sub>nb</sub>	lb/ft <sup>2</sup> )	d <sub>bkf</sub> (ft)	Slope S	lb/ft <sup>2</sup> )	$ au_{bkf}$	(NBS)		
≥		Volcait : O=-	diant / ft /	Near-Bank							
Level IV	(7)	velocity Grad	dient (ft/sec t)	Stress (NBS)							
Le		, .		, -,							
			a. (a. u.t.)	luoc to a t	loor Davi	Ctuess (ND	C) Detine				
Near-B	ank Str	ess (NBS)	iverting Va	ilues to a f	Near-Bank M	Stress (NE ethod numb					
14Gal 4D	rating		(1)	(2)	(3)	(4)	(5)	(6)	(7)		
	Very Lo		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		
	Modera	ate	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 Hi		(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		
	Extren		Above	< 1.50	> 1.00	> 1.20	> 3.00	> 1.60	> 2.40		
				Overall N	ear-Bank \$	Stress (NB	S) rating	Hi	gh		

Stream:	Tributary to Five Mile Creek	Observer(s):	IT RS	TRS Data: IT QA/QC: RS T		Total Score:	Total Score:		NA					
Reach:		Comments:					Modera	Moderate						
Location:	LB-20	Bank Length	28		Total Score	Very Low	Low	Moderate	High	Very High	Extreme			
Date:	5/24/2022							Values:	5-10	10-20	20-30	30-40	40-45	45-50

			101 010 37 1 1 1		
		E	rodibility Variabl	ies	
Bank Height / Bankft					
Bank Height	Bankfull Height	Value	Index	Bank Erosion Potental	Notes
3.00					
Root Depth / Bank H	eight Ratio				
Root Depth	Bank Height	Value	Index	Bank Erosion Potental	Notes
	3.00				
Weighted Root Densi	ty				
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					
	тот	AL SCORE	Moderate		

			Bank Eros	ion Potential				
			Very Low	Low	Moderate	High	Very High	Extreme
	D	Value	1.00-1.10	1.11-1.19	1.20-1.50	1.60-2.00	2.10-2.80	>2.80
les	Bank Height / Bankfull Height	Index	1.0-1.9	2.0-3.9	4.0-5.9	6.0-7.9	8.0-9.0	10
Variables	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
	Root Deptil / Balik Height	Index	1.0-1.9	2.0-3.9	4.0-5.9	6.0-7.9	8.0-9.0	10
Erodibility	Weighted Root Density	Value	100-80	79-55	54-30	29-15	14-5	<5
dib	Weighted Root Delisity	Index	1.0-1.9	2.0-3.9	4.0-5.9	6.0-7.9	8.0-9.0	10
Ere	Bank Angle	Value	0-20	21-60	61-80	81-90	91-119	>119
	Dank Angic	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
	Surface Frotection	Index	1.0-1.9	2.0-3.9	4.0-5.9	6.0-7.9	8.0-9.0	10
			Adju	stments				
	Bedrock	Bedrock banks	have a very lo	w erosion po	tential.			
	Boulders	Boulder banks	have a low ere	osion potentia	l.			
ਾਫ	Cobble	Substract 10 po	oints. No adjus	stment if sand	gravel compo	se greater that	n 50% of bank	
iteri	Clay/Silt Loam	Add 5 points.						
Ma	Gravel	Add 5-10 point	s depending o	n percentage	of bank mater	ial composed	of sand.	
Bank Material	Sand	Add 10 points.						
B	Silt / Clay	No adjustment.						
			Strat	ification				
	Add 5-10 p	oints depending	on position of	funstable laye	rs in relation t	o bankfull sta	ge.	

	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.

erosion rate.											
Estimating Near-Bank Stress (NBS)											
Stream:	Tributa	ary to Five	Mile Creek		Location:	Rolling Ri	dge Park				
Station:	LB-20			S	tream Type:		,	√alley Type:			
Observe	ers:	IT RS						Date:	5/24/2022		
			Methods for	or Estimati	ng Near-Ba	ank Stress	(NBS)				
(1) Chani	nel pattern	, transverse baı	or split channe	l/central bar cre	eating NBS		Level I	issance			
(2) Ratio	of radius o	f curvature to b	ankfull width (F	R <sub>c</sub> / W <sub>bkf</sub> )			Level II	General	prediction		
(3) Ratio	of pool slo	pe to average v	vater surface slo		Level II	General	prediction				
(4) Ratio	General	prediction									
(4) Ratio of pool slope to riffle slope ( $S_p/S_{rif}$ ) Level II (5) Ratio of near-bank maximum depth to bankfull mean depth ( $d_{nb}/d_{bkf}$ ) Level III									prediction		
(6) Ratio	of near-ba	nk shear stress	to bankfull she	ar stress ( τ <sub>nb</sub> /	$\tau_{bkf}$ )		Level III	Detailed	prediction		
(7) Veloc	ity profiles	/ Isovels / Veloc	city gradient				Level IV	Valid	lation		
=		Transverse a	nd/or central b	ars-short and/	or discontinuo	us		NBS = Hig	ıh / Very High		
Level	(1)										
<u> </u>		Chute cutoffs	, down-valley	meander mig	ration, conver	ging flow		NE	BS = Extreme		
		Radius of	Bankfull	Potio P /	Near-Bank						
	(2)	Curvature R <sub>c</sub> (ft)	Width W <sub>bkf</sub> (ft)	<i>Ratio</i> R <sub>c</sub> / W <sub>bkf</sub>	Stress (NBS)						
		1 10 (11)	(1.7)	DKI	(1.126)	Ì					
					Near-Bank		Method	1			
=	(0)	Pool Slope	Average		Stress			inant			
Level	(3)	S <sub>p</sub>	Slope S	Ratio S <sub>p</sub> / S	(NBS)		Near-Bar	nk Stress			
_							Mode	erate			
					Near-Bank	'			<u>-</u> '		
	(4)	Pool Slope	Riffle Slope	Ratio S <sub>p</sub> /	Stress						
	(-,	S <sub>p</sub>	S <sub>rif</sub>	S <sub>rif</sub>	(NBS)	1					
		Near-Bank Max Depth	Mara Barda	Ratio d <sub>nb</sub> /	Near-Bank						
	(5)	d <sub>nb</sub> (ft)	Mean Depth d <sub>bkf</sub> (ft)	d <sub>bkf</sub>	Stress (NBS)						
=		TID ( )	Did ( )	DIG							
Level III				Near-Bank			Bankfull				
Pe		Near-Bank		Shear			Shear		Near-Bank		
	(6)	Max Depth	Near-Bank	Stress τ <sub>nb</sub> (	Mean Depth		Stress $\tau_{bkf}$ (		Stress		
		d <sub>nb</sub> (ft)	Slope S <sub>nb</sub>	lb/ft <sup>2</sup> )	d <sub>bkf</sub> (ft)	Slope S	lb/ft <sup>2</sup> )	$ au_{bkf}$	(NBS)		
≥		Valaa'' . 0		Near-Bank							
Level IV	(7)		dient (ft/sec ft)	Stress (NBS)							
<u> </u>			- /	(* )							
					<u> </u>	0.4	0) 5				
Noor F	Sank Ct-		nverting Va	alues to a l							
Near-Bank Stress (NBS) ratings			(1)	(2)	(3)	ethod numb (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		
			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		
	Modera		l			0.81 – 1.00	1.81 – 2.50				
	Modera High		See	1.81 - 2.00	0.61 – 0.80	0.01 - 1.00	1.01 - 2.00	1.15 - 1.19	1.01 – 2.00		
	High		See (1)	1.81 – 2.00 1.50 – 1.80	0.61 - 0.80 0.81 - 1.00			1.15 – 1.19 1.20 – 1.60	1.61 – 2.00 2.01 – 2.40		
	High Very Hi	gh		1.81 – 2.00 1.50 – 1.80 < 1.50	0.61 – 0.80 0.81 – 1.00 > 1.00	1.01 – 1.20 > 1.20	2.51 – 3.00 > 3.00	1.13 – 1.19 1.20 – 1.60 > 1.60	2.01 – 2.40 > 2.40		
	High	gh	(1)	1.50 – 1.80 < 1.50	0.81 – 1.00	1.01 – 1.20 > 1.20	2.51 – 3.00 > 3.00	1.20 – 1.60 > 1.60	2.01 – 2.40		

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

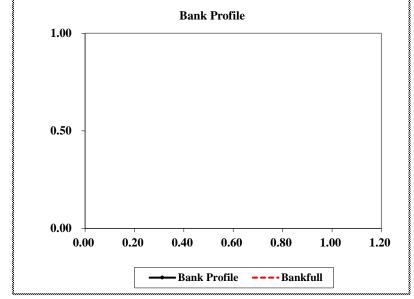
Patio of pool slope to average water surface slope ( $S_p/S$ )  Level II  General prediction  Ratio of pool slope to riffle slope ( $S_p/S_{rif}$ )  Level II  General prediction  Ratio of near-bank maximum depth to bankfull mean depth ( $d_{nb}/d_{bkf}$ )  Ratio of near-bank shear stress to bankfull shear stress ( $\tau_{nb}/\tau_{bkf}$ )  Level III  Detailed prediction  Detailed prediction	erosion rate.										
Targournest	Estimating Near-Bank Stress (NBS)										
Description	Stream:	Tributa	ary to Five	Mile Creek		Location:	Rolling Ri	dge Park			
Channel pattern, transverse bar or split channel/central bar creating NBS   Level     Reconaissance	Station:	LB-20			S	tream Type:		,	√alley Type:		
Channel pattern, transverse bar or split channel/central bar creating NBS	Observe	rs:	IT RS						Date:	5/24/2022	
Ratio of radius of curvature to bankfull width ( R <sub>c</sub> / W <sub>sat</sub> )   Level   II   General prediction   Ratio of pool slope to average water surface slope ( S <sub>p</sub> / S)   Level   II   General prediction   Ratio of pool slope to riffle slope ( S <sub>p</sub> / S <sub>tri</sub> )   Level   II   General prediction   Ratio of pool slope to riffle slope ( S <sub>p</sub> / S <sub>tri</sub> )   Level   II   Detailed prediction   Ratio of near-bank maximum depth to bankfull mean depth ( d <sub>the</sub> / d <sub>bat</sub> )   Level   II   Detailed prediction   Ratio of near-bank shear stress to bankfull shear stress ( T <sub>Ca</sub> / T <sub>Surf</sub> )   Level   II   Detailed prediction   Validation   Valida				Methods fo	or Estimati	ng Near-B	ank Stress	(NBS)			
Ratio of pool slope to average water surface slope (S <sub>p</sub> / S <sub>g</sub> )   Level II   General prediction	(1) Chanr	nel pattern	, transverse bar	or split channe	l/central bar cre	eating NBS		Level I	issance		
Ratio of pool slope to riffie slope (S <sub>p</sub> / S <sub>m</sub> r)   Ratio of near-bank maximum depth to bankfull mean depth (d <sub>nb</sub> / d <sub>bat</sub> r)   Level III   Detailed prediction	( <b>2</b> ) Ratio	of radius o	f curvature to b		Level II	General	prediction				
Ratio of near-bank maximum depth to bankfull mean depth ( dn <sub>D</sub> / d <sub>bel</sub> )   Level III   Detailed prediction	( <b>3</b> ) Ratio	of pool slo	pe to average w	ater surface slo		Level II	General	prediction			
Ratio of near-bank maximum depth to bankfull mean depth (d <sub>nb</sub> / d <sub>bak</sub> )   Level III   Detailed prediction	( <b>4</b> ) Ratio	General	prediction								
Velocity profiles / Isovels / Velocity gradient   Validation	( <b>5</b> ) Ratio	Detailed	prediction								
1	( <b>6</b> ) Ratio	of near-ba	nk shear stress	to bankfull she	ar stress ( $\tau_{nb}$ /	$\tau_{bkf}$ )		Level III	Detailed	prediction	
California   Cal	(7) Veloci	ty profiles	/ Isovels / Veloc	city gradient				Level IV	Valid	lation	
Radius of Curvature (viidh Wold Wold Wold Wold Wold Wold Wold (NBS)	=		Transverse a	nd/or central b	ars-short and/	or discontinuo	us		NBS = Hig	jh / Very High	
Radius of Curvature (viidh Wold Wold Wold Wold Wold Wold Wold (NBS)	eve.	(1)									
California   Cal	ت			, down-valley	meander mig	ration, conver	ging flow		NE	BS = Extreme	
Continue					Patio P /						
Continue		(2)			-						
Color   Colo			()	(,	DKI	(1.126)	Ì				
Color   Colo						Noor Book	l	Method	1		
(4)	=	(0)	Pool Slope	Average					inant		
(4)	eve.	(3)		Slope S	Ratio S <sub>p</sub> / S	(NBS)		Near-Bar	nk Stress		
(4)   Pool Slope   S <sub>p</sub>   Riffle Slope   S <sub>rif</sub>   Stress   (NBS)	_							Mode	erate		
(6) Near-Bank Average (NBS)  (7) Velocity Gradient (ft / sec / ft)  Testings  (1) (2) (3) (4) (5) (6) (7)  Very Low  N/A  2.21 - 3.00  N/A  2.21 - 3.00  N/A  2.21 - 3.00  Near-Bank Stress (NBS)  Nea						Near-Bank					
Sp		(4)				Stress					
(5)   Max Depth   d <sub>bkf</sub> (ft)   Mean Depth   d <sub>bkf</sub> (ft)   Mean Depth   d <sub>bkf</sub> (ft)   Mean Depth   Stress (NBS)		(-)	S <sub>p</sub>	S <sub>rif</sub>	S <sub>rif</sub>	(NBS)					
(5)   Max Depth   d <sub>bkf</sub> (ft)   Mean Depth   d <sub>bkf</sub> (ft)   Mean Depth   d <sub>bkf</sub> (ft)   Mean Depth   Stress (NBS)							ļ				
(6)					Datio d /						
(6) Near-Bank Max Depth dnb (ft) Near-Bank Stress Tnb (lb/ft²) Mean Depth dnb (ft) Near-Bank Stress (NBS)  (7) Velocity Gradient (ft / sec / ft )  Near-Bank Stress (NBS)  ratings  (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 1.01 - 1.20 2.51 - 3.00 1.20 - 1.60 2.01 - 2.40  Extreme Above < 1.50 > 1.00 > 1.00 > 1.20 - 3.00 > 2.40		(5)									
(6)   Max Depth   Appendix   A	=		* HD ( *)	- DKI (1-7)	-DKI	(1.126)					
(6)   Max Depth   Appendix   A	vel				Near-Bank		<del></del>	Bankfull			
Converting Values to a Near-Bank Stress (NBS)   Converting Values to a Near	Le		Near-Bank							Near-Bank	
Converting Values to a Near-Bank Stress (NBS) Rating   Near-Bank Stress (NBS)		(6)			Stress τ <sub>nb</sub> (					Stress	
Converting Values to a Near-Bank Stress (NBS) Rating   Near-Bank Stress (NBS)			d <sub>nb</sub> (ft)	Slope S <sub>nb</sub>	lb/ft²)	d <sub>bkf</sub> (ft)	Slope S	lb/ft²)	$ au_{bkf}$	(NBS)	
Converting Values to a Near-Bank Stress (NBS) Rating   Near-Bank Stress (NBS)											
Converting Values to a Near-Bank Stress (NBS) Rating   Near-Bank Stress (NBS)     Near-Bank Stress (NBS)     Nethod number     Near-Bank Stress (NBS)     Nethod number     Near-Bank Stress (NBS)     Nethod number   Near-Bank Stress (NBS)   Nethod number   Nethod numbe	≥		V-1	Part ( fr. )							
Converting Values to a Near-Bank Stress (NBS) Rating   Near-Bank Stress (NBS)     Near-Bank Stress (NBS)     Nethod number     Near-Bank Stress (NBS)     Nethod number     Near-Bank Stress (NBS)     Nethod number   Near-Bank Stress (NBS)   Nethod number   Nethod numbe	_ e	(7)									
Near-Bank Stress (NBS)	Le		/	• /	(1400)						
Near-Bank Stress (NBS)											
ratings         (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	Nos- D	onle Ct		nverting Va	alues to a l		•				
Very Low         N / A         > 3.00         < 0.20				(1)	(2)				(6)	(7)	
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											
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											
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											
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											
Extreme Above < 1.50 > 1.00 > 1.20 > 3.00 > 1.60 > 2.40											
2.11.0											
Overall Near-Dank Stress (NDS) rating Moderate		•••	•								
					Overali N	cai-Dalik (	211622 (IAD	o) rating	IVIOU	ciale	

Stream:	Tributary to Five Mile Creek	Observer(s):	IT RS	IT RS Data: IT QA/QC: RS			Total Score:							
Reach:		Comments:												
Location:	LB-21	Bank Length	22				Total Score	Very Low	Low	Moderate	High	Very High	Extreme	
Date:	5/24/2022							Values:	5-10	10-20	20-30	30-40	40-45	45-50

		E	rodibility Variabl	les					
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 Densi	ity								
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									
	TOT	AL SCORE							

			Bank Eros	ion Potential							
			Very Low	Low	Moderate	High	Very High	Extreme			
	D	Value	1.00-1.10	1.11-1.19	1.20-1.50	1.60-2.00	2.10-2.80	>2.80			
səle	Bank Height / Bankfull Height	Index	1.0-1.9	2.0-3.9	4.0-5.9	6.0-7.9	8.0-9.0	10			
Variables	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			
	Root Deptil / Balik Height	Index	1.0-1.9	2.0-3.9	4.0-5.9	6.0-7.9	8.0-9.0	10			
Erodibility	Weighted Root Density	Value	100-80	79-55	54-30	29-15	14-5	<5			
dib	Weighted Root Delisity	Index	1.0-1.9	2.0-3.9	4.0-5.9	6.0-7.9	8.0-9.0	10			
Erc	Bank Angle	Value	0-20	21-60	61-80	81-90	91-119	>119			
	Dank Angie	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			
	Surface Protection	Index	1.0-1.9	2.0-3.9	4.0-5.9	6.0-7.9	8.0-9.0	10			
			Adju	stments							
	Bedrock	Bedrock banks	have a very lo	w erosion po	tential.						
	Boulders	Boulder banks have a low erosion potential.									
ਢ	Cobble	Substract 10 points. No adjustment if sand/gravel compose greater than 50% of bank.									
Bank Material	Clay/Silt Loam	Add 5 points.									
Ma	Gravel	Add 5-10 points depending on percentage of bank material composed of sand.									
ank	Sand	Add 10 points.									
B	Silt / Clay	No adjustment.									
			Strat	ification			•				
	Add 5-10 p	oints depending	on position of	funstable laye	rs in relation t	o bankfull sta	ge.				

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



Removed due to deposition

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

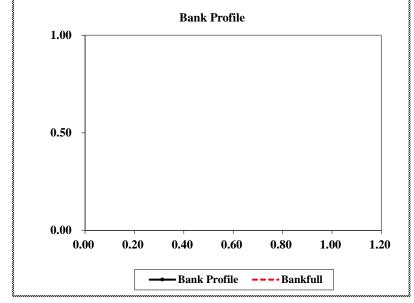
erosion	Estimating Near-Bank Stress ( NBS )											
			Estim	ating Nea	r-Bank St	ress ( NBS	S)					
Stream:	Tributa	ry to Five M	1ile Creek		Location:	Rolling Ri	dge Park					
Station:	LB-21			S	tream Type:		,	Valley Type:				
Observe	rs:	IT RS						Date:	5/24/2022			
			Methods for	or Estimati	ng Near-B	ank Stress	(NBS)					
(1) Chanr	nel pattern	, transverse bar	or split channe	l/central bar cre	eating NBS		Level I	Recona	aissance			
( <b>2</b> ) Ratio	of radius o	f curvature to b	ankfull width (F	R <sub>c</sub> / W <sub>bkf</sub> )			Level II					
( <b>3</b> ) Ratio	of pool slo	pe to average v		Level II	General	prediction						
(4) Ratio	of pool slo	pe to riffle slope	e (S <sub>p</sub> /S <sub>rif</sub> )				Level II	General	prediction			
( <b>5</b> ) Ratio	of near-ba	nk maximum de	epth to bankfull	mean depth ( d	<sub>nb</sub> / d <sub>bkf</sub> )		Level III	Detailed	prediction			
( <b>6</b> ) Ratio	of near-ba	nk shear stress	to bankfull she	ar stress ( τ <sub>nb</sub> /	τ <sub>bkf</sub> )		Level III	Detailed	prediction			
(7) Veloci	ity profiles	/ Isovels / Veloc	city gradient				Level IV	Valid	dation			
=								_	, , ,			
Level	(1)											
د				meander mig		ging flow		NI	35 = Extreme			
		Radius of	Bankfull Width W	Ratio R <sub>c</sub> /	Near-Bank							
(2) Curvature $R_c$ (ft) Width $R_c$ (ft) $R_c$ Stress (NBS)												
TYG (II) (II) VVbkf (INDO)												
_					Near-Bank		Method		1			
Level II	(2)	Pool Slope	Average		Stress			inant	1			
Lev	(3)	S <sub>p</sub>	Slope S	Ratio S <sub>p</sub> / S	(NBS)	1	Near-Bar	nk Stress				
					Near-Bank							
	(4)	Pool Slope	Riffle Slope	Ratio S <sub>p</sub> /	Stress							
	, ,	S <sub>p</sub>	S <sub>rif</sub>	S <sub>rif</sub>	(NBS)							
		Near Donk				l						
		Near-Bank Max Depth	Mean Depth	Ratio d <sub>nb</sub> /	Near-Bank Stress							
	(5)	d <sub>nb</sub> (ft)	d <sub>bkf</sub> (ft)	d <sub>bkf</sub>	(NBS)							
≡												
Level III				Near-Bank			Bankfull					
Le		Near-Bank	Near-Bank	Shear			Shear	Dotio - /	Near-Bank			
	(6)	Max Depth d <sub>nb</sub> (ft)	Slope S <sub>nb</sub>	lb/ft <sup>2</sup> )	Mean Depth		lb/ft <sup>2</sup> )	Ratio τ <sub>nb</sub> /	Stress (NBS)			
		∽np (¹t/)	OUD	ib/it )	d <sub>bkf</sub> (ft)	Slope S	iD/It )	$ au_{ m bkf}$	(NDO)			
				Man David								
Level IV	/=·	Velocity Grad	dient (ft/sec	Near-Bank Stress								
eve	(7)		t)	(NBS)								
٦												
		Col	nverting Va	alues to a N	Near-Bank	Stress (NF	S) Rating					
Near-E	Bank Str	ess (NBS)	70.000			ethod numb						
	rating		(1)	(2)	(3)	(4)	(5)	(6)	(7)			
	Very Lo	ow	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			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			
<b>Very High</b> (1) 1.50 – 1.8				1.50 – 1.80	0.81 – 1.00	1.01 – 1.20	2.51 – 3.00	1.20 – 1.60	2.01 – 2.40			
	Extren	ne	Above	< 1.50	> 1.00	> 1.20	> 3.00	> 1.60	> 2.40			
				Overall N	lear-Bank \$	Stress (NB	S) rating					

Stream:	Tributary to Five Mile Creek	Observer(s):	IT RS Data: IT QA/QC: RS T					Total Score:		NA	NA				
Reach:		Comments:								Modera	Moderate				
Location:	LB-22	Bank Length		14				Total Score	Very Low	Low	Moderate	High	Very High	Extreme	
Date:	5/24/2022						Values:	5-10	10-20	20-30	30-40	40-45	45-50		

		-			
		E	rodibility Variabl	les	
Bank Height / Bankf	ull Height Ratio				
Bank Height	Bankfull Height	Value	Index	Bank Erosion Potental	Notes
1.80					
Root Depth / Bank H	eight Ratio				
Root Depth	Bank Height	Value	Index	Bank Erosion Potental	Notes
	1.80				
Weighted Root Densi	ity				
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					
	тот	AL SCORE	Moderate		

			Bank Eros	ion Potential								
			Very Low	Low	Moderate	High	Very High	Extreme				
	Pouls Height / Poulsfull Height	Value	1.00-1.10	1.11-1.19	1.20-1.50	1.60-2.00	2.10-2.80	>2.80				
səle	Bank Height / Bankfull Height	Index	1.0-1.9	2.0-3.9	4.0-5.9	6.0-7.9	8.0-9.0	10				
Variables	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				
	Root Deptil / Bank Height	Index	1.0-1.9	2.0-3.9	4.0-5.9	6.0-7.9	8.0-9.0	10				
Erodibility	Weighted Root Density	Value	100-80	79-55	54-30	29-15	14-5	<5				
dib	Weighted Root Density	Index	1.0-1.9	2.0-3.9	4.0-5.9	6.0-7.9	8.0-9.0	10				
Erc	Bank Angle	Value	0-20	21-60	61-80	81-90	91-119	>119				
	Dank Angle	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				
	Surface I Totection	Index	1.0-1.9	2.0-3.9	4.0-5.9	6.0-7.9	8.0-9.0	10				
			Adju	stments								
	Bedrock	Bedrock banks	have a very lo	w erosion pot	tential.							
	Boulders	Boulder banks	have a low ere	osion potentia	l.							
ਢ	Cobble	Substract 10 po	ints. No adjus	tment if sand	gravel compo	se greater that	n 50% of bank					
Material	Clay/Silt Loam	Add 5 points.										
Ma	Gravel	Add 5-10 point	s depending o	n percentage	of bank mater	ial composed	of sand.					
Bank	Sand	Add 10 points.										
B	Silt / Clay No adjustment.											
			Strat	fication								
	Add 5-10 p	oints depending	on position of	unstable laye	rs in relation t	to bankfull sta	ge.					

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



Occular estimate - Moderate

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

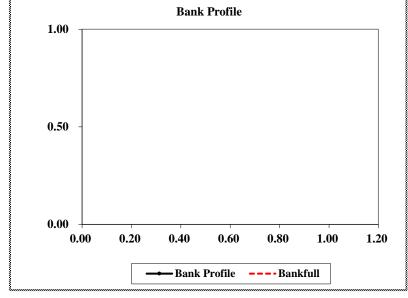
Estimating Near-Bank Stress (NBS)												
			Estim	ating Nea	r-Bank St	ress ( NBS	S)					
Stream:	Tributa	ry to Five	Mile Creek		Location:	Rolling Ri	dge Park					
Station:	LB-22			S	tream Type:		•	Valley Type:				
Observe	rs:	IT RS						Date:	5/24/2022			
			Methods fo	or Estimati	ng Near-B	ank Stress	(NBS)					
(1) Chanr	nel pattern.	transverse bar	or split channe	l/central bar cre	eating NBS		Level I	Recona	aissance			
	·		ankfull width ( F				Level II		prediction			
			vater surface slo				Level II	General	prediction			
		pe to riffle slope	Level II	General	prediction							
		nk maximum de	Level III		prediction							
			to bankfull she				Level III		prediction			
		/ Isovels / Veloc		( -110	*DKI 7		Level IV		dation			
	9			ars-short and/	or discontinuo	us						
(1) Extensive deposition (continuous, cross-channel)												
Le	NI	BS = Extreme										
		Radius of Curvature	Bankfull Width W <sub>bkf</sub>	Ratio R <sub>c</sub> /	Near-Bank Stress							
	(2)											
R <sub>c</sub> (ft) (ft) W <sub>bkf</sub> (NBS)												
			Method	1	1							
=		Pool Slope	Average		Near-Bank Stress			inant				
Level II	(3)	S <sub>p</sub>	Slope S	Ratio S <sub>p</sub> / S	(NBS)		Near-Bar	nk Stress				
_							Lo	ow				
					Near-Bank	,						
	(4)	Pool Slope	Riffle Slope									
	(4) S <sub>p</sub> S <sub>rif</sub> S <sub>rif</sub> (NBS)											
		Near-Bank Max Depth	Maan Danth	<i>Ratio</i> d <sub>nb</sub> /	Near-Bank							
	(5)	d <sub>nb</sub> (ft)	Mean Depth d <sub>bkf</sub> (ft)	d <sub>bkf</sub>	Stress (NBS)							
=			Dia ( )	5.0								
Level III				Near-Bank			Bankfull					
Le		Near-Bank	No De al	Shear			Shear		Near-Bank			
	(6)	Max Depth	Near-Bank Slope S <sub>nb</sub>	Stress τ <sub>nb</sub> (	Mean Depth		Stress τ <sub>bkf</sub> (	Ratio $\tau_{nb}$ /	Stress			
		d <sub>nb</sub> (ft)	Slope S <sub>nb</sub>	lb/ft <sup>2</sup> )	d <sub>bkf</sub> (ft)	Slope S	lb/ft <sup>2</sup> )	$ au_{bkf}$	(NBS)			
≥		Velocity Grad	dient (ft / sec	Near-Bank Stress								
Level IV	(7)	/ f	,	(NBS)								
Ľ												
		Col	nverting Va	dues to a l	loar Bank	Stroce (NE	2C) Dating					
Near-B	Bank Str	ess (NBS)	Iverting ve	ilues to a i		ethod numb						
	rating		(1)	(2)	(3)	(4)	(5)	(6)	(7)			
	Very Lo	ow	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			
	Modera	ate	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 Hi	gh	(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			
	Extren	ne	Above	< 1.50	> 1.00	> 1.20	> 3.00	> 1.60	> 2.40			
				Overall N	lear-Bank \$	Stress (NB	S) rating	Lo	ow			
							,9					

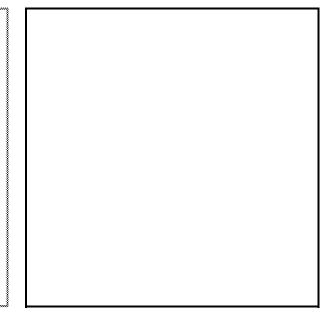
Stream:	Tributary to Five Mile Creek	Observer(s):	IT RS Data: IT QA/QC: RS T					Total Score:		30.25	30.25				
Reach:		Comments:								High	High				
Location:	RB-1	Bank Length	37				Total Score	Very Low	Low	Moderate	High	Very High	Extreme		
Date:	5/24/2022						Values:	5-10	10-20	20-30	30-40	40-45	45-50		

		E	rodibility Variabl	les	
Bank Height / Bankf	ull Height Ratio		rodibiney variable		
Bank Height	Bankfull Height	Value	Index	Bank Erosion Potental	Notes
2.10	0.40	5.25	10.00	Extreme	
Root Depth / Bank H	eight Ratio				
Root Depth	Bank Height	Value	Index	Bank Erosion Potental	Notes
1.00	2.10	0.48	4.14	Moderate	
Weighted Root Densi	ity				
Root Density (%)	Root Depth / Bank Height	Value	Index	Bank Erosion Potental	Notes
20.00	0.48	9.52	8.50	Very High	
Bank Angle					
Bank Angle ( °)			Index	Bank Erosion Potental	Notes
70.00			4.90	Moderate	
Surface Protection					
Surface Protection (%)			Index	Bank Erosion Potental	Notes
70.00			2.71	Low	
			Adjustment		Notes
Bank Materials			0.00		
			Adjustment		Notes
Bank Stratification			0.00		
	TOT	AL SCORE	30.25		

			Bank Eros	ion Potential								
			Very Low	Low	Moderate	High	Very High	Extreme				
	Pouls Height / Poulsfull Height	Value	1.00-1.10	1.11-1.19	1.20-1.50	1.60-2.00	2.10-2.80	>2.80				
səle	Bank Height / Bankfull Height	Index	1.0-1.9	2.0-3.9	4.0-5.9	6.0-7.9	8.0-9.0	10				
Variables	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				
	Root Deptil / Bank Height	Index	1.0-1.9	2.0-3.9	4.0-5.9	6.0-7.9	8.0-9.0	10				
Erodibility	Weighted Root Density	Value	100-80	79-55	54-30	29-15	14-5	<5				
dib	Weighted Root Density	Index	1.0-1.9	2.0-3.9	4.0-5.9	6.0-7.9	8.0-9.0	10				
Erc	Bank Angle	Value	0-20	21-60	61-80	81-90	91-119	>119				
	Dank Angie	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				
	Surface I Totection	Index	1.0-1.9	2.0-3.9	4.0-5.9	6.0-7.9	8.0-9.0	10				
			Adju	stments								
	Bedrock	Bedrock banks	have a very lo	w erosion pot	tential.							
	Boulders	Boulder banks	have a low ere	osion potentia	l.							
ਢ	Cobble	Substract 10 po	ints. No adjus	tment if sand	gravel compo	se greater that	n 50% of bank					
Material	Clay/Silt Loam	Add 5 points.										
Ma	Gravel	Add 5-10 point	s depending o	n percentage	of bank mater	ial composed	of sand.					
Bank	Sand	Add 10 points.										
B	Silt / Clay No adjustment.											
			Strat	fication								
	Add 5-10 p	oints depending	on position of	unstable laye	rs in relation t	to bankfull sta	ge.					

