Vermont Stream Geomorphic Assessment

Appendix A - Phase 2 Field Forms

Field Notes Form for Steps 1 - 5

Cross-Section Worksheet

Field Quick Refer Tables

Quality Assurance Data Sheet

Rapid Habitat Assessment (RHA)

Rapid Geomorphic Assessment (RGA)

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Rapid Stream Assessment Field Notes

Stream Name:_____ Segment I.D: _____ ☐ Sub-Reach
Location: _____ Date:_____
_____ Town:_____
Observers: _____ Segment Length: _____ ft.
Organization /Agency: _____ Segment Not Assessed: W/I/N/G/B/O
Weather:_____ Rain Storm within past 7 days: Y / N
Flood history known: Y / N (date of known flood _____)
Segment Impacted by TSI Flooding or recent flood (within last 1-5 yrs) Y/N; Segment Altered by Flood Work Y/N

1. Valley and River Corridor

1.1 Segmentation: GC/CD/SS/PS/DF/CE/BB/FS/PA/SR/VW/OT/None
1.2 Alluvial Fan (FIT): Yes/No/UK

1.3 River Corridor Encroachments (FIT)	**Reach or Segment Length**			**1.4 Slope of the Adjacent Terrace or Hillside**	
	One Bank	**Both Banks**	**Height from tw**	**Left Corridor**	**Right Corridor**
Berms				flat (0-3%) hilly (4-8%) steep (9-15%) very steep (16-25%) x-steep (>25%) **Continuous w/bank** A / S / N **Within 1x Wbkf** A / S / N Texture of Exposed Slope till boulder/cobble gravel sand silt clay bedrock other Not Evaluated	flat (0-3%) hilly (4-8%) steep (9-15%) very steep (16-25%) x-steep (>25%) **Continuous w/bank** A / S / N **Within 1x Wbkf** A / S / N Texture of Exposed Slope till boulder/cobble gravel sand silt clay bedrock other Not Evaluated
Roads					
Railroads					
Improved Paths					
Development			NA		

1.5 Confinement *Valley width / Channel width*	**1.6 Grade Controls (FIT)** ☐ none — Fill out height fields for grade controls if applicable → **Location in Reach** (record locations on field map) **Waterfall // Ledge // Dam // Weir**	Total Height (0.0 ft)	Height Above Water Surface (0.0 ft)	Photo Yes / No
Valley Width:_____ ☐ Gorge Estimated / Measured ☐ Human caused change in valley width				
Narrowly Confined (>=1 & < 2)				
Semi-confined (>2 & < 4)				
Narrow (>= 4 & < 6)				
Broad (>= 6 & <10)				
Very Broad (>= 10)				

2. Stream Channel

2.1 Bankfull Width: _____ ft. **2.1a Wetted Width:** _____ ft.

2.1b Ratio (W_{wetted} / W_{bkf}):_____ **2.2 Max. Bankfull Depth:** _____ ft. **2.3 Mean Bankfull Depth:**_____ ft.

2.4 Floodprone Width: _____ft. **2.5 Recently Abandoned FP :** _____ ft. **2.6 Ratio W/d_{mean}:**_____

2.7 Entrenchment: _____ **2.8 Incision Ratio:** _____ IR_{hef} **:**_____ **2.9 Sinuosity:** _____

2.10 Riffles/Steps: complete / eroded / sedimented / NA / NE **2.11 Riffle/Step Spacing:** _____ ft.

Dimensions Altered by Flood Y/N ; Altered by Flood Work Y/N ; Channel Enlargement Measure = _____

2.12 Bed Substrate Composition (percent):

1 **Bedrock**	2 **Boulder**	3 **Cobble**	4 **Gravel** Course	Fine	5 **Sand**	6 **Silt or Clay**	**Embeddedness** Mean Channel	Mean Margin	**2.13 Avg. Size of Largest Particles on:** Bed:_____ Bar:_____ **circle**: inches or millimeters **2.13a** % Exp. Substrate:_____
						Y / N			

2.14 Stream Type: A G F B E C D 1 2 3 4 5 6 a b c
Cascade Step-Pool Plane Bed Riffle-Pool Ripple-Dune Braided ☐Reference Type

Stream Type

3. Riparian banks, Buffers, and Corridors

3.1	**Typical Bank Slope**		shallow	moderate	steep	undercut	**(evaluate on the higher of the two banks)**					
	Bank Texture-RB	**Lower**	bedrock	boulder/cobble	gravel	sand	silt/clay	mix	cohesive / non-cohesive			
		Upper	bedrock	boulder/cobble	gravel	sand	silt/clay	mix	cohesive / non-cohesive			
	Bank Texture-LB	**Lower**	bedrock	boulder/cobble	gravel	sand	silt/clay	mix	cohesive / non-cohesive			
		Upper	bedrock	boulder/cobble	gravel	sand	silt/clay	mix	cohesive / non-cohesive			
	Bank Erosion (FIT)	**Left**	**Length:** ft.	**Height:** ft.	**Bank Revetment Type:**	**Length:** ft.						
		Right	**Length:** ft.	**Height:** ft.	**Bank Revetment Type:**	**Length:** ft.						
	Near Bank Vegetation Type	**Trees**	L % cover	Invasive	Conifer	Deciduous	R % cover	Invasive	Conifer	Deciduous		
		Shrubs / Saps.	L % cover	Invasive	WADs	Saplings	R % cover	Invasive	WADs	Saplings		
		Herbs	L % cover	Invasive	Grasses	Forbs	R % cover	Invasive	Grasses	Forbs		
	Bank Canopy	**Left**	76 - 100%	51 - 75%	26 - 50%	1 - 25%	0%	**Channel Canopy**				
		Right	76 - 100%	51 - 75%	26 - 50%	1 - 25%	0%	Open	Closed			
3.2	**Buffer Width (dom/sub) (FIT 0-25 ft)**	**Left**	0 – 25 ft.	26 – 50 ft.	51 – 100 ft.	> 100 ft	none (SD).					
		Right	0 – 25 ft.	26 – 50 ft.	51 – 100 ft.	> 100 ft	none (SD).					
	Buffer Vegetation Type	**Trees**	L % cover	Invasive	Conifer	Deciduous	R % cover	Invasive	Conifer	Deciduous		
		Shrubs / Saps.	L % cover	Invasive	WADs	Saplings	R % cover	Invasive	WADs	Saplings		
		Herbs	L % cover	Invasive	Grasses	Forbs	R % cover	Invasive	Grasses	Forbs		
3.3	**Riparian Corridor (dom/sub)**	**Left**	forest	shrub-sapling	crop/pasture/hay	commercial/industrial	residential	bare	none (SD)			
		Right	forest	shrub-sapling	crop/pasture/hay	commercial/industrial	residential	bare	none (SD)			

4.1 Springs or Seeps: extensive /present / minimum / none / altered **4.2 Adjacent Wetlands**: extensive / present / minimum/none/altered

4.3 Flow status: base / low / avg. **4.4 Current Debris Jams (FIT)**: #_____

Flood related jam yes/no ; If yes = Significant for (all that apply) habitat/channel adjustment / flood damage concerns

4.5 Flow Regs. & Withdrawals (FIT): TYPE: withdrawal / bypass / r-o-r / store & release / none / unk
SIZE : small / large ; **USE:** drinking / irrigation, flood-control / hydro-electric / recreation /other

4.6 Upstream/Downstream Flow Regs. : upstream / downstream / both / none

4.7 Stormwater Inputs (FIT): tile drain ___ / road ditch___ / urban stormwater ___ / field ditch ___/ overland flow ___

4.8 Constrictions ☐ none **menu**: instream culvert // bridge // old abutment // bedrock outcrop // other

						Problems (check all that apply)					
Constriction Type (from menu	**Width** (ft)	**Photo** Yes / No		channel constriction	floodprone constriction	deposition above	deposition below	scour above	scour below	alignment	none
				☐	☐						
				☐	☐						
				☐	☐						

4.9 Beaver Dams (FIT): # _____ _____ft. of the segment affected. ☐ Bridge & Culvert Assessments

5. Channel Bed and Planform Changes **(5.0 to 5.3 record on tally sheet)**

5.4 Stream Ford or Animal Crossing (FIT): Yes / No

5.5 Channel Alterations (FIT) (circle all that apply): dredging gravel mining commercial mining none
Length of Straightening: _____ (With Windrowing : Yes / No) Alteration from Flood Work Yes/No

Flood Berms : material from channel / material pushed out of field / notes _____

Comments:

Sketch Form for Sites – Segments – Reaches

Stream Name:_____ Segment or Site ID: _____
Date:_____ Town:_____
Observers:_____ Elevation: _____ Ft.
Organization /Agency: _____

Site Sketch - see reverse side for sketch codes and tally columns for left and right bank erosion, revetments, and corridor developments and calculating the total length of the segment affected by beaver flowages.

Height of bankfull features above water surface (Ft.)

_____ _____ _____ _____ _____ Selected BKF Height

_____ _____ _____ _____ _____ _____

Constrictions α

LWD tally
Debris Jams
Stormwater

FIT Features

Parameters	Map Codes and Sketch Examples
Alluvial Fan	**AF**
Bank Revetments	**rprp** XXXXXXXX Rip Rap **trvt** XXXXXXXX Tree-revetment
Bars and other Depositional Features	**Pbr** Point Bar **Mbr** Mid-channel Bar **Dbr** Diagonal Bar **Dtbr** Delta Bar **Sbr** Side Bar **BS** – -Bar
Bed Features	**Rf** Riffle **Stp** Step **P** Pool
Bedrock	BR
Benchmark Locations	**BM**
Berms	B
Buffers	**Bfr** ∈∈∈∈∈∈∈∈∈
Chutes, Cut-offs and Avulsions	**FC** Flood Chutes **NC** Neck Cut-off **CA** Channel Avulsion
Cross Section Locations and Number	**CS#**___
Culverts and Bridges	**Cul** Culvert **Brg** Bridge
Debris Jam Locations	**DJ** Debris Jam
Developments	**D-R** Residential **D-C** Commercial / Industrial
Eroding E Scale:	**BF** Bank Failure **MF** Mass Failure
Floodplains and Terraces	**Fp** Floodplain **Tr** Terrace
Flow Direction	
Flow Regulation or Withdrawal Structures	**Dam** **Weir** **Snow** Snowmaking **Irrig** Irrigation
Grade Controls	**GC** (also note type of control)
Head-cuts and Steep Riffles	**HC** Head Cut **ST** Steep Riffle
Longitudinal Profile	**LP-start** and **LP-end**
North Arrow	**N**
Pebble Count (mark start and end points)	PC-start **and** PC-end
Photo Points	**P#** **(# to correspond w/ photo log #)**
Reach and Segment start/end points (also include reach number from Phase 1 data)	**R-start** and **S-start** **R-end** and **S-end**
Roads, Railroads, Improved Paths	**RD** Roads **RR** Railroads **IP** Improved Path
Seep / Spring	**S**
Stormwater Features	**SI** Stormwater Input **G** Gulley
Stream Fords or Animal Crossings	**SF** Stream Ford **AC** Animal Crossing
Tributary	**Trib**