	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.

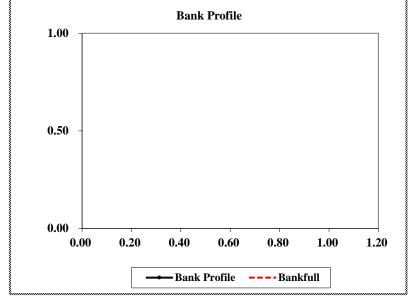
Estimating Near-Bank Stress (NBS)												
			Estim	ating Nea	r-Bank St	ress ( NBS	5)					
Stream:	Tributa	ry to Five	Mile Creek		Location:	Rolling Ri	dge Park					
Station:	RB-1			S	tream Type:		1	Valley Type:				
Observe	rs:	IT RS						Date:	5/24/2022			
			Methods for	or Estimati	ng Near-B	ank Stress	(NBS)					
(1) Chanr	nel pattern	, transverse bar	or split channe	l/central bar cre	eating NBS		Level I	Recona	issance			
( <b>2</b> ) Ratio	of radius o	f curvature to b	ankfull width (F	R <sub>c</sub> / W <sub>bkf</sub> )			Level II	General	prediction			
( <b>3</b> ) Ratio	of pool slo	pe to average v	vater surface slo	ope (S <sub>p</sub> /S)			Level II	General	prediction			
(4) Ratio	of pool slo	pe to riffle slope	Level II	General	prediction							
( <b>5</b> ) Ratio	of near-ba	nk maximum de		Level III	Detailed	prediction						
( <b>6</b> ) Ratio	of near-ba	nk shear stress	to bankfull she	ar stress ( τ <sub>nb</sub> /	τ <sub>bkf</sub> )		Level III	Detailed	prediction			
(7) Veloci	ty profiles	/ Isovels / Veloc	city gradient				Level IV	Valid	lation			
=									, , ,			
(1) Extensive deposition (continuous, cross-channel)												
تّ	NI	BS = Extreme										
		Radius of Curvature	Bankfull Width W <sub>bkf</sub>	Ratio R <sub>c</sub> /	Near-Bank Stress							
R <sub>c</sub> (ft) (ft) W <sub>bkf</sub> (NBS)												
			Method	1								
=	(2)	Pool Slope	Average		Near-Bank Stress			inant				
Level II	(3)	S <sub>p</sub>	Slope S	Ratio S <sub>p</sub> / S	(NBS)		Near-Bai	nk Stress				
							Lo	ow				
					Near-Bank		=					
	(4)	Pool Slope	Riffle Slope	Ratio S <sub>p</sub> /								
	( )	S <sub>p</sub>	S <sub>rif</sub>	S <sub>rif</sub>	(NBS)	]						
		Na an David										
		Near-Bank Max Depth	Mean Depth	Ratio d <sub>nb</sub> /	Near-Bank Stress							
	(5)	d <sub>nb</sub> (ft)	d <sub>bkf</sub> (ft)	d <sub>bkf</sub>	(NBS)							
=												
Level III				Near-Bank			Bankfull					
Le		Near-Bank	Near-Bank	Shear			Shear	Datia - /	Near-Bank			
	(6)	Max Depth d <sub>nb</sub> (ft)	Slope S <sub>nb</sub>	Stress $\tau_{nb}$ ( $lb/ft^2$ )	Mean Depth	Average Slope S	Stress τ <sub>bkf</sub> (	Ratio τ <sub>nb</sub> /	Stress (NBS <b>)</b>			
		u <sub>nb</sub> (it)	Ciopo C <sub>ND</sub>	ID/It )	d <sub>bkf</sub> (ft)	Slope S	10/11	$ au_{ m bkf}$	(NDO)			
				N 5 :								
≥		Velocity Grad	dient (ft/sec	Near-Bank Stress								
Level IV	(7)	/ f	,	(NBS)								
_												
		Col	nverting Va	dues to a N	Near-Bank	Strace (NE	SS) Rating					
Near-B	ank Str	ess (NBS)	Tvorting ve	ilucs to a i		ethod numb						
	rating		(1)	(2)	(3)	(4)	(5)	(6)	(7)			
	Very Lo	ow	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 Hi	gh	(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			
	Extren	ne	Above	< 1.50	> 1.00	> 1.20	> 3.00	> 1.60	> 2.40			
				Overall N	lear-Bank \$	Stress (NB	S) rating	Lo	ow .			
							,9					

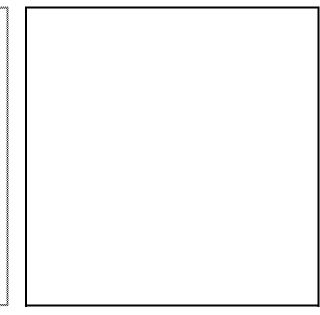
Stream:	Tributary to Five Mile Creek	Observer(s):	IT RS Data: IT QA/QC: RS T					Total Score:		36.20	36.20				
Reach:		Comments:								High	High				
Location:	RB-2	Bank Length		42				Total Score	Very Low	Low	Moderate	High	Very High	Extreme	
Date:	5/24/2022						Values:	5-10	10-20	20-30	30-40	40-45	45-50		

		F	rodibility Variabl	lac .	
Bank Height / Bankft	ull Height Ratio	E	Todibility variable	ics	
Bank Height	Bankfull Height	Value	Index	Bank Erosion Potental	Notes
4.50	0.40	11.25	10.00	Extreme	
Root Depth / Bank H	eight Ratio				
Root Depth	Bank Height	Value	Index	Bank Erosion Potental	Notes
2.50	4.50	0.56	3.63	Low	
Weighted Root Densi	ity				
Root Density (%)	Root Depth / Bank Height	Value	Index	Bank Erosion Potental	Notes
30.00	0.56	16.67	7.67	High	
Bank Angle					
Bank Angle ( °)			Index	Bank Erosion Potental	Notes
80.00			5.90	Moderate	
Surface Protection					
Surface Protection (%)			Index	Bank Erosion Potental	Notes
10.00			9.00	Very High	
			Adjustment		Notes
Bank Materials			0.00		
			Adjustment		Notes
Bank Stratification			0.00		
	тот	AL SCORE	36.20		

			Bank Eros	ion Potential				
			Very Low	Low	Moderate	High	Very High	Extreme
	D	Value	1.00-1.10	1.11-1.19	1.20-1.50	1.60-2.00	2.10-2.80	>2.80
les	Bank Height / Bankfull Height	Index	1.0-1.9	2.0-3.9	4.0-5.9	6.0-7.9	8.0-9.0	10
Variables	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
	Root Deptil / Balik Height	Index	1.0-1.9	2.0-3.9	4.0-5.9	6.0-7.9	8.0-9.0	10
Erodibility	Weighted Root Density	Value	100-80	79-55	54-30	29-15	14-5	<5
dib	Weighted Root Density	Index	1.0-1.9	2.0-3.9	4.0-5.9	6.0-7.9	8.0-9.0	10
Ere	Bank Angle	Value	0-20	21-60	61-80	81-90	91-119	>119
	Dank Angic	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
	Surface Frotection	Index	1.0-1.9	2.0-3.9	4.0-5.9	6.0-7.9	8.0-9.0	10
			Adju	stments				
	Bedrock	Bedrock banks	have a very lo	w erosion po	tential.			
	Boulders	Boulder banks	have a low ere	osion potentia	l.			
ਾਫ	Cobble	Substract 10 po	oints. No adjus	stment if sand	gravel compo	se greater that	n 50% of bank	
iteri	Clay/Silt Loam	Add 5 points.						
Ma	Gravel	Add 5-10 point	s depending o	n percentage	of bank mater	ial composed	of sand.	
Bank Material	Sand	Add 10 points.						
B	Silt / Clay	No adjustment.						
			Strati	ification				
	Add 5-10 p	oints depending	on position of	funstable laye	rs in relation t	o bankfull sta	ge.	

	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.

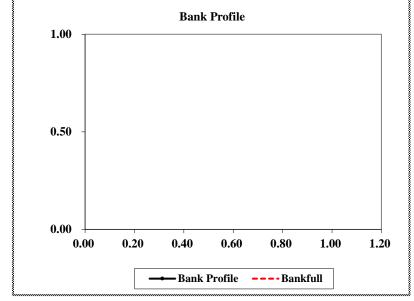
erosion	rate.										
			Estim	ating Nea	r-Bank St	ress ( NBS	S)				
Stream:	Tributa	ary to Five	Mile Creek		Location:	Rolling Ri	dge Park				
Station:	RB-2			S	tream Type:	-	,	Valley Type:			
Observe	rs:	IT RS							5/24/2022		
			Methods fo	or Estimati	ng Near-Ba	ank Stress	(NBS)				
(1) Chanr	nel pattern	, transverse bai	or split channe	l/central bar cre	eating NBS		Level I	Recona	nissance		
		of curvature to b	·		<u> </u>		Level II		prediction		
		pe to average v					Level II		prediction		
		pe to riffle slope		. , р ,			Level II	General	prediction		
		nk maximum de		mean depth ( d	ob/dblf)		Level III		prediction		
		nk shear stress					Level III		prediction		
		/ Isovels / Veloc		ar orross ( v <sub>nb</sub> /	CDKT /		Level IV		lation		
	ty promoc			ars-short and/	or discontinuo	us					
Level	(1)				channel)			-			
Le		Chute cutoffs	, down-valley	meander mig	ration, conver	ging flow		NE	BS = Extreme		
		Radius of	Bankfull		Near-Bank						
	(2)	Curvature	Width W <sub>bkf</sub>	Ratio R <sub>c</sub> /	Stress						
	` ,	R <sub>c</sub> (ft)	(ft)	W <sub>bkf</sub>	(NBS)						
Near-Bank Method 1											
=		Pool Slope	Average		Near-Bank Stress			inant			
Level II	(3)	S <sub>p</sub>	Slope S	Ratio S <sub>p</sub> / S	(NBS)			nk Stress			
							Hi	gh			
					Near-Bank						
	(4)	Pool Slope	Riffle Slope	Ratio S <sub>p</sub> /	Stress						
	(4)	S <sub>p</sub>	S <sub>rif</sub>	S <sub>rif</sub>	(NBS)	l					
		Near-Bank			Near-Bank						
	(5)	Max Depth d <sub>nb</sub> (ft)	Mean Depth	Ratio d <sub>nb</sub> /	Stress (NBS)						
=		u <sub>nb</sub> (It)	d <sub>bkf</sub> (ft)	d <sub>bkf</sub>	(NDO)						
Level III				Near-Bank			Bankfull				
Lev		Near-Bank		Shear			Shear		Near-Bank		
	(6)	Max Depth	Near-Bank	Stress $\tau_{\text{nb}}$ (	Mean Depth	Average		Ratio $\tau_{nb}$ /	Stress		
		d <sub>nb</sub> (ft)	Slope S <sub>nb</sub>	lb/ft <sup>2</sup> )	d <sub>bkf</sub> (ft)	Slope S	lb/ft <sup>2</sup> )	$ au_{bkf}$	(NBS)		
≥				Near-Bank							
Level IV	(7)	Velocity Grad	dient (ft/sec	Stress (NBS)							
Le		/ 1	( )	(NDO)	Ì						
			nverting Va	alues to a l	Near-Bank						
Near-B		ess (NBS)	(1)	(2)		ethod numb		(6)	(7)		
	rating Very L		(1) N/A	(2)	(3)	(4)	(5)	(6)	(7)		
	Very Low		N/A	> 3.00 2.21 – 3.00	< 0.20 0.20 – 0.40	< 0.40 0.41 – 0.60	< 1.00 1.00 – 1.50	< 0.80 0.80 – 1.05	< 0.50 0.50 – 1.00		
	Modera		N/A	2.21 – 3.00	0.20 - 0.40	0.41 - 0.80	1.51 – 1.80				
	High		See	1.81 – 2.00	0.41 - 0.60	0.61 - 0.80	1.81 – 2.50	1.06 – 1.14 1.15 – 1.19	1.01 – 1.60 1.61 – 2.00		
	Very Hi		(1)	1.50 – 1.80	0.81 – 0.80	1.01 – 1.20	2.51 – 3.00	1.15 – 1.19	2.01 – 2.40		
	Extren		Above	< 1.50	> 1.00	> 1.20	> 3.00	> 1.60	> 2.40		
	EAU CI										
				Overali N	lear-Bank S	orress (NB	o) rating	HI	gh		

Stream:	Tributary to Five Mile Creek	Observer(s):	IT RS	IT RS Data: IT QA/QC: RS To			Total Score:						
Reach:		Comments:											
Location:	RB-3	Bank Length		40		Total Score	Very Low	Low	Moderate	High	Very High	Extreme	
Date:	5/24/2022						Values:	5-10	10-20	20-30	30-40	40-45	45-50

		F	rodibility Variabl	lac .	
Bank Height / Bankft	ull Height Patio	E	Tourninty variable	ics	
Bank Height	Bankfull Height	Value	Index	Bank Erosion Potental	Notes
Dank Height	Bankran Height	v aruc	mucx	Bank Erosion i otentar	riotes
Root Depth / Bank H	eight Ratio				
Root Depth	Bank Height	Value	Index	Bank Erosion Potental	Notes
Root Bepin	Dunk Height	, and	much	Dank Program Fotomar	110105
Weighted Root Densi	ity				
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					
	тот	AL SCORE			

			Bank Eros	ion Potential				
			Very Low	Low	Moderate	High	Very High	Extreme
	D	Value	1.00-1.10	1.11-1.19	1.20-1.50	1.60-2.00	2.10-2.80	>2.80
les	Bank Height / Bankfull Height	Index	1.0-1.9	2.0-3.9	4.0-5.9	6.0-7.9	8.0-9.0	10
Variables	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
	Root Deptil / Balik Height	Index	1.0-1.9	2.0-3.9	4.0-5.9	6.0-7.9	8.0-9.0	10
Erodibility	Weighted Root Density	Value	100-80	79-55	54-30	29-15	14-5	<5
dib	Weighted Root Density	Index	1.0-1.9	2.0-3.9	4.0-5.9	6.0-7.9	8.0-9.0	10
Ere	Bank Angle	Value	0-20	21-60	61-80	81-90	91-119	>119
	Dank Angic	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
	Surface Frotection	Index	1.0-1.9	2.0-3.9	4.0-5.9	6.0-7.9	8.0-9.0	10
			Adju	stments				
	Bedrock	Bedrock banks	have a very lo	w erosion po	tential.			
	Boulders	Boulder banks	have a low ere	osion potentia	l.			
ਾਫ	Cobble	Substract 10 po	oints. No adjus	stment if sand	gravel compo	se greater that	n 50% of bank	
iteri	Clay/Silt Loam	Add 5 points.						
Ma	Gravel	Add 5-10 point	s depending o	n percentage	of bank mater	ial composed	of sand.	
Bank Material	Sand	Add 10 points.						
B	Silt / Clay	No adjustment.						
			Strati	ification				
	Add 5-10 p	oints depending	on position of	funstable laye	rs in relation t	o bankfull sta	ge.	

	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.

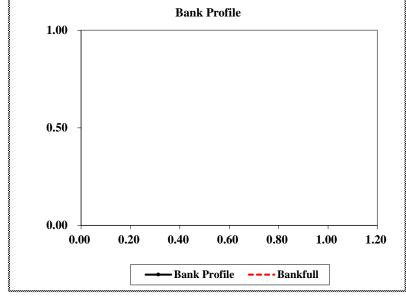
erosion	rate.								
			Estim	ating Nea	r-Bank St	ress ( NBS	S)		
Stream:	Tributa	ary to Five	Mile Creek		Location:	Rolling Ri	dge Park		
Station:	RB-3			S	tream Type:		,	√alley Type:	
Observe	rs:	IT RS						Date:	5/24/2022
			Methods fo	or Estimati	ng Near-Ba	ank Stress	(NBS)		
(1) Chann	nel pattern,	, transverse bar	or split channe	l/central bar cre	eating NBS		Level I	Recona	aissance
( <b>2</b> ) Ratio	of radius o	f curvature to b	ankfull width ( F	R <sub>c</sub> / W <sub>bkf</sub> )			Level II	General	prediction
( <b>3</b> ) Ratio	of pool slo	pe to average v	ater surface slo	ope (S <sub>p</sub> /S)			Level II	General	prediction
( <b>4</b> ) Ratio	of pool slo	pe to riffle slope	e (S <sub>p</sub> /S <sub>rif</sub> )				Level II	General	prediction
( <b>5</b> ) Ratio	of near-ba	nk maximum de	pth to bankfull	mean depth ( d	<sub>nb</sub> / d <sub>bkf</sub> )		Level III	Detailed	prediction
( <b>6</b> ) Ratio	of near-ba	nk shear stress	to bankfull she	ar stress ( τ <sub>nb</sub> /	τ <sub>bkf</sub> )		Level III	Detailed	prediction
(7) Veloci	Valid	lation							
=								-	
Level	(1)				,				
		Ī		meander mig	ration, conver	ging flow		NI	55 = EXTREME
		Radius of Curvature	Bankfull Width W <sub>bkf</sub>	Ratio R <sub>c</sub> /	Near-Bank Stress				
	(2)	R <sub>c</sub> (ft)	(ft)	W <sub>bkf</sub>	(NBS)				
_					Near-Bank		Method		
Level II	(3)	Pool Slope	Average		Stress			inant	
Lev	(3)	S <sub>p</sub>	Slope S	Ratio S <sub>p</sub> / S	(NBS)	1	Near-Bar	nk Stress	
				Detie O. /	Near-Bank				
	(4)	Pool Slope S <sub>p</sub>	Riffle Slope S <sub>rif</sub>	Ratio S <sub>p</sub> / S <sub>rif</sub>	Stress (NBS)				
		- Op	On	On	(NBC)				
		Near-Bank			Near Book	l			
	(5)	Max Depth	Mean Depth	Ratio d <sub>nb</sub> /	Near-Bank Stress				
	(5)	d <sub>nb</sub> (ft)	d <sub>bkf</sub> (ft)	d <sub>bkf</sub>	(NBS)	1			
≣									
Level III				Near-Bank Shear			Bankfull Shear		
ے	(6)	Near-Bank Max Depth	Near-Bank		Mean Depth	A	Stress τ <sub>bkf</sub> (	Ratio τ <sub>nb</sub> /	Near-Bank
	(6)	d <sub>nb</sub> (ft)	Slope S <sub>nb</sub>	Ib/ft <sup>2</sup> )	d <sub>bkf</sub> (ft)	Average Slope S	lb/ft <sup>2</sup> )	$\tau_{\rm bkf}$	Stress (NBS)
		,	1		Did ( )			DKI	
				Near-Bank					
Level IV	(7)	Velocity Grad	dient (ft/sec	Stress					
-ev	(1)	/ f	t )	(NBS)	1				
_									
		Coi	nverting Va	alues to a l	Near-Bank	Stress (NE	S) Rating		
Near-B		ess (NBS)			M	ethod numb	er		
	rating		(1)	(2)	(3)	(4)	(5)	(6)	(7)
	Very Lo		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
	Modera		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 Hi		(1) Above	1.50 – 1.80	0.81 – 1.00	1.01 – 1.20	2.51 – 3.00	1.20 – 1.60	2.01 – 2.40
	Extren	ile .	ADOVE	< 1.50	> 1.00	> 1.20	> 3.00	> 1.60	> 2.40
				Overall N	lear-Bank S	stress (NB	S) rating		

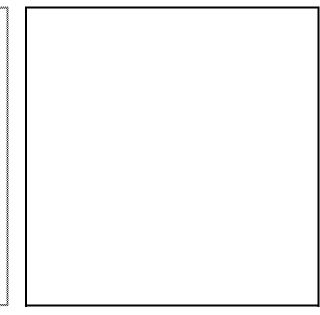
Stream:	Tributary to Five Mile Creek	Observer(s):	IT RS	IT RS Data: IT QA/QC: RS To			Total Score:		40.09	40.09				
Reach:		Comments:							Very Hi	Very High				
Location:	RB-4	Bank Length		32		Total Score	Very Low	Low	Moderate	High	Very High	Extreme		
Date:	5/24/2022						Values:	5-10	10-20	20-30	30-40	40-45	45-50	

		E	rodibility Variabl	les	
Bank Height / Bankf	ull Height Ratio		Toursmey (uran)		
Bank Height	Bankfull Height	Value	Index	Bank Erosion Potental	Notes
1.70	0.40	4.25	10.00	Extreme	
Root Depth / Bank H	eight Ratio				
Root Depth	Bank Height	Value	Index	Bank Erosion Potental	Notes
0.80	1.70	0.47	4.19	Moderate	
Weighted Root Densi	ity				
Root Density (%)	Root Depth / Bank Height	Value	Index	Bank Erosion Potental	Notes
10.00	0.47	4.71	10.00	Extreme	
Bank Angle					
Bank Angle ( °)			Index	Bank Erosion Potental	Notes
80.00			5.90	Moderate	
Surface Protection					
Surface Protection (%)			Index	Bank Erosion Potental	Notes
5.00			10.00	Extreme	
			Adjustment		Notes
Bank Materials			0.00		
			Adjustment		Notes
Bank Stratification			0.00		
	TOT	AL SCORE	40.09		

			Bank Eros	sion Potential				
			Very Low	Low	Moderate	High	Very High	Extreme
	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
səle	Bank Height / Bankiuli Height	Index	1.0-1.9	2.0-3.9	4.0-5.9	6.0-7.9	8.0-9.0	10
Variables	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
	Root Deptil / Bank Height	Index	1.0-1.9	2.0-3.9	4.0-5.9	6.0-7.9	8.0-9.0	10
ility	Weighted Root Density	Value	100-80	79-55	54-30	29-15	14-5	<5
Erodibility	Weighted Root Density	Index	1.0-1.9	2.0-3.9	4.0-5.9	6.0-7.9	8.0-9.0	10
Ere	Bank Angle	Value	0-20	21-60	61-80	81-90	91-119	>119
	Dank Angie	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
	Surface I Totection	Index	1.0-1.9	2.0-3.9	4.0-5.9	6.0-7.9	8.0-9.0	10
			Adju	stments				
	Bedrock	Bedrock banks	have a very lo	w erosion po	tential.			
	Boulders	Boulder banks	have a low ere	osion potentia	l.			
a	Cobble	Substract 10 po	oints. No adjus	stment if sand	gravel compo	se greater that	n 50% of bank	
teri	Clay/Silt Loam	Add 5 points.						
Ma	Gravel	Add 5-10 point	s depending of	n percentage	of bank mater	ial composed	of sand.	•
Bank Material	Sand	Add 10 points.	•				•	•
B	Silt / Clay	No adjustment.						•
		_	Strati	ification			•	·
	Add 5-10 p	oints depending	on position of	funstable laye	rs in relation t	o bankfull sta	ge.	

	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.

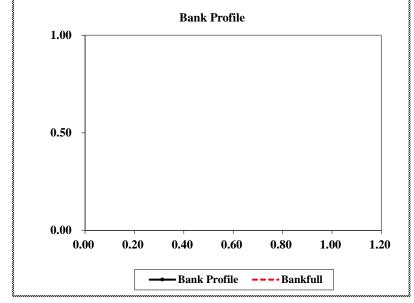
erosion	rate.								
			Estim	ating Nea	r-Bank St	ress ( NBS	S)		
Stream:	Tributa	ary to Five	Mile Creek		Location:	Rolling Ri	dge Park		
Station:	RB-4			S	tream Type:		,	√alley Type:	
Observe	rs:	IT RS						Date:	5/24/2022
			Methods fo	or Estimati	ng Near-B	ank Stress	(NBS)		
(1) Chanr	nel pattern	, transverse bar	or split channe	l/central bar cre	eating NBS		Level I	Recona	aissance
( <b>2</b> ) Ratio	of radius o	f curvature to b	ankfull width ( F	R <sub>c</sub> / W <sub>bkf</sub> )			Level II	General	prediction
( <b>3</b> ) Ratio	of pool slo	pe to average w	ater surface slo	ope (S <sub>p</sub> /S)			Level II	General	prediction
( <b>4</b> ) Ratio	of pool slo	pe to riffle slope	e (S <sub>p</sub> /S <sub>rif</sub> )	·			Level II	General	prediction
		nk maximum de		mean depth ( d	<sub>nb</sub> / d <sub>bkf</sub> )		Level III	Detailed	prediction
( <b>6</b> ) Ratio	of near-ba	nk shear stress	to bankfull she	ar stress ( τ <sub>nb</sub> /	$\tau_{bkf}$ )		Level III	Detailed	prediction
		/ Isovels / Veloc					Level IV	Valid	lation
=		Transverse a	nd/or central b	ars-short and/	or discontinuo	us		NBS = Hig	jh / Very High
Level	(1)								
تّ		Chute cutoffs	, down-valley	meander mig	ration, conver	ging flow		NE	BS = Extreme
		Radius of	Bankfull	Dotio D /	Near-Bank				
	(2)	Curvature R <sub>c</sub> (ft)	Width W <sub>bkf</sub> (ft)	<i>Ratio</i> R <sub>c</sub> / W <sub>bkf</sub>	Stress (NBS)				
		1 (0 (10)	(11)	V V DKT	(NBC)				
					Near Book	l	Method	1	
=	(0)	Pool Slope	Average		Near-Bank Stress			inant	
Level II	(3)	S <sub>p</sub>	Slope S	Ratio S <sub>p</sub> / S	(NBS)		Near-Bar	nk Stress	
_							Hi	gh	
					Near-Bank				
	(4)	Pool Slope	Riffle Slope	Ratio S <sub>p</sub> /	Stress				
	( - /	S <sub>p</sub>	S <sub>rif</sub>	S <sub>rif</sub>	(NBS)	1			
		Near-Bank Max Depth	Maan Danth	Ratio d <sub>nb</sub> /	Near-Bank				
	(5)	d <sub>nb</sub> (ft)	Mean Depth d <sub>bkf</sub> (ft)	d <sub>bkf</sub>	Stress (NBS)				
=		TID ( )	DRI ( )	DIG					
Level III				Near-Bank			Bankfull		
Le		Near-Bank		Shear			Shear		Near-Bank
	(6)	Max Depth	Near-Bank	Stress τ <sub>nb</sub> (	Mean Depth		Stress $\tau_{bkf}$ (		Stress
		d <sub>nb</sub> (ft)	Slope S <sub>nb</sub>	lb/ft <sup>2</sup> )	d <sub>bkf</sub> (ft)	Slope S	lb/ft <sup>2</sup> )	$ au_{bkf}$	(NBS)
≥		Volcait: O==	diant / ft /	Near-Bank					
Level IV	(7)	/ f	dient (ft / sec t)	Stress (NBS)					
Le		·	- /						
			arrantina M	dues to the	loor Doo'	04	O) D-('		
Near-P	ank Str	ess (NBS)	iverting Va	alues to a l	Near-Bank M	Stress (NE ethod numb			
14Gai 4D	rating	•	(1)	(2)	(3)	(4)	(5)	(6)	(7)
	Very Lo		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
	Modera		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 Hi		(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
	Extren		Above	< 1.50	> 1.00	> 1.20	> 3.00	> 1.60	> 2.40
					lear-Bank S				gh
							- ,9		J

Stream:	Tributary to Five Mile Creek	Observer(s):	IT RS Data: IT QA/QC: RS To			Total Score:							
Reach:		Comments:											
Location:	RB-5	Bank Length			25			Very Low	Low	Moderate	High	Very High	Extreme
Date:	5/24/2022						Values:	5-10	10-20	20-30	30-40	40-45	45-50

		F	rodibility Variabl	los.	
Bank Height / Bankf	ull Height Patio	E	Todibility variabl	les	
Bank Height	Bankfull Height	Value	Index	Bank Erosion Potental	Notes
				Dank Erosion Fotonia	2.0000
Root Depth / Bank H	eight Ratio				
Root Depth	Bank Height	Value	Index	Bank Erosion Potental	Notes
Weighted Root Dens	ity				
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					
	TOT	AL SCORE			

			Bank Eros	ion Potential				
			Very Low	Low	Moderate	High	Very High	Extreme
	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
səle	Bank Height / Bankiuli Height	Index	1.0-1.9	2.0-3.9	4.0-5.9	6.0-7.9	8.0-9.0	10
Variables	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
	Root Deptil / Bank Height	Index	1.0-1.9	2.0-3.9	4.0-5.9	6.0-7.9	8.0-9.0	10
ility	Weighted Root Density	Value	100-80	79-55	54-30	29-15	14-5	<5
Erodibility	Weighted Root Density	Index	1.0-1.9	2.0-3.9	4.0-5.9	6.0-7.9	8.0-9.0	10
Erc	Bank Angle	Value	0-20	21-60	61-80	81-90	91-119	>119
	Dank Angie	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
	Surface I Totection	Index	1.0-1.9	2.0-3.9	4.0-5.9	6.0-7.9	8.0-9.0	10
			Adju	stments				
	Bedrock	Bedrock banks	have a very lo	w erosion pot	tential.			
	Boulders	Boulder banks	have a low ere	osion potentia	l.			
a	Cobble	Substract 10 po	oints. No adjus	tment if sand	gravel compo	se greater that	n 50% of bank	
teri	Clay/Silt Loam	Add 5 points.						
Bank Material	Gravel	Add 5-10 point	s depending of	n percentage	of bank mater	ial composed	of sand.	·
ank	Sand	Add 10 points.	•			•		
B	Silt / Clay	No adjustment.						·
		_	Strati	ification		•		
	Add 5-10 p	oints depending	on position of	unstable laye	rs in relation t	to bankfull sta	ge.	

	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.

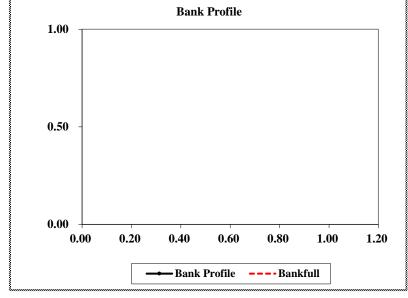
erosion	rate.								
			Estim	ating Nea	r-Bank St	ress ( NBS	S)		
Stream:	Tributa	ary to Five	Mile Creek		Location:	Rolling Ri	dge Park		
Station:	RB-5			S	tream Type:		,	Valley Type:	
Observe	rs:	IT RS						Date:	5/24/2022
			Methods fo	or Estimati	ng Near-B	ank Stress	(NBS)		
(1) Chani	nel pattern	, transverse bar	or split channe	l/central bar cre	eating NBS		Level I	Recona	issance
( <b>2</b> ) Ratio	of radius o	f curvature to b	ankfull width (F	R <sub>c</sub> / W <sub>bkf</sub> )			Level II	General	prediction
(3) Ratio	of pool slo	pe to average w	vater surface slo	ope (S <sub>p</sub> /S)			Level II	General	prediction
(4) Ratio	of pool slo	pe to riffle slope	e ( S <sub>p</sub> / S <sub>rif</sub> )				Level II	General	prediction
( <b>5</b> ) Ratio	of near-ba	nk maximum de	epth to bankfull	mean depth ( d	<sub>nb</sub> / d <sub>bkf</sub> )		Level III	Detailed	prediction
(6) Ratio	of near-ba	nk shear stress	to bankfull she	ar stress ( τ <sub>nb</sub> /	$\tau_{bkf}$ )		Level III	Detailed	prediction
(7) Veloc	ity profiles	/ Isovels / Veloc	city gradient				Level IV	Valid	lation
=		Transverse a	nd/or central b	ars-short and/	or discontinuo	us		NBS = Hig	ıh / Very High
Level	(1)								
تّ		Chute cutoffs	, down-valley	meander mig	ration, conver	ging flow		NE	BS = Extreme
		Radius of	Bankfull	Ratio R <sub>c</sub> /	Near-Bank				
	(2)	Curvature R <sub>c</sub> (ft)	Width W <sub>bkf</sub> (ft)	W <sub>bkf</sub>	Stress (NBS)				
		()	()	DKI	(1.126)	Ì			
					Near-Bank	J	Method		
=	(0)	Pool Slope	Average		Stress			inant	
Level II	(3)	S <sub>p</sub>	Slope S	Ratio S <sub>p</sub> / S	(NBS)		Near-Bar	nk Stress	
_									
									•
	(4)	Pool Slope	Riffle Slope	Ratio S <sub>p</sub> /	Stress				
	(4)	S <sub>p</sub>	S <sub>rif</sub>	S <sub>rif</sub>	(NBS)				
						ļ			
		Near-Bank		Datio d /	Near-Bank				
	(5)	Max Depth d <sub>nb</sub> (ft)	Mean Depth d <sub>bkf</sub> (ft)	Ratio d <sub>nb</sub> / d <sub>bkf</sub>	Stress (NBS)				
=		* HD ( *)	S-DKI (1-7)	- DKI	(1.126)				
Level III				Near-Bank			Bankfull		
Le		Near-Bank		Shear			Shear		Near-Bank
	(6)	Max Depth	Near-Bank	Stress τ <sub>nb</sub> (	Mean Depth			Ratio τ <sub>nb</sub> /	Stress
		d <sub>nb</sub> (ft)	Slope S <sub>nb</sub>	lb/ft <sup>2</sup> )	d <sub>bkf</sub> (ft)	Slope S	lb/ft <sup>2</sup> )	$ au_{bkf}$	(NBS)
≥		\/ola =:t- \ O:-	diant / ft /	Near-Bank					
Level IV	(7)		dient (ft/sec t)	Stress (NBS)					
Ë			- /	(**===)					
					<u> </u>	04	10) 5 4		
Near E	Pank Str	Col ess (NBS)	nverting Va	ilues to a l		Stress (NE ethod numb			
14 <del>C</del> a1-E	rating		(1)	(2)	(3)	(4)	(5)	(6)	(7)
	Very Lo		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
	Modera		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 Hi		(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
	Extren		Above	< 1.50	> 1.00	> 1.20	> 3.00	> 1.60	> 2.40
					lear-Bank \$				
				O VOI alli IV	Jan Bank (	21,009 (IAD	o, rading		

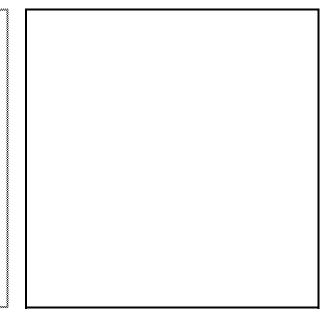
	Tributary to Five Mile Creek	Observer(s):	IT RS Data: IT QA/QC: RS To			Total Score:		38.99	38.99					
Reach:		Comments:						High	High					
Location:	RB-6	Bank Length		31		Total Score	Very Low	Low	Moderate	High	Very High	Extreme		
Date:	5/24/2022							Values:	5-10	10-20	20-30	30-40	40-45	45-50

		_			
		E	rodibility Variabl	es	
Bank Height / Bankf	· · ·				
Bank Height	Bankfull Height	Value	Index	Bank Erosion Potental	Notes
2.80	0.40	7.00	10.00	Extreme	
Root Depth / Bank H	eight Ratio				
Root Depth	Bank Height	Value	Index	Bank Erosion Potental	Notes
1.00	2.80	0.36	5.33	Moderate	
Weighted Root Densi	ity				
Root Density (%)	Root Depth / Bank Height	Value	Index	Bank Erosion Potental	Notes
20.00	0.36	7.14	8.76	Very High	
Bank Angle					
Bank Angle ( °)			Index	Bank Erosion Potental	Notes
80.00			5.90	Moderate	
Surface Protection					
Surface Protection (%)			Index	Bank Erosion Potental	Notes
10.00			9.00	Very High	
			Adjustment		Notes
Bank Materials			0.00		
			Adjustment		Notes
Bank Stratification			0.00		
	тот	AL SCORE	38.99		

			Bank Eros	sion Potential				
			Very Low	Low	Moderate	High	Very High	Extreme
	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
oles	Bank Height / Bankiuli Height	Index	1.0-1.9	2.0-3.9	4.0-5.9	6.0-7.9	8.0-9.0	10
Variables	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
	Root Deptil / Balik Height	Index	1.0-1.9	2.0-3.9	4.0-5.9	6.0-7.9	8.0-9.0	10
ility	Weighted Root Density	Value	100-80	79-55	54-30	29-15	14-5	<5
Erodibility	Weighted Root Delisity	Index	1.0-1.9	2.0-3.9	4.0-5.9	6.0-7.9	8.0-9.0	10
Ere	Bank Angle	Value	0-20	21-60	61-80	81-90	91-119	>119
	Dank Angie	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
	Surface Protection	Index	1.0-1.9	2.0-3.9	4.0-5.9	6.0-7.9	8.0-9.0	10
			Adju	stments				
	Bedrock	Bedrock banks	have a very lo	w erosion po	tential.			
	Boulders	Boulder banks	have a low ere	osion potentia	l.			
ਢ	Cobble	Substract 10 po	oints. No adjus	stment if sand	gravel compo	se greater that	n 50% of bank	
teri	Clay/Silt Loam	Add 5 points.						
Ma	Gravel	Add 5-10 point	s depending o	n percentage	of bank mater	ial composed	of sand.	
Bank Material	Sand	Add 10 points.						
B	Silt / Clay	No adjustment.				•	•	•
			Strat	ification				
	Add 5-10 p	oints depending	on position of	unstable laye	rs in relation t	to bankfull sta	ge.	

	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.

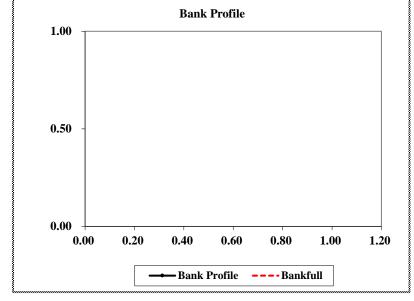
erosion	rate.								
			Estim	ating Nea	r-Bank St	ress ( NBS	S)		
Stream:	Tributa	ary to Five	Mile Creek		Location:	Rolling Ri	dge Park		
Station:	RB-6			S	tream Type:		,	√alley Type:	
Observe	ers:	IT RS						Date:	5/24/2022
			Methods fo	or Estimati	ng Near-Ba	ank Stress	(NBS)		
(1) Chani	nel pattern	, transverse bar	or split channe	l/central bar cre	eating NBS		Level I	Recona	issance
(2) Ratio	of radius o	f curvature to b	ankfull width (F	R <sub>c</sub> / W <sub>bkf</sub> )			Level II	General	prediction
(3) Ratio	of pool slo	pe to average w	vater surface slo	ope (S <sub>p</sub> /S)			Level II	General	prediction
(4) Ratio	of pool slo	pe to riffle slope	e ( S <sub>p</sub> / S <sub>rif</sub> )				Level II	General	prediction
(5) Ratio	of near-ba	nk maximum de	epth to bankfull	mean depth ( d	<sub>nb</sub> / d <sub>bkf</sub> )		Level III	Detailed	prediction
( <b>6</b> ) Ratio	of near-ba	nk shear stress	to bankfull she	ar stress ( τ <sub>nb</sub> /	$\tau_{bkf}$ )		Level III	Detailed	prediction
(7) Veloc	ity profiles	/ Isovels / Veloc	city gradient				Level IV	Valid	lation
=		Transverse a	nd/or central b	ars-short and/	or discontinuo	us		NBS = Hig	ıh / Very High
Level	(1)								
تّ			, down-valley	meander mig	ration, conver	ging flow		NE	BS = Extreme
		Radius of	Bankfull	Ratio R <sub>c</sub> /	Near-Bank				
	(2)	Curvature R <sub>c</sub> (ft)	Width W <sub>bkf</sub> (ft)	W <sub>bkf</sub>	Stress (NBS)				
		()	(,	DKI	(1.126)	Ì			
					Near-Bank		Method	1	
	(0)	Pool Slope	Average		Stress			inant	
Level II	(3)	S <sub>p</sub>	Slope S	Ratio S <sub>p</sub> / S	(NBS)		Near-Bar	nk Stress	
1							Hi	gh	
					Near-Bank	'			_
	(4)	Pool Slope	Riffle Slope	Ratio S <sub>p</sub> /	Stress				
	( ',	S <sub>p</sub>	S <sub>rif</sub>	S <sub>rif</sub>	(NBS)	1			
		Near-Bank Max Depth	Mara Barda	<i>Ratio</i> d <sub>nb</sub> /	Near-Bank				
	(5)	d <sub>nb</sub> (ft)	Mean Depth d <sub>bkf</sub> (ft)	d <sub>bkf</sub>	Stress (NBS)				
=		TID ( )	Did ( )	DKI					
Level III				Near-Bank			Bankfull		
Le		Near-Bank		Shear			Shear		Near-Bank
	(6)	Max Depth	Near-Bank	Stress τ <sub>nb</sub> (	Mean Depth		Stress $\tau_{bkf}$ (		Stress
		d <sub>nb</sub> (ft)	Slope S <sub>nb</sub>	lb/ft <sup>2</sup> )	d <sub>bkf</sub> (ft)	Slope S	lb/ft <sup>2</sup> )	$ au_{bkf}$	(NBS)
≥		\/ola =:t- \ O:-	diant / ft /	Near-Bank					
Level IV	(7)	velocity Grad / f	dient (ft/sec	Stress (NBS)					
Le			- /	(**===)					
						01	0) 5 4		
Noor F	Sank Ct-	Coi ess (NBS)	nverting Va	liues to a l		Stress (NE ethod numb			
ivedi-E	rating	•	(1)	(2)	(3)	(4)	(5)	(6)	(7)
	Very Lo		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
	Modera		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
			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
	Hiah		000				. =		
	High Very Hi		(1)		0.81 – 1.00	1.01 – 1.20	2.51 – 3.00	1.20 - 1.60	2.01 – 2.40
	Very Hi	gh		1.50 – 1.80	0.81 – 1.00 > 1.00	1.01 – 1.20 > 1.20	2.51 – 3.00 > 3.00	1.20 – 1.60 > 1.60	2.01 – 2.40 > 2.40
		gh	(1)	1.50 – 1.80 < 1.50		> 1.20	> 3.00	> 1.60	

Stream:	Tributary to Five Mile Creek	Observer(s):	IT RS Data: IT QA/QC: RS			Total Score:								
Reach:		Comments:												
Location:	RB-7	Bank Length		40			Total Score	Very Low	Low	Moderate	High	Very High	Extreme	
Date:	5/24/2022							Values:	5-10	10-20	20-30	30-40	40-45	45-50

		F	rodibility Variabl	lac .							
Bank Height / Bankft	ull Height Patio	E	Tourninty variable	ics							
Bank Height	Bankfull Height	Value	Index	Bank Erosion Potental	Notes						
Dank Height	Bankran Height	v aruc	mucx	Bank Erosion i otentar	riotes						
Root Depth / Bank H	eight Ratio										
Root Depth	Bank Height	Value	Index	Bank Erosion Potental	Notes						
Root Bepin	Dunk Height	, and	much	Dank Program Fotomar	110105						
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											
	тот	AL SCORE									

			Bank Eros	ion Potential					
			Very Low	Low	Moderate	High	Very High	Extreme	
	D	Value	1.00-1.10	1.11-1.19	1.20-1.50	1.60-2.00	2.10-2.80	>2.80	
les	Bank Height / Bankfull Height	Index	1.0-1.9	2.0-3.9	4.0-5.9	6.0-7.9	8.0-9.0	10	
Variables	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	
	Root Deptil / Balik Height	Index	1.0-1.9	2.0-3.9	4.0-5.9	6.0-7.9	8.0-9.0	10	
Erodibility	Weighted Root Density	Value	100-80	79-55	54-30	29-15	14-5	<5	
dib	Weighted Root Delisity	Index	1.0-1.9	2.0-3.9	4.0-5.9	6.0-7.9	8.0-9.0	10	
Ere	Bank Angle	Value	0-20	21-60	61-80	81-90	91-119	>119	
	Dank Angic	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	
	Surface Frotection	Index	1.0-1.9	2.0-3.9	4.0-5.9	6.0-7.9	8.0-9.0	10	
			Adju	stments					
	Bedrock	Bedrock banks	have a very lo	w erosion po	tential.				
	Boulders	Boulder banks	have a low ere	osion potentia	l.				
ਾਫ	Cobble	Substract 10 po	oints. No adjus	stment if sand	gravel compo	se greater that	n 50% of bank		
iteri	Clay/Silt Loam	Add 5 points.							
Ma	Gravel	Add 5-10 point	s depending o	n percentage	of bank mater	ial composed	of sand.		
Bank Material	Sand	Add 10 points.							
B	Silt / Clay	No adjustment.							
			Strat	ification					
	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.

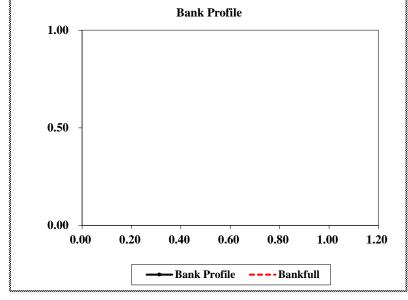
erosior	rosion rate.										
			Estim	ating Nea	r-Bank St	ress ( NBS	S)				
Stream	Tributa	ary to Five	Mile Creek		Location:	Rolling Ri	dge Park				
Station:	RB-7			S	tream Type:		,	Valley Type:			
Observ	ers:	IT RS						Date:	5/24/2022		
			Methods for	or Estimati	ng Near-B	ank Stress	(NBS)				
( <b>1</b> ) Char	nnel pattern	, transverse bai	or split channe	l/central bar cre	eating NBS		Level I	Recona	issance		
( <b>2</b> ) Ratio	o of radius o	of curvature to b	ankfull width (F	R <sub>c</sub> / W <sub>bkf</sub> )			Level II	General	prediction		
( <b>3</b> ) Ratio	o of pool slo	pe to average v	vater surface slo	ope (S <sub>p</sub> /S)			Level II	General	prediction		
( <b>4</b> ) Ratio	o of pool slo	pe to riffle slope	e (S <sub>p</sub> /S <sub>rif</sub> )				Level II	General	prediction		
( <b>5</b> ) Ratio	of near-ba	nk maximum de	epth to bankfull	mean depth ( d	<sub>nb</sub> / d <sub>bkf</sub> )		Level III	Detailed	prediction		
(6) Ratio of near-bank shear stress to bankfull shear stress ( $\tau_{nb}/\tau_{bkf}$ ) Level III									prediction		
(7) Velocity profiles / Isovels / Velocity gradient Level IV									lation		
			nd/or central b					_	, ,		
Level	(1)		position (conti								
			, down-valley	meander mig	ration, conver	ging flow		NI	oo = Extreme		
		Radius of Curvature	Bankfull Width W <sub>bkf</sub>	Ratio R <sub>c</sub> /	Near-Bank Stress						
	(2)	R <sub>c</sub> (ft)	(ft)	W <sub>bkf</sub>	(NBS)						
_					Near-Bank		Method				
Level II	(3)	Pool Slope	Average	Ratio S₀ / S	Stress (NBS)			inant			
Lev	(3)	S <sub>p</sub>	Slope S	 	Near-Bar	nk Stress					
			5.41 6.	Datia C /	Near-Bank						
	(4)	Pool Slope S <sub>p</sub>	Riffle Slope S <sub>rif</sub>	Ratio S <sub>p</sub> / S <sub>rif</sub>	Stress (NBS)						
		Ор	On	On	(NBC)						
		Near-Bank			Near Book	<u> </u> 					
	(5)	Max Depth	Mean Depth	Ratio d <sub>nb</sub> /	Near-Bank Stress						
	(5)	d <sub>nb</sub> (ft)	d <sub>bkf</sub> (ft)	d <sub>bkf</sub>	(NBS)	1					
≡											
Level III				Near-Bank Shear			Bankfull Shear				
_	(6)	Near-Bank Max Depth	Near-Bank		Mean Depth	Average	Stress τ <sub>bkf</sub> (	Ratio τ <sub>ob</sub> /	Near-Bank		
	(6)	d <sub>nb</sub> (ft)	Slope S <sub>nb</sub>	lb/ft <sup>2</sup> )	d <sub>bkf</sub> (ft)	Average Slope S	lb/ft <sup>2</sup> )	$ au_{\mathrm{bkf}}$	Stress (NBS)		
				,			,				
1				Near-Bank							
Level IV	(7)	Velocity Grad	dient (ft/sec	Stress							
Lev	(')	/ f	t)	(NBS)	<u> </u> 						
					<u> </u>						
		Col	nverting Va	alues to a N	Near-Bank	Stress (NE	S) Rating				
Near-		ess (NBS)				ethod numb					
	rating		(1)	(2)	(3)	(4)	(5)	(6)	(7)		
	Very Lo		N/A N/A	> 3.00	< 0.20	< 0.40	< 1.00	< 0.80	< 0.50		
				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 See	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			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 Extreme		(1) Above	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				< 1.50	> 1.00	> 1.20	> 3.00	> 1.60	> 2.40		
				Overall N	lear-Bank \$	Stress (NB	S) rating				

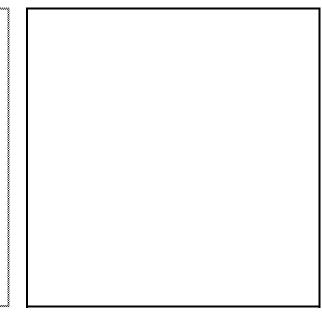
Stream:	Tributary to Five Mile Creek	Observer(s):	IT RS Data: IT QA/QC: RS 7			Total Score:		35.85	35.85					
Reach:		Comments:							High	High				
Location:	RB-8	Bank Length		24			Total Score	Very Low	Low	Moderate	High	Very High	Extreme	
Date:	5/24/2022							Values:	5-10	10-20	20-30	30-40	40-45	45-50

		E	rodibility Variabl	les							
Bank Height / Bankf	· · · · · · · · · · · · · · · · · · ·										
Bank Height	Bankfull Height	Value	Index	Bank Erosion Potental	Notes						
1.10	0.40	2.75	8.93	Very High							
Root Depth / Bank H	leight Ratio										
Root Depth	Bank Height	Value	Index	Bank Erosion Potental	Notes						
0.60	1.10	0.55	3.68	Low							
Weighted Root Density											
Root Density (%)	Root Depth / Bank Height	Value	Index	Bank Erosion Potental	Notes						
20.00	0.55	10.91	8.34	Very High							
Bank Angle											
Bank Angle (°)			Index	Bank Erosion Potental	Notes						
80.00			5.90	Moderate							
Surface Protection											
Surface Protection (%)			Index	Bank Erosion Potental	Notes						
10.00			9.00	Very High							
			Adjustment		Notes						
Bank Materials			0.00								
			Adjustment		Notes						
Bank Stratification			0.00								
	тот	AL SCORE	35.85								

			Bank Eros	ion Potential					
			Very Low	Low	Moderate	High	Very High	Extreme	
	D	Value	1.00-1.10	1.11-1.19	1.20-1.50	1.60-2.00	2.10-2.80	>2.80	
les	Bank Height / Bankfull Height	Index	1.0-1.9	2.0-3.9	4.0-5.9	6.0-7.9	8.0-9.0	10	
Variables	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	
	Root Deptil / Balik Height	Index	1.0-1.9	2.0-3.9	4.0-5.9	6.0-7.9	8.0-9.0	10	
Erodibility	Weighted Root Density	Value	100-80	79-55	54-30	29-15	14-5	<5	
dib	Weighted Root Delisity	Index	1.0-1.9	2.0-3.9	4.0-5.9	6.0-7.9	8.0-9.0	10	
Ere	Bank Angle	Value	0-20	21-60	61-80	81-90	91-119	>119	
	Dank Angic	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	
	Surface Frotection	Index	1.0-1.9	2.0-3.9	4.0-5.9	6.0-7.9	8.0-9.0	10	
			Adju	stments					
	Bedrock	Bedrock banks	have a very lo	w erosion po	tential.				
	Boulders	Boulder banks	have a low ere	osion potentia	l.				
ਾਫ	Cobble	Substract 10 po	oints. No adjus	stment if sand	gravel compo	se greater that	n 50% of bank		
iteri	Clay/Silt Loam	Add 5 points.							
Ma	Gravel	Add 5-10 point	s depending o	n percentage	of bank mater	ial composed	of sand.		
Bank Material	Sand	Add 10 points.							
B	Silt / Clay	No adjustment.							
			Strat	ification					
	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.