List showing the field data that will need exact location in the FIT

Impact	Shape	Sub-Impact
Beaver Dam	Point	N/A
Cross Section Location	Point	NOT Representative Representative
Debris Jam	Point	N/A
Gully	Point	N/A
Mass Failure	Polyline	N/A
Steep Riffle or Head Cut	Point	Head Cut Steep Riffle
Storm Water Input	Point	Field Ditch Other Overland Flow Road Ditch Tile Drain Urban Storm Water Pipe
Stream Crossing	Point	Animal Crossing Stream Ford
PHASE	**1**	**UPDATE**
Alluvial Fan	Point	N/A
Bank Armoring or Revetment	Polyline	Rip-Rap Hard Bank Other
Bridge and Culvert	Point	Bridge Culvert Other
Buffer Less than 25 feet	Polyline	N/A
Development	Polyline	N/A
Dredging	Polyline	Commercial Mining Dredging Gravel Mining
Encroachment	Polyline	Berm Improved Path Railroad Road
Erosion	Polyline	N/A
Flow Regulation and Water Withdrawal	Point	Large Bypass Large Run of River Large Store and Release Large Withdrawal Small Bypass Small Run of River Small Store and Release Small Withdrawal
Grade Control	Point	Dam Ledge Waterfall Weir
Migration	Point	Avulsion Braiding Flood Chute Neck Cutoff
Straightening	Polyline	Straightening With Windrowing

Database - Photo Log

Photo ID: ___________________
Photo Date: _________________
Photographer:________________________

Site ID (If location is in Sites table): ______________
Stream Name: ______________________________
Town:________________________________
Waterbody ID: __________________
Valley Type: ___________________
XS #: ___________

Photo Type: aerial photo / digital photo / referenced aerial
Site Type: degraded / gage / reference / restoration
Instability Type: dimension / hydrology / lateral / pattern profile / sediment regime
Management Activities: floodplain / in channel / riparian / watershed

- ☐ Graphic Enhanced
- ☐ Clear Bankfull Indicators
- ☐ People
- ☐ Structure
- ☐ Monitoring Photo point

Database - Photo Log

Photo ID: ___________________
Photo Date: _________________
Photographer:________________________

Site ID (If location is in Sites table): ______________
Stream Name: ______________________________
Town:________________________________
Waterbody ID: __________________
Valley Type: ___________________
XS #: ___________

Photo Type: aerial photo / digital photo / referenced aerial
Site Type: degraded / gage / reference / restoration
Instability Type: dimension / hydrology / lateral / pattern profile / sediment regime
Management Activities: floodplain / in channel / riparian / watershed

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- ☐ Clear Bankfull Indicators
- ☐ People
- ☐ Structure
- ☐ Monitoring Photo point

Database - Photo Log

Photo ID: ___________________
Photo Date: _________________
Photographer:________________________

Site ID (If location is in Sites table): ______________
Stream Name: ______________________________
Town:________________________________
Waterbody ID: __________________
Valley Type: ___________________
XS #: ___________

Photo Type: aerial photo / digital photo / referenced aerial
Site Type: degraded / gage / reference / restoration
Instability Type: dimension / hydrology / lateral / pattern profile / sediment regime
Management Activities: floodplain / in channel / riparian / watershed

- ☐ Graphic Enhanced
- ☐ Clear Bankfull Indicators
- ☐ People
- ☐ Structure
- ☐ Monitoring Photo point

Database - Photo Log

Photo ID: ___________________
Photo Date: _________________
Photographer:________________________

Site ID (If location is in Sites table): ______________
Stream Name: ______________________________
Town:________________________________
Waterbody ID: __________________
Valley Type: ___________________
XS #: ___________

Photo Type: aerial photo / digital photo / referenced aerial
Site Type: degraded / gage / reference / restoration
Instability Type: dimension / hydrology / lateral / pattern profile / sediment regime
Management Activities: floodplain / in channel / riparian / watershed

- ☐ Graphic Enhanced
- ☐ Clear Bankfull Indicators
- ☐ People
- ☐ Structure
- ☐ Monitoring Photo point

Standard Photo Log

Reach or Segment Number	GPS coordinates	Photo View* or Feature	Photo Description

6. Photo views would include upstream, downstream, right bank, left bank, cross-section, etc.

Tally Sheet (page 1)

Stream Name:_____ Segment I.D: _____
Location: _____ Date:_____

☐ Sub-Reach

Step 2.1 Height of bankfull above water surface

Bankfull Height	Chan. Wdth	Comments (describe indicators)

Step 5. Channel Bed and Planform Changes

Record actual number of features			Tally
5.1	Depositional Features (Bar Type)	Mid	
		Point	
		Side	
		Diagonal	
		Delta	
		Island	
5.2 FIT	Flood Chutes		
	Neck Cut-offs		
	Channel Avulsions		
	Braiding		
	Migration		
5.3 FIT	Aggrade	Steep Riffles	
	Degrade	Head Cuts	
	Tributary Rejuvenation?	Yes / No	

Step 3.1 Bank Erosion **FIT**

Left Bank Length	Height	Right Bank Length	Height
Total:	**Avg.**	**Total:**	**Avg.**

Step 3.3 Mass Failures and Gullies **FIT**

Mass Fail - Length		Height	Gully - Length		Length
Left	Right		Left	Right	

Step 3.1 Bank Revetment **FIT**

Length	
Left Bank	**Right Bank**
Total:	**Total:**

Step 4.8 Channel Constrictions

	Constriction Type	Width	Photo?	GPS?	Ch. Constr.	FP. Constr.	DA	DB	SA	SB	A	None
1.)												
2.)												
3.)												
4.)												
5.)												

		Tally
Step 2.12	**Large Woody Debris**	
Step 4.4	**Debris Jams**	

Step 2.11	**Riffle/Step Spacing:**		
Step 2.13	**Avg. Largest Particle**	**On Bed:**	**On Bar:**

Step 1.3 River Corridor Encroachments **FIT**

Type	Length		Height of Fill
	One Side	Both Sides	

Step 4.6 Stormwater **FIT**

	Tally
Field Ditch	
Overland Flow	
Road Ditch	
Tile Drain	
Urban Stormwater	
Other	

Tally Sheet (page 2)

Stream Name:_____ Segment I.D: _____
Location: _____ Date:_____

☐ Sub-Reach

Note CPOM, algae, location of fines

6.1 Large Woody Debris and Jams

Rank	D_{large} (ft)	L (w_{bkf})	Tally	#	%
1	0.5 - 1.0	< 0.5			
2	0.5 - 1.0	> 0.5			
3	1.0 - 2.0	< 0.5			
4	1.0 - 2.0	> 0.5			
5	> 2.0	< 0.5			
6	> 2.0	> 0.5			
		Total LWDs			
		# LWDs / mile			
		# Debris jams			
		# Debris jams / mile			

6.2 Pools (note vegetative cover, surface turbulence, fines)

Rank	D (ft)	L,W (w_{bkf})	Tally	#	%
1	1.0 - 2.0	< 0.5			
2	1.0 - 2.0	> 0.5			
3	2.0 - 3.0	< 0.5			
4	2.0 - 3.0	> 0.5			
5	> 3.0	< 0.5			
6	> 3.0	> 0.5			
7	> 3.0	≥ 1.0			
		Total pools			
		# Pools / mile			

6.3 Refuge Areas / Connections

ID	Location	Q_{access}	Notes
	in / out	low / bkf	
	in / out	low / bkf	
	in / out	low / bkf	
	in / out	low / bkf	
	in / out	low / bkf	
	in / out	low / bkf	
	in / out	low / bkf	

6.4 Undercut Banks (note stability, overhanging vegetation)

Rank	D_{max} (ft)	L (ft)	Tally	#	%
1	0.5 – 1.0	< 2.0			
2	0.5 – 1.0	> 2.0			
3	1.0 – 2.0	< 2.0			
4	1.0 – 2.0	> 2.0			
5	>2.0	< 2.0			
6	>2.0	> 2.0			
		Total undercuts			
		# undercut banks / mile			

Cross-Section Worksheet

Stream Name:_____
Reach-Segment: _____
Location: _____
Date:_____
Observers: _____

Cross-Section Notes Codes

LTER = Left Terrace	RTER = Right Terrace	TW = Thalweg
LFPA = Left Flood Plane	RFPA = Right Flood Plane	LPIN = Left Pin
LTOB = Left Top of Bank	RTOB = Right Top of Bank	RPIN = Right Pin
LBF = Left Bankfull Stage	RBF = Right Bankfull Stage	
LEW = Left Edge of Water	REW = Right Edge of Water	
RAF = Recently Abandoned Floodplain		

Cross-sections - Number and Location Description: (bkf height = _____)

Note	Distance	Depth	Note	Distance	Depth	Note	Distance	Depth

Bankfull Width		Bankfull Width		Bankfull Width	
Max. Depth		Max. Depth		Max. Depth	
Mean Depth		Mean Depth		Mean Depth	
Floodprone Width		Floodprone Width		Floodprone Width	
Low Bank Height		Low Bank Height		Low Bank Height	
Width/depth Ratio		Width/depth Ratio		Width/depth Ratio	
Entrenchment		Entrenchment		Entrenchment	
Incision Ratio		Incision Ratio		Incision Ratio	
IRhef		IRhef		IRhef	
Wetted Width		Wetted Width		Wetted Width	
Ratio (W_{wetted} / W_{bkf}):		Ratio (W_{wetted} / W_{bkf}):		Ratio (W_{wetted} / W_{bkf}):	
*Channel Enlargement		* Channel Enlargement		* Channel Enlargement	
XS Changed by Flooding Yes/No		XS Changed by Flooding Yes/No		XS Changed by Flooding Yes/No	
Altered by Flood Work Yes/No		Altered by Flood Work Yes/No		Altered by Flood Work Yes/No	

Drawing of Typical Cross-Section

* channel enlargement measure ($E = A_{tob}/A_{curve}$ X 100)

Bed Substrate Composition

Size Class	Millimeters	Inches	Relative Size			Distribution of 100 Particles			Percent	
1-Bedrock	> 4096	> 160	Bigger than a VW Bug							
2-Boulder	256 – 4096	10.1 – 160	Basketball to VW Bug							
3-Cobble	64 – 256	2.5 – 10.1	Tennis ball to basketball							
4-Coarse Gravel	16 – 64	0.63 – 2.5	Marble to tennis ball							
4-Fine Gravel	2 – 16	0.08 – 0.63	Pepper corn to marble							
5-Sand or Smaller	< 2.00	< 0.08	Smaller than a pepper corn							
Embeddedness	Ch1	Ch2	Ch3	Ch4	Ch5	Ma1	Ma2	Ma3	Ma4	Ma5
Largest mobile particles	Bd1	Bd2	Bd3	Bd4	Bd5	Br1	Br2	Br3	Br4	Br5

Step 1: Valley and Floodplain Corridor – Quick Refer Menus and Tables

1.1 SEGMENTATION

GC	Grade Control
CD	Channel Dimensions
SS	Substrate Size
PS	Planform and Slope
DF	Depositional Features
CE	Corridor Encroachments
BB	Banks and Buffers
FS	Flow Status
PA	Property Access
OT	Other Reason – Explain in Comments
None	No segments

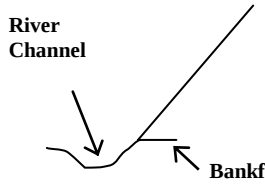
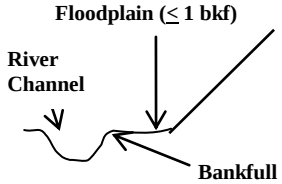
1.2 ALLUVIAL FAN

Yes	Segment or reach potentially on alluvial fan.
No	Segment or reach not potentially on alluvial fan.
Unknown	Unknown whether the segment is located on an alluvial fan

1.3 CORRIDOR ENCROACHMENTS

Yes	Encroachment within the corridor
No	Encroachment <u>not</u> within the corridor

1.4 ADJACENT SIDE SLOPE

Continuous	Within 1 Bankfull Width
	

Classification	Percent Slope
Flat	0-3%
Hilly	4-8%
Steep	9-15%
Very Steep	16-25%
Extremely Steep	>25%

Slope Texture

Bedrock	**Boulder**	**Cobble**	**Gravel**	**Sand**
Silt /Clay	**Mixed Texture**		**Other**	**Not Evaluated (NE)**

1.5 CONFINEMENT

Valley Description	Valley Width / Channel Width Ratio
Narrowly Confined	≥1 and < 2
Semi Confined	≥2 and <4
Narrow	≥4 and <6
Broad	≥6 and <10
Very Broad	≥10 with abandoned terraces on one or both sides

1.6 GRADE CONTROLS

Waterfalls	Bedrock that extends across the channel and forms a vertical, or near vertical, drop in the channel bed, usually ≥ 2 feet high.
Ledge	Bedrock that extends across the channel and forms no noticeable drop in the channel bed, or only a gradual drop in the channel bed, usually < 2' high.
Dams	High cross-channel structures.
Weirs	Low cross-channel structures.

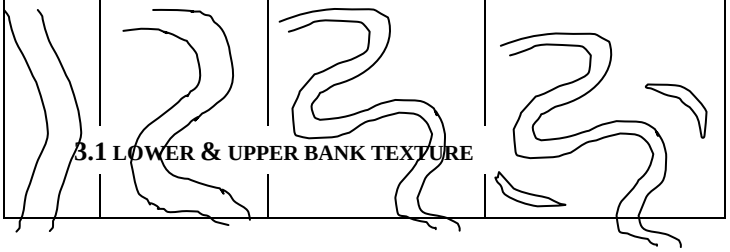
2.6 WIDTH / DEPTH RATIO: Divide the bankfull width (2.1) by the mean depth (2.3)
2.7 ENTRENCHMENT RATIO: Divide flood-prone width (2.4) by the bankfull width (2.1)
2.8 INCISION RATIO: Divide the low bank height (2.5) by the bankfull maximum depth (2.2)

3.1 TYPICAL BANK SLOPE

2.10 RIFFLES/STEPS

Low	Moderate	High	Oxbows

2.9 SINUOSITY



3.1 LOWER & UPPER BANK TEXTURE

3.1 BANK REVETMENTS

Complete	or steps completely cross the channel and are perpendicular, or slightly askew, to the channel banks
Eroded	Including partially eroded riffles/steps that do not completely cross the channel (scour process). Predominately runs, riffles/steps washing out or not present, as seen in a sediment limited reach or where bed degradation is occurring.
Sedimented	Including steep diagonal or transverse riffle/step features that cross the channel at a sharp angle in relation to the channel banks (depositional process). Riffles/steps may appear continuous, as seen during an aggradation process, and appearing as a coarse plane bed.
Not Applica	appear in ripple dune and plane bed streambed types.
Not Evaluated	Riffles and steps were not evaluated for completeness – Comment on reason.

3.2 BUFFER WIDTH

2.11 Riffle / Step Spacing		**Spacing**
Cascade / Step-pool	A	1-3 times W_{bkf}
Step / Riffle-pool	B	3-5 times W_{bkf}
Riffle-pool	C & E	5-7 times W_{bkf}
Plane bed / Ripple-dune	any	Riffles and steps are not present

2.12 BED SUBSTRATE COMPOSITION

			Relative Size
1-Bedrock	> 4096	> 160	Bigger than a Volkswagen Bug
2-Boulder	256 – 4096	10.1 - 160	Basketball to Volkswagen Bug
3-Cobble	64 – 256	2.5 - 10.1	Tennis ball to basketball
4-Gravel	2 – 64	0.1 – 2.5	Pepper corn to tennis ball
5-Sand	0.062 – 2.00	0.002 -0.1	Smaller than a pepper corn
6 – Silt	<.062	<.08	

Slope Subscript	Slope %
a	4-10
b	2-4
c	<2

2.14 STREAM TYPE

Stream Type	**(1) Entrenchment (+ or – 0.2)**	**(2) Width/d (+ or – 2)**	**3.2 BUFFER VEGEATION TYPE (+ or – 0.2)**	**(See Note)**
A – Single Thread	**<1.4** - Entrenched	**<12** – Low	**<1.2** – Low	**4-10**
G – Single Thread	**<1.4** - Entrenched	**<12** – Low	**>1.2** – Low to Mod.	**2-4**
F – Single Thread	**<1.4** - Entrenched	**>12** – Mod. to High	**>1.2** – Low to Mod.	**<4**
B – Single Thread	**1.4 -2.2** – Moderately Entrenched	**>12** – Moderate	**>1.2** – Low to Mod.	**2-4**
E – Single Thread	**>2.2** – Slightly Entrenched	**<12** – Very Low	**>1.5** – Very High	**<2**
C – Single Thread	**>2.2** – Slightly Entrenched	**>12** – Mod. to High	**>1.2** – Moderate	**<2**
D – Multiple Thread		**>40** – Very high	**<1.2** - Low	**<4**

Cascade	Generally occur in very steep channels, narrowly confined by valley walls. Characterized by longitudinally and laterally disorganized bed materials, typically bedrock, boulders, and cobbles. Small, partial channel-spanning pools spaced < 1 channel width apart common.
Step-Pool	Often associated with steep channels, low width/depth ratios and confining valleys. Characterized by longitudinal steps formed by large particles (boulder/cobbles) organized into discrete channel-spanning accumulations that separate pools, which contain smaller sized materials. Step-pool systems exhibit pool spacing of 1 to 4 channel widths.
Plane Bed	Occur in moderate to high gradient and relatively straight channels, have low width/depth ratios, and may be either unconfined or confined by valley walls. Composed of sand to small boulder-sized particles, but dominated by gravel and cobble substrates. Channel lacks discrete bed features (such as pools, riffles, and point bars) and may have long stretches of featureless bed.
Riffle-Pool	Occur in moderate to low gradient and moderately sinuous channels, generally in unconfined valleys, and has well-established floodplain. Channel has undulating bed that defines a sequence of bars, pools, and riffles. Pools spaced every 5 to 7 channel widths in a self-formed e-pool channel.

3.1 BANK CANOPY

Dune-Ripple	iated with low gradient and highly sinuous channels. Dominated by sand-sized substrates. Channel may exhibit point bars or other bedforms forced by channel geometry. Typically undulating bed does not establish distinct pools and riffles.
Bedrock	Lack a continuous alluvial bed. Some alluvial material may be temporarily stored in scour holes, or behind obstructions. Often confined by valley walls.
Braided	Multiple channel system found on steep depositional fans and deltas. Channel gradient is generally the same as the valley slope. Ongoing deposition leads to high bank erosion rates. Bed features result from the convergence/divergence process of local bed scour and sediment deposition. Unvegetated islands may shift position frequently during runoff events. High bankfull widths and very low meander (belt) widths.

4.2 ADJACENT WETLAND

Undercut	upper bank overhanging the streambed
Shallow	bank slope (<30%)
Moderate	bank slope (31-50%)
Steep	bank slope (>51%)

4.1 SPRING, SEEPS AND TRIBUTARIES

Rip-rap	Blanket of rock covering the bank, usually large angular boulders
Hard Bank	Walls of large rocks, concrete blocks or rectangular gabion wire baskets (filled with stone) lining banks
Other	e.g.: tree revetments or vanes intended to stop the lateral erosion of the stream channel
None	No bank revetments observed

Bedrock	Very resistant to erosion
Boulder/ Cobble	(boulders > 10 inches / cobbles 2.5 to 10 inches) Moderately resistant to erosion
Gravel	(0.1 to 2.5 inches) Moderate to high bank erodibility when present as dominant component or as part of the bank materials
Sand	High bank erodibility when present as dominant component or as part of the bank materials
Silt/Clay	Non-cohesive silt has very high / extreme bank erodibility; while cohesive clays are relatively resistant to erosion
Mix	Variety of particle sizes present from very small to very large. Glacial till may be an example of mixed bank materials (Figure 3.3)

0 – 25 ft.
26 – 50 ft.
51 – 100 ft
> 100 ft

Coniferous	Trees that keep their leaves year round i.e. pine, cedar, hemlock
Deciduous	Trees that lose their leaves seasonally i.e. elm, butternut, maple, oak
Shrubs-saplings	Small trees, saplings, and brush species, such as alder, willows, sumac, and dogwood
Herbaceous	Native grasses, rushes and sedges, & plants such as asters, goldenrod
Lawn	Mowed lawn
Pasture	Land managed for grazing livestock
Bare	Bare soil, no or very sparse vegetation. This does not pertain to unvegetated features such as point-bars, mid-channel bars or shoals.
Invasives	Non-native invasive plant species: Phragmites, Japanese knotweed, Purple loosestrife, Honeysuckle (note there are native honeysuckles too)

Coniferous	Trees that keep their leaves year round. i.e. pine, cedar, hemlock
Deciduous	Trees that lose their leaves seasonally. i.e. elm, butternut, maple, oak
Mixed Trees	A fairly even mix of conifers and deciduous trees
Shrubs-Saplings	Small trees, saplings, and brush species, such as alder, willows, sumac, and dogwood
Herbaceous	Native grasses, rushes and sedges, & plants such as asters, goldenrod
Invasives	Non-native invasive plant species: Phragmites, Japanese knotweed, Purple loosestrife, Honeysuckle (note there are native honeysuckles too)
None	No buffer present, bare ground up to the top of the bank

3.3 RIPARIAN CORRIDOR

Forest	Woodlands of deciduous or coniferous trees
Shrub-sapling	Fallow field or wetland
Crop Pasture Hay	Agricultural lands planted in row crops, mowed as a hay field, or pastured with livestock. Circle the appropriate type of agriculture.
Commercial Industrial	Retail businesses with land developed for buildings, roads, and parking areas
Residential	Land developed with houses, lawns, and driveways
Bare	Bare soil, no or very sparse vegetation. Pertains to gravel pits, construction sites, and similar bare ground

76 – 100 %	canopy over stream channel
51 – 75%	canopy over stream channel
26 – 50%	canopy over stream channel
1 – 25 %	canopy over stream channel
0 %	no canopy over stream channel

Step 4: Flow Modifiers – Quick Refer Menus and Tables

Abundant	Numerous small tributaries, springs and/or seeps entering the segment (reach)
Minimal	Infrequent small tributaries, springs and/or seeps entering the segment (reach)
None	No small tributaries, springs and/or seeps observed entering the segment (reach)

4.3 STAGE

Low	Flow in channel low due to drought conditions
Moderate	Flow in channel is typical summer flows
High	Flow in channel is high as a result of flooding

4.6 UPSTREAM FLOW REGULATION OR WATER WITHDRAWAL

Upstream	Flow regulation or water withdrawal upstream affecting the reach.
Downstream	Flow regulation or water withdrawal downstream affecting the reach.
Both	Flow regulation or water withdrawal both upstream and downstream affecting the reach.

4.8 CHANNEL CONSTRICTIONS

Instream culverts	Structures under a transportation route through which the stream flows
Bridges	Structures under a transportation route under which the stream flows
Old abutments	Bridge abutments that no longer have a travel deck between them.
Bedrock outcrops	Bedrock outcrops on both the right and left banks between which the stream flows
Other	Other built structures that constrict the channel, for instance rock rip-rap or gabions on both banks that constrict flood flows
None	No structures or features exist within the segment (or reach) that constricts the bankfull or floodprone widths or flows

Abundant	Extensive wetlands present along stream site.
Minimal	Wetlands present but to small extent along stream segment (reach)
None	No wetlands observed along stream segment (reach)

4.5 FLOW REGULATION

TYPE:

Withdrawal	A withdrawal of water from the stream
Bypass	The water is diverted away from the channel and re-enters down stream.
Run of River	Upstream or in reach flows are impounded. Flow quantity spilling or released below the dam is the same as flow quantity entering the impoundment at all times.
Store and Release	Water is impounded and stored and released only during certain times.
None	No known flow regulation or water withdrawals. Select "none" if you have completed the appropriate research and have found no evidence of flow regulations.
No Data	No data sources are available to determine if a flow regulation or water withdrawal exists.
Not Evaluated	All data sources (as described by the meta data) HAVE NOT been evaluated.