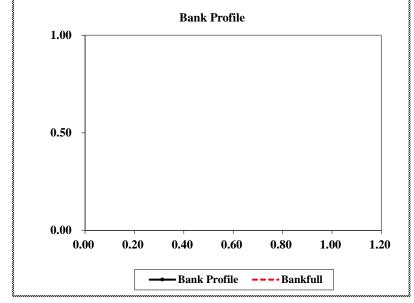
	Todorrate.										
			Estim	ating Nea	r-Bank St	ress ( NBS	S)				
Stream:	Tributa	ry to Five	Mile Creek		Location:	Rolling Ri	dge Park				
Station:	RB-8			S	tream Type:		,	Valley Type:			
Observe	ers:	IT RS						Date:	5/24/2022		
			Methods fo	or Estimati	ng Near-B	ank Stress	(NBS)				
(1) Chani	nel pattern	transverse bar	or split channe	l/central bar cre	eating NBS		Level I	Recona	aissance		
(2) Ratio	of radius o	f curvature to b	ankfull width ( F	R <sub>c</sub> / W <sub>bkf</sub> )			Level II	General	prediction		
(3) Ratio	of pool slo	pe to average w	vater surface slo	ppe (S <sub>p</sub> /S)			Level II	General prediction			
(4) Ratio	of pool slo	pe to riffle slope	e (S <sub>p</sub> /S <sub>rif</sub> )				Level II	General	prediction		
( <b>5</b> ) Ratio	of near-ba	nk maximum de	epth to bankfull	mean depth ( d	<sub>nb</sub> / d <sub>bkf</sub> )		Level III	Detailed	prediction		
(6) Ratio	of near-ba	nk shear stress	to bankfull she	ar stress (τ <sub>nb</sub> /	$\tau_{bkf}$ )		Level III	Detailed	prediction		
(7) Veloc	ity profiles	/ Isovels / Veloc	city gradient				Level IV	Valid	dation		
=	_ Transverse and/or central bars-short and/or discontinuousNBS = High / Very High										
Levell	(1)		position (conti								
Ľ		Chute cutoffs	, down-valley	meander mig	ration, conver	ging flow		NI	BS = Extreme		
		Radius of Curvature	Bankfull Width W	Ratio R <sub>c</sub> /	Near-Bank						
	(2)	R <sub>c</sub> (ft)	Width W <sub>bkf</sub> (ft)	W <sub>bkf</sub>	Stress (NBS)						
TIC (II) (II) TO BRIT (INDO)											
_					Near-Bank		Method	1	1		
Level	(3)	Pool Slope	Average		Stress			inant	1		
Lev	(3)	Sp	Slope S	Ratio S <sub>p</sub> / S	(NBS)	1		nk Stress			
Moderate Moderate											
				D-11- 0 /	Near-Bank						
	(4)	Pool Slope S <sub>p</sub>	Riffle Slope S <sub>rif</sub>	Ratio S <sub>p</sub> / S <sub>rif</sub>	Stress (NBS)						
		Ор	O III	O III	(NBC)						
		Near-Bank			Near-Bank						
	<i>(E</i> )	Max Depth	Mean Depth	Ratio d <sub>nb</sub> /	Stress						
	(5)	d <sub>nb</sub> (ft)	d <sub>bkf</sub> (ft)	d <sub>bkf</sub>	(NBS)	i					
=							1		1		
Level III				Near-Bank Shear			Bankfull Shear				
_	(6)	Near-Bank Max Depth	Near-Bank	Stress τ <sub>nb</sub> (	Mean Depth	Average	Stress τ <sub>bkf</sub> (	Ratio τ <sub>nb</sub> /	Near-Bank Stress		
	(0)	d <sub>nb</sub> (ft)	Slope S <sub>nb</sub>	lb/ft <sup>2</sup> )	d <sub>bkf</sub> (ft)	Slope S	lb/ft <sup>2</sup> )	$ au_{bkf}$	(NBS)		
>				Near-Bank							
Level IV	(7)	-	dient (ft/sec	Stress							
Lev	( ,	/ f	t )	(NBS)	1						
			nverting Va	lues to a l							
Near-E		ess (NBS)	(4)	(0)		ethod numb		(0)	l /3\		
	rating		(1) N/A	(2)	(3)	(4)	(5)	(6)	(7)		
	Very Low		N/A	> 3.00	< 0.20	< 0.40	< 1.00	< 0.80 0.80 – 1.05	< 0.50		
	Modera		N/A	2.21 – 3.00 2.01 – 2.20	0.20 - 0.40 0.41 - 0.60	0.41 - 0.60 0.61 - 0.80	1.00 – 1.50 1.51 – 1.80		0.50 - 1.00		
	High		See	1.81 – 2.00	0.41 - 0.60	0.61 - 0.80		1.06 – 1.14	1.01 – 1.60		
	Very Hi		(1)	1.81 – 2.00	0.61 – 0.80	1.01 – 1.20	1.81 – 2.50 2.51 – 3.00	1.15 – 1.19 1.20 – 1.60	1.61 – 2.00 2.01 – 2.40		
	Extren		Above	< 1.50 – 1.80	> 1.00	> 1.20	> 3.00	> 1.60	> 2.40		
	-AU GII										
				Overali N	lear-Bank \$	orress (NR	o) rating	IVIO	erate		

Stream:	Tributary to Five Mile Creek	Observer(s):	IT RS	TRS Data: IT QA/QC: RS		Total Score:								
Reach:		Comments:												
Location:	RB-9	Bank Length		28		Total Score	Very Low	Low	Moderate	High	Very High	Extreme		
Date:	5/24/2022							Values:	5-10	10-20	20-30	30-40	40-45	45-50

		F	rodibility Variabl	lac .							
Bank Height / Bankft	ull Height Patio	E	Tourninty variable	ics							
Bank Height	Bankfull Height	Value	Index	Bank Erosion Potental	Notes						
Dank Height	Bankran Height	v aruc	mucx	Bank Erosion i otentar	riotes						
Root Depth / Bank H	eight Ratio										
Root Depth	Bank Height	Value	Index	Bank Erosion Potental	Notes						
Root Bepin	Dunk Height	, and	much	Dank Program Fotomar	110105						
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											
	тот	AL SCORE									

			Bank Eros	ion Potential							
			Very Low	Low	Moderate	High	Very High	Extreme			
	D	Value	1.00-1.10	1.11-1.19	1.20-1.50	1.60-2.00	2.10-2.80	>2.80			
les	Bank Height / Bankfull Height	Index	1.0-1.9	2.0-3.9	4.0-5.9	6.0-7.9	8.0-9.0	10			
Variables	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			
	Root Deptil / Balik Height	Index	1.0-1.9	2.0-3.9	4.0-5.9	6.0-7.9	8.0-9.0	10			
Erodibility	Weighted Root Density	Value	100-80	79-55	54-30	29-15	14-5	<5			
dib	Weighted Root Delisity	Index	1.0-1.9	2.0-3.9	4.0-5.9	6.0-7.9	8.0-9.0	10			
Ere	Bank Angle	Value	0-20	21-60	61-80	81-90	91-119	>119			
	Dank Angic	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			
	Surface Frotection	Index	1.0-1.9	2.0-3.9	4.0-5.9	6.0-7.9	8.0-9.0	10			
			Adju	stments							
	Bedrock	Bedrock banks	drock banks have a very low erosion potential.								
	Boulders	Boulder banks	oulder banks have a low erosion potential.								
ਾਫ	Cobble	Substract 10 po	oints. No adjus	stment if sand	gravel compo	se greater that	n 50% of bank				
iteri	Clay/Silt Loam	Add 5 points.									
Ma	Gravel	Add 5-10 point	s depending o	n percentage	of bank mater	ial composed	of sand.				
Bank Material	Sand	Add 10 points.									
B	Silt / Clay	No adjustment.									
			Strat	ification							
	Add 5-10 p	oints depending	on position of	funstable laye	rs in relation t	o bankfull sta	ge.				

	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.

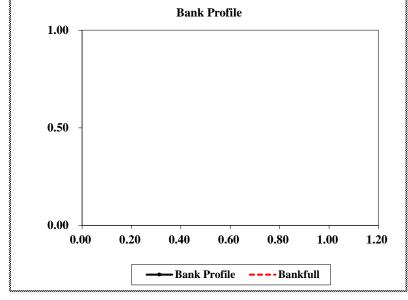
erosion	rate.									
			Estim	ating Nea	r-Bank St	ress ( NBS	S)			
Stream:	Tributa	ary to Five	Mile Creek		Location:	Rolling Ri	dge Park			
Station:	RB-9			S	tream Type:		,	√alley Type:		
Observe	rs:	IT RS						Date:	5/24/2022	
			Methods fo	or Estimati	ng Near-B	ank Stress	(NBS)			
(1) Chanr	nel pattern	, transverse bar	or split channe	l/central bar cre	eating NBS		Level I	Recona	issance	
( <b>2</b> ) Ratio	of radius o	f curvature to b	ankfull width ( F	R <sub>c</sub> / W <sub>bkf</sub> )			Level II	General	prediction	
( <b>3</b> ) Ratio	of pool slo	pe to average v	ater surface slo	ope (S <sub>p</sub> /S)			Level II	General	prediction	
( <b>4</b> ) Ratio	of pool slo	pe to riffle slope	e (S <sub>p</sub> /S <sub>rif</sub> )				Level II	General	prediction	
( <b>5</b> ) Ratio	of near-ba	nk maximum de	pth to bankfull	mean depth ( d	<sub>nb</sub> / d <sub>bkf</sub> )		Level III	Detailed	prediction	
( <b>6</b> ) Ratio	of near-ba	nk shear stress	to bankfull she	ar stress ( τ <sub>nb</sub> /	τ <sub>bkf</sub> )		Level III	Detailed	prediction	
(7) Veloci	ty profiles	/ Isovels / Veloc	city gradient				Level IV	Valid	lation	
=								-		
Level	(1)									
				meander mig	ration, conver	ging flow		NI	35 = Extreme	
		Radius of Curvature	Bankfull Width W <sub>bkf</sub>	Ratio R <sub>c</sub> /	Near-Bank					
	(2) $\begin{bmatrix} \text{Curvature} \\ \text{R}_{c} \text{ (ft)} \end{bmatrix}$ $\begin{bmatrix} \text{Width W}_{bkf} \\ \text{(ft)} \end{bmatrix}$ $\begin{bmatrix} \text{Ratio R}_{c} / \\ \text{W}_{bkf} \end{bmatrix}$ $\begin{bmatrix} \text{Stress} \\ \text{(NBS)} \end{bmatrix}$									
_					Near-Bank		Method			
Level II	(3)	Pool Slope	Average		Stress			inant		
Lev	(3)	S <sub>p</sub>	Slope S	Ratio S <sub>p</sub> / S	(NBS)	1	Near-Bar	nk Stress		
						]				
				5 / 6 /	Near-Bank					
	(4)	Pool Slope S <sub>p</sub>	Riffle Slope S <sub>rif</sub>	Ratio S <sub>p</sub> / S <sub>rif</sub>	Stress (NBS)					
		O <sub>p</sub>	Orif	O <sub>rif</sub>	(NDO)	Ì				
		Near-Bank			No se De el					
	<b>(=</b> )	Max Depth	Mean Depth	Ratio d <sub>nb</sub> /	Near-Bank Stress					
	(5)	d <sub>nb</sub> (ft)	d <sub>bkf</sub> (ft)	d <sub>bkf</sub>	(NBS)					
≡										
Level III				Near-Bank			Bankfull			
Ľ	(0)	Near-Bank	Near-Bank	Shear	5 //	_	Shear Stress $\tau_{bkf}$ (	Ratio τ <sub>nb</sub> /	Near-Bank	
	(6)	Max Depth d <sub>nb</sub> (ft)	Slope S <sub>nb</sub>	Ib/ft <sup>2</sup> )	Mean Depth d <sub>bkf</sub> (ft)	Average Slope S	lb/ft <sup>2</sup> )		Stress (NBS)	
		Sub (ir)	zi-F 2 CIID	ib/it )	ODKI (II)	Olope 0	io/it )	τ <sub>bkf</sub>	(INDO)	
				Noor Don!						
Level IV	/ <del>7</del> \	Velocity Grad	dient (ft/sec	Near-Bank Stress						
eve.	(7)	/ f		(NBS)	1					
_										
		Coi	nverting Va	alues to a N	Near-Bank	Stress (NE	SS) Rating			
Near-B	ank Str	ess (NBS)				ethod numb				
	rating	S	(1)	(2)	(3)	(4)	(5)	(6)	(7)	
	Very Lo	ow	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	
	Modera		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 Hi		(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	
	Extren	ne	Above	< 1.50	> 1.00	> 1.20	> 3.00	> 1.60	> 2.40	
				Overall N	lear-Bank \$	Stress (NB	S) rating			

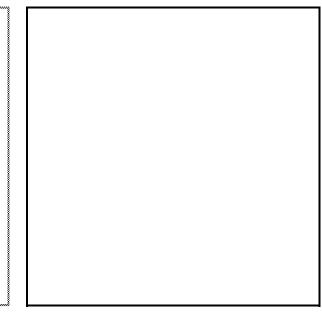
Stream:	Tributary to Five Mile Creek	Observer(s):	IT RS	IT RS Data: IT QA/QC: RS T			Total Score:		37.47	37.47				
Reach:		Comments:							High					
Location:	RB-10	Bank Length			29			Total Score	Very Low	Low	Moderate	High	Very High	Extreme
Date:	5/24/2022							Values:	5-10	10-20	20-30	30-40	40-45	45-50

		F	rodibility Variabl	06	
Bank Height / Bankf	ull Height Patio	E	Todibility variable	CS	
Bank Height	Bankfull Height	Value	Index	Bank Erosion Potental	Notes
1.80	0.40	4.50	10.00	Extreme	110100
Root Depth / Bank H	eight Ratio				
Root Depth	Bank Height	Value	Index	Bank Erosion Potental	Notes
1.00	1.80	0.56	3.63	Low	
Weighted Root Densi	ity				
Root Density (%)	Root Depth / Bank Height	Value	Index	Bank Erosion Potental	Notes
10.00	0.56	5.56	8.94	Very High	
Bank Angle					
Bank Angle ( °)			Index	Bank Erosion Potental	Notes
80.00			5.90	Moderate	
Surface Protection					
Surface Protection (%)			Index	Bank Erosion Potental	Notes
10.00			9.00	Very High	
			Adjustment		Notes
Bank Materials			0.00		
			Adjustment		Notes
Bank Stratification			0.00		
	тот	AL SCORE	37.47		

			Bank Eros	ion Potential							
			Very Low	Low	Moderate	High	Very High	Extreme			
	Pouls Height / Poulsfull Height	Value	1.00-1.10	1.11-1.19	1.20-1.50	1.60-2.00	2.10-2.80	>2.80			
səle	Bank Height / Bankfull Height	Index	1.0-1.9	2.0-3.9	4.0-5.9	6.0-7.9	8.0-9.0	10			
Variables	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			
	Root Deptil / Bank Height	Index	1.0-1.9	2.0-3.9	4.0-5.9	6.0-7.9	8.0-9.0	10			
Erodibility	Weighted Root Density	Value	100-80	79-55	54-30	29-15	14-5	<5			
dib	Weighted Root Density	Index	1.0-1.9	2.0-3.9	4.0-5.9	6.0-7.9	8.0-9.0	10			
Erc	Bank Angle	Value	0-20	21-60	61-80	81-90	91-119	>119			
	Dank Angle	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			
	Surface I Totection	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	drock banks have a very low erosion potential.								
	Boulders	Boulder banks	oulder banks have a low erosion potential.								
ਢ	Cobble	Substract 10 po	ints. No adjus	tment if sand	gravel compo	se greater that	n 50% of bank				
Material	Clay/Silt Loam	Add 5 points.	dd 5 points.								
Ma	Gravel	Add 5-10 point	dd 5-10 points depending on percentage of bank material composed of sand.								
Bank	Sand	Add 10 points.									
B	Silt / Clay	No adjustment.									
			Strat	fication							
	Add 5-10 p	oints depending	on position of	unstable laye	rs in relation t	to bankfull sta	ge.				

	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.

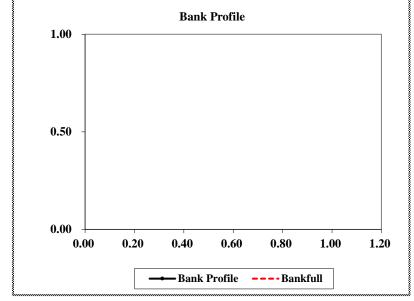
CIUSIUII	erosion rate.										
			Estim	ating Nea	r-Bank St	ress ( NBS	3)				
Stream:	Tributa	ary to Five	Mile Creek		Location:	Rolling Ri	dge Park				
Station:	RB-10			S	tream Type:		,	Valley Type:			
Observe	ers:	IT RS						Date:	5/24/2022		
			Methods for	or Estimati	ng Near-Ba	ank Stress	(NBS)				
(1) Chani	nel pattern	, transverse bai	or split channe	l/central bar cre	eating NBS		Level I	Recona	issance		
		of curvature to b					Level II	General	prediction		
		pe to average w					Level II	General	prediction		
		pe to riffle slope		<u> </u>			Level II	General	prediction		
( <b>5</b> ) Ratio	of near-ba	nk maximum de	epth to bankfull	mean depth ( d	<sub>nh</sub> / d <sub>hkf</sub> )		Level III	Detailed	prediction		
		nk shear stress					Level III	Detailed	prediction		
		/ Isovels / Veloc		( 110	DKI 7		Level IV		lation		
_				ars-short and/	or discontinuo	us		NBS = Hig	ıh / Very High		
Level	(1)				channel)						
<u> </u>		Chute cutoffs	, down-valley	meander mig	ration, conver	ging flow		NE	BS = Extreme		
		Radius of	Bankfull	Potic D /	Near-Bank						
	(2)	Curvature R <sub>c</sub> (ft)	Width W <sub>bkf</sub> (ft)	Ratio R <sub>c</sub> / W <sub>bkf</sub>	Stress (NBS)						
		110 (11)	(11)	• • DKT	(NBC)						
					Near-Bank	ļ	Method	1			
=	(0)	Pool Slope	Average		Stress			inant			
Level II	(3)	S <sub>p</sub>	Slope S	Ratio S <sub>p</sub> / S	(NBS)		Near-Bar	nk Stress			
_							Mod	erate			
					Near-Bank	•	=		-		
	(4)	Pool Slope	Riffle Slope	Ratio S <sub>p</sub> /	Stress						
	``	S <sub>p</sub>	S <sub>rif</sub>	S <sub>rif</sub>	(NBS)	1					
		Near-Bank Max Depth	Mean Depth	<i>Ratio</i> d <sub>nb</sub> /	Near-Bank Stress						
	(5)	d <sub>nb</sub> (ft)	d <sub>bkf</sub> (ft)	d <sub>bkf</sub>	(NBS)						
=											
Level III				Near-Bank			Bankfull				
Le Le		Near-Bank	Naar Dard	Shear			Shear		Near-Bank		
	(6)	Max Depth	Near-Bank Slope S <sub>nb</sub>	Stress τ <sub>nb</sub> (	Mean Depth		Stress τ <sub>bkf</sub> (		Stress		
		d <sub>nb</sub> (ft)	Slope S <sub>nb</sub>	lb/ft <sup>2</sup> )	d <sub>bkf</sub> (ft)	Slope S	lb/ft <sup>2</sup> )	$ au_{bkf}$	(NBS)		
≥		Velocity Gray	dient (ft/sec	Near-Bank Stress							
Level IV	(7)	/ f		(NBS)							
د											
		Co	overting V	dues to a N	lear-Bank	Strose (NID	(S) Pating				
Near-F	Bank Str	ess (NBS)	TVEITING V	iiues io a l		ethod numb					
	rating		(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				0.20 - 0.40	0.41 – 0.60	1.00 – 1.50	0.80 – 1.05	0.50 – 1.00		
				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	l	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 H	igh	(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		
	Extren	ne	Above	< 1.50	> 1.00	> 1.20	> 3.00	> 1.60	> 2.40		
	Overall Near-Bank Stress (NBS) rating Moderate							erate			

Stream:	Tributary to Five Mile Creek	Observer(s):	IT RS	TT RS Data: IT QA/QC: RS T		Total Score:	Total Score:		NA					
Reach:		Comments:						Modera	te					
Location:	RB-11	Bank Length	18		Total Score	Very Low	Low	Moderate	High	Very High	Extreme			
Date:	5/24/2022							Values:	5-10	10-20	20-30	30-40	40-45	45-50

		-			
		E	rodibility Variabl	les	
Bank Height / Bankf	ull Height Ratio				
Bank Height	Bankfull Height	Value	Index	Bank Erosion Potental	Notes
0.50					
Root Depth / Bank H	eight Ratio				
Root Depth	Bank Height	Value	Index	Bank Erosion Potental	Notes
	0.50				
Weighted Root Densi	ity				
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					
	тот	AL SCORE	Moderate		

			Bank Eros	ion Potential							
			Very Low	Low	Moderate	High	Very High	Extreme			
	Pouls Height / Poulsfull Height	Value	1.00-1.10	1.11-1.19	1.20-1.50	1.60-2.00	2.10-2.80	>2.80			
səle	Bank Height / Bankfull Height	Index	1.0-1.9	2.0-3.9	4.0-5.9	6.0-7.9	8.0-9.0	10			
Variables	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			
	Root Deptil / Bank Height	Index	1.0-1.9	2.0-3.9	4.0-5.9	6.0-7.9	8.0-9.0	10			
Erodibility	Weighted Root Density	Value	100-80	79-55	54-30	29-15	14-5	<5			
dib	Weighted Root Density	Index	1.0-1.9	2.0-3.9	4.0-5.9	6.0-7.9	8.0-9.0	10			
Erc	Bank Angle	Value	0-20	21-60	61-80	81-90	91-119	>119			
	Dank Angle	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			
	Surface I Totection	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	drock banks have a very low erosion potential.								
	Boulders	Boulder banks	oulder banks have a low erosion potential.								
ਢ	Cobble	Substract 10 po	ints. No adjus	tment if sand	gravel compo	se greater that	n 50% of bank				
Material	Clay/Silt Loam	Add 5 points.	dd 5 points.								
Ma	Gravel	Add 5-10 point	dd 5-10 points depending on percentage of bank material composed of sand.								
Bank	Sand	Add 10 points.									
B	Silt / Clay	No adjustment.									
			Strat	fication							
	Add 5-10 p	oints depending	on position of	unstable laye	rs in relation t	to bankfull sta	ge.				

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



Ocular estimate - Moderate

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

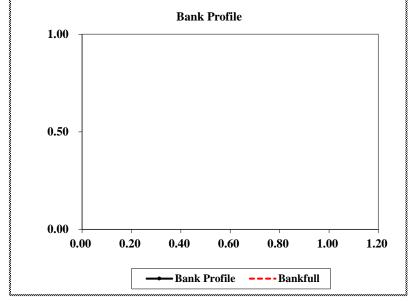
erosion	rate.									
			Estim	ating Nea	r-Bank St	ress ( NBS	S)			
Stream:	Tributa	ary to Five	Mile Creek		Location:	Rolling Ri	dge Park			
Station:	<b>RB-11</b>			S	tream Type:		1	√alley Type:		
Observe	rs:	IT RS						Date:	5/24/2022	
			Methods fo	or Estimati	ng Near-Ba	ank Stress	(NBS)			
(1) Chani	nel pattern	, transverse bar	or split channe	l/central bar cre	eating NBS		Level I	Recona	issance	
(2) Ratio	of radius o	f curvature to b	ankfull width ( F	R <sub>c</sub> / W <sub>bkf</sub> )			Level II	General prediction		
(3) Ratio	of pool slo	pe to average w	ater surface slo	ope (S <sub>p</sub> /S)			Level II	General prediction		
(4) Ratio	of pool slo	pe to riffle slope	e (S <sub>p</sub> /S <sub>rif</sub> )	·			Level II	General	prediction	
		nk maximum de		mean depth ( d	<sub>nb</sub> / d <sub>bkf</sub> )		Level III	Detailed	prediction	
		nk shear stress					Level III	Detailed	prediction	
		/ Isovels / Veloc		, III	Dia 7		Level IV		lation	
=		Transverse a	nd/or central b	ars-short and/	or discontinuo	us		NBS = Hig	ıh / Very High	
Level	(1)									
Le		Chute cutoffs	, down-valley	meander mig	ration, conver	ging flow		NE	BS = Extreme	
		Radius of	Bankfull	Dotio D /	Near-Bank					
	(2)	Curvature R <sub>c</sub> (ft)	Width W <sub>bkf</sub> (ft)	<i>Ratio</i> R <sub>c</sub> / W <sub>bkf</sub>	Stress (NBS)					
		1 (0 (10)	(11)	V V DKT	(NBC)					
					Near Beak	ļ	Method	1		
=	(0)	Pool Slope	Average		Near-Bank Stress			inant		
Level II	(3)	S <sub>p</sub>	Slope S	Ratio S <sub>p</sub> / S	(NBS)	nk Stress				
1							Lo	ow		
					Near-Bank	'			-	
	(4)	Pool Slope	Riffle Slope	Ratio S <sub>p</sub> /	Stress					
	( ',	S <sub>p</sub>	S <sub>rif</sub>	S <sub>rif</sub>	(NBS)	1				
		Near-Bank Max Depth	Maan Danth	Ratio d <sub>nb</sub> /	Near-Bank					
	(5)	d <sub>nb</sub> (ft)	Mean Depth d <sub>bkf</sub> (ft)	d <sub>bkf</sub>	Stress (NBS)					
=		TID ( )	DRI ( )	DIG						
Level III				Near-Bank			Bankfull			
Le		Near-Bank		Shear			Shear		Near-Bank	
	(6)	Max Depth	Near-Bank	Stress τ <sub>nb</sub> (	Mean Depth		Stress τ <sub>bkf</sub> (		Stress	
		d <sub>nb</sub> (ft)	Slope S <sub>nb</sub>	lb/ft <sup>2</sup> )	d <sub>bkf</sub> (ft)	Slope S	lb/ft <sup>2</sup> )	$ au_{bkf}$	(NBS)	
≥		\/ola =:t- \ O:-	diant/ft/	Near-Bank						
Level IV	(7)	velocity Grad / f	dient (ft / sec	Stress (NBS)						
Le			- /	(**===)						
						01	0) 5 4			
Noor F	Sank Ct-		nverting Va	alues to a l	Near-Bank					
Near-Bank Stress (NBS) ratings (1)					(3)	ethod numb (4)	(5)	(6)	(7)	
	Very Lo		N/A	<b>(2)</b> > 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	
				2.01 – 2.20	0.41 – 0.60	0.61 – 0.80	1.51 – 1.80	1.06 – 1.14	1.01 – 1.60	
				1.81 – 2.00	0.61 – 0.80	0.81 – 1.00	1.81 – 2.50	1.15 – 1.19	1.61 – 2.00	
	Hiah									
			(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	
	High Very Hi Extren	gh	(1) Above	1.50 – 1.80 < 1.50	0.81 – 1.00 > 1.00	1.01 – 1.20 > 1.20	2.51 – 3.00 > 3.00	1.20 – 1.60 > 1.60	2.01 – 2.40 > 2.40	
	Very Hi	gh		< 1.50		> 1.20	> 3.00	> 1.60		

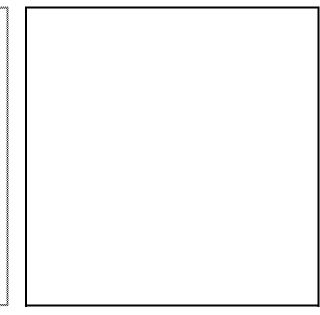
Stream:	Tributary to Five Mile Creek	Observer(s):	IT RS Data: IT QA/QC: RS T					Total Score:		42.19	42.19				
Reach:		Comments:							Very Hi	Very High					
Location:	RB-12	Bank Length	54				Total Score	Very Low	Low	Moderate	High	Very High	Extreme		
Date:	5/24/2022							Values:	5-10	10-20	20-30	30-40	40-45	45-50	

		E	rodibility Variabl	les	
Bank Height / Bankf	ull Height Ratio		Toursmey (uran)		
Bank Height	Bankfull Height	Value	Index	Bank Erosion Potental	Notes
4.10	0.40	10.25	10.00	Extreme	
Root Depth / Bank H	eight Ratio				
Root Depth	Bank Height	Value	Index	Bank Erosion Potental	Notes
0.80	4.10	0.20	7.29	High	
Weighted Root Densi	ity				
Root Density (%)	Root Depth / Bank Height	Value	Index	Bank Erosion Potental	Notes
25.00	0.20	4.88	10.00	Extreme	
Bank Angle					
Bank Angle ( °)			Index	Bank Erosion Potental	Notes
80.00			5.90	Moderate	
Surface Protection					
Surface Protection (%)			Index	Bank Erosion Potental	Notes
10.00			9.00	Very High	
			Adjustment		Notes
Bank Materials			0.00		
			Adjustment		Notes
Bank Stratification			0.00		
	TOT	AL SCORE	42.19		

			Bank Eros	ion Potential								
			Very Low	Low	Moderate	High	Very High	Extreme				
	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				
səle	Bank Height / Bankiuli Height	Index	1.0-1.9	2.0-3.9	4.0-5.9	6.0-7.9	8.0-9.0	10				
Variables	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				
	Root Deptil / Bank Height	Index	1.0-1.9	2.0-3.9	4.0-5.9	6.0-7.9	8.0-9.0	10				
Erodibility	Weighted Root Density	Value	100-80	79-55	54-30	29-15	14-5	<5				
gib	Weighted Root Delisity	Index	1.0-1.9	2.0-3.9	4.0-5.9	6.0-7.9	8.0-9.0	10				
Σī	Bank Angle	Value	0-20	21-60	61-80	81-90	91-119	>119				
	Dank Angk	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				
	Surface I Totection	Index	1.0-1.9	2.0-3.9	4.0-5.9	6.0-7.9	8.0-9.0	10				
			Adju	stments								
	Bedrock	Bedrock banks	have a very lo	w erosion pot	tential.							
	Boulders	Boulder banks	have a low ere	osion potentia	l.							
a	Cobble	Substract 10 po	ints. No adjus	stment if sand	gravel compo	se greater that	n 50% of bank					
Material	Clay/Silt Loam	Add 5 points.										
Ma	Gravel	Add 5-10 point	s depending o	n percentage	of bank mater	ial composed	of sand.					
Bank	Sand	Add 10 points.		•				•				
B	Silt / Clay No adjustment.											
			Strat	ification								
	Add 5-10 p	oints depending	on position of	funstable laye	rs in relation t	to bankfull sta	ge.	•				

	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.