SIZE:

Small	Impoundments not much wider than river itself or withdrawals not affecting the channel forming flow.
Large	Impoundments much wider than river itself (createng a reservoire) or withdrawals significantly affecting the channel forming flow.

Step 5: Channel Bed and Planform Changes – Quick Refer Menus and Tables

5.1 BED SEDIMENT STORAGE AND BAR TYPES

Mid-Channel	Sediment deposits in the middle of the channel with split flow
Point	Unvegetated sediment deposits located on inside of channel meander bend
Side (Lateral)	Unvegetated sediment deposits located along the margins of the channel in locations other than the inside of channel meander bends
Diagonal	Bars that cross the channel at sharp oblique angles, associated with transverse riffles
Delta	Sediment deposits where tributary enters the mainstem.
Islands	Well vegetated mid-channel deposits of sediment
None	No deposits of sediment evident.

5.4: CHANNEL ALTERATIONS

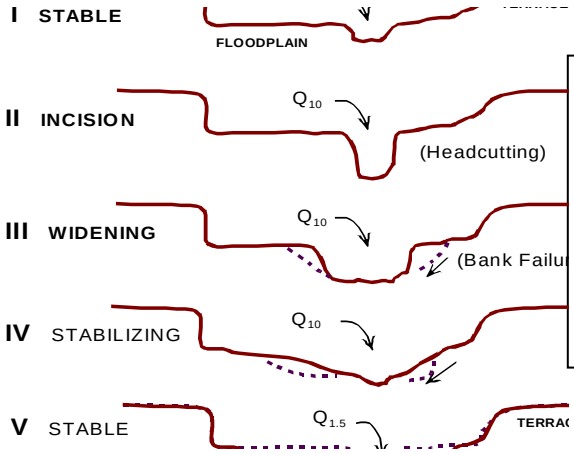
Dredging	Evidence of removal of sediments and other material from the channel.
Commercial Mining	Historic (pre-1988) large-scale commercial extraction of gravel from channel.
Bar scalping / gravel mining	Bar scalping: gravel has been removed from the top of bars. Gravel mining: gravel has been removed from bars or bed of river.
None	No evidence that any channel alterations have been done

5.5 CHANNEL STRAIGHTENING

Straightening	Evidence that there has been the removal of meander bends and realignment of channel. Historically done in village centers and along roadways, railroads, and agricultural fields.
With Windrowing	Pushing gravel up from the stream bed onto the top of either bank as a part of the straightening of the river.

Step 7: Rapid Geomorphic Assessment - Quick Refer Menus and Tables

7.5 Channel Adjustment Process



I) In regime, reference to good condition, insignificant to minimal adjustment.
II) Fair to poor condition, major to extreme channel degradation
III) Fair to poor condition, major to extreme widening and aggradataion
IV) Fair to good condition, major reducing to minor aggradation, widening, and planform adjustments
V) In regime, reference to good condition, insignificant to minimal adjustment.

Schumm Channel Evolution Model – See Appendix C for Vermont modified versions

7.6 Stream Condition

0.85 – 1.0	Reference Condition
0.65 – 0.84	Good Condition
0.35 – 0.64	Fair Condition
0.00 – 0.34	Poor Condition

7.7 Phase 2 Stream Sensitivity Ratings

Existing Stream Type	In regime – Reference or good condition	Major Adjustment – Fair Condition	Stream Type Departure or Poor Condition
A1, A2, B1, B2	Very Low	Very Low	Low
C1, C2	Very Low	Low	Moderate
G1, G2	Low	Moderate	High
F1, F2	Low	Moderate	High
B3, B4, B5	Moderate	High	High
B3c, C3, E3	Moderate	High	High
C4, C5, B4c, B5c	High	Very High	Very High
A3, A4, A5, G3, F3	High	Very High	Extreme
F4, F5, G4, G5	Very High	Very High	Extreme
D3, D4, D5	Extreme	Extreme	Extreme
C6, E4, E5, E6	High	Extreme	Extreme

Phase 2 – Quality Assurance Worksheet

Stream Name:_____ Watershed: _____ Date:_____
QA Team Leader: _____ Organization /Agency: _____
ANR Team Leader: _____

Check one or more boxes to indicate the types of ANR sponsored training received by field team members	**Phase 2**	
	QA	

Segment/Reach Sketch and Map Documentation completed	
Phase 1 Assessment used in Phase 2 analysis of geomorphic condition	
ANR SGA Handbook Protocols and Database used exclusively	
Other protocols used:	

Phase 1 Step Number	Tool Used to Collect Data	Confidence Level	Date Completed	Date Updated	Date of Local QA Team Review	Date of State QA Team Review	Comments
Step 1		Low to Moderate Moderate Moderate to High High					
Step 2		Low to Moderate Moderate Moderate to High High					
Step 3		Low to Moderate Moderate Moderate to High High					
Step 4		Low to Moderate Moderate Moderate to High High					
Step 5		Low to Moderate Moderate Moderate to High High					
Step 6		Low to Moderate Moderate Moderate to High High					
Step 7		Low to Moderate Moderate Moderate to High High					

VTANR REACH HABITAT ASSESSMENT ----- RIFFLE-POOL STREAM TYPE

(Also use this form for dune-ripple stream type.)

Stream Name:_____ Segment I.D: _____
Location: _____ Date:_____
_____ Town:_____
Observers: _____ Elevation: _____ ft.
Organization /Agency: _____ Latitude (N/S):_____
USGS Map Name(s):_____ Longitude (E/W): _____
Weather:_____ Drainage Area: _____ sq. mi.
Flow: base / low / avg. Storm within past 7 days: Y / N Segment Length: _____ ft.

Habitat Parameter	Condition (Departure) Category																			
	Reference (None)					**Good (Minor)**					**Fair (Major)**					**Poor (Severe)**				
6.1 Woody Debris Cover LWD size rank variable only used if ≥ 10 pieces	☐ LWD pieces / mile > 100 ☐ LWD size rank 3-6 >50% ☐ debris jams / mile > 5 ☐ high woody debris recruitment potential ☐ CPOM present in channel and margins					☐ 100 ≥ LWD / mile > 50 ☐ 50 ≥ LWD rank 3-6 > 25% ☐ 5 ≥ jams / mile > 3 ☐ moderate woody debris recruitment potential ☐ CPOM limited in channel and present in margins					☐ 50 ≥ LWD / mile > 25 ☐ 25 ≥ LWD rank 3-6 > 10% ☐ 3 ≥ jams / mile > 1 ☐ low woody debris recruitment potential ☐ CPOM limited in both channel and margins					☐ LWD / mile ≤ 25 ☐ LWD size rank 3-6 ≤ 10% ☐ debris jams absent ☐ no woody debris recruitment potential ☐ CPOM absent				
SCORE	20	19	18	17	16	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1
6.2 Bed Substrate Cover *fines: sand if d_{50} ≥ gravel, otherwise silt. (Dune-ripple stream type: Fining only.)	☐ riffle embeddedness < 20% margin embeddedness < 40% ☐ fining* < 10% ☐ Riffle stability index < 70% ☐ sediment apparently stable & sorted ☐ substrate free of dense algae growth					☐ 20 ≤ emb_{riffle} < 40% 40 ≤ emb_{margin} < 60% ☐ 10 ≤ fining* < 20% ☐ 70 ≤ RSI < 80% ☐ some evidence of sediment mobility & lack of sorting ☐ small substrate patches covered by dense algae growth					☐ 40 ≤ emb_{riffle} < 75% 60 ≤ emb_{margin} < 80% ☐ 20 ≤ fining* < 40% ☐ 80 ≤ RSI < 90% ☐ major evidence of sediment mobility & lack of sorting ☐ large substrate patches covered by dense algae growth					☐ riffle embeddedness ≥ 75% margin embeddedness ≥ 80% ☐ fining* ≥ 40% ☐ RSI ≥ 90% ☐ sediments unstable, unsorted, soft underfoot ☐ most of substrate covered by dense algae growth				
SCORE	20	19	18	17	16	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1
6.3 Scour and Deposition Features (Dune-ripple stream type: Only evaluate pools and ripples.) *Depth-velocity combinations* *fast-shallow* *fast-deep* *slow-shallow* *slow-deep* *(cutoffs: 1.0 fps, 1.5 ft)* Pool size rank variable only used if ≥ 5 pools	☐ pools / mile > 40 ☐ pool size rank 3-7 >50% ☐ good cover > 75% of total pool surface area ☐ riffle (ripple) coverage > 25% reach area, distinctly formed and complete ☐ 5 ≤ riffle spacing ≤ 7 bankfull channel widths (w_{bkf}) ☐ well-defined riffle-run-pool-glide pattern with all four depth-velocity combinations present ☐ finer deposition located entirely in slack water below larger substrates/debris, and along margins					☐ 40 ≥ pools / mile > 20 ☐ 50 ≥ pool rank 3-7 > 25% ☐ 75 ≥ good cover > 50% of total pool surface area ☐ 25 ≥ riffle coverage > 10% reach area, moderately well formed and complete ☐ 3 ≤ riffle spacing < 5, or 7 < riffle spacing ≤ 10 x w_{bkf} ☐ well-defined riffle-run-pool-glide pattern with three depth-velocity combinations dominant ☐ finer deposition located in slack water below larger substrates/debris, signs of mid-channel accumulation					☐ 20 ≥ pools / mile > 10 ☐ 25 ≥ pool rank 3-7 > 10% ☐ 50 ≥ good cover > 25% of total pool surface area ☐ 25 ≥ riffle coverage > 10% reach area, poorly formed and incomplete ☐ 1 ≤ riffle spacing < 3, or 10 < riffle spacing ≤ 12 x w_{bkf} ☐ moderately defined riffle-run-pool-glide pattern with two depth-velocity combinations dominant ☐ very large depositional features below larger substrates/debris, abundant mid-channel accumulation					☐ pools / mile ≤ 10 ☐ pool size rank 3-7 ≤ 10% ☐ good cover ≤ 25% of total pool surface area ☐ riffle (ripple) coverage ≤ 10% reach area, or mostly indistinct ☐ riffle spacing ≥ 12 bankfull channel widths ☐ poorly defined riffle-run-pool-glide pattern with one depth-velocity combination dominant ☐ finer deposition throughout channel, even filling pools, larger substrates almost buried **or** bed largely incised				
SCORE	20	19	18	17	16	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1
6.4 Channel Morphology	☐ width/depth < 15, natural ☐ entrenchment ratio ≥ 1.4, incision ratio < 1.2, good floodplain access ☐ no evidence of channel alteration					☐ 15 ≤ w / d < 25, widening ☐ entrenchment ratio ≥ 1.4, 1.2 ≤ incision ratio < 1.4, reduced floodplain access ☐ evidence of minor historic channel alteration					☐ 25 ≤ w / d < 40, widening ☐ entrenchment ratio ≥ 1.4, 1.4 ≤ incision ratio < 2.0, limited floodplain access ☐ major historic or minor recent channel alteration					☐ w / d > 40, over-widening ☐ entrenchment ratio < 1.4 **or** incision ratio ≥ 2.0, floodplain access unlikely ☐ extensive historic or major recent channel alteration				
SCORE	20	19	18	17	16	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1

Habitat Parameter	Condition (Departure) Category			
	Reference (None)	**Good (Minor)**	**Fair (Major)**	**Poor (Severe)**
6.5 Hydrologic Characteristics	☐ wetted width / W_{bkf} > 0.75 ☐ exposed substrate < 20% ☐ adjacent springs, seeps, and wetlands extensive ☐ no known flow alteration	☐ 0.75 ≥ W_{wet} / W_{bkf} > 0.50 ☐ 20 ≤ exp. substrate < 40% ☐ adjacent springs, seeps, and wetlands present ☐ minor flow alteration likely due to flow regulation and/or land use changes	☐ 0.50 ≥ W_{wet} / W_{bkf} > 0.25 ☐ 40 ≤ exp. substrate < 60% ☐ adjacent springs, seeps, and wetlands minimal ☐ major flow alteration likely due to flow regulation and/or land use changes	☐ W_{wet} / W_{bkf} ≤ 0.25 ☐ exposed substrate ≥ 60% ☐ adjacent springs, seeps, and wetlands absent or altered ☐ runoff characteristics completely altered due to flow regulation and storm water influence
SCORE	20 19 18 17 16	15 14 13 12 11	10 9 8 7 6	5 4 3 2 1
6.6 Connectivity Tend towards a higher/lower score for natural/man-made obstructions	☐ no obstructions in reach that block longitudinal movement of aquatic species over all but the lowest flows ☐ system obstructions absent ☐ abundant low **and** high flow refuge	☐ one or two small low flow obstructions present in reach that block movement of aquatic species ☐ limited system obstructions ☐ abundant refuge, with low **or** high flow refuge limited	☐ one or two small to medium bankfull obstructions present in reach that block movement of aquatic species ☐ system obstructions present ☐ limited low **and** high flow refuge	☐ more than two bankfull obstructions present in reach that block movement of aquatic species ☐ many system obstructions ☐ refuge absent
SCORE	20 19 18 17 16	15 14 13 12 11	10 9 8 7 6	5 4 3 2 1
6.7 River Banks Select different boxes for LB and RB if necessary	☐ bank erosion <10%, typical of natural conditions, little or no bank revetments ☐ bank vegetation > 90% in tree, shrub and herb layers, diverse assemblages, plants create good cover and roots help stabilize bank	☐ 10 ≤ bank erosion < 30%, infrequent small areas, some bank revetments ☐ 90 ≥ bank vegetation > 75% in each layer, diverse assemblages, plants create good cover and roots help stabilize bank	☐ 30 ≤ bank erosion < 60%, mod. unstable banks, and/or extensive bank revetments ☐ 75 ≥ bank vegetation > 50%, in two of three layers, reduced diversity, plants create limited cover and roots do not stabilize bank	☐ bank erosion ≥ 60%, banks unstable, extensive erosion, and failing bank revetments ☐ bank vegetation ≤ 50% in two of three layers, limited diversity, plants create no cover and roots do not stabilize bank
Undercut size rank variable only used if ≥ 5 undercuts	☐ bank canopy > 90% ☐ undercut banks / mile > 30 ☐ undercut bank size rank 3-6 > 50%	☐ 90 ≥ bank canopy > 75% ☐ 30 ≥ undercuts / mile > 15 ☐ 50 ≥ undercut bank size rank 3-6 > 25%	☐ 75 ≥ bank canopy > 50% ☐ 15 ≥ undercuts / mile > 5 ☐ 25 ≥ undercut bank size rank 3-6 > 10%	☐ bank canopy ≤ 50% ☐ undercuts / mile ≤ 5 ☐ undercut bank size rank 3-6 ≤ 10%
(score each bank)	☐ undercut banks with mostly stable boundaries, abundant overhanging vegetation, and consistent water adjacency ☐ no mass failures in valley	☐ undercuts with some unstable boundaries or reduced overhanging vegetation, and consistent water adjacency ☐ 1 mass failure in valley	☐ undercuts with some unstable boundaries or reduced overhanging vegetation, and reduced water adjacency ☐ 1 - 2 mass failures in valley	☐ undercuts with mostly unstable boundaries, no overhanging vegetation, and reduced water adjacency ☐ ≥ 3 mass failures in valley
SCORE _____ (LB)	Left Bank 10 9	8 7 6	5 4 3	2 1
SCORE _____ (RB)	Right Bank 10 9	8 7 6	5 4 3	2 1
6.8 Riparian Area Select different boxes for LB and RB if necessary	☐ buffer width > 150 ft ☐ rip. vegetation > 75% in tree, shrub and herb layers, diverse assemblages, no invasives, maximum channel canopy	☐ 150 ≥ buffer width > 100 ft ☐ 75 ≥ rip. veg. > 50% in each layer, one plant type absent, minimal invasives, maximum channel canopy	☐ 100 ≥ buffer width > 50 ft ☐ 75 ≥ rip. veg. > 50% in each layer, several types absent, altered patches, invasives present, reduced canopy	☐ buffer width ≤ 50 ft ☐ rip. veg. ≤ 50% in each layer, several types absent, large altered areas, invasives present, reduced canopy
(score each side of the channel)	☐ river corridor development and infrastructure absent	☐ river corridor development and infrastructure minimal	☐ river corridor development and infrastructure common	☐ river corridor development and infrastructure abundant
SCORE _____ (LB)	Left Bank 10 9	8 7 6	5 4 3	2 1
SCORE _____ (RB)	Right Bank 10 9	8 7 6	5 4 3	2 1

6.9 Score: front _____ + back _____ = total _____

Percentage: total score _____ x (100 / 160) = _____

Overall Physical Habitat Condition: _____

SHTD ☐ Existing Stream Habitat Type: _____

Score	*Percentage*	*Condition (Departure)*
136 – 160	**85 – 100**	Reference (None)
104 – 135	**65 – 84**	Good (Minor)
56 – 103	**35 – 64**	Fair (Major)
0 – 55	**0 – 34**	Poor (Severe)

VTANR REACH HABITAT ASSESSMENT ----- STEP-POOL STREAM TYPE

(Also use this form for cascade and bedrock stream types.)

Stream Name:_____ Segment I.D: _____
Location: _____ Date:_____
_____ Town:_____
Observers: _____ Elevation: _____ ft.
Organization /Agency: _____ Latitude (N/S):_____
USGS Map Name(s):_____ Longitude (E/W): _____
Weather:_____ Drainage Area: _____ sq. mi.
Flow: base / low / avg. Storm within past 7 days: Y / N Segment Length: _____ ft.

Habitat Parameter	Condition (Departure) Category			
	Reference (None)	**Good (Minor)**	**Fair (Major)**	**Poor (Severe)**
6.1 Woody Debris Cover LWD size rank variable only used if ≥ 10 pieces	□ LWD pieces / mile > 200 □ LWD size rank 3-6 >75% □ debris jams / mile > 25 □ high woody debris recruitment potential □ CPOM present in channel and margins	□ 200 ≥ LWD / mile > 100 □ 75 ≥ LWD rank 3-6 > 50% □ 25 ≥ jams / mile > 15 □ moderate woody debris recruitment potential □ CPOM limited in channel and present in margins	□ 100 ≥ LWD / mile > 50 □ 50 ≥ LWD rank 3-6 > 25% □ 15 ≥ jams / mile > 5 □ low woody debris recruitment potential □ CPOM limited in both channel and margins	□ LWD / mile ≤ 50 □ LWD size rank 3-6 ≤ 25% □ jams / mile ≤ 5 □ no woody debris recruitment potential □ CPOM absent
SCORE	20 19 18 17 16	15 14 13 12 11	10 9 8 7 6	5 4 3 2 1
6.2 Bed Substrate Cover *fines: sand if d_{50} ≥ gravel, otherwise silt.	□ pool embeddedness < 25% margin embeddedness < 40% □ fining* < 10% □ sediment apparently stable & sorted □ substrate free of dense algae growth	□ 25 ≤ emb_{pool} < 50% 40 ≤ emb_{margin} < 60% □ 10 ≤ fining* < 20% □ some evidence of sediment mobility & lack of sorting □ small substrate patches covered by dense algae growth	□ 50 ≤ emb_{pool} < 75% 60 ≤ emb_{margin} < 80% □ 20 ≤ fining* < 40% □ major evidence of sediment mobility & lack of sorting □ large substrate patches covered by dense algae growth	□ pool embeddedness ≥ 75% margin embeddedness ≥ 80% □ fining* ≥ 40% □ sediments unstable, unsorted, soft underfoot □ most of substrate covered by dense algae growth
SCORE	20 19 18 17 16	15 14 13 12 11	10 9 8 7 6	5 4 3 2 1
6.3 Scour and Deposition Features *Depth-velocity combinations* *fast-shallow* *fast-deep* *slow-shallow* *slow-deep* *(cutoffs: 1.0 fps, 1.5 ft)* Pool size rank variable only used if ≥ 5 pools (Cascade and bedrock stream types: Do not evaluate variables related to step pattern.)	□ pools / mile > 70 □ pool size rank 3-7 >50% □ good cover > 75% of total pool surface area □ steps are distinctly formed, complete and stable □ 5 ≤ step spacing ≤ 7 bankfull channel widths (w_{bkf}) □ more than two depth-velocity combinations present □ finer deposition located entirely in slack water below larger substrates/debris, and along margins	□ 70 ≥ pools / mile > 50 □ 50 ≥ pool rank 3-7 > 25% □ 75 ≥ good cover > 50% of total pool surface area □ steps are moderately well formed, complete and stable □ 3 ≤ step spacing < 5, or 7 < step spacing ≤ 10 x w_{bkf} □ two depth-velocity combinations present □ finer deposition located in slack water below larger substrates/debris, signs of mid-channel accumulation	□ 50 ≥ pools / mile > 30 □ 25 ≥ pool rank 3-7 > 10% □ 50 ≥ good cover > 25% of total pool surface area □ steps are poorly formed, incomplete and unstable □ 1 ≤ step spacing < 3, or 10 < step spacing ≤ 15 x w_{bkf} □ one or two depth-velocity combinations present □ very large depositional features below larger substrates/debris, abundant mid-channel accumulation	□ pools / mile ≤ 30 □ pool size rank 3-7 ≤ 10% □ good cover over ≤ 25% of total pool surface area □ steps are indistinct or absent, or very unstable □ step spacing ≥ 15 bankfull channel widths □ one depth-velocity combination present □ finer deposition throughout channel, even filling pools, larger substrates almost buried **or** bed largely incised
SCORE	20 19 18 17 16	15 14 13 12 11	10 9 8 7 6	5 4 3 2 1
6.4 Channel Morphology	□ width/depth < 12, natural □ entrenchment ratio ≥ 1.2, incision ratio < 1.2, good floodplain access □ no evidence of channel alteration	□ 12 ≤ w / d < 15, widening □ entrenchment ratio ≥ 1.2, 1.2 ≤ incision ratio < 1.4, reduced floodplain access □ evidence of minor historic channel alteration	□ 15 ≤ w / d < 25, widening □ entrenchment ratio ≥ 1.2, 1.4 ≤ incision ratio < 2.0, limited floodplain access □ major historic or minor recent alteration	□ w / d ≥ 25, over-widening □ entrenchment ratio < 1.2 **or** incision ratio ≥ 2.0, floodplain access unlikely □ extensive historic or major recent alteration
SCORE	20 19 18 17 16	15 14 13 12 11	10 9 8 7 6	5 4 3 2 1