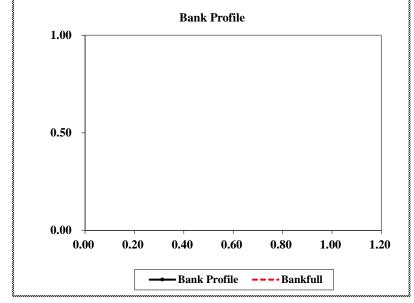
erosion	rate.									
			Estim	ating Nea	r-Bank St	ress ( NBS	S)			
Stream:	Tributa	ary to Five	Mile Creek		Location:	Rolling Ri	dge Park			
Station:	RB-12			S	tream Type:		,	Valley Type:		
Observe	rs:	IT RS						Date:	5/24/2022	
			Methods fo	or Estimati	ng Near-Ba	ank Stress	(NBS)			
(1) Chanr	nel pattern	, transverse bai	or split channe	l/central bar cre	eating NBS		Level I	Recona	issance	
( <b>2</b> ) Ratio	of radius o	of curvature to b	ankfull width (F	R <sub>c</sub> / W <sub>bkf</sub> )			Level II	General	prediction	
( <b>3</b> ) Ratio	of pool slo	pe to average w	vater surface slo	ope (S <sub>p</sub> /S)			Level II	General	prediction	
(4) Ratio	of pool slo	pe to riffle slope	e (S <sub>p</sub> /S <sub>rif</sub> )	·			Level II	General	prediction	
( <b>5</b> ) Ratio	of near-ba	nk maximum de	epth to bankfull	mean depth ( d	<sub>nb</sub> / d <sub>bkf</sub> )		Level III	Detailed	prediction	
( <b>6</b> ) Ratio	of near-ba	nk shear stress	to bankfull she	ar stress ( $\tau_{nb}$ /	$\tau_{bkf}$ )		Level III	Detailed	prediction	
		/ Isovels / Veloc					Level IV	Valid	lation	
=		Transverse a	nd/or central b	ars-short and/	or discontinuo	us		NBS = Hig	ıh / Very High	
Level	(1)				channel)					
<u> </u>			, down-valley	meander mig	ration, conver	ging flow		NE	3S = Extreme	
		Radius of	Bankfull	Ratio R <sub>c</sub> /	Near-Bank					
	(2)	Curvature R <sub>c</sub> (ft)	Width W <sub>bkf</sub> (ft)	W <sub>bkf</sub>	Stress (NBS)					
		1 10 (11)	()	DKI	(1.126)					
					Near-Bank		Method	1		
el II	(2)	Pool Slope	Average		Stress			inant		
Level II	(3)	S <sub>p</sub>	Slope S	Ratio S <sub>p</sub> / S	(NBS)	i	Near-Bar	nk Stress		
_							Hi	igh		
					Near-Bank		=			
	(4)	Pool Slope	Riffle Slope	Ratio S <sub>p</sub> /	Stress					
	( - /	S <sub>p</sub>	S <sub>rif</sub>	S <sub>rif</sub>	(NBS)					
		Near-Bank Max Depth	Mean Depth	<i>Ratio</i> d <sub>nb</sub> /	Near-Bank					
	(5)	d <sub>nb</sub> (ft)	d <sub>bkf</sub> (ft)	d <sub>bkf</sub>	Stress (NBS)					
=		110 ( )	Dia ( )	Div.						
Level III				Near-Bank			Bankfull			
Le		Near-Bank		Shear			Shear		Near-Bank	
	(6)	Max Depth	Near-Bank	Stress τ <sub>nb</sub> (	Mean Depth		Stress τ <sub>bkf</sub> (		Stress	
		d <sub>nb</sub> (ft)	Slope S <sub>nb</sub>	lb/ft <sup>2</sup> )	d <sub>bkf</sub> (ft)	Slope S	lb/ft <sup>2</sup> )	$ au_{ m bkf}$	(NBS)	
≥		Volcoit: Cr-	diant / ft / aa -	Near-Bank						
Level IV	(7)	velocity Grad	dient (ft/sec t)	Stress (NBS)						
Le		, .		, -,						
			a. (a. u.t.)	dues to a h	loor David	Ctuess (ND	C) Detine			
Near-B	ank Str	ess (NBS)	iverting Va	alues to a f	Near-Bank M	Stress (NE ethod numb				
i i i i i	rating		(1)	(2)	(3)	(4)	(5)	(6)	(7)	
	Very Lo		N/A	> 3.00	< 0.20	< 0.40	< 1.00	< 0.80	< 0.50	
	Low N/A				0.20 - 0.40	0.41 - 0.60	1.00 – 1.50	0.80 - 1.05	0.50 - 1.00	
	Modera	ate	N/A	2.21 – 3.00 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 Hi		(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	
	Extren		Above	< 1.50	> 1.00	> 1.20	> 3.00	> 1.60	> 2.40	
	Overall					Stress (NB	S) rating	Hi	gh	

Stream:	Tributary to Five Mile Creek	Observer(s):	IT RS Data: IT QA/QC: RS To					Total Score:						
Reach:		Comments:												
Location:	RB-13	Bank Length		64				Total Score	Very Low	Low	Moderate	High	Very High	Extreme
Date:	5/24/2022							Values:	5-10	10-20	20-30	30-40	40-45	45-50

	T.	uodibility Vouiobl	lea .	
HIT ' LA DA'	ID.	rodibility variable	les	
Bankfull Height	Value	Index	Bank Erosion Potental	Notes
eight Ratio				
Bank Height	Value	Index	Bank Erosion Potental	Notes
ity				
Root Depth / Bank Height	Value	Index	Bank Erosion Potental	Notes
		Index	Bank Erosion Potental	Notes
		Index	Bank Erosion Potental	Notes
		Adjustment		Notes
		Adjustment		Notes
тот	AL SCORE			
	Bank Height  ty  Root Depth / Bank Height	Bankfull Height Value eight Ratio Bank Height Value ty Root Depth / Value	Bankfull Height Value Index  eight Ratio  Bank Height Value Index  ty  Root Depth / Bank Height Value Index  Index  Index  Index  Adjustment	Bank Frosion Potental  eight Ratio  Bank Height Value Index Bank Erosion Potental  ty  Root Depth / Bank Height Value Index Bank Erosion Potental  Index Bank Erosion Potental  Index Bank Erosion Potental  Index Bank Erosion Potental  Adjustment  Adjustment

			Bank Eros	ion Potential				
			Very Low	Low	Moderate	High	Very High	Extreme
	D	Value	1.00-1.10	1.11-1.19	1.20-1.50	1.60-2.00	2.10-2.80	>2.80
les	Bank Height / Bankfull Height	Index	1.0-1.9	2.0-3.9	4.0-5.9	6.0-7.9	8.0-9.0	10
Variables	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
	Root Deptil / Balik Height	Index	1.0-1.9	2.0-3.9	4.0-5.9	6.0-7.9	8.0-9.0	10
Erodibility	Weighted Root Density	Value	100-80	79-55	54-30	29-15	14-5	<5
dib	Weighted Root Delisity	Index	1.0-1.9	2.0-3.9	4.0-5.9	6.0-7.9	8.0-9.0	10
Ere	Bank Angle	Value	0-20	21-60	61-80	81-90	91-119	>119
	Dank Angic	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
	Surface Frotection	Index	1.0-1.9	2.0-3.9	4.0-5.9	6.0-7.9	8.0-9.0	10
			Adju	stments				
	Bedrock	Bedrock banks	have a very lo	w erosion po	tential.			
	Boulders	Boulder banks	have a low ere	osion potentia	l.			
ਾਫ	Cobble	Substract 10 po	oints. No adjus	stment if sand	gravel compo	se greater that	n 50% of bank	
iteri	Clay/Silt Loam	Add 5 points.						
Ma	Gravel	Add 5-10 point	s depending o	n percentage	of bank mater	ial composed	of sand.	
Bank Material	Sand	Add 10 points.						
B	Silt / Clay	No adjustment.						
			Strat	ification				
	Add 5-10 p	oints depending	on position of	funstable laye	rs in relation t	o bankfull sta	ge.	

	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.

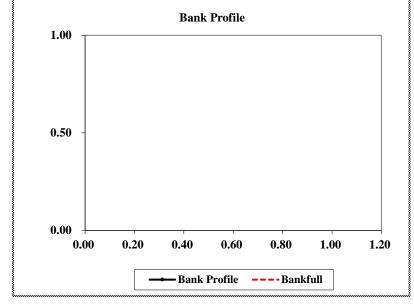
Ratio of pool slope to average water surface slope ( $S_p/S$ )  Level II  General prediction  Ratio of pool slope to riffle slope ( $S_p/S_{rif}$ )  Level II  General prediction  Ratio of near-bank maximum depth to bankfull mean depth ( $d_{nb}/d_{bkf}$ )  Level III  Detailed prediction  Ratio of near-bank shear stress to bankfull shear stress ( $\tau_{nb}/\tau_{bkf}$ )  Level III  Detailed prediction	erosion	rate.										
Deservers:   IT RS				Estim	ating Nea	r-Bank St	ress ( NBS	3)				
Diservers:   IT RS	Stream:	Tributa	ry to Five	Mile Creek		Location:	Rolling Ri	dge Park				
	Station:	<b>RB-13</b>			S	tream Type:		,	√alley Type:			
Channel pattern, transverse bar or split channel/central bar creating NBS	Observe	rs:	IT RS						Date:	5/24/2022		
Pation of radius of curvature to bankfull width (R <sub>c</sub> / W <sub>bar</sub> )   Level II   General prediction   General prediction of pool slope to average water surface slope (S <sub>p</sub> / S)   Level II   General prediction   General p				Methods fo	or Estimati	ng Near-B	ank Stress	(NBS)				
Partio of pool slope to average water surface slope (S <sub>p</sub> / S)   Level II   General prediction   General prediction   General prediction   Central prediction   Central prediction   Central perfection   Central perfect	(1) Chann	nel pattern,	, transverse bar	or split channe	l/central bar cre	eating NBS		Level I	Reconaissance			
Ratio of pool slope to riffle slope   Sp / Syr	( <b>2</b> ) Ratio	of radius o	f curvature to b	ankfull width ( F	R <sub>c</sub> / W <sub>bkf</sub> )			Level II	General prediction			
Pation of near-bank maximum depth to bankfull mean depth (d <sub>nb</sub> / d <sub>bat</sub> )   Level III   Detailed prediction   NES = Extreme   Extensive deposition (continuous, cross-channel)   NES = Extreme   NES = Ext	( <b>3</b> ) Ratio	of pool slo	pe to average v	vater surface slo	ope (S <sub>p</sub> /S)			Level II	General	prediction		
Ratio of near-bank shear stress to bankfull shear stress (\tau_{ab}/\tau_{bur})   Velocity profiles / Isovels / Velocity gradient   Level III   Detailed prediction   Validation   NBS = High / Very High   Very	( <b>4</b> ) Ratio	of pool slo	pe to riffle slope	e (S <sub>p</sub> /S <sub>rif</sub> )				Level II	General	prediction		
Velocity profiles / Isovels / Velocity gradient   Cevel IV   Validation	( <b>5</b> ) Ratio	of near-ba	nk maximum de	epth to bankfull	mean depth ( d	<sub>nb</sub> / d <sub>bkf</sub> )		Level III	Detailed	prediction		
Transverse andior central bars-short andior discontinuous	( <b>6</b> ) Ratio	of near-ba	nk shear stress	to bankfull she	ar stress ( τ <sub>nb</sub> /	τ <sub>bkf</sub> )		Level III	Detailed	prediction		
Canal	(7) Veloci	ty profiles	/ Isovels / Veloc	city gradient				Level IV	Valid	lation		
Radius of Curvature Rc (ft)	=								-			
Radius of Curvature Rc (ft)	eve	(1)										
Campaigness	Ľ				meander mig	ration, conver	ging flow		NE	35 = Extreme		
California   Cal					Ratio P /							
Converting Values to a Near-Bank Stress (NBS)   Converting Values (NBS)   Converting V		(2)			_							
Color   Pool Slope   Average   Slope S   Ratio Sp / S   Near-Bank   Stress   (NBS)			()	(,	DKI	(1.126)	Ì					
Companies   Comp						Noor Book	l	Method				
(4) Pool Slope S <sub>p</sub> Riffle Slope S <sub>rif</sub> Ratio S <sub>p</sub> / Stress (NBS)  (5) Near-Bank Max Depth d <sub>obt</sub> (ft) Near-Bank Stress (NBS)  (6) Near-Bank Max Depth d <sub>obt</sub> (ft) Near-Bank Stress t <sub>obt</sub> (NBS)  (7) Velocity Gradient (ft / sec / ft) Near-Bank Stress (NBS)  (8) Near-Bank Stress (NBS)  (8) Near-Bank Stress (NBS)  (9) Near-Bank Stress (NBS)  (10) Near-Bank Stress (NBS)  (11) (2) (3) (4) (5) (6) (7)  Very Low N/A 2.21 - 3.00 (.20 - 0.40 (.41 - 0.60 (.1.00 - 1.50 (.80 - 1.14 (.1.01 - 1.60 (.80 - 1.00 (.81 - 1.40 (.80 - 1.00 (.81 - 1.40 (.80 - 1.00 (.81 - 1.40 (.80 - 1.00 (.81 - 1.40 (.80 (.80 - 1.40 (.80 (.80 - 1.40 (.80 (.80 (.80 (.80 (.80 (.80 (.80 (.8	=	(0)	Pool Slope	Average					inant			
(4) Pool Slope S <sub>p</sub> Riffle Slope S <sub>rif</sub> Ratio S <sub>p</sub> / Stress (NBS)  (5) Near-Bank Max Depth d <sub>obt</sub> (ft) Near-Bank Stress (NBS)  (6) Near-Bank Max Depth d <sub>obt</sub> (ft) Near-Bank Stress t <sub>obt</sub> (NBS)  (7) Velocity Gradient (ft / sec / ft) Near-Bank Stress (NBS)  (8) Near-Bank Stress (NBS)  (8) Near-Bank Stress (NBS)  (9) Near-Bank Stress (NBS)  (10) Near-Bank Stress (NBS)  (11) (2) (3) (4) (5) (6) (7)  Very Low N/A 2.21 - 3.00 (.20 - 0.40 (.41 - 0.60 (.1.00 - 1.50 (.80 - 1.14 (.1.01 - 1.60 (.80 - 1.00 (.81 - 1.40 (.80 - 1.00 (.81 - 1.40 (.80 - 1.00 (.81 - 1.40 (.80 - 1.00 (.81 - 1.40 (.80 (.80 - 1.40 (.80 (.80 - 1.40 (.80 (.80 (.80 (.80 (.80 (.80 (.80 (.8	ev.	(3)	S <sub>p</sub>	Slope S	Ratio S <sub>p</sub> / S	(NBS)		nk Stress				
Color   Pool Slope   Sp	_											
(4) S <sub>p</sub> S <sub>rif</sub> S <sub>rif</sub> (NBS)  (5) Near-Bank Max Depth d <sub>nb</sub> (ft) Mean Depth d <sub>nb</sub> (ft) Near-Bank Stress (NBS)  (6) Near-Bank Max Depth d <sub>nb</sub> (ft) Near-Bank Stress τ <sub>nb</sub> (NBS)  (7) Velocity Gradient (ft / sec / ft) Near-Bank Stress (NBS)  (8) Near-Bank Stress (NBS)  (9) Near-Bank Stress (NBS)  (1) (2) (3) (4) (5) (6) (7)  Very 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 1.01-1.20 2.51-3.00 1.20-1.60 2.01-2.40  Extreme Above <1.50 > 1.00 > 1.00 > 2.40  Extreme Above <1.50 > 1.00 > 1.20 > 3.00 > 1.60 > 2.40						Near-Bank				-		
(6) Near-Bank Max Depth dnb (ft) Near-Bank Stress (NBS) (NBS)  (7) Velocity Gradient (ft / sec / ft) (1) (2) (3) (4) (5) (6) (7) (7) Very Low N/A 2.21 – 3.00 (2.00 – 0.40 (3.10 – 0.80 (3.10 – 1.50 (3.00 – 1.00 (3.00 – 1.14 (1.01 – 1.60 (3.10 – 1.20 (3.		(4)										
(5)   Max Depth   Mean Depth   Abd (ft)   Mean Depth   Abd (ft)   Mean Depth   Abd (ft)   Mean Depth   Abd (ft)   Mean Depth   Average   Shear   Stress τ <sub>bk</sub> (    Mean Depth   Average   Shear   Stress τ <sub>bk</sub> (    Mean Depth   Mean Depth   Average   Shear   Stress τ <sub>bk</sub> (    Mean Depth   Average   Stress τ <sub>bkf</sub> (    Ratio τ <sub>nb</sub> /		(-)	$S_p$	S <sub>rif</sub>	S <sub>rif</sub>	(NBS)	1					
(5)   Max Depth   Mean Depth   Abd (ft)   Mean Depth   Abd (ft)   Mean Depth   Abd (ft)   Mean Depth   Abd (ft)   Mean Depth   Average   Shear   Stress τ <sub>bk</sub> (    Mean Depth   Average   Shear   Stress τ <sub>bk</sub> (    Mean Depth   Mean Depth   Average   Shear   Stress τ <sub>bk</sub> (    Mean Depth   Average   Stress τ <sub>bkf</sub> (    Ratio τ <sub>nb</sub> /												
Converting Values to a Near-Bank Stress (NBS)   Rating				5 4	Potio d /							
Near-Bank   Near-Bank   Near-Bank   Shear   Stress \( \tau_{nb} \) (ft)		(5)				1. 1. 1. 1. 1. 1.						
(6)   Max Depth dnb (ft)   Near-Bank Slope S nb   Stress τnb (lb/ft²)   Mean Depth dbkf (ft)   Slope S   Stress τbkf (lb/ft²)   Near-Bank Stress (NBS)	=		* HD ( *)	S-DKI (1-7)	-DKI	(1.126)						
(6)   Max Depth dnb (ft)   Near-Bank Slope S nb   Stress τnb (lb/ft²)   Mean Depth dbkf (ft)   Slope S   Stress τbkf (lb/ft²)   Near-Bank Stress (NBS)	vel				Near-Bank		<del></del>	Bankfull				
Converting Values to a Near-Bank Stress (NBS)   Rating	Le		Near-Bank							Near-Bank		
Velocity Gradient ( ft / sec		(6)			Stress $\tau_{nb}$ (				Ratio $\tau_{nb}$ /	Stress		
Velocity Gradient (ft / sec /ft)			d <sub>nb</sub> (ft)	Slope S <sub>nb</sub>	lb/ft²)	d <sub>bkf</sub> (ft)	Slope S	lb/ft <sup>2</sup> )	$ au_{bkf}$	(NBS)		
Velocity Gradient (ft / sec /ft)												
Converting Values to a Near-Bank Stress (NBS) Rating   Near-Bank Stress (NBS)   Tatings   (1)   (2)   (3)   (4)   (5)   (6)   (7)   (7)   (1)   (2)   (3)   (4)   (5)   (6)   (7)	≥		V-1	P 1 / ft /								
Converting Values to a Near-Bank Stress (NBS) Rating   Near-Bank Stress (NBS)   Tatings   (1)   (2)   (3)   (4)   (5)   (6)   (7)   (7)   (1)   (2)   (3)   (4)   (5)   (6)   (7)	vel	(7)										
Near-Bank Stress (NBS)   (1)   (2)   (3)   (4)   (5)   (6)   (7)	Le		/ 1	• /	(1400)							
Near-Bank Stress (NBS)   (1)   (2)   (3)   (4)   (5)   (6)   (7)												
ratings         (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	Nos- D	onle Ct		nverting Va	alues to a l							
Very Low         N/A         > 3.00         < 0.20	near-B			(1)	(2)				(6)	(7)		
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												
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												
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												
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												
Extreme Above < 1.50 > 1.00 > 1.20 > 3.00 > 1.60 > 2.40	11.91											
2.100 2.100 2.100 2.100 2.100			_									
Overall Near-Dalik Stress (NDS) fatting			•									
					Overall N	i <del>c</del> ai -Ddiik (	วแ <i>ธ</i> 22 (NB	o) rating				

Stream:	Tributary to Five Mile Creek	Observer(s):	IT RS Data: IT QA/QC: RS T					Total Score:		NA	NA				
Reach:		Comments:							Very Hi	Very High					
Location:	RB-14	Bank Length	24					Very Low	Low	Moderate	High	Very High	Extreme		
Date:	5/24/2022							Values:	5-10	10-20	20-30	30-40	40-45	45-50	

		E	rodibility Variabl	les	
Bank Height / Bankf	ull Height Ratio		<u> </u>		
Bank Height	Bankfull Height	Value	Index	Bank Erosion Potental	Notes
5.00					
Root Depth / Bank H	leight Ratio				
Root Depth	Bank Height	Value	Index	Bank Erosion Potental	Notes
	5.00				
Weighted Root Dens	ity				
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					
	TOT	AL SCORE	Very High		

			Bank Eros	ion Potential							
			Very Low	Low	Moderate	High	Very High	Extreme			
	D	Value	1.00-1.10	1.11-1.19	1.20-1.50	1.60-2.00	2.10-2.80	>2.80			
les	Bank Height / Bankfull Height	Index	1.0-1.9	2.0-3.9	4.0-5.9	6.0-7.9	8.0-9.0	10			
Variables	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			
	Root Deptil / Balik Height	Index	1.0-1.9	2.0-3.9	4.0-5.9	6.0-7.9	8.0-9.0	10			
Erodibility	Weighted Root Density	Value	100-80	79-55	54-30	29-15	14-5	<5			
gib	Weighted Root Density	Index	1.0-1.9	2.0-3.9	4.0-5.9	6.0-7.9	8.0-9.0	10			
Ere	Bank Angle	Value	0-20	21-60	61-80	81-90	91-119	>119			
	Dank Angic	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			
	Surface Frotection	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 lo	w erosion po	tential.						
	Boulders	Boulder banks	have a low ere	osion potentia	l.						
ਾਫ	Cobble	Substract 10 po	oints. No adjus	stment if sand	gravel compo	se greater that	n 50% of bank				
iteri	Clay/Silt Loam	Add 5 points.									
Ma	Gravel	Add 5-10 point	s depending o	n percentage	of bank mater	ial composed	of sand.				
Bank Material	Sand	Add 10 points.									
B	Silt / Clay	No adjustment.									
			Strat	ification							
	Add 5-10 p	oints depending	on position of	funstable laye	rs in relation t	o bankfull sta	ge.				

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



Ocular estimate - Very High

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

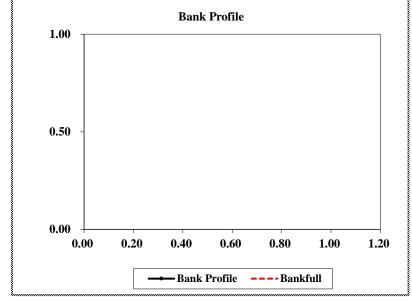
erosion	Tale.										
			Estim	ating Nea	r-Bank St	ress ( NBS	S)				
Stream:	Tributa	ary to Five	Mile Creek		Location:	<b>Rolling Ri</b>	dge Park				
Station:	<b>RB-14</b>			S	tream Type:		•	Valley Type:			
Observe	rs:	IT RS						Date:	5/24/2022		
			Methods fo	or Estimati	ng Near-Ba	ank Stress	(NBS)				
(1) Chanr	nel pattern	, transverse bar	or split channe	l/central bar cre	eating NBS		Level I	Recona	nissance		
( <b>2</b> ) Ratio	of radius o	f curvature to b	ankfull width ( F	R <sub>c</sub> / W <sub>bkf</sub> )	-		Level II	General	prediction		
(3) Ratio	of pool slo	pe to average w	ater surface slo	ope (S <sub>p</sub> /S)			Level II	General	prediction		
		pe to riffle slope		<u> </u>			Level II	General	prediction		
		nk maximum de		mean depth ( d,	<sub>nh</sub> / d <sub>hkf</sub> )		Level III		prediction		
		nk shear stress					Level III		prediction		
		/ Isovels / Veloc		( 110	· DKI 7		Level IV		lation		
_				ars-short and/	or discontinuo	us					
Level	(1)	Extensive de	position (conti	nuous, cross-	channel)			NE	BS = Extreme		
Le		Chute cutoffs	, down-valley	meander mig	ration, conver	ging flow		NE	BS = Extreme		
		Radius of	Bankfull	Dette D. A	Near-Bank						
	(2)	Curvature R <sub>c</sub> (ft)	Width W <sub>bkf</sub> (ft)	<i>Ratio</i> R <sub>c</sub> / W <sub>bkf</sub>	Stress (NBS)						
		IV <sub>C</sub> (II)	(11)	V V bkf	(NDO)	Ì					
Near-Bank Method 1											
=		Pool Slope	Average		Near-Bank Stress			inant			
Level II	(3)	S <sub>p</sub>	Slope S	Ratio S <sub>p</sub> / S	(NBS)	ļ	Near-Bai	nk Stress			
_							Very	High			
					Near-Bank						
	(4)	Pool Slope	Riffle Slope	Ratio S <sub>p</sub> /	Stress						
	(-)	S <sub>p</sub>	S <sub>rif</sub>	S <sub>rif</sub>	(NBS)	1					
		Near-Bank Max Depth	Mara Danda	<i>Ratio</i> d <sub>nb</sub> /	Near-Bank						
	(5)	d <sub>nb</sub> (ft)	Mean Depth d <sub>bkf</sub> (ft)	d <sub>bkf</sub>	Stress (NBS)						
=		IID ( 7	- DNI (* 7)	- DVI	(1120)						
Level III				Near-Bank			Bankfull				
Le		Near-Bank		Shear			Shear		Near-Bank		
	(6)	Max Depth	Near-Bank		Mean Depth		Stress $\tau_{bkf}$ (	Ratio $\tau_{nb}$ /	Stress		
		d <sub>nb</sub> (ft)	Slope S <sub>nb</sub>	lb/ft <sup>2</sup> )	d <sub>bkf</sub> (ft)	Slope S	lb/ft <sup>2</sup> )	$ au_{bkf}$	(NBS)		
≥		V-1	Part ( fr. )	Near-Bank							
Level IV	(7)	Velocity Grad / f	dient (ft/sec	Stress (NBS)							
Le		, ,	.,	(NBC)							
					<u> </u>	<b>.</b>					
Near 5	lank St-		nverting Va	alues to a N	Near-Bank	Stress (NE ethod numb					
ivear-E	rating	ess (NBS) s	(1)	(2)	(3)	(4)	(5)	(6)	(7)		
	Very Lo		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		
	Modera		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 Hi		(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		
	Extren		Above	< 1.50	> 1.00	> 1.20	> 3.00	> 1.60	> 2.40		
	Overall Near-Bank Stress (NBS) rating Very High								911		

Stream:	Tributary to Five Mile Creek	Observer(s):	IT RS	IT RS Data: IT QA/QC: RS To			Total Score:		NA	NA				
Reach:		Comments:							High	High				
Location:	RB-15	Bank Length		32		Total Score	Very Low	Low	Moderate	High	Very High	Extreme		
Date:	5/24/2022							Values:	5-10	10-20	20-30	30-40	40-45	45-50

			111 111		
		E	rodibility Variabl	les	
Bank Height / Bankf				•	
Bank Height	Bankfull Height	Value	Index	Bank Erosion Potental	Notes
4.40					
Root Depth / Bank H	eight Ratio				
Root Depth	Bank Height	Value	Index	Bank Erosion Potental	Notes
	4.40				
Weighted Root Densi	ity				
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					
	тот	AL SCORE	High		

			Bank Eros	ion Potential							
			Very Low	Low	Moderate	High	Very High	Extreme			
	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			
les	Bank Height / Banktuli Height	Index	1.0-1.9	2.0-3.9	4.0-5.9	6.0-7.9	8.0-9.0	10			
Variables	Boot Douth / Bonk Hoight	Value	1.00-0.90	0.89-0.50	0.49-0.30	0.29-0.15	0.14-0.05	< 0.05			
	Root Depth / Bank Height	Index	1.0-1.9	2.0-3.9	4.0-5.9	6.0-7.9	8.0-9.0	10			
Erodibility	Weighted Root Density	Value	100-80	79-55	54-30	29-15	14-5	<5			
dib	Weighted Root Density	Index	1.0-1.9	2.0-3.9	4.0-5.9	6.0-7.9	8.0-9.0	10			
Erc	Bank Angle	Value	0-20	21-60	61-80	81-90	91-119	>119			
	Dank Angie	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			
	Surface 1 Totection	Index	1.0-1.9	2.0-3.9	4.0-5.9	6.0-7.9	8.0-9.0	10			
			Adju	stments							
	Bedrock	Bedrock banks	have a very lo	a very low erosion potential.							
	Boulders	Boulder banks	have a low ere	osion potentia	l.						
a	Cobble	Substract 10 po	oints. No adjus	stment if sand	gravel compo	se greater that	n 50% of bank				
teri	Clay/Silt Loam	Add 5 points.									
Ma	Gravel	Add 5-10 point	s depending o	n percentage	of bank mater	ial composed	of sand.				
Bank Material											
B	Silt / Clay	No adjustment.									
			Strati	ification		•	•				
	Add 5-10 p	oints depending	on position of	funstable laye	rs in relation t	to bankfull sta	ge.	•			