Habitat Parameter	Condition (Departure) Category																			
	Reference (None)					**Good (Minor)**					**Fair (Major)**					**Poor (Severe)**				
6.5 Hydrologic Characteristics	□ wetted width / W_{bkf} > 0.75 □ exposed substrate < 10% □ adjacent springs, seeps, and wetlands extensive □ no known flow alteration					□ 0.75 ≥ W_{wet} / W_{bkf} > 0.50 □ 10 ≤ exp. substrate < 30% □ adjacent springs, seeps, and wetlands present □ minor flow alteration likely due to flow regulation and/or land use changes					□ 0.50 ≥ W_{wet} / W_{bkf} > 0.25 □ 30 ≤ exp. substrate < 50% □ adjacent springs, seeps, and wetlands minimal □ major flow alteration likely due to flow regulation and/or land use changes					□ W_{wet} / W_{bkf} ≤ 0.25 □ exposed substrate ≥ 50% □ adjacent springs, seeps, and wetlands absent or altered □ runoff characteristics completely altered due to flow regulation and storm water influence				
SCORE	20	19	18	17	16	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1
6.6 Connectivity Tend towards a higher/lower score for natural/man-made obstructions	□ no obstructions in reach that block longitudinal movement of aquatic species over all but the lowest flows □ system obstructions absent □ abundant low **and** high flow refuge					□ one or two small low flow obstructions present in reach that block movement of aquatic species □ limited system obstructions □ abundant refuge, with low **or** high flow refuge limited					□ one or two small to medium bankfull obstructions present in reach that block movement of aquatic species □ system obstructions present □ limited low **and** high flow refuge					□ more than two bankfull obstructions present in reach that block movement of aquatic species □ many system obstructions □ refuge absent				
SCORE	20	19	18	17	16	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1
6.7 River Banks Select different boxes for LB and RB if necessary Undercut size rank variable only used if ≥ 5 undercuts **(score each bank)**	□ bank erosion <10%, typical of natural conditions, little or no bank revetments □ bank vegetation > 90% in tree, shrub and herb layers, diverse assemblages, plants create good cover and roots help stabilize bank □ bank canopy > 90% □ undercut banks / mile > 15 □ undercut bank size rank 3-6 > 50% □ undercut banks with mostly stable boundaries, abundant overhanging vegetation, and consistent water adjacency □ no mass failures in valley					□ 10 ≤ bank erosion < 20%, infrequent small areas, some bank revetments □ 90 ≥ bank vegetation > 75% in each layer, diverse assemblages, plants create good cover and roots help stabilize bank □ 90 > bank canopy > 80% □ 15 ≥ undercuts / mile > 10 □ 50 ≥ undercut bank size rank 3-6 > 25% □ undercuts with some unstable boundaries or reduced overhanging vegetation, and consistent water adjacency □ 1 mass failure in valley					□ 20 ≤ bank erosion < 50%, mod. unstable banks, and/or extensive bank revetments □ 75 ≥ bank vegetation > 50%, in two of three layers, reduced diversity, plants create limited cover and roots do not stabilize bank □ 80 ≥ bank canopy > 60% □ 10 ≥ undercuts / mile > 5 □ 25 ≥ undercut bank size rank 3-6 > 10% □ undercuts with some unstable boundaries or reduced overhanging vegetation, and reduced water adjacency □ 1 - 2 mass failures in valley					□ bank erosion ≥ 50%, banks unstable, extensive erosion, and failing bank revetments □ bank vegetation ≤ 50% in two of three layers, limited diversity, plants create no cover and roots do not stabilize bank □ bank canopy ≤ 60% □ undercuts / mile ≤ 5 □ undercut bank size rank 3-6 ≤ 10% □ undercuts with mostly unstable boundaries, no overhanging vegetation, and reduced water adjacency □ > 3 mass failures in valley				
SCORE _____ (LB)	Left Bank	10	9			8	7	6			5	4	3			2			1	
SCORE _____ (RB)	Right Bank	10	9			8	7	6			5	4	3			2			1	
6.8 Riparian Area Select different boxes for LB and RB if necessary **(score each side of the channel)**	□ buffer width > 200 ft □ rip. vegetation > 90% in tree, shrub and herb layers, diverse assemblages, no invasives, maximum channel canopy □ river corridor development and infrastructure absent					□ 200 ≥ buffer width > 150 ft □ 90 ≥ rip. veg. > 75% in each layer, one plant type absent, minimal invasives, maximum channel canopy □ river corridor development and infrastructure minimal					□ 150 ≥ buffer width > 100 ft □ 75 ≥ rip. veg. > 50% in each layer, several types absent, altered patches, invasives present, reduced canopy □ river corridor development and infrastructure common					□ buffer width ≤ 100 ft □ rip. veg. ≤ 50% in each layer, several types absent, large altered areas, invasives present, reduced canopy □ river corridor development and infrastructure abundant				
SCORE _____ (LB)	Left Bank	10	9			8	7	6			5	4	3			2			1	
SCORE _____ (RB)	Right Bank	10	9			8	7	6			5	4	3			2			1	

6.9 Score: front _____ + back _____ = total _____

Percentage: total score _____ x (100 / 160) = _____

Overall Physical Habitat Condition: _____

SHTD □ Existing Stream Habitat Type: _____

Score	*Percentage*	*Condition (Departure)*
136-160	**85 – 100**	Reference (None)
104 – 135	**65 – 84**	Good (Minor)
56 – 103	**35 – 64**	Fair (Major)
0 – 55	**0 – 34**	Poor (Severe)

VTANR REACH HABITAT ASSESSMENT ----- PLANE BED STREAM TYPE

Stream Name:_____ Segment I.D: _____
Location: _____ Date:_____
_____ Town:_____
Observers: _____ Elevation: _____ ft.
Organization /Agency: _____ Latitude (N/S):_____
USGS Map Name(s):_____ Longitude (E/W): _____
Weather:_____ Drainage Area: _____ sq. mi.
Flow: base / low / avg. Storm within past 7 days: Y / N Segment Length: _____ ft.

Habitat Parameter	Condition (Departure) Category																			
	Reference (None)					Good (Minor)					Fair (Major)					Poor (Severe)				
6.1 Woody Debris Cover LWD size rank variable only used if ≥ 10 pieces	☐ LWD pieces / mile > 50 ☐ LWD size rank 3-6 >50% ☐ debris jams / mile > 5 ☐ high woody debris recruitment potential ☐ CPOM present in channel and margins					☐ 50 ≥ LWD / mile > 25 ☐ 50 ≥ LWD rank 3-6 > 25% ☐ 5 ≥ jams / mile > 3 ☐ moderate woody debris recruitment potential ☐ CPOM limited in channel and present in margins					☐ 25 ≥ LWD / mile > 10 ☐ 25 ≥ LWD rank 3-6 > 10% ☐ 3 ≥ jams / mile > 1 ☐ low woody debris recruitment potential ☐ CPOM limited in both channel and margins					☐ LWD / mile ≤ 10 ☐ LWD size rank 3-6 ≤ 10% ☐ debris jams absent ☐ no woody debris recruitment potential ☐ CPOM absent				
SCORE	20	19	18	17	16	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1
6.2 Bed Substrate Cover *fines: sand if d_{50} ≥ gravel, otherwise silt.	☐ run embeddedness < 20% margin embeddedness < 40% ☐ fining* < 10% ☐ sediment apparently stable & sorted ☐ imbrication limited, or mostly with the short axis of particles overlapping in the direction of flow ☐ substrate free of dense algae growth					☐ 20 ≤ emb_{run} < 40% 40 ≤ emb_{margin} < 60% ☐ 10 ≤ fining* < 20% ☐ some evidence of sediment mobility & lack of sorting ☐ imbrication moderate, mostly with the short axis of particles overlapping in the direction of flow ☐ small substrate patches covered by dense algae growth					☐ 40 ≤ emb_{run} < 75% 60 ≤ emb_{margin} < 80% ☐ 20 ≤ fining* < 40% ☐ major evidence of sediment mobility & lack of sorting ☐ imbrication moderate, mostly with the long axis of particles overlapping in the direction of flow ☐ large substrate patches covered by dense algae growth					☐ run embeddedness ≥ 75% margin embeddedness ≥ 80% ☐ fining* ≥ 40% ☐ sediments unstable, unsorted, soft underfoot ☐ imbrication extensive, mostly with the long axis of particles overlapping in the direction of flow ☐ most of substrate covered by dense algae growth				
SCORE	20	19	18	17	16	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1
6.3 Scour and Deposition Features *Depth-velocity combinations* *fast-shallow* *fast-deep* *slow-shallow* *slow-deep* *(cutoffs: 1.0 fps, 1.5 ft)* Pool size rank variable only used if ≥ 5 pools	☐ pool formation evident, with ≥50% pool size rank 3-7 ☐ widespread riffle formation ☐ more than two depth-velocity combinations present ☐ meandering thalweg clearly identifiable in cross section, with evidence of side and lateral bar formation ☐ finer deposition located entirely in slack water below larger substrates/debris, and along margins					☐ pool formation evident, with <50% pool size rank 3-7 ☐ moderate riffle formation ☐ two depth-velocity combinations present ☐ meandering thalweg moderately identifiable in cross section, with some evidence of bar formation ☐ finer deposition located in slack water below larger substrates/debris, signs of mid-channel accumulation					☐ limited trace of pool formation ☐ limited riffle formation ☐ one or two depth-velocity combinations present ☐ meandering thalweg barely identifiable in the cross section, with minimal evidence of bar formation ☐ very large depositional features below larger substrates/debris, abundant mid-channel accumulation					☐ pool formation completely absent ☐ no riffle formation ☐ one depth-velocity combination present ☐ meandering thalweg not identifiable in the cross section, with no evidence of bar formation ☐ finer deposition throughout channel, even filling pools, larger substrates almost buried **or** bed largely incised				
SCORE	20	19	18	17	16	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1
6.4 Channel Morphology	☐ width/depth < 15, natural ☐ entrenchment ratio ≥ 1.4, incision ratio < 1.2, good floodplain access ☐ no evidence of channel alteration					☐ 15 ≤ w / d < 25, widening ☐ entrenchment ratio ≥ 1.4, 1.2 ≤ incision ratio < 1.4, reduced floodplain access ☐ evidence of minor historic channel alteration					☐ 25 ≤ w /d < 40, widening ☐ entrenchment ratio ≥ 1.4, 1.4 ≤ incision ratio < 2.0, limited floodplain access ☐ major historic or minor recent channel alteration					☐ w /d ≥ 40, over-widening ☐ entrenchment ratio < 1.4 **or** incision ratio ≥ 2.0, floodplain access unlikely ☐ extensive historic or major recent channel alteration				
SCORE	20	19	18	17	16	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1