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



Ocular estimate - High

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

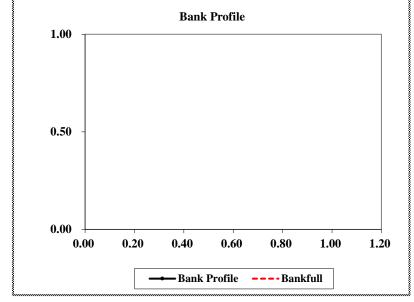
erosion	iale.											
			Estim	ating Nea	r-Bank St	ress ( NBS	3)					
Stream:	Tributa	ry to Five	Mile Creek		Location:	Rolling Ri	dge Park					
Station:	RB-15			S	tream Type:		,	√alley Type:				
Observe	rs:	IT RS						Date:	5/24/2022			
			Methods fo	or Estimati	ng Near-Ba	ank Stress	(NBS)					
(1) Chann	el pattern	, transverse bar	or split channe	l/central bar cre	eating NBS		Level I	Recona	issance			
( <b>2</b> ) Ratio	of radius o	f curvature to b	ankfull width ( F	R <sub>c</sub> / W <sub>bkf</sub> )			Level II	General	prediction			
( <b>3</b> ) Ratio	of pool slo	pe to average v	vater surface slo	ope (S <sub>p</sub> /S)			Level II	General	prediction			
( <b>4</b> ) Ratio	of pool slo	pe to riffle slope	e (S <sub>p</sub> /S <sub>rif</sub> )				Level II	General	prediction			
( <b>5</b> ) Ratio	of near-ba	nk maximum de	epth to bankfull	mean depth ( d	<sub>nb</sub> / d <sub>bkf</sub> )		Level III	Detailed	prediction			
( <b>6</b> ) Ratio	of near-ba	nk shear stress	to bankfull she	ar stress ( τ <sub>nb</sub> /	τ <sub>bkf</sub> )		Level III	Detailed	prediction			
(7) Veloci	ty profiles	/ Isovels / Veloc	city gradient				Level IV	Valid	lation			
=								-				
Level	(1)		•									
ĭ				meander mig		ging flow		NI	35 = Extreme			
		Radius of Curvature	Bankfull Width W <sub>bkf</sub>	Ratio R <sub>c</sub> /	Near-Bank Stress							
	(2)	R <sub>c</sub> (ft)	(ft)	W <sub>bkf</sub>	(NBS)							
Near-Bank Method 1												
ell	(3)	Pool Slope	Average		Stress			inant				
Level II	(3)	Sp	Slope S	Ratio S <sub>p</sub> / S	(NBS)	1	Near-Bar	nk Stress				
_						]	Hi	gh				
				5 11 6 1	Near-Bank							
	(4)	Pool Slope S <sub>p</sub>	Riffle Slope S <sub>rif</sub>	Ratio S <sub>p</sub> / S <sub>rif</sub>	Stress (NBS)							
		Op	Orit	O <sub>rif</sub>	(NDO)	Ì						
		Near-Bank			Nissa Davi							
	<b>(=</b> )	Max Depth	Mean Depth	Ratio d <sub>nb</sub> /	Near-Bank Stress							
	(5)	d <sub>nb</sub> (ft)	d <sub>bkf</sub> (ft)	d <sub>bkf</sub>	(NBS)							
≣												
Level III				Near-Bank			Bankfull					
ĭ	(0)	Near-Bank	Near-Bank	Shear	Mara Barda		Shear Stress $\tau_{bkf}$ (	Ratio τ <sub>nb</sub> /	Near-Bank			
	(6)	Max Depth d <sub>nb</sub> (ft)	Slope S <sub>nb</sub>	Ib/ft <sup>2</sup> )	Mean Depth d <sub>bkf</sub> (ft)	Average Slope S	lb/ft <sup>2</sup> )	$\tau_{\rm bkf}$	Stress (NBS)			
		SIID (11)	- 110	ib/it )	ODKT (11)	Giope G	ib/it )	*DKf	(NBO)			
				Near-Bank								
Level IV	<b>/7</b> \	Velocity Grad	dient (ft/sec	Stress								
.eve	(7)	/ f	t)	(NBS)	1							
		Coi	nverting Va	alues to a l	Near-Bank	Stress (NE	S) Rating					
Near-B		ess (NBS)				ethod numb						
	rating	s	(1)	(2)	(3)	(4)	(5)	(6)	(7)			
	Very Lo		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			
	Modera		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 Hi	_	(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			
	Extren	ne	Above	< 1.50	> 1.00	> 1.20	> 3.00	> 1.60	> 2.40			
Overall Near-Bank Stress (NBS) rating High								gh				

Stream:	Tributary to Five Mile Creek	Observer(s):	IT RS Data: IT QA/QC: RS To			Total Score:		NA	NA				
Reach:		Comments:							Very Hi	Very High			
Location:	RB-16	Bank Length		60		Total Score	Very Low	Low	Moderate	High	Very High	Extreme	
Date:	5/24/2022						Values:	5-10	10-20	20-30	30-40	40-45	45-50

		-			
		Е	rodibility Variabl	es	
Bank Height / Bankf	ull Height Ratio				
Bank Height	Bankfull Height	Value	Index	Bank Erosion Potental	Notes
5.00					
Root Depth / Bank H	leight Ratio				
Root Depth	Bank Height	Value	Index	Bank Erosion Potental	Notes
	5.00				
Weighted Root Dens	ity				
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					
	тот	AL SCORE	Very High		

			Bank Eros	ion Potential							
			Very Low	Low	Moderate	High	Very High	Extreme			
	D	Value	1.00-1.10	1.11-1.19	1.20-1.50	1.60-2.00	2.10-2.80	>2.80			
səle	Bank Height / Bankfull Height	Index	1.0-1.9	2.0-3.9	4.0-5.9	6.0-7.9	8.0-9.0	10			
Variables	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			
	Root Deptil / Bank Height	Index	1.0-1.9	2.0-3.9	4.0-5.9	6.0-7.9	8.0-9.0	10			
Erodibility	Weighted Root Density	Value	100-80	79-55	54-30	29-15	14-5	<5			
dib	Weighted Root Density	Index	1.0-1.9	2.0-3.9	4.0-5.9	6.0-7.9	8.0-9.0	10			
Ere	Bank Angle	Value	0-20	21-60	61-80	81-90	91-119	>119			
	Dank Angle	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			
	Surface I Totection	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	rock banks have a very low erosion potential.								
	Boulders	Boulder banks	have a low ere	osion potentia	l.						
ਾਫ	Cobble	Substract 10 po	oints. No adjus	stment if sand	gravel compo	se greater that	n 50% of bank				
iteri	Clay/Silt Loam	Add 5 points.									
Ma	Gravel	Add 5-10 point	n percentage	of bank mater	ial composed	of sand.					
Bank Material	Sand	Add 10 points.									
B	Silt / Clay	No adjustment.									
			Strat	ification							
	Add 5-10 p	oints depending	on position of	unstable laye	rs in relation t	to bankfull sta	ge.				

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



Ocular estimate - Very High

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

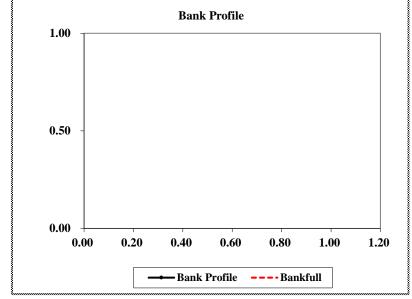
erosion rate.										
Estimating Near-Bank Stress ( NBS )										
Stream: Tributary to Five Mile Creek Location: Rolling Ridge Park										
Station: <b>RB-16</b> Stream Type: Valley Type:										
Observers: IT RS Date: 5/24/202									5/24/2022	
Methods for Estimating Near-Bank Stress (NBS)										
( <b>1</b> ) Chani	nel pattern	, transverse baı		Level I	Recona	issance				
(2) Ratio of radius of curvature to bankfull width ( R <sub>c</sub> / W <sub>bkf</sub> ) Level II General prediction										
(3) Ratio of pool slope to average water surface slope (S <sub>p</sub> /S) Level II General prediction										
(4) Ratio of pool slope to riffle slope ( S <sub>p</sub> / S <sub>rif</sub> ) Level II General prediction										
(5) Ratio of near-bank maximum depth to bankfull mean depth ( d <sub>nb</sub> / d <sub>bkf</sub> ) Level III Detailed prediction										
(6) Ratio	of near-ba	nk shear stress	to bankfull she	ar stress ( τ <sub>nb</sub> /	$\tau_{bkf}$ )		Level III	Detailed	prediction	
(7) Veloc	ity profiles	/ Isovels / Veloc	city gradient				Level IV	Valid	lation	
=		Transverse a	nd/or central b	ars-short and/	or discontinuo	us		NBS = Hig	h / Very High	
Level	(1)									
<u>ٽ</u>			, down-valley	meander mig	ration, conver	ging flow		NE	3S = Extreme	
		Radius of	Bankfull	Ratio R <sub>c</sub> /	Near-Bank					
	(2)	Curvature R <sub>c</sub> (ft)	Width W <sub>bkf</sub> (ft)	W <sub>bkf</sub>	Stress (NBS)					
		1 10 (11)	(1.7)	DKI	(1.126)	Ì				
					Near-Bank		Method	1		
=	(0)	Pool Slope	Average		Stress			inant		
Level	(3)	S <sub>p</sub>	Slope S	Ratio S <sub>p</sub> / S	(NBS)		Near-Bar	nk Stress		
_							Very	High		
					Near-Bank	'			-	
	(4)	Pool Slope	Riffle Slope	Ratio S <sub>p</sub> /	Stress					
	``'	S <sub>p</sub>	S <sub>rif</sub>	S <sub>rif</sub>	(NBS)	1				
		Near-Bank Max Depth	Mara Barda	Ratio d <sub>nb</sub> /	Near-Bank					
	(5)	d <sub>nb</sub> (ft)	Mean Depth d <sub>bkf</sub> (ft)	d <sub>bkf</sub>	Stress (NBS)					
=		TID ( )	Did ( )	DIG						
Level III				Near-Bank			Bankfull			
É		Near-Bank		Shear			Shear		Near-Bank	
	(6)	Max Depth	Near-Bank	Stress τ <sub>nb</sub> (	Mean Depth		Stress τ <sub>bkf</sub> (	Ratio $\tau_{nb}$ /	Stress	
		d <sub>nb</sub> (ft)	Slope S <sub>nb</sub>	lb/ft <sup>2</sup> )	d <sub>bkf</sub> (ft)	Slope S	lb/ft <sup>2</sup> )	$ au_{bkf}$	(NBS)	
≥		Valasit : O	diant/ft/	Near-Bank						
Level IV	(7)		dient (ft/sec ft)	Stress (NBS)						
Ë			- /	(**						
						01	0) 5 4			
Near F	Pank St-		nverting Va	alues to a l		Stress (NE ethod numb				
ivedi-E	rating	ess (NBS) s	(1)	(2)	(3)	(4)	(5)	(6)	(7)	
Very Low			N/A	> 3.00	< 0.20	< 0.40	< 1.00	< 0.80	< 0.50	
				2.21 – 3.00	0.20 - 0.40	0.41 – 0.60	1.00 – 1.50	0.80 – 1.05	0.50 – 1.00	
	Low		N/A	. 5.00		0.61 – 0.80	1.51 – 1.80	1.06 – 1.14		
			N/A	2.01 – 2.20	0.41 - 0.60	0.01 – 0.00		1.00 - 1.14	1.01 – 1.60	
	Modera	ate	N/A See	2.01 – 2.20 1.81 – 2.00	0.41 - 0.60 0.61 - 0.80				1.01 – 1.60 1.61 – 2.00	
	Modera High	ate		1.81 – 2.00	0.61 - 0.80	0.81 – 1.00	1.81 – 2.50	1.15 – 1.19	1.61 – 2.00	
	Modera High Very Hi	ate igh	See							
	Modera High	ate igh	See (1)	1.81 – 2.00 1.50 – 1.80 < 1.50	0.61 - 0.80 0.81 - 1.00	0.81 – 1.00 1.01 – 1.20 > 1.20	1.81 – 2.50 2.51 – 3.00 > 3.00	1.15 – 1.19 1.20 – 1.60 > 1.60	1.61 – 2.00 2.01 – 2.40	

Stream:	Tributary to Five Mile Creek	Observer(s):	IT RS Data: IT QA/QC: RS			Total Score:	core: NA							
Reach:		Comments:						High						
Location:	RB-17	Bank Length				Total Score	Very Low	Low	Moderate	High	Very High	Extreme		
Date:	5/24/2022							Values:	5-10	10-20	20-30	30-40	40-45	45-50

		-						
	Erodibility Variables							
Bank Height / Bankf	ull Height Ratio							
Bank Height	Bankfull Height	Value	Index	Bank Erosion Potental	Notes			
3.50								
Root Depth / Bank H	eight Ratio							
Root Depth	Bank Height	Value	Index	Bank Erosion Potental	Notes			
	3.50							
Weighted Root Densi	ity							
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								
	тот	AL SCORE	High					

			Bank Eros	ion Potential						
		Very Low	Low	Moderate	High	Very High	Extreme			
	D	Value	1.00-1.10	1.11-1.19	1.20-1.50	1.60-2.00	2.10-2.80	>2.80		
les	Bank Height / Bankfull Height	Index	1.0-1.9	2.0-3.9	4.0-5.9	6.0-7.9	8.0-9.0	10		
Variables	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		
	Root Depth / Bank Height	Index	1.0-1.9	2.0-3.9	4.0-5.9	6.0-7.9	8.0-9.0	10		
Erodibility	Weighted Root Density	Value	100-80	79-55	54-30	29-15	14-5	<5		
dib	Weighted Root Delisity	Index	1.0-1.9	2.0-3.9	4.0-5.9	6.0-7.9	8.0-9.0	10		
Ere	Bank Angle	Value	0-20	21-60	61-80	81-90	91-119	>119		
	Dank Angie	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		
	Surface Protection	Index	1.0-1.9	2.0-3.9	4.0-5.9	6.0-7.9	8.0-9.0	10		
			Adju	stments						
	Bedrock	Bedrock banks	have a very lo	w erosion po	tential.					
	Boulders	Boulder banks	have a low ere	osion potentia	l.					
ㅁ	Cobble	Substract 10 po	oints. No adjus	stment if sand	gravel compo	se greater that	n 50% of bank			
teri	Clay/Silt Loam	Add 5 points.								
Ma	Gravel	ial composed	omposed of sand.							
ank	Clay/Silt Loam Add 5 points. No adjustment it same graver compose greater than 50% of oan Add 5 points.  Gravel Add 5-10 points depending on percentage of bank material composed of sand.  Add 10 points.									
B	Silt / Clay	No adjustment.								
			Strat	ification						
	Add 5-10 p	oints depending	on position of	funstable laye	rs in relation t	to bankfull sta	ge.			

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



Ocular estimate - High

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

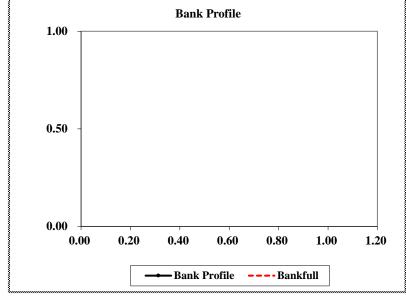
Estimating Near-Bank Stress ( NBS )											
			Estim	ating Nea	r-Bank St	ress ( NBS	3)				
Stream:	Tributa	ary to Five	Mile Creek		Location:	Rolling Ri	dge Park				
Station:	<b>RB-17</b>			S	Stream Type: Valley Type:						
Observe	ers:	IT RS						Date:	5/24/2022		
			Methods for	or Estimati	ng Near-Ba	ank Stress	(NBS)				
(1) Chani	nel pattern	, transverse baı	or split channe	l/central bar cre	eating NBS		Level I	Reconaissance			
(2) Ratio	of radius o	f curvature to b	ankfull width (F	R <sub>c</sub> / W <sub>bkf</sub> )			Level II	General	orediction		
(3) Ratio	of pool slo	pe to average v	vater surface slo	ope (S <sub>p</sub> /S)			Level II	General	orediction		
(4) Ratio	of pool slo	pe to riffle slope	e ( S <sub>p</sub> / S <sub>rif</sub> )	·			Level II	General	orediction		
( <b>5</b> ) Ratio	of near-ba	nk maximum de	epth to bankfull	mean depth ( d	<sub>nb</sub> / d <sub>bkf</sub> )		Level III	Detailed	prediction		
(6) Ratio	of near-ba	nk shear stress	to bankfull she	ar stress ( τ <sub>nb</sub> /	$\tau_{bkf}$ )		Level III	Detailed	prediction		
(7) Veloc	ity profiles	/ Isovels / Veloc	city gradient				Level IV	Valid	lation		
=		Transverse a	nd/or central b	ars-short and/	or discontinuo	us		NBS = Hig	h / Very High		
Level	(1)										
<u>ٽ</u>		Ī	, down-valley	meander mig	ration, conver	ging flow		NE	3S = Extreme		
		Radius of	Bankfull	Patio P /	Near-Bank						
	(2)	Curvature R <sub>c</sub> (ft)	Width W <sub>bkf</sub> (ft)	Ratio R <sub>c</sub> / W <sub>bkf</sub>	Stress (NBS)						
		1 10 (11)	(1.7)	DKI	(1.126)	Ì					
					Near-Bank		Method	1			
=	(0)	Pool Slope	Average		Stress			inant			
Level	(3)	S <sub>p</sub>	Slope S	Ratio S <sub>p</sub> / S	(NBS)	Near-Bank Stress					
_							Mode	erate			
					Near-Bank	'			-		
	(4)	Pool Slope	Riffle Slope	Ratio S <sub>p</sub> /	Stress						
	( ',	S <sub>p</sub>	S <sub>rif</sub>	S <sub>rif</sub>	(NBS)	1					
		Near-Bank	Mara Barda	Ratio d <sub>nb</sub> /	Near-Bank						
	(5)	Max Depth d <sub>nb</sub> (ft)	Mean Depth d <sub>bkf</sub> (ft)	d <sub>bkf</sub>	Stress (NBS)						
=		TID ( )	Did ( )	DIG							
Level III				Near-Bank			Bankfull				
É		Near-Bank		Shear			Shear		Near-Bank		
	(6)	Max Depth	Near-Bank	Stress τ <sub>nb</sub> (	Mean Depth		Stress τ <sub>bkf</sub> (		Stress		
		d <sub>nb</sub> (ft)	Slope S <sub>nb</sub>	lb/ft <sup>2</sup> )	d <sub>bkf</sub> (ft)	Slope S	lb/ft <sup>2</sup> )	$ au_{bkf}$	(NBS)		
≥		Volcait : O==	diant / ft /	Near-Bank							
Level IV	(7)		dient (ft/sec ft)	Stress (NBS)							
تّ			,								
						01	10) D 1				
Near F	Sank Str	ess (NBS)	nverting Va	alues to a l		Stress (NE ethod numb					
INCAI-E	rating		(1)	(2)	(3)	(4)	(5)	(6)	(7)		
	Very Lo		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		
	Modera					0.81 – 1.00	1.81 – 2.50	1.15 – 1.19	1.61 – 2.00		
		1	See	1.81 – 2.00	0.61 – 0.80	0.01 - 1.00					
	High		See (1)	1.81 – 2.00 1.50 – 1.80	0.61 - 0.80 0.81 - 1.00						
	High Very Hi	gh		1.81 – 2.00 1.50 – 1.80 < 1.50	0.81 – 0.80 0.81 – 1.00 > 1.00	1.01 – 1.20 > 1.20	2.51 – 3.00 > 3.00	1.20 – 1.60	2.01 – 2.40 > 2.40		
	High	gh	(1)	1.50 – 1.80 < 1.50	0.81 – 1.00	1.01 – 1.20 > 1.20	2.51 – 3.00 > 3.00	1.20 – 1.60 > 1.60	2.01 – 2.40		

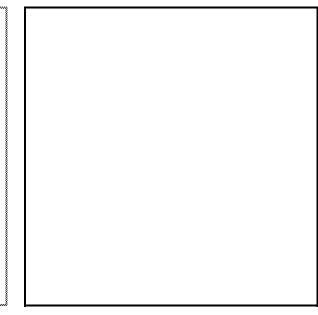
Stream:	Tributary to Five Mile Creek	Observer(s):	IT RS Data: IT QA/QC: RS T					Total Score:		33.29	33.29				
Reach:		Comments:							High						
Location:	RB-18	Bank Length		29				Total Score	Very Low	Low	Moderate	High	Very High	Extreme	
Date:	5/24/2022						Values:	5-10	10-20	20-30	30-40	40-45	45-50		

		E	rodibility Variabl	les	
Bank Height / Bankft	ull Height Ratio		Toursmey ( urano		
Bank Height	Bankfull Height	Value	Index	Bank Erosion Potental	Notes
2.10	0.40	5.25	10.00	Extreme	
Root Depth / Bank H	eight Ratio				
Root Depth	Bank Height	Value	Index	Bank Erosion Potental	Notes
1.00	2.10	0.48	4.14	Moderate	
Weighted Root Densi	ity				
Root Density (%)	Root Depth / Bank Height	Value	Index	Bank Erosion Potental	Notes
40.00	0.48	19.05	7.35	High	
Bank Angle					
Bank Angle ( °)			Index	Bank Erosion Potental	Notes
80.00			5.90	Moderate	
Surface Protection					
Surface Protection (%)			Index	Bank Erosion Potental	Notes
30.00			5.90	Moderate	
			Adjustment		Notes
Bank Materials			0.00		
			Adjustment		Notes
Bank Stratification			0.00		
	тот	AL SCORE	33.29		

			Bank Eros	ion Potential				
			Very Low	Low	Moderate	High	Very High	Extreme
	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
les	Bank Height / Banktuli Height	Index	1.0-1.9	2.0-3.9	4.0-5.9	6.0-7.9	8.0-9.0	10
Variables	Boot Douth / Bonk Hoight	Value	1.00-0.90	0.89-0.50	0.49-0.30	0.29-0.15	0.14-0.05	< 0.05
	Root Depth / Bank Height	Index	1.0-1.9	2.0-3.9	4.0-5.9	6.0-7.9	8.0-9.0	10
Erodibility	Weighted Root Density	Value	100-80	79-55	54-30	29-15	14-5	<5
dib	Weighted Root Density	Index	1.0-1.9	2.0-3.9	4.0-5.9	6.0-7.9	8.0-9.0	10
Erc	Bank Angle	Value	0-20	21-60	61-80	81-90	91-119	>119
	Dank Angie	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
	Surface 1 Totection	Index	1.0-1.9	2.0-3.9	4.0-5.9	6.0-7.9	8.0-9.0	10
			Adju	stments				
	Bedrock	Bedrock banks	have a very lo	w erosion pot	tential.			
	Boulders	Boulder banks	have a low ere	osion potentia	l.			
a	Cobble	Substract 10 po	oints. No adjus	stment if sand	gravel compo	se greater that	n 50% of bank	
teri	Clay/Silt Loam	Add 5 points.						
Ma	Gravel	Add 5-10 point	s depending o	n percentage	of bank mater	ial composed	of sand.	
Bank Material	Sand	Add 10 points.						
B	Silt / Clay	No adjustment.						
			Strat	ification		•	•	
	Add 5-10 p	oints depending	on position of	funstable laye	rs in relation t	to bankfull sta	ge.	•

	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.

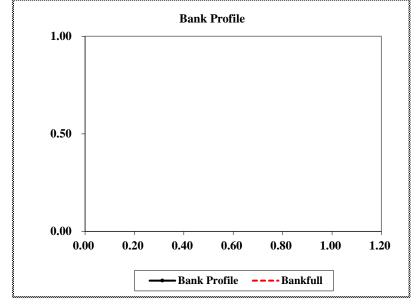
Estimating Near-Bank Stress ( NBS )											
			Estim	ating Nea	r-Bank St	ress ( NBS	3)				
Stream:	Tributa	ry to Five	Mile Creek		Location:	Rolling Ri	dge Park				
Station:	<b>RB-18</b>			S	tream Type:		1	/alley Type:			
Observe	ers:	IT RS						Date:	5/24/2022		
			Methods for	or Estimati	ng Near-Ba	ank Stress	(NBS)				
( <b>1</b> ) Chani	nel pattern	, transverse bai	or split channe	l/central bar cre	eating NBS		Level I	Recona	issance		
(2) Ratio	of radius o	f curvature to b	ankfull width (F	R <sub>c</sub> / W <sub>bkf</sub> )			Level II	General prediction			
(3) Ratio	of pool slo	pe to average w	vater surface slo	ope (S <sub>p</sub> /S)			Level II	General	orediction		
(4) Ratio	of pool slo	pe to riffle slope	e ( S <sub>p</sub> / S <sub>rif</sub> )	·			Level II	General	orediction		
( <b>5</b> ) Ratio	of near-ba	nk maximum de	epth to bankfull	mean depth ( d	<sub>nb</sub> / d <sub>bkf</sub> )		Level III	Detailed	prediction		
(6) Ratio	of near-ba	nk shear stress	to bankfull she	ar stress ( $\tau_{nb}$ /	$\tau_{bkf}$ )		Level III	Detailed	prediction		
(7) Veloc	ity profiles	/ Isovels / Veloc	city gradient				Level IV	Valid	lation		
=		Transverse a	nd/or central b	ars-short and/	or discontinuo	us		NBS = Hig	h / Very High		
Level	(1)										
_ ٽ			, down-valley	meander mig	ration, conver	ging flow		NE	BS = Extreme		
		Radius of	Bankfull	Patio P /	Near-Bank						
	(2)	Curvature R <sub>c</sub> (ft)	Width W <sub>bkf</sub> (ft)	Ratio R <sub>c</sub> / W <sub>bkf</sub>	Stress (NBS)						
		()	(1.7)	DKI	(1.126)	Ì					
					Near-Bank		Method	1			
=	(0)	Pool Slope	Average		Stress			inant			
Level	(3)	S <sub>p</sub>	Slope S	Ratio S <sub>p</sub> / S	(NBS)	Near-Bank Stress					
_							Mode	erate			
					Near-Bank	'			-		
	(4)	Pool Slope	Riffle Slope	Ratio S <sub>p</sub> /	Stress						
	``'	S <sub>p</sub>	S <sub>rif</sub>	S <sub>rif</sub>	(NBS)	1					
		Near-Bank Max Depth	Mara Barda	Ratio d <sub>nb</sub> /	Near-Bank						
	(5)	d <sub>nb</sub> (ft)	Mean Depth d <sub>bkf</sub> (ft)	d <sub>bkf</sub>	Stress (NBS)						
=		TID ( )	Did ( )	DIG							
Level III				Near-Bank			Bankfull				
É		Near-Bank		Shear			Shear		Near-Bank		
	(6)	Max Depth	Near-Bank	Stress τ <sub>nb</sub> (	Mean Depth		Stress $\tau_{bkf}$ (		Stress		
		d <sub>nb</sub> (ft)	Slope S <sub>nb</sub>	lb/ft <sup>2</sup> )	d <sub>bkf</sub> (ft)	Slope S	lb/ft <sup>2</sup> )	$ au_{bkf}$	(NBS)		
≥		Valasii O		Near-Bank							
Level IV	(7)		dient (ft/sec ft)	Stress (NBS)							
Ë			- /	(* )							
						01	0) 5 (				
Near F	Pank St-	Col ess (NBS)	nverting Va	alues to a l							
ivedi-E		•	(1)	(2)	(3)	ethod numb (4)	(5)	(6)	(7)		
ratings			N/A	> 3.00	< 0.20	< 0.40	< 1.00	< 0.80	< 0.50		
	Verv I	J VV	•	- 3.00			1.00 – 1.50				
	Very Low		N/A	2.21 – 3.00	0.20 - 0.40	0.41 - 0.60		0.00 - 1 03	0.50 - 1 00		
	Low		N/A N/A	2.21 – 3.00 2.01 – 2.20	0.20 - 0.40 0.41 - 0.60	0.41 - 0.60 0.61 - 0.80		0.80 - 1.05 1.06 - 1.14	0.50 - 1.00 1.01 - 1.60		
	Low Modera	ate		2.01 – 2.20	0.41 – 0.60	0.61 - 0.80	1.51 – 1.80	1.06 – 1.14	1.01 – 1.60		
	Low Modera High	ate	N/A	2.01 – 2.20 1.81 – 2.00	0.41 - 0.60 0.61 - 0.80	0.61 - 0.80 0.81 - 1.00	1.51 – 1.80 1.81 – 2.50	1.06 – 1.14 1.15 – 1.19	1.01 – 1.60 1.61 – 2.00		
	Low Modera	ate gh	N/A See	2.01 – 2.20	0.41 – 0.60	0.61 - 0.80	1.51 – 1.80	1.06 – 1.14	1.01 – 1.60		
	Modera High Very Hi	ate gh	N/A See (1)	2.01 - 2.20 1.81 - 2.00 1.50 - 1.80 < 1.50	0.41 - 0.60 0.61 - 0.80 0.81 - 1.00	0.61 - 0.80 0.81 - 1.00 1.01 - 1.20 > 1.20	1.51 – 1.80 1.81 – 2.50 2.51 – 3.00 > 3.00	1.06 – 1.14 1.15 – 1.19 1.20 – 1.60 > 1.60	1.01 – 1.60 1.61 – 2.00 2.01 – 2.40		

Stream:	Tributary to Five Mile Creek	Observer(s):	IT RS Data: IT QA/QC: RS T					Total Score:		NA	NA				
Reach:		Comments:								Very Hi	Very High				
Location:	RB-19	Bank Length		44				Total Score	Very Low	Low	Moderate	High	Very High	Extreme	
Date:	5/24/2022							Values:	5-10	10-20	20-30	30-40	40-45	45-50	

		-			
		E	rodibility Variabl	les	
Bank Height / Bankf	ull Height Ratio				
Bank Height	Bankfull Height	Value	Index	Bank Erosion Potental	Notes
6.00					
Root Depth / Bank H	eight Ratio				
Root Depth	Bank Height	Value	Index	Bank Erosion Potental	Notes
	6.00				
Weighted Root Densi	ity				
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					
	тот	AL SCORE	Very High		

			Bank Eros	ion Potential				
			Very Low	Low	Moderate	High	Very High	Extreme
	Pouls Height / Poulsfull Height	Value	1.00-1.10	1.11-1.19	1.20-1.50	1.60-2.00	2.10-2.80	>2.80
səle	Bank Height / Bankfull Height	Index	1.0-1.9	2.0-3.9	4.0-5.9	6.0-7.9	8.0-9.0	10
Variables	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
	Root Deptil / Bank Height	Index	1.0-1.9	2.0-3.9	4.0-5.9	6.0-7.9	8.0-9.0	10
Erodibility	Weighted Root Density	Value	100-80	79-55	54-30	29-15	14-5	<5
dib	Weighted Root Density	Index	1.0-1.9	2.0-3.9	4.0-5.9	6.0-7.9	8.0-9.0	10
Erc	Bank Angle	Value	0-20	21-60	61-80	81-90	91-119	>119
	Dank Angle	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
	Surface I Totection	Index	1.0-1.9	2.0-3.9	4.0-5.9	6.0-7.9	8.0-9.0	10
			Adju	stments				
	Bedrock	Bedrock banks	have a very lo	w erosion pot	tential.			
	Boulders	Boulder banks	have a low ere	osion potentia	l.			
ਢ	Cobble	Substract 10 po	ints. No adjus	tment if sand	gravel compo	se greater that	n 50% of bank	
Material	Clay/Silt Loam	Add 5 points.						
Ma	Gravel	Add 5-10 point	s depending o	n percentage	of bank mater	ial composed	of sand.	
Bank	Sand	Add 10 points.						
B	Silt / Clay	No adjustment.						
			Strat	fication				
	Add 5-10 p	oints depending	on position of	unstable laye	rs in relation t	to bankfull sta	ge.	

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



Ocular estimate - Very High

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

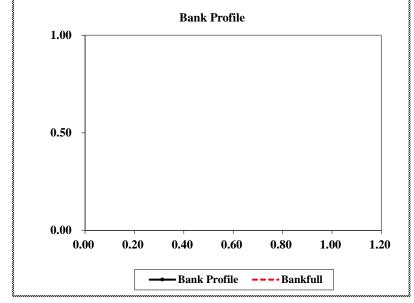
erosion	rate.										
			Estim	ating Nea	r-Bank St	ress ( NBS	<b>S</b> )				
Stream:	Tributa	ary to Five	Mile Creek		Location:	Rolling Ri	dge Park				
Station:	RB-19			S	tream Type:		,	Valley Type:			
Observe	rs:	IT RS			•				5/24/2022		
			Methods fo	or Estimati	ng Near-Ba	ank Stress	(NBS)				
( <b>1</b> ) Chanr	nel pattern	, transverse bai	or split channe	l/central bar cre	eating NBS		Level I	Recona	nissance		
		of curvature to b	· · · · · · · · · · · · · · · · · · ·				Level II	General prediction			
( <b>3</b> ) Ratio	of pool slo	pe to average v	ater surface slo	ope (S <sub>p</sub> /S)			Level II		prediction		
( <b>4</b> ) Ratio	of pool slo	pe to riffle slope	e (S <sub>p</sub> /S <sub>rif</sub> )	<u> </u>			Level II	General	prediction		
		nk maximum de		mean depth ( d	nb / d <sub>bkf</sub> )		Level III	Detailed	prediction		
		nk shear stress					Level III	Detailed	prediction		
		/ Isovels / Veloc					Level IV	Valid	lation		
=		Transverse a	nd/or central b	ars-short and/	or discontinuo	us		NBS = Hig	jh / Very High		
Level	(1)				channel)						
Ľ		Chute cutoffs	, down-valley	meander mig	ration, conver	ging flow		NE	BS = Extreme		
		Radius of	Bankfull	Patio P /	Near-Bank						
	(2)	Curvature R <sub>c</sub> (ft)	Width W <sub>bkf</sub> (ft)	<i>Ratio</i> R <sub>c</sub> / W <sub>bkf</sub>	Stress (NBS)						
		CVY	(1-7)	DKI	(112)						
					Near-Bank	l	Method	1			
Level II	(2)	Pool Slope	Average		Stress		Dom	inant			
-ev	(3)	Sp	Slope S	Ratio S <sub>p</sub> / S	(NBS)	i	Near-Bai	nk Stress			
_							Hi	gh			
					Near-Bank						
	(4)	Pool Slope	Riffle Slope	Ratio S <sub>p</sub> /	Stress						
	( )	S <sub>p</sub>	S <sub>rif</sub>	S <sub>rif</sub>	(NBS)	1					
		Norm David									
		Near-Bank Max Depth	Mean Depth	Ratio d <sub>nb</sub> /	Near-Bank Stress						
	(5)	d <sub>nb</sub> (ft)	d <sub>bkf</sub> (ft)	d <sub>bkf</sub>	(NBS)						
≡											
Level III				Near-Bank			Bankfull				
Ľ	(0)	Near-Bank	Near-Bank	Shear			Shear	Potio # /	Near-Bank		
	(6)	Max Depth d <sub>nb</sub> (ft)	Slope S <sub>nb</sub>	Ib/ft <sup>2</sup> )	Mean Depth d <sub>bkf</sub> (ft)	Average Slope S	Ib/ft <sup>2</sup> )	Ratio τ <sub>nb</sub> /	Stress (NBS <b>)</b>		
		GIID (11)	OTHE STID	15/11	Obst (11)	оюрс о	10/10	τ <sub>bkf</sub>	(NDO)		
				Near-Bank							
Level IV	/ <del>-</del> 7\	Velocity Grad	dient (ft/sec	Near-Bank Stress							
eve.	(7)		t )	(NBS)	1						
		Coi	nverting Va	alues to a N	Near-Bank	Stress (NE	S) Rating				
Near-B	ank Str	ess (NBS)				ethod numb					
	rating	ıs	(1)	(2)	(3)	(4)	(5)	(6)	(7)		
	Very L	ow	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		
	Modera		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		
	Extren	ne	Above	< 1.50	> 1.00	> 1.20	> 3.00	> 1.60	> 2.40		
				Overall N	ear-Bank S	Stress (NB	S) rating	Hi	gh		
			-		-						

Stream:	Tributary to Five Mile Creek	Observer(s):	IT RS Data: IT QA/QC: RS T					Total Score:						
Reach:		Comments:												
Location:	RB-20	Bank Length		37				Total Score	Very Low	Low	Moderate	High	Very High	Extreme
Date:	5/24/2022							Values:	5-10	10-20	20-30	30-40	40-45	45-50

		E	rodibility Variabl	les	
Bank Height / Bankf	ull Height Ratio		Toursely (uran)		
Bank Height	Bankfull Height	Value	Index	Bank Erosion Potental	Notes
Root Depth / Bank H	eight Ratio				
Root Depth	Bank Height	Value	Index	Bank Erosion Potental	Notes
Weighted Root Densi	ity				
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					
	TOT	AL SCORE			

			Bank Eros	sion Potential				
			Very Low	Low	Moderate	High	Very High	Extreme
	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
səle	Bank Height / Bankiuli Height	Index	1.0-1.9	2.0-3.9	4.0-5.9	6.0-7.9	8.0-9.0	10
Variables	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
	Root Deptil / Bank Height	Index	1.0-1.9	2.0-3.9	4.0-5.9	6.0-7.9	8.0-9.0	10
ility	Weighted Root Density	Value	100-80	79-55	54-30	29-15	14-5	<5
Erodibility	Weighted Root Density	Index	1.0-1.9	2.0-3.9	4.0-5.9	6.0-7.9	8.0-9.0	10
Erc	Bank Angle	Value	0-20	21-60	61-80	81-90	91-119	>119
	Dank Angie	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
	Surface I Totection	Index	1.0-1.9	2.0-3.9	4.0-5.9	6.0-7.9	8.0-9.0	10
			Adju	stments				
	Bedrock	Bedrock banks	have a very lo	w erosion po	tential.			
	Boulders	Boulder banks	have a low ere	osion potentia	l.			
a	Cobble	Substract 10 po	oints. No adjus	stment if sand	gravel compo	se greater that	n 50% of bank	
teri	Clay/Silt Loam	Add 5 points.						
Ma	Gravel	n percentage	of bank mater	ial composed	of sand.	•		
Bank Material	Sand	Add 10 points.	•				•	•
B	Silt / Clay	No adjustment.						•
		_	Strat	ification			•	·
	Add 5-10 p	oints depending	on position of	funstable laye	rs in relation t	o bankfull sta	ge.	

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



Removed due to deposition

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

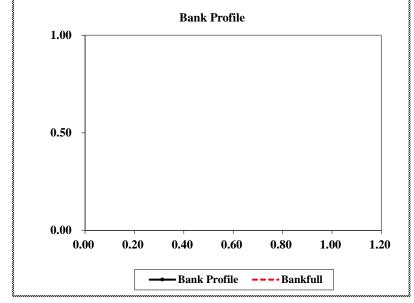
erosion	rate.										
			Estim	ating Nea	r-Bank St	ress ( NBS	3)				
Stream:	Tributa	ry to Five	Mile Creek		Location:	Rolling Ri	dge Park				
Station:	RB-20			S	tream Type:		,	√alley Type:			
Observe	rs:	IT RS						Date:	5/24/2022		
			Methods fo	or Estimati	ng Near-Ba	ank Stress	(NBS)				
(1) Chanr	nel pattern,	, transverse bar	or split channe	l/central bar cre	eating NBS		Level I	Recona	aissance		
( <b>2</b> ) Ratio	of radius o	f curvature to b	ankfull width ( F	R <sub>c</sub> / W <sub>bkf</sub> )			Level II	General	prediction		
( <b>3</b> ) Ratio	of pool slo	pe to average v	vater surface slo	ope (S <sub>p</sub> /S)			Level II	General	prediction		
( <b>4</b> ) Ratio	of pool slo	pe to riffle slope	e (S <sub>p</sub> /S <sub>rif</sub> )				Level II	General	prediction		
( <b>5</b> ) Ratio	of near-ba	nk maximum de	epth to bankfull	mean depth ( d	<sub>nb</sub> / d <sub>bkf</sub> )		Level III	Detailed	prediction		
( <b>6</b> ) Ratio	of near-ba	nk shear stress	to bankfull she	ar stress ( τ <sub>nb</sub> /	τ <sub>bkf</sub> )		Level III	Detailed	prediction		
(7) Veloci	ty profiles	/ Isovels / Veloc	city gradient				Level IV	Valid	lation		
=								-			
Level	(1)		•								
ت				meander mig	ration, conver	ging flow		NI	35 = Extreme		
		Radius of Curvature	Bankfull Width W <sub>bkf</sub>	Ratio R <sub>c</sub> /	Near-Bank Stress						
	(2)	R <sub>c</sub> (ft)	(ft)	W <sub>bkf</sub>	(NBS)						
_ Near-Bank Method											
Level II	(3)	Pool Slope	Average		Stress			inant			
Lev	(3)	S <sub>p</sub>	Slope S	Ratio S <sub>p</sub> / S	(NBS)	1	Near-Bar	nk Stress			
						]					
				5 11 6 1	Near-Bank						
	(4)	Pool Slope S <sub>p</sub>	Riffle Slope S <sub>rif</sub>	Ratio S <sub>p</sub> / S <sub>rif</sub>	Stress (NBS)						
		Op	Orit	O <sub>rif</sub>	(NDO)	Ì					
		Near-Bank			Nissa Davi						
	(=)	Max Depth	Mean Depth	Ratio d <sub>nb</sub> /	Near-Bank Stress						
	(5)	d <sub>nb</sub> (ft)	d <sub>bkf</sub> (ft)	d <sub>bkf</sub>	(NBS)						
≣											
Level III				Near-Bank			Bankfull				
ŭ	(0)	Near-Bank	Near-Bank	Shear	Mara Barda		Shear Stress $\tau_{bkf}$ (	Ratio τ <sub>nb</sub> /	Near-Bank		
	(6)	Max Depth d <sub>nb</sub> (ft)	Slope S <sub>nb</sub>	Ib/ft <sup>2</sup> )	Mean Depth d <sub>bkf</sub> (ft)	Average Slope S	lb/ft <sup>2</sup> )	$\tau_{\rm bkf}$	Stress (NBS)		
		SIID (11)	- 110	ib/it )	ODKT (11)	Giope G	ib/it )	DKI	(NBC)		
				Near-Bank							
Level IV	/ <b>7</b> \	Velocity Grad	dient (ft/sec	Stress							
-eve	(7)	/ f	t)	(NBS)	1						
-											
		Coi	nverting Va	alues to a l	Near-Bank	Stress (NE	S) Rating				
Near-B		ess (NBS)				ethod numb					
	rating	s	(1)	(2)	(3)	(4)	(5)	(6)	(7)		
	Very Lo		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		
	Modera		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 Hi	_	(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		
	Extren	ne	Above	< 1.50	> 1.00	> 1.20	> 3.00	> 1.60	> 2.40		
				Overall N	lear-Bank S	Stress (NB	S) rating				

Stream:	Tributary to Five Mile Creek	Observer(s):	IT RS Data: IT QA/QC: RS T			Total Score:		NA	NA				
Reach:		Comments:						High	High				
Location:	RB-21	Bank Length			38		Total Score	Very Low	Low	Moderate	High	Very High	Extreme
Date:	5/24/2022						Values:	5-10	10-20	20-30	30-40	40-45	45-50

		-			
		E	rodibility Variabl	les	
Bank Height / Bankft	all Height Ratio				
Bank Height	Bankfull Height	Value	Index	Bank Erosion Potental	Notes
2.20					
Root Depth / Bank H	eight Ratio				
Root Depth	Bank Height	Value	Index	Bank Erosion Potental	Notes
	2.20				
Weighted Root Densi	ity				
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					
	тот	AL SCORE	High		

			Bank Eros	ion Potential				
			Very Low	Low	Moderate	High	Very High	Extreme
	B	Value	1.00-1.10	1.11-1.19	1.20-1.50	1.60-2.00	2.10-2.80	>2.80
les	Bank Height / Bankfull Height	Index	1.0-1.9	2.0-3.9	4.0-5.9	6.0-7.9	8.0-9.0	10
Variables	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
	Root Deptn / Bank Height	Index	1.0-1.9	2.0-3.9	4.0-5.9	6.0-7.9	8.0-9.0	10
Erodibility	Weighted Root Density	Value	100-80	79-55	54-30	29-15	14-5	<5
dib	Weighted Root Density	Index	1.0-1.9	2.0-3.9	4.0-5.9	6.0-7.9	8.0-9.0	10
Ere	Bank Angle	Value	0-20	21-60	61-80	81-90	91-119	>119
	Dank Angie	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
	Surface Frotection	Index	1.0-1.9	2.0-3.9	4.0-5.9	6.0-7.9	8.0-9.0	10
			Adju	stments				
	Bedrock	Bedrock banks	have a very lo	w erosion pot	tential.			
	Boulders	Boulder banks	have a low ere	osion potentia	l.			
а	Cobble	Substract 10 po	oints. No adjus	tment if sand	gravel compo	se greater that	n 50% of bank	
teri	Clay/Silt Loam	Add 5 points.						
Ma	Gravel	Add 5-10 point	s depending o	n percentage	of bank mater	ial composed	of sand.	
Bank Material	Sand	Add 10 points.	•				•	
B	Silt / Clay	No adjustment.			·	·		
			Strat	fication				
	Add 5-10 p	oints depending	on position of	unstable laye	rs in relation t	o bankfull sta	ge.	

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



Ocular estimate - High

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

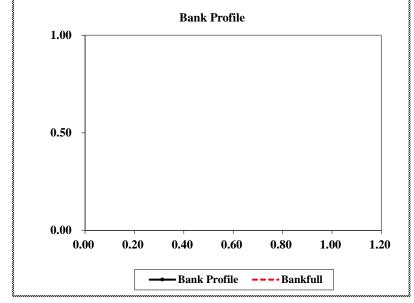
erosion	rate.									
			Estim	ating Nea	r-Bank St	ress ( NBS	3)			
Stream:	Tributa	ary to Five	Mile Creek		Location:	Rolling Ri	dge Park			
Station:	<b>RB-21</b>			S	tream Type:		,	√alley Type:		
Observe	rs:	IT RS						Date:	5/24/2022	
			Methods fo	or Estimati	ng Near-Ba	ank Stress	(NBS)			
(1) Chanı	nel pattern	, transverse bar	or split channe	l/central bar cre	eating NBS		Level I	Recona	issance	
(2) Ratio	of radius o	f curvature to b	ankfull width (F	R <sub>c</sub> / W <sub>bkf</sub> )			Level II	General prediction		
(3) Ratio	of pool slo	pe to average v	ater surface slo	ope (S <sub>p</sub> /S)			Level II	General	prediction	
(4) Ratio	of pool slo	pe to riffle slope	e (S <sub>p</sub> /S <sub>rif</sub> )				Level II	General	prediction	
(5) Ratio	of near-ba	nk maximum de	pth to bankfull	mean depth ( d	<sub>nb</sub> / d <sub>bkf</sub> )		Level III	Detailed	prediction	
(6) Ratio	of near-ba	nk shear stress	to bankfull she	ar stress ( τ <sub>nb</sub> /	τ <sub>bkf</sub> )		Level III	Detailed	prediction	
(7) Veloci	ity profiles	/ Isovels / Veloc	city gradient				Level IV	Valid	lation	
=								-		
Level	(1)									
ٽ				meander mig	ration, conver	ging flow		NE	35 = Extreme	
		Radius of	Bankfull	Ratio R <sub>c</sub> /	Near-Bank					
	(2)	Curvature R <sub>c</sub> (ft)	Width W <sub>bkf</sub> (ft)	W <sub>bkf</sub>	Stress (NBS)					
		0 ( )		DKI						
					Near-Bank		Method	1		
=	(2)	Pool Slope	Average		Stress		Dom	inant		
Level	(3)	S <sub>p</sub>	Slope S	Ratio S <sub>p</sub> / S	(NBS)		Near-Bar	nk Stress		
_							Hi	gh		
					Near-Bank		=		-	
	(4)	Pool Slope	Riffle Slope	Ratio S <sub>p</sub> /	Stress					
	( ',	S <sub>p</sub>	S <sub>rif</sub>	S <sub>rif</sub>	(NBS)	1				
		Near-Bank Max Depth	Mara Danda	Ratio d <sub>nb</sub> /	Near-Bank					
	(5)	d <sub>nb</sub> (ft)	Mean Depth d <sub>bkf</sub> (ft)	d <sub>bkf</sub>	Stress (NBS)					
=		TID ( )	DRI ( )	DIG						
Level III				Near-Bank			Bankfull			
Pe		Near-Bank		Shear			Shear		Near-Bank	
	(6)	Max Depth	Near-Bank	Stress τ <sub>nb</sub> (	Mean Depth		Stress $\tau_{bkf}$ (		Stress	
		d <sub>nb</sub> (ft)	Slope S <sub>nb</sub>	lb/ft <sup>2</sup> )	d <sub>bkf</sub> (ft)	Slope S	lb/ft <sup>2</sup> )	$ au_{bkf}$	(NBS)	
≥		Valasit : O	diant / ft /	Near-Bank						
Level IV	(7)	velocity Grad / f	dient (ft / sec	Stress (NBS)						
Ë			- /	(* )						
						01	00 5 4			
Noor F	Sank Ct-	Coi ess (NBS)	nverting Va	alues to a l	Near-Bank	Stress (NE ethod numb				
Medi-E	rating	•	(1)	(2)	(3)	(4)	(5)	(6)	(7)	
	Very Lo		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	
	Modera		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	
			(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	
	Verv Hi	gn	( ' )	1.50 - 1.00						
	Very Hi		Above	< 1.50	> 1.00	> 1.20	> 3.00	> 1.60	> 2.40	
	Very Hi			< 1.50		> 1.20	> 3.00	> 1.60		

Stream:	Tributary to Five Mile Creek	Observer(s):	IT RS	IT RS Data: IT QA/QC: RS To			Total Score:	Total Score:		NA				
Reach:		Comments:							Very Hi	Very High				
Location:	RB-22	Bank Length		19		Total Score	Very Low	Low	Moderate	High	Very High	Extreme		
Date:	5/24/2022					Values:	5-10	10-20	20-30	30-40	40-45	45-50		

		-	10.00. 77 1.11		
		E	rodibility Variabl	les	
Bank Height / Bankf	ull Height Ratio				
Bank Height	Bankfull Height	Value	Index	Bank Erosion Potental	Notes
5.20					
Root Depth / Bank H	eight Ratio				
Root Depth	Bank Height	Value	Index	Bank Erosion Potental	Notes
	5.20				
Weighted Root Densi	ity				
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					
	тот	AL SCORE	Very High		

			Bank Eros	ion Potential				
			Very Low	Low	Moderate	High	Very High	Extreme
	D	Value	1.00-1.10	1.11-1.19	1.20-1.50	1.60-2.00	2.10-2.80	>2.80
les	Bank Height / Bankfull Height	Index	1.0-1.9	2.0-3.9	4.0-5.9	6.0-7.9	8.0-9.0	10
Variables	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
	Root Deptil / Balik Height	Index	1.0-1.9	2.0-3.9	4.0-5.9	6.0-7.9	8.0-9.0	10
Erodibility	Weighted Root Density	Value	100-80	79-55	54-30	29-15	14-5	<5
dib	Weighted Root Delisity	Index	1.0-1.9	2.0-3.9	4.0-5.9	6.0-7.9	8.0-9.0	10
Ere	Bank Angle	Value	0-20	21-60	61-80	81-90	91-119	>119
	Dank Angie	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
	Surface Frotection	Index	1.0-1.9	2.0-3.9	4.0-5.9	6.0-7.9	8.0-9.0	10
			Adju	stments				
	Bedrock	Bedrock banks	have a very lo	w erosion po	tential.			
	Boulders	Boulder banks	have a low ere	osion potentia	l.			
ਾਫ	Cobble	Substract 10 po	oints. No adjus	stment if sand	gravel compo	se greater that	n 50% of bank	
iteri	Clay/Silt Loam	Add 5 points.						
Ma	Gravel	Add 5-10 point	s depending o	n percentage	of bank mater	ial composed	of sand.	
Bank Material	Sand	Add 10 points.						
B	Silt / Clay	No adjustment.						
			Strati	ification				
	Add 5-10 p	oints depending	on position of	funstable laye	rs in relation t	o bankfull sta	ge.	

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



Ocular estimate - Very High

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

erosion	Tale.									
	Estimating Near-Bank Stress ( NBS )									
Stream:	Tributa	ary to Five	Mile Creek		Location:	<b>Rolling Ri</b>	dge Park			
Station:	RB-22			S	tream Type:		,	Valley Type:		
Observe	rs:	IT RS						Date:	5/24/2022	
Methods for Estimating Near-Bank Stress (NBS)										
(1) Chanr	nel pattern	, transverse bai	or split channe	l/central bar cre	eating NBS		Level I	Recona	issance	
	·	f curvature to b	·		<u> </u>		Level II General predic			
						Level II General predict				
<ul> <li>(3) Ratio of pool slope to average water surface slope (S<sub>p</sub> / S)</li> <li>(4) Ratio of pool slope to riffle slope (S<sub>p</sub> / S<sub>rif</sub>)</li> </ul>							Level II	evel II General prediction		
		nk maximum de		mean depth ( d,	nh / dhkf )		Level III Detailed prediction			
		nk shear stress								
		/ Isovels / Veloc		(	*DKI 7		Level IV Validation			
_	., p			ars-short and/	or discontinuo	us				
Level	(1)		and/or central bars-short and/or discontinuousNBS = High / Very High eposition (continuous, cross-channel)							
Le		Chute cutoffs	, down-valley	meander mig	ration, conver	ging flow		NE	BS = Extreme	
		Radius of	Bankfull		Near-Bank					
	(2)	Curvature R <sub>c</sub> (ft)	Width W <sub>bkf</sub>	Ratio R <sub>c</sub> / W <sub>bkf</sub>	Stress (NBS)					
	,	iX <sub>C</sub> (it)	(ft)	V V bkf	(INDO)					
					N D I		Method	1		
=		Pool Slope	Average		Near-Bank Stress			inant		
Level II	(3)	S <sub>p</sub>	Slope S	Ratio S <sub>p</sub> / S	(NBS)		Near-Bar	nk Stress		
_							Hi	gh		
					Near-Bank	,				
	(4)	Pool Slope	Riffle Slope	Ratio S <sub>p</sub> /	Stress					
	(-)	S <sub>p</sub>	S <sub>rif</sub>	S <sub>rif</sub>	(NBS)	1				
						ļ				
		Near-Bank	5 4	Potio d /	Near-Bank					
	(5)	Max Depth d <sub>nb</sub> (ft)	Mean Depth d <sub>bkf</sub> (ft)	<i>Ratio</i> d <sub>nb</sub> / d <sub>bkf</sub>	Stress (NBS)					
=		* HD ( *)	S-DKI (1-7)	- DKI	(1126)					
Level III				Near-Bank		<del></del>	Bankfull			
Le		Near-Bank	_	Shear			Shear		Near-Bank	
	(6)	Max Depth	Near-Bank		Mean Depth		Stress $\tau_{bkf}$ (	Ratio $\tau_{nb}$ /	Stress	
		d <sub>nb</sub> (ft)	Slope S <sub>nb</sub>	lb/ft <sup>2</sup> )	d <sub>bkf</sub> (ft)	Slope S	lb/ft <sup>2</sup> )	$ au_{bkf}$	(NBS)	
≥		V-12 0	P 1 / ft /	Near-Bank						
Level IV	(7)	Velocity Grad	dient (ft/sec	Stress (NBS)						
Le l'		/ !	• /	(11,50)						
			41 11		l	0	0) 5 1			
Converting Values to a Near-Bank						Stress (NBS) Rating ethod number				
Near-Bank Stress (NBS) ratings		(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							
			Overall Inear-Dalik Stress (INDS) rating High					ייפ		

# Rolling Ridge Park – Stream Assessment Harborcreek Township, Pennsylvania

Photographic Log





Client: Harborcreek Township, PA

Site: Rolling Ridge Park

Project #: 7526210007

Photo: 1

Date: 5/24/2022

Photographer: INT

**Description: LB-1** 



Client: Harborcreek Township, PA

Site: Rolling Ridge

Park

Project #: 7526210007

Photo: 2

Date: 5/24/2022

**Photographer: INT** 

Description: LB-2,
Deposition



Site: Rolling Ridge

Project #: 7526210007

Photo: 3

Date: 5/24/2022

**Photographer: INT** 

**Description: LB-3** 



Client: Harborcreek Township, PA

Site: Rolling Ridge

Park

Project #: 7526210007

Photo: 4

Date: 5/24/2022

**Photographer: INT** 



Site: Rolling Ridge Park

Project #: 7526210007

Photo: 5

Date: 5/24/2022

**Photographer: INT** 

**Description: LB-6** 



Client: Harborcreek Township, PA

Site: Rolling Ridge

Park

Project #: 7526210007

Photo: 6

Date: 5/24/2022

**Photographer: INT** 



Site: Rolling Ridge Park

Project #: 7526210007

Photo: 7

Date: 5/24/2022

**Photographer: INT** 

Description: LB-8, Unnamed Tributary



Client: Harborcreek Township, PA

Site: Rolling Ridge

Park

Project #: 7526210007

Photo: 8

Date: 5/24/2022

**Photographer: INT** 



Site: Rolling Ridge Park

Project #: 7526210007

Photo: 9

Date: 5/24/2022

**Photographer: INT** 

**Description: LB-10** 



Client: Harborcreek Township, PA

Site: Rolling Ridge

Park

Project #: 7526210007

Photo: 10

Date: 5/24/2022

**Photographer: INT** 



Site: Rolling Ridge Park

Project #: 7526210007

Photo: 11

Date: 5/24/2022

**Photographer: INT** 

Description: LB-212,

Deposition



Client: Harborcreek Township, PA

Site: Rolling Ridge

Park

Project #: 7526210007

Photo: 12

Date: 5/24/2022

**Photographer: INT** 



Site: Rolling Ridge Park

Project #: 7526210007

Photo: 13

Date: 5/24/2022

**Photographer: INT** 

Description: LB-14,





Client: Harborcreek Township, PA

Site: Rolling Ridge

Park

Project #: 7526210007

Photo: 14

Date: 5/24/2022

**Photographer: INT** 



Site: Rolling Ridge Park

Project #: 7526210007

Photo: 15

Date: 5/24/2022

**Photographer: INT** 

**Description: LB-16** 



Client: Harborcreek Township, PA

Site: Rolling Ridge

Park

Project #: 7526210007

Photo: 16

Date: 5/24/2022

**Photographer: INT** 



Site: Rolling Ridge Park

Project #: 7526210007

Photo: 17

Date: 5/24/2022

**Photographer: INT** 

**Description: LB-19** 



Client: Harborcreek Township, PA

Site: Rolling Ridge

Park

Project #: 7526210007

Photo: 18

Date: 5/24/2022

**Photographer: INT** 



Site: Rolling Ridge Park

Project #: 7526210007

Photo: 19

Date: 5/24/2022

**Photographer: INT** 

Description: LB-21,

Deposition



Client: Harborcreek Township, PA

Site: Rolling Ridge

Park

Project #: 7526210007

Photo: 20

Date: 5/24/2022

**Photographer: INT** 



Site: Rolling Ridge Park

Project #: 7526210007

Photo: 21

Date: 5/24/2022

**Photographer: INT** 

Description: RB-1



Client: Harborcreek Township, PA

Site: Rolling Ridge

Park

Project #: 7526210007

Photo: 22

Date: 5/24/2022

**Photographer: INT** 



Site: Rolling Ridge Park

Project #: 7526210007

Photo: 23

Date: 5/24/2022

**Photographer: INT** 

Description: RB-3,
Deposition



Client: Harborcreek Township, PA

Site: Rolling Ridge

Park

Project #: 7526210007

Photo: 24

Date: 5/24/2022

**Photographer: INT** 



Site: Rolling Ridge Park

Project #: 7526210007

Photo: 25

Date: 5/24/2022

**Photographer: INT** 

Description: RB-5, Deposition, confluence of piped Five Mile Creek and tributary

Client: Harborcreek Township, PA

Site: Rolling Ridge

Park

Project #: 7526210007

Photo: 26

Date: 5/24/2022

**Photographer: INT** 





Site: Rolling Ridge Park

Project #: 7526210007

Photo: 27

Date: 5/24/2022

**Photographer: INT** 

Description: RB-7,
Deposition



Client: Harborcreek Township, PA

Site: Rolling Ridge

Park

Project #: 7526210007

Photo: 28

Date: 5/24/2022

**Photographer: INT** 



Site: Rolling Ridge Park

Project #: 7526210007

Photo: 29

Date: 5/24/2022

**Photographer: INT** 

Description: RB-9, Deposition



Client: Harborcreek Township, PA

Site: Rolling Ridge

Park

Project #: 7526210007

Photo: 30

Date: 5/24/2022

**Photographer: INT** 



Site: Rolling Ridge Park

Project #: 7526210007

Photo: 31

Date: 5/24/2022

**Photographer: INT** 

Description: RB-12



Client: Harborcreek Township, PA

Site: Rolling Ridge

Park

Project #: 7526210007

Photo: 32

Date: 5/24/2022

**Photographer: INT** 

Description: RB-13,

Deposition



Site: Rolling Ridge Park

Project #: 7526210007

Photo: 33

Date: 5/24/2022

**Photographer: INT** 

Description: RB-14



Client: Harborcreek Township, PA

Site: Rolling Ridge

Park

Project #: 7526210007

Photo: 34

Date: 5/24/2022

**Photographer: INT** 



Site: Rolling Ridge Park

Project #: 7526210007

Photo: 35

Date: 5/24/2022

**Photographer: INT** 

**Description: RB-16** 



Client: Harborcreek Township, PA

Site: Rolling Ridge

Park

Project #: 7526210007

Photo: 36

Date: 5/24/2022

**Photographer: INT** 



Site: Rolling Ridge Park

Project #: 7526210007

Photo: 37

Date: 5/24/2022

**Photographer: INT** 

**Description: RB-18** 



Client: Harborcreek Township, PA

Site: Rolling Ridge

Park

Project #: 7526210007

Photo: 38

Date: 5/24/2022

**Photographer: INT** 



Site: Rolling Ridge Park

Project #: 7526210007

Photo: 39

Date: 5/24/2022

**Photographer: INT** 

Description: RB-20,

Deposition



Client: Harborcreek Township, PA

Site: Rolling Ridge

Park

Project #: 7526210007

Photo: 40

Date: 5/24/2022

**Photographer: INT** 



Site: Rolling Ridge Park

Project #: 7526210007

Photo: 41

Date: 5/24/2022

**Photographer: INT** 

**Description: RB-22** 

Note: No photos for LB-5, LB-18, or RB-10



# Geotechnical Data Report

# Rolling Ridge Park Stream Restoration Erie, Pennsylvania

June 6, 2022 Terracon Project No. JD215067C

# **Prepared for:**

Wood Environment & Infrastructure Solutions Inc.
Chantilly, Virginia

# Prepared by:

Terracon Consultants, Inc. Ashburn, Virginia

Environmental Bracilities Geotechnical Materials

#### June 6, 2022



Wood Environment & Infrastructure Solutions Inc. 14424 Albemarle Point Place, Suite 115 Chantilly, Virginia 20151

Attn: Ms. Lynne Mowery, PE, CFM

P: (703) 488-3773

E: lynne.mowery@woodplc.com

Re: Geotechnical Data Report

Rolling Ridge Park Stream Restoration

3901 Brierwood Drive Erie, Pennsylvania

Terracon Project No. JD215067C

Dear Ms. Mowery:

We have completed the Geotechnical Data Report services for the above referenced project. This study was performed in general accordance with Terracon Proposal No. PJD225108 dated March 16, 2022. This data report presents the findings of the subsurface exploration for the above referenced project.