Habitat Parameter	Condition (Departure) Category																			
	Reference (None)					**Good (Minor)**					**Fair (Major)**					**Poor (Severe)**				
6.5 Hydrologic Characteristics	☐ wetted width / W_{bkf} > 0.75 ☐ exposed substrate < 20% ☐ adjacent springs, seeps, and wetlands extensive ☐ no known flow alteration					☐ 0.75 ≥ W_{wet} / W_{bkf} > 0.50 ☐ 20 ≤ exp. substrate < 40% ☐ adjacent springs, seeps, and wetlands present ☐ minor flow alteration likely due to flow regulation and/or land use changes					☐ 0.50 ≥ W_{wet} / W_{bkf} > 0.25 ☐ 40 ≤ exp. substrate < 60% ☐ adjacent springs, seeps, and wetlands minimal ☐ major flow alteration likely due to flow regulation and/or land use changes					☐ W_{wet} / W_{bkf} ≤ 0.25 ☐ exposed substrate ≥ 60% ☐ adjacent springs, seeps, and wetlands altered or absent ☐ runoff characteristics completely altered due to flow regulation and storm water influence				
SCORE	20	19	18	17	16	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1
6.6 Connectivity Tend towards a higher/lower score for natural/man-made obstructions	☐ no obstructions in reach that block longitudinal movement of aquatic species over all but the lowest flows ☐ system obstructions absent ☐ abundant low **and** high flow refuge					☐ one or two small low flow obstructions present in reach that block movement of aquatic species ☐ limited system obstructions ☐ abundant refuge, with low **or** high flow refuge limited					☐ one or two small to medium bankfull obstructions present in reach that block movement of aquatic species ☐ system obstructions present ☐ limited low **and** high flow refuge					☐ more than two bankfull obstructions present in reach that block movement of aquatic species ☐ many system obstructions ☐ refuge absent				
SCORE	20	19	18	17	16	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1
6.7 River Banks Select different boxes for LB and RB if necessary Undercut size rank variable only used if ≥ 5 undercuts **(score each bank)**	☐ bank erosion <10%, typical of natural conditions, little or no bank revetments ☐ bank vegetation > 90% in tree, shrub and herb layers, diverse assemblages, plants create good cover and roots help stabilize bank ☐ bank canopy > 90% ☐ undercut banks / mile > 20 ☐ undercut bank size rank 3-6 > 50% ☐ undercut banks with mostly stable boundaries, abundant overhanging vegetation, and consistent water adjacency ☐ no mass failures in valley					☐ 10 ≤ bank erosion < 30%, infrequent small areas, some bank revetments ☐ 90 ≥ bank vegetation > 75% in each layer, diverse assemblages, plants create good cover and roots help stabilize bank ☐ 90 ≥ bank canopy > 75% ☐ 20 ≥ undercuts / mile > 15 ☐ 50 ≥ undercut bank size rank 3-6 > 25% ☐ undercuts with some unstable boundaries or reduced overhanging vegetation, and consistent water adjacency ☐ 1 mass failure in valley					☐ 30 ≤ bank erosion < 60%, mod. unstable banks, and/or extensive bank revetments ☐ 75 ≥ bank vegetation > 50%, in two of three layers, reduced diversity, plants create limited cover and roots do not stabilize bank ☐ 75 ≥ bank canopy > 50% ☐ 15 ≥ undercuts / mile > 5 ☐ 25 ≥ undercut bank size rank 3-6 > 10% ☐ undercuts with some unstable boundaries or reduced overhanging vegetation, and reduced water adjacency ☐ 1 - 2 mass failures in valley					☐ bank erosion ≥ 60%, banks unstable, extensive erosion, and failing bank revetments ☐ bank vegetation ≤ 50% in two of three layers, limited diversity, plants create no cover and roots do not stabilize bank ☐ bank canopy ≤ 50% ☐ undercuts / mile ≤ 5 ☐ undercut bank size rank 3-6 ≤ 10% ☐ undercuts with mostly unstable boundaries, no overhanging vegetation, and reduced water adjacency ☐ > 3 mass failures in valley				
SCORE _____ (LB)	Left Bank	10	9			8	7	6			5	4	3			2	1			
SCORE _____ (RB)	Right Bank	10	9			8	7	6			5	4	3			2	1			
6.8 Riparian Area Select different boxes for LB and RB if necessary **(score each side of the channel)**	☐ buffer width > 150 ft ☐ rip. vegetation > 75% in tree, shrub and herb layers, diverse assemblages, no invasives, maximum channel canopy ☐ river corridor development and infrastructure absent					☐ 150 ≥ buffer width > 100 ft ☐ 75 ≥ rip. veg. > 50% in each layer, one plant type absent, minimal invasives, maximum channel canopy ☐ river corridor development and infrastructure minimal					☐ 100 ≥ buffer width > 50 ft ☐ 75 ≥ rip. veg. > 50% in each layer, several types absent, altered patches, invasives present, reduced canopy ☐ river corridor development and infrastructure common					☐ buffer width ≤ 50 ft ☐ rip. veg. ≤ 50% in each layer, several types absent, large altered areas, invasives present, reduced canopy ☐ river corridor development and infrastructure abundant				
SCORE _____ (LB)	Left Bank	10	9			8	7	6			5	4	3			2	1			
SCORE _____ (RB)	Right Bank	10	9			8	7	6			5	4	3			2	1			

6.9 Score: front _____ + back _____ = total _____

Percentage: total score _____ x (100 / 160) = _____

Overall Physical Habitat Condition: _____

SHTD ☐ Existing Stream Habitat Type: _____

Score	*Percentage*	*Condition (Departure)*
136 – 160	**85 – 100**	Reference (None)
104 – 135	**65 – 84**	Good (Minor)
56 – 103	**35 – 64**	Fair (Major)
0 – 55	**0 – 34**	Poor (Severe)

VTANR REACH HABITAT ASSESSMENT ----- BRAIDED STREAM TYPE

(Also use this form for alluvial fans.)

Stream Name:_____ Segment I.D: _____
Location: _____ Date:_____
_____ Town:_____
Observers: _____ Elevation: _____ ft.
Organization /Agency: _____ Latitude (N/S):_____
USGS Map Name(s):_____ Longitude (E/W): _____
Weather:_____ Drainage Area: _____ sq. mi.
Flow: base / low / avg. Storm within past 7 days: Y / N Segment Length: _____ ft.

Habitat Parameter	Condition (Departure) Category				
	Reference (None)	**Good (Minor)**	**Fair (Major)**	**Poor (Severe)**	
6.1 Woody Debris Cover LWD size rank variable only used if ≥ 10 pieces	☐ LWD pieces / mile > 100 ☐ LWD size rank 3-6 >50% ☐ debris jams / mile > 5 ☐ high woody debris recruitment potential ☐ CPOM present in channel and margins	☐ 100 ≥ LWD / mile > 50 ☐ 50 ≥ LWD rank 3-6 > 25% ☐ 5 ≥ jams / mile > 3 ☐ moderate woody debris recruitment potential ☐ CPOM limited in channel and present in margins	☐ 50 ≥ LWD / mile > 25 ☐ 25 ≥ LWD rank 3-6 > 10% ☐ 3 ≥ jams / mile > 1 ☐ low woody debris recruitment potential ☐ CPOM limited in both channel and margins	☐ LWD / mile ≤ 25 ☐ LWD size rank 3-6 ≤ 10% ☐ debris jams absent ☐ no woody debris recruitment potential ☐ CPOM absent	
SCORE	20 19 18 17 16	15 14 13 12 11	10 9 8 7 6	5 4 3 2 1	
6.2 Bed Substrate Cover *fines: sand if d_{50} ≥ gravel, otherwise silt.	☐ riffle embeddedness < 20% margin embeddedness < 40% ☐ fining* < 10% ☐ Riffle stability index < 70% ☐ sediment apparently stable & sorted ☐ substrate free of dense algae growth	☐ 20 ≤ emb_{riffle} < 40% 40 ≤ emb_{margin} < 60% ☐ 10 ≤ fining* < 20% ☐ 70 ≤ RSI < 80% ☐ some evidence of sediment mobility & lack of sorting ☐ small substrate patches covered by dense algae growth	☐ 40 ≤ emb_{riffle} < 75% 60 ≤ emb_{margin} < 80% ☐ 20 ≤ fining* < 40% ☐ 80 ≤ RSI < 90% ☐ major evidence of sediment mobility & lack of sorting ☐ large substrate patches covered by dense algae growth	☐ riffle embeddedness ≥ 75% margin embeddedness ≥ 80% ☐ fining* ≥ 40% ☐ RSI ≥ 90% ☐ sediments unstable, unsorted, soft underfoot ☐ most of substrate covered by dense algae growth	
SCORE	20 19 18 17 16	15 14 13 12 11	10 9 8 7 6	5 4 3 2 1	
6.3 Scour and Deposition Features *Depth-velocity combinations* *fast-shallow* *fast-deep* *slow-shallow* *slow-deep* *(cutoffs: 1.0 fps, 1.5 ft)* Pool size rank variable only used if ≥ 5 pools	☐ pools / mile > 40 ☐ pool size rank 3-7 >50% ☐ good cover > 75% of total pool surface area ☐ riffle coverage > 25% reach area, distinctly formed and complete ☐ 5 ≤ riffle spacing ≤ 7 bankfull channel widths (w_{bkf}) ☐ well-defined riffle-run-pool-glide pattern with all four depth-velocity combinations present ☐ stable bars, vegetative cover on depositional features ≥ 50%, particles well-sorted	☐ 40 ≥ pools / mile > 20 ☐ 50 ≥ pool rank 3-7 > 25% ☐ 75 ≥ good cover > 50% of total pool surface area ☐ 25 ≥ riffle coverage > 10% reach area, moderately well formed and complete ☐ 3 ≤ riffle spacing < 5, or 7 < riffle spacing ≤ 10 x w_{bkf} ☐ well-defined riffle-run-pool-glide pattern with three depth-velocity combinations dominant ☐ mostly stable bars, vegetative cover on depositional features 50-25%, particles moderately sorted	☐ 20 ≥ pools / mile > 10 ☐ 25 ≥ pool rank 3-7 > 10% ☐ 50 ≥ good cover > 25% of total pool surface area ☐ 25 ≥ riffle coverage > 10% reach area, poorly formed and incomplete ☐ 1 ≤ riffle spacing < 3, or 10 < riffle spacing ≤ 12 x w_{bkf} ☐ moderately defined riffle-run-pool-glide pattern with two depth-velocity combinations dominant ☐ unstable bars present, vegetative cover on depositional features 25-10%, particles minimally sorted	☐ pools / mile ≤ 10 ☐ pool size rank 3-7 ≤ 10% ☐ good cover ≤ 25% of total pool surface area ☐ riffle coverage ≤ 10% reach area, or mostly indistinct or absent ☐ riffle spacing ≥ 12 bankfull channel widths ☐ poorly defined riffle-run-pool-glide pattern with one depth-velocity combination dominant ☐ mostly unstable bars, vegetative cover on depositional features < 10%, particles not sorted	
SCORE	20 19 18 17 16	15 14 13 12 11	10 9 8 7 6	5 4 3 2 1	
6.4 Channel Morphology	☐ width/depth < 30, natural ☐ entrenchment ratio ≥ 2.0, incision ratio < 1.0, good floodplain access ☐ no evidence of channel alteration	☐ 30 ≤ w/ d < 40, widening ☐ entrenchment ratio ≥ 2.0, 1.0 ≤ incision ratio < 1.2, reduced floodplain access ☐ evidence of minor historic channel alteration	☐ 40 ≤ w / d < 50, widening ☐ entrenchment ratio ≥ 2.0, 1.2 ≤ incision ratio < 1.4, limited floodplain access ☐ major historic or minor recent channel alteration	☐ w / d ≥ 50, over-widening ☐ entrenchment ratio < 2.0 **or** incision ratio ≥ 1.4, floodplain access unlikely ☐ extensive historic or major recent channel alteration	
SCORE	20 19 18 17 16	15 14 13 12 11	10 9 8 7 6	5 4 3 2 1	