We appreciate the opportunity to be of service to you on this project. If you have any questions concerning this report or if we may be of further service, please contact us.

Sincerely,

**Terracon Consultants, Inc.** 

Dylan Nixon, PE Senior Staff Engineer Rebecca Smith-Zakowicz, PG, PE Principal

# **REPORT TOPICS**

INTRODUCTION	1
SITE CONDITIONS	1
PROJECT DESCRIPTION	1
BULK DENSITY TEST RESULTS	2
EQUILIBRIUM BED SLOPE	
GENERAL COMMENTS	
ATTACHMENTS	
ATTACTIMENTO	🤜

**Note:** This report was originally delivered in a web-based format. For more interactive features, please view your project online at <u>client.terracon.com</u>.

# **ATTACHMENTS**

EXPLORATION AND TESTING PROCEDURES SITE LOCATION AND EXPLORATION PLANS EXPLORATION RESULTS SUPPORTING INFORMATION

**Note:** Refer to each individual Attachment for a listing of contents.

# **Geotechnical Data Report**

# Rolling Ridge Park Stream Restoration Erie, Pennsylvania Terracon Project No. JD215067C

Terracon Project No. JD215067C June 6, 2022

## INTRODUCTION

This report presents the results of our subsurface exploration services performed for the proposed stream restoration to be located at Rolling Ridge Park in Erie, Pennsylvania.

The geotechnical engineering Scope of Services for this project included the collection of 3 hand auger samples to depths ranging from approximately 3 to 4 feet below existing site grades.

Maps showing the site and hand auger locations are shown in the **Site Location** and **Exploration Plan** sections, respectively. The results of the laboratory testing performed on soil samples obtained from the site during the field exploration are included in the **Exploration Results** section.

### SITE CONDITIONS

The following description of site conditions is derived from our site visit in association with the field exploration and our review of publicly available geologic and topographic maps.

Item	Description		
	The project is located at Rolling Ridge Park in Erie, Pennsylvania.		
Parcel Information	Latitude: 42.136525°, Longitude: -79.993038° (approximate)		
	See Site Location		
Current Ground Cover	Moderate to dense vegetation, steep stream banks		
<b>Existing Topography</b>	The approximate elevation (EL) at the site ranges from EL 828 to EL 799. The		
(from Google Earth)	elevation is in mean sea level.		
Geology	Our experience near the vicinity of the proposed development and readily available geologic maps indicates subsurface conditions consist of soils derived from the weathering of Girard shale and siltstone of the Devonian geologic period. Based on our subsurface investigation, the sediments and strata correspond favorably to the geologic publications.		

#### PROJECT DESCRIPTION

Our initial understanding of the project was provided in our proposal and was discussed during project planning. A period of collaboration has transpired since the project was initiated, and our final understanding of the project conditions is as follows:

#### **Geotechnical Data Report**

Rolling Ridge Park Stream Restoration Erie, Pennsylvania June 6, 2022 Terracon Project No. JD215067C



Item	Description				
Information Provided	<ul> <li>Emails and conversations with Wood ranging from January 31, 2022 to April 26, 2022</li> <li>Recommendations for Crediting Outfall and Gully Stabilizations Projects in the Chesapeake Bay Watershed prepared by the Water Quality Goal Implementation Team dated October 15, 2019</li> </ul>				
Project Description	The project includes stream restoration (in accordance with the Prevented Sediment Protocol for Urban Stream Restoration dated February 27, 2020) along the stream that flows through Rolling Ridge Park.				

### **BULK DENSITY TEST RESULTS**

A total of 3 soil samples were collected along the northeastern and southwestern streambanks along the existing stream using a 3-inch x 6-inch in-situ soil core sampling device, fitted with a drive hammer and plastic liner. Samples were collected by driving the coring cylinder into the ground and removing an intact, uncompacted cylindrical soil core. The plastic liner and core were then removed from the sampler, labeled, and capped. Soil cores were then cut to produce a perpendicular surface at the end of the plastic sleeve, and soil was ejected from the sleeve and placed into an oven drying tray. The samples were dried at 105 C° overnight (16 hours) and/or until no further weight change was recorded. Bulk density was calculated as the samples weight in pounds (lbs) divided by the sample size in cubic feet (cf), reported as lbs/cf.

Test was performed in accordance with the USDA-NRCS Bulk Density Soil Cores method was described in the Kellogg Soil Survey Laboratory Methods Manual, Soil Survey Investigation Report No. 42, Version 5.0, Issued 2014, pp. 138-140.

A summary of the bulk density test results is presented below:

Sample ID	Bulk Density (lbs/cf)	Sample Location
BD-1	58.4	Streambank
BD-2	87.5	Streambank
BD-3	54.1	Streambank

## **EQUILIBRIUM BED SLOPE**

Based on the requirements outlined in the Recommendations for Crediting Outfall and Gully Stabilization Projects in the Chesapeake Bay Watershed prepared by the Water Quality Goal Implementation Team dated October 15, 2019, it is our recommendation that the bed slope equation for "Cohesive Bed" is utilized in design. The results of our grain size analysis with

#### **Geotechnical Data Report**

Rolling Ridge Park Stream Restoration Erie, Pennsylvania June 6, 2022 Terracon Project No. JD215067C



hydrometer testing showed the majority of the particle sizes in the samples tested were <0.1 mm in size.

Cohesive Bed	$S_{\text{eq}} = 0.0028A^{-0.33}$				
Sand and Fine Gravel (0.1-5mm particle size)	Seq= 0.06 / (y * 62.43)				
Beds Coarser than Sand (>5mm particle size)	Average of 4 Equations Details can be found in 2.1.3 of Appendix A.				
	s drainage area (km²), and y is mean flow ear stress, a 10-year recurrence interval can mediate suspended sediment concentration				

## **GENERAL COMMENTS**

(1,000 to 2,000 ppm) can be assumed.

Our analysis and opinions are based upon our understanding of the project, the geotechnical conditions in the area, and the data obtained from our site exploration. Natural variations will occur between exploration point locations or due to the modifying effects of construction or weather. The nature and extent of such variations may not become evident until during or after construction. Terracon should be retained as the Geotechnical Engineer, where noted in this report, to provide observation and testing services during pertinent construction phases. If variations appear, we can provide further evaluation and supplemental recommendations. If variations are noted in the absence of our observation and testing services on-site, we should be immediately notified so that we can provide evaluation and supplemental recommendations.

Our Scope of Services does not include either specifically or by implication any environmental or biological (e.g., mold, fungi, bacteria) assessment of the site or identification or prevention of pollutants, hazardous materials or conditions. If the owner is concerned about the potential for such contamination or pollution, other studies should be undertaken.

Our services and any correspondence or collaboration through this system are intended for the sole benefit and exclusive use of our client for specific application to the project discussed and are accomplished in accordance with generally accepted geotechnical engineering practices with no third-party beneficiaries intended. Any third-party access to services or correspondence is solely for information purposes to support the services provided by Terracon to our client. Reliance upon the services and any work product is limited to our client, and is not intended for third parties. Any use or reliance of the provided information by third parties is done solely at their own risk. No warranties, either express or implied, are intended or made.

#### **Geotechnical Data Report**

Rolling Ridge Park Stream Restoration • Erie, Pennsylvania June 6, 2022 • Terracon Project No. JD215067C



Site characteristics as provided are for design purposes and not to estimate excavation cost. Any use of our report in that regard is done at the sole risk of the excavating cost estimator as there may be variations on the site that are not apparent in the data that could significantly impact excavation cost. Any parties charged with estimating excavation costs should seek their own site characterization for specific purposes to obtain the specific level of detail necessary for costing. Site safety, and cost estimating including, excavation support, and dewatering requirements/design are the responsibility of others. If changes in the nature, design, or location of the project are planned, our conclusions and recommendations shall not be considered valid unless we review the changes and either verify or modify our conclusions in writing.

# **ATTACHMENTS**

#### **EXPLORATION AND TESTING PROCEDURES**

### Field Exploration

Number of Hand-Auger Borings	Boring Depth (feet)	Planned Location			
3	3-4	Rolling Ridge Park stream			

**Boring Layout and Elevations:** Unless otherwise noted, Terracon personnel provided the boring layout.

**Subsurface Exploration Procedures:** We advanced the borings using hand augers. One composite sample was obtained in the upper 3 to 4 feet of each hand auger boring. For safety purposes, all hand auger borings were backfilled with auger cuttings after their completion.

### **Laboratory Testing**

The project engineer reviewed the field data and assigned laboratory tests to understand the engineering properties of the various soil strata, as necessary, for this project. Procedural standards noted below are for reference to methodology in general. In some cases, variations to methods were applied because of local practice or professional judgment. Standards noted below include reference to other, related standards. Such references are not necessarily applicable to describe the specific test performed.

- ASTM D2216 Standard Test Methods for Laboratory Determination of Water (Moisture)
   Content of Soil and Rock by Mass
- ASTM D4318 Standard Test Methods for Liquid Limit, Plastic Limit, and Plasticity Index of Soils
- ASTM D422 Standard Test Method for Particle-Size Analysis of Soils
- ASTM D798 Standard Test Method for Particle-Size Distribution (Gradation) of Fine-Grained Soils Using the Sedimentation (Hydrometer) Analysis

The laboratory testing program often included examination of soil samples by an engineer. Based on the material's texture and plasticity, we described and classified the soil samples in accordance with the Unified Soil Classification System.

# SITE LOCATION AND EXPLORATION PLANS

### **Contents:**

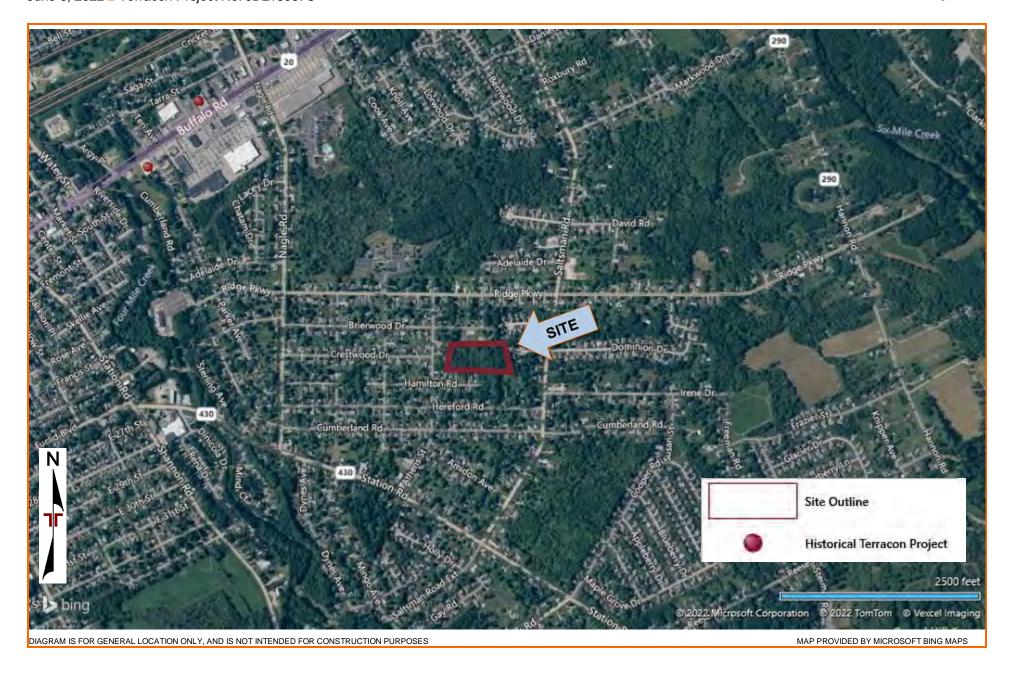
Site Location Plan Exploration Plan

Note: All attachments are one page unless noted above.

#### SITE LOCATION

Rolling Ridge Park Stream Restoration • Erie, Pennsylvania June 6, 2022 • Terracon Project No. JD215067C





#### **EXPLORATION PLAN**

Rolling Ridge Park Stream Restoration • Erie, Pennsylvania June 6, 2022 • Terracon Project No. JD215067C





# **EXPLORATION RESULTS**

## **Contents:**

Atterberg Limits & Grain Size Distribution Test Results (3 pages)

Note: All attachments are one page unless noted above.

## **SUMMARY OF LABORATORY RESULTS**

ATE.GDT 5/12/22	BORING ID	Depth	USCS Classification and Soil Description	AASHTO Class.	Munsell Color	Liquid Limit	Plastic Limit	Plasticity Index	% <#200 Sieve	% Gravel	% Sand	% Silt	% Clay	Water Content (%)	Optimum Moisture Content (%)	Maximum Dry Density, (pcf)*
'ATEMPL	B-1	0 - 3	SILT with SAND(ML)	A-4 (5)		34	27	7	76.8	0.1	23.1	63.8	13.0	32		
TATE	B-2	0 - 3	SILTY, CLAYEY SAND with	A-4 (0)		23	18	5	39.1	16.5	44.4	29.4	9.8	18		
J_DAT			GRAVEL(SC-SM)													
ACON	B-3	0 - 4	CLAYEY SAND(SC)	A-6 (2)		28	17	11	47.3	7.7	45.0	31.7	15.6	16		

\*Per IDOT Matls. IM 309, Single-Point Method. \*\*Soil of Glacial Origin

PROJECT: Rolling Ridge Park Stream Restoration

SITE: 3901 Brierwood Dr Erie, PA

PH. 703-726-8030 FAX.

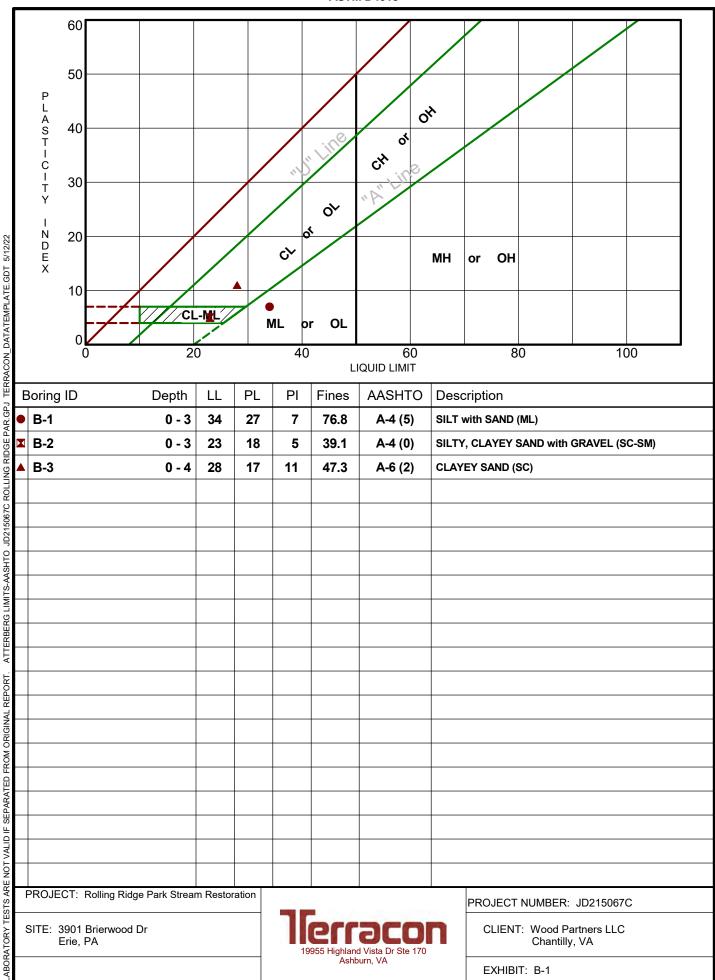
PROJECT NUMBER: JD215067C

CLIENT: Wood Partners LLC Chantilly, VA

EXHIBIT: B-1

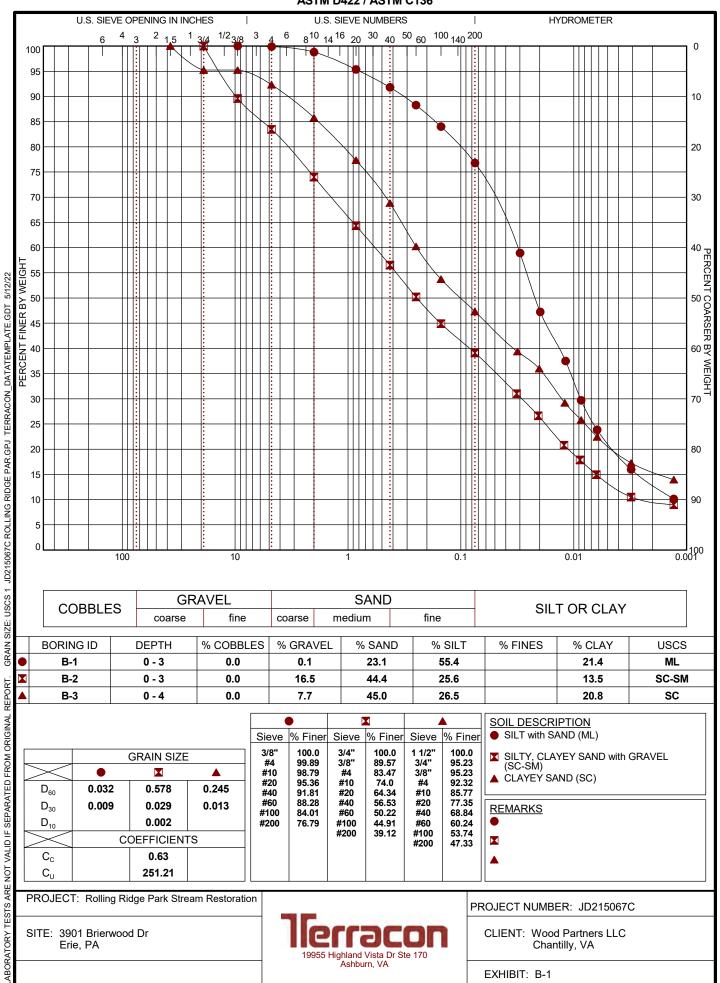
# ATTERBERG LIMITS RESULTS

**ASTM D4318** 



### **GRAIN SIZE DISTRIBUTION**

**ASTM D422 / ASTM C136** 



19955 Highland Vista Dr Ste 170 , Ashburn, VA

EXHIBIT: B-1

# **SUPPORTING INFORMATION**

## **Contents:**

General Notes Unified Soil Classification System

Note: All attachments are one page unless noted above.

### **GENERAL NOTES**

SAMPLING	WATER LEVEL	FIELD TESTS		
	Water Initially Encountered	N	Standard Penetration Test Resistance (Blows/Ft.)	
	Water Level After a Specified Period of Time	(HP)	Hand Penetrometer	
Grab Sample		(T)	Torvane	
	Cave In Encountered	(DCP)	Dynamic Cone Penetrometer	
	Water levels indicated on the soil boring logs are the levels measured in the borehole at the times indicated. Groundwater level variations will occur	UC Unconfined Compressive Strength		
	over time. In low permeability soils, accurate determination of groundwater levels is not possible with short term water level observations.	(PID) Photo-Ionization Detector		
		(OVA)	Organic Vapor Analyzer	

#### DESCRIPTIVE SOIL CLASSIFICATION

Soil classification as noted on the soil boring logs is based Unified Soil Classification System. Where sufficient laboratory data exist to classify the soils consistent with ASTM D2487 "Classification of Soils for Engineering Purposes" this procedure is used. ASTM D2488 "Description and Identification of Soils (Visual-Manual Procedure)" is also used to classify the soils, particularly where insufficient laboratory data exist to classify the soils in accordance with ASTM D2487. In addition to USCS classification, coarse grained soils are classified on the basis of their in-place relative density, and fine-grained soils are classified on the basis of their consistency. See "Strength Terms" table below for details. The ASTM standards noted above are for reference to methodology in general. In some cases, variations to methods are applied as a result of local practice or professional judgment.

#### **LOCATION AND ELEVATION NOTES**

Exploration point locations as shown on the Exploration Plan and as noted on the soil boring logs in the form of Latitude and Longitude are approximate. See Exploration and Testing Procedures in the report for the methods used to locate the exploration points for this project. Surface elevation data annotated with +/- indicates that no actual topographical survey was conducted to confirm the surface elevation. Instead, the surface elevation was approximately determined from topographic maps of the area.

	STRENGTH TERMS								
RELATIVE DENSITY	OF COARSE-GRAINED SOILS	CONSISTENCY OF FINE-GRAINED SOILS							
	retained on No. 200 sieve.)  Standard Penetration Resistance	(50% or more passing the No. 200 sieve.)  Consistency determined by laboratory shear strength testing, field visual-manual procedures or standard penetration resistance							
Descriptive Term (Density)	Standard Penetration or N-Value Blows/Ft.	Descriptive Term (Consistency) Unconfined Compressive Strength Qu, (tsf) Standard Penetra N-Value Blows/Ft.							
Very Loose	0 - 3	Very Soft	Very Soft less than 0.25						
Loose	4 - 9	Soft	0.25 to 0.50	2 - 4					
Medium Dense	10 - 29	Medium Stiff	0.50 to 1.00	4 - 8					
Dense	30 - 50	Stiff	1.00 to 2.00	8 - 15					
Very Dense	> 50	Very Stiff	2.00 to 4.00	15 - 30					
		Hard	> 4.00	> 30					

#### RELEVANCE OF SOIL BORING LOG

The soil boring logs contained within this document are intended for application to the project as described in this document. Use of these soil boring logs for any other purpose may not be appropriate.





		Soil Classification			
Criteria for Assign	Group Symbol	Group Name <sup>B</sup>			
		Clean Gravels:	Cu ≥ 4 and 1 ≤ Cc ≤ 3 <sup>E</sup>	GW	Well-graded gravel F
	Gravels: More than 50% of	Less than 5% fines <sup>C</sup>	Cu < 4 and/or [Cc<1 or Cc>3.0] E	GP	Poorly graded gravel F
	coarse fraction retained on No. 4 sieve	Gravels with Fines:	Fines classify as ML or MH	GM	Silty gravel F, G, H
Coarse-Grained Soils: More than 50% retained	retained on No. 4 Sieve	More than 12% fines <sup>C</sup>	Fines classify as CL or CH	GC	Clayey gravel F, G, H
on No. 200 sieve		Clean Sands:	Cu ≥ 6 and 1 ≤ Cc ≤ 3 <sup>E</sup>	SW	Well-graded sand
	Sands: 50% or more of coarse fraction passes No. 4	Less than 5% fines D	Cu < 6 and/or [Cc<1 or Cc>3.0] E	SP	Poorly graded sand
		Sands with Fines:	Fines classify as ML or MH	SM	Silty sand G, H, I
	sieve	More than 12% fines D	Fines classify as CL or CH	SC	Clayey sand <sup>G, H, I</sup>
		Ingrapia	PI > 7 and plots on or above "A"	CL	Lean clay <sup>K, L, M</sup>
	Silts and Clays:	Inorganic:	PI < 4 or plots below "A" line J	ML	Silt K, L, M
	Liquid limit less than 50	Organic:	Liquid limit - oven dried	OL	Organic clay K, L, M, N
Fine-Grained Soils: 50% or more passes the		Organic.	Liquid limit - not dried	OL	Organic silt K, L, M, O
No. 200 sieve		Inorganic:	PI plots on or above "A" line	CH	Fat clay <sup>K, L, M</sup>
	Silts and Clays:	morganic.	PI plots below "A" line	MH	Elastic Silt K, L, M
	Liquid limit 50 or more	Organic:	Liquid limit - oven dried	ОН	Organic clay K, L, M, P
	Organic.		Liquid limit - not dried	011	Organic silt K, L, M, Q
Highly organic soils:	Primarily	PT	Peat		

- A Based on the material passing the 3-inch (75-mm) sieve.
- <sup>B</sup> If field sample contained cobbles or boulders, or both, add "with cobbles or boulders, or both" to group name.
- Gravels with 5 to 12% fines require dual symbols: GW-GM well-graded gravel with silt, GW-GC well-graded gravel with clay, GP-GM poorly graded gravel with silt, GP-GC poorly graded gravel with clay.
- D Sands with 5 to 12% fines require dual symbols: SW-SM well-graded sand with silt, SW-SC well-graded sand with clay, SP-SM poorly graded sand with silt, SP-SC poorly graded sand with clay.

E 
$$Cu = D_{60}/D_{10}$$
  $Cc = \frac{(D_{30})^2}{D_{10} \times D_{60}}$ 

- $^{\text{F}}$  If soil contains  $\geq$  15% sand, add "with sand" to group name.
- <sup>G</sup> If fines classify as CL-ML, use dual symbol GC-GM, or SC-SM.

- $\ensuremath{^{\textbf{H}}}\xspace$  If fines are organic, add "with organic fines" to group name.
- If soil contains ≥ 15% gravel, add "with gravel" to group name.
- Jelf Atterberg limits plot in shaded area, soil is a CL-ML, silty clay. □
- K If soil contains 15 to 29% plus No. 200, add "with sand" or "with gravel," whichever is predominant.
- Left soil contains ≥ 30% plus No. 200 predominantly sand, add "sandy" to group name.
- MIf soil contains ≥ 30% plus No. 200, predominantly gravel, add "gravelly" to group name.
- $^{N}$  PI  $\geq$  4 and plots on or above "A" line.
- OPI < 4 or plots below "A" line.
- P PI plots on or above "A" line.
- PI plots below "A" line.