Habitat Parameter	Condition (Departure) Category			
	Reference (None)	**Good (Minor)**	**Fair (Major)**	**Poor (Severe)**
6.5 Hydrologic Characteristics	□ wetted width / W_{bkf} > 0.50 □ exposed substrate < 50% □ adjacent springs, seeps, and wetlands extensive □ no known flow alteration	□ 0.50 ≥ W_{wet} / W_{bkf} > 0.30 □ 50 ≤ exp. substrate < 60% □ adjacent springs, seeps, and wetlands present □ minor flow alteration likely due to flow regulation and/or land use changes	□ 0.30 ≥ W_{wet} / W_{bkf} > 0.10 □ 60 ≤ exp. substrate < 70% □ adjacent springs, seeps, and wetlands minimal □ major flow alteration likely due to flow regulation and/or land use changes	□ W_{wet} / W_{bkf} ≤ 0.10 □ exposed substrate ≥ 70% □ adjacent springs, seeps, and wetlands absent or altered □ runoff characteristics completely altered due to flow regulation and storm water influence
SCORE	20 19 18 17 16	15 14 13 12 11	10 9 8 7 6	5 4 3 2 1
6.6 Connectivity Tend towards a higher/lower score for natural/man-made obstructions	□ no obstructions in reach that block longitudinal movement of aquatic species over all but the lowest flows □ system obstructions absent □ abundant low **and** high flow refuge	□ one or two small low flow obstructions present in reach that block movement of aquatic species □ limited system obstructions □ abundant refuge, with low **or** high flow refuge limited	□ one or two small to medium bankfull obstructions present in reach that block movement of aquatic species □ system obstructions present □ limited low **and** high flow refuge	□ more than two bankfull obstructions present in reach that block movement of aquatic species □ many system obstructions □ refuge absent
SCORE	20 19 18 17 16	15 14 13 12 11	10 9 8 7 6	5 4 3 2 1
6.7 River Banks Select different boxes for LB and RB if necessary	□ bank erosion <10%, typical of natural conditions, little or no bank revetments □ bank vegetation > 90% in tree, shrub and herb layers, diverse assemblages, plants create good cover and roots help stabilize bank	□ 10 ≤ bank erosion < 30%, infrequent small areas, some bank revetments □ 90 ≥ bank vegetation > 75% in each layer, diverse assemblages, plants create good cover and roots help stabilize bank	□ 30 ≤ bank erosion < 60%, mod. unstable banks, and/or extensive bank revetments □ 75 ≥ bank vegetation > 50%, in two of three layers, reduced diversity, plants create limited cover and roots do not stabilize bank	□ bank erosion ≥ 60%, banks unstable, extensive erosion, and failing bank revetments □ bank vegetation ≤ 50% in two of three layers, limited diversity, plants create no cover and roots do not stabilize bank
Undercut size rank variable only used if ≥ 5 undercuts	□ bank canopy > 90% □ undercut banks / mile > 30 □ undercut bank size rank 3-6 > 50%	□ 90 ≥ bank canopy > 75% □ 30 ≥ undercuts / mile > 15 □ 50 ≥ undercut bank size rank 3-6 > 25%	□ 75 ≥ bank canopy > 50% □ 15 ≥ undercuts / mile > 5 □ 25 ≥ undercut bank size rank 3-6 > 10%	□ bank canopy ≤ 50% □ undercuts / mile ≤ 5 □ undercut bank size rank 3-6 ≤ 10%
(score each bank)	□ undercut banks with mostly stable boundaries, abundant overhanging vegetation, and consistent water adjacency □ no mass failures in valley	□ undercuts with some unstable boundaries or reduced overhanging vegetation, and consistent water adjacency □ 1 mass failure in valley	□ undercuts with some unstable boundaries or reduced overhanging vegetation, and reduced water adjacency □ 1 - 2 mass failures in valley	□ undercuts with mostly unstable boundaries, no overhanging vegetation, and reduced water adjacency □ > 3 mass failures in valley
SCORE ___ (LB)	Left Bank 10 9	8 7 6	5 4 3	2 1
SCORE ___ (RB)	Right Bank 10 9	8 7 6	5 4 3	2 1
6.8 Riparian Area Select different boxes for LB and RB if necessary	□ buffer width > 150 ft □ rip. vegetation > 75% in tree, shrub and herb layers, diverse assemblages, no invasives, maximum channel canopy	□ 150 ≥ buffer width > 100 ft □ 75 ≥ rip. veg. > 50% in each layer, one plant type absent, minimal invasives, maximum channel canopy	□ 100 ≥ buffer width > 50 ft □ 75 ≥ rip. veg. > 50% in each layer, several types absent, altered patches, invasives present, reduced canopy	□ buffer width ≤ 50 ft □ rip. veg. ≤ 50% in each layer, several types absent, large altered areas, invasives present, reduced canopy
(score each side of the channel)	□ river corridor development and infrastructure absent	□ river corridor development and infrastructure minimal	□ river corridor development and infrastructure common	□ river corridor development and infrastructure abundant
SCORE ___ (LB)	Left Bank 10 9	8 7 6	5 4 3	2 1
SCORE ___ (RB)	Right Bank 10 9	8 7 6	5 4 3	2 1

6.9 Score: front _____ + back _____ = total _____

Percentage: total score _____ x (100 / 160) = _____

Overall Physical Habitat Condition: _____

SHTD □ Existing Stream Habitat Type: _____

Score	*Percentage*	*Condition (Departure)*
136 – 160	**85 – 100**	Reference (None)
104 – 135	**65 – 84**	Good (Minor)
56 – 103	**35 – 64**	Fair (Major)
0 – 55	**0 – 34**	Poor (Severe)

VT RAPID GEOMORPHIC ASSESSMENT ----- CONFINED STREAMS

For narrowly and semi-confined valley types (confinement ratio < 4)

Stream Name:_____ Segment I.D: _____
Location: _____ Date:_____
_____ Town:_____
Observers: _____ Elevation: _____ ft.
Organization /Agency: _____ Weather:_____
Reference Stream Type _____ ☐ Modified Rain Storm within past 7 days: Y / N
(If bedrock controlled gorge, alluvial fan, or naturally braided system see Handbook Protocols)

Adjustment Process	Condition Category: Reference	Good	Fair	Poor
7.1 Channel Degradation (Incision) • Exposed till or fresh substrate in the stream bed and exposed infrastructure (bridge footings). • New terraces or recently abandoned flood prone areas. • Headcuts, or nickpoints significantly steeper bed segment and comprised of smaller bed material than typical steps. • Freshly eroded, vertical banks. • Alluvial sediments that are imbricated (stacked like dominoes) high in the bank. • Tributary rejuvenation, observed through the presence of nickpoints at or upstream of the mouth of a tributary. • Depositional features with steep faces, usually occurring on the downstream end. **Stream Type Departure** ☐ **Type of STD:**_____	☐ Little evidence of localized slope increase or nickpoints.	☐ Minor localized slope increase or nickpoints.	☐ Sharp change in slope, head cuts present, and/or tributaries rejuvenating.	☐ Sharp change in slope and / or multiple head cuts present. Tributaries rejuvenating.
	☐ Incision Ratio ≥ 1.0 < 1.2 **and** Where channel slope < 4% Entrenchment ratio > 1.4 Where channel slope ≥ 4% Entrenchment ratio > 1.2	☐ Incision Ratio ≥ 1.2 < 1.4 **and** Where channel slope < 4% Entrenchment ratio > 1.4 Where channel slope ≥ 4% Entrenchment ratio > 1.2	☐ Incision Ratio ≥ 1.4 < 2.0 **and** Where channel slope < 4% Entrenchment ratio > 1.4 Where channel slope ≥ 4% Entrenchment ratio > 1.2	☐ Incision ratio ≥ 2.0 **and** Where channel slope < 4% Entrenchment ratio ≤ 1.4 Where channel slope ≥ 4% Entrenchment ratio ≤ 1.2
	☐ Step-pool systems have full complement of expected bed features, steps complete with coarser sediment (≥ D80).	☐ Step-pool systems have full complement of expected bed features, steps mostly complete.	☐ Step-pool systems with incomplete (eroded) steps, dominated by runs.	☐ Step-pool bed features eroded and replaced by plane bed features.
	☐ No significant human-caused change in channel confinement.	☐ Only minor human-caused change in channel confinement.	☐ Significant human-caused change in channel confinement but no change in valley type.	☐ Human caused change in valley type.
	☐ No evidence of historic / present channel straightening, dredging, and/or channel avulsions.	☐ Evidence of minor historic dredging and/or channel avulsion.	☐ Evidence of significant historic channel straightening, dredging, or gravel mining, and/or channel avulsions.	☐ Extensive historic channel straightening, commercial gravel mining, and/or recent channel avulsions.
	☐ No known flow alterations (i.e., increases in flow and/or decreases in sediment supply).	☐ Some increase in flow and/or minor reduction of sediment load.	☐ Major historic flow alterations, greater flows and/or reduction of sediment load.	☐ Major existing flow alterations, greater flows and/or reduction of sediment load.
Score: **Historic** ☐	20 19 18 17 16	15 14 13 12 11	10 9 8 7 6	5 4 3 2 1
7.2 Channel Aggradation • Shallow pool depths. • Abundant sediment deposition on side bars and unvegetated mid-channel bars and extensive sediment deposition at obstructions, channel constrictions. Islands may be present • Most of the channel bed is exposed during typical low flow periods. • Coarse gravels, cobbles, and boulders may be embedded with sand/silt and fine gravel. **Stream Type Departure** ☐ **Type of STD:**_____	☐ Step-pool systems have full complement of expected bed features, complete steps and deep pools.	☐ Step-pool systems with full complement of bed features. Pools filling with fine sediment and may be only slightly deeper and wider than runs.	☐ Step-pool systems with incomplete steps, dominated by runs. Pools filling with fine sediment and may be absent with runs prevailing.	☐ Step-pool bed features are filled with sediment and stream appears as a plane bed.
	☐ Minor side or delta bars present. Minor depositional features typically less than half bankfull stage in height.	☐ Single to multiple mid-channel, side or diagonal bars present. Minor depositional features typically less than bankfull stage in height.	☐ Multiple unvegetated mid-channel, side or diagonal bars present. Sediment buildup at constrictions leading to steep riffles and/or flood chutes.	☐ Multiple unvegetated mid-channel, side or diagonal bars or islands present, splitting or braiding flows even under low flow conditions.
	☐ No apparent increase in gravel / sand substrates (pebble count).	☐ Some increase in small gravel / sand substrates that may comprise over 50% of the sediments.	☐ Large increase in gravel / sand substrates that may comprise over 70% of the sediments.	☐ Homogenous gravel/sand substrates may comprise over 90% of the sediments. Fine sediment feels soft underfoot.
	☐ Low width/depth ratio ≤ 20 for channel slopes < 4% ≤ 12 for channel slopes ≥ 4%	☐ Low to moderate W/d ratio > 20 ≤ 30 for slopes < 4% > 12 ≤ 20 for slopes ≥ 4%	☐ Moderate to high W/d ratio > 30 ≤ 40 for slopes < 4% > 20 ≤ 30 for slopes ≥ 4%	☐ High width/depth ratio > 40 for channel slopes < 4% > 30 for channel slopes ≥ 4%
	☐ No known flow alterations (i.e., decrease in flow and/or increase in sediment supply).	☐ Minor reduction in flow and / or increase in sediment load. Flood-related sediment working through reach, seen as enlarged bars.	☐ Major historic flow alterations, reduction in flows and / or increase in sediment load.	☐ Major existing flow alterations, extreme reduction in flows and / or increase in sediment load.
	☐ No human-made constrictions causing upstream deposition.	☐ Human-made constrictions smaller than floodprone width, causing minor to moderate upstrm / dwnstrm deposition.	☐ Human-made constrictions significantly smaller than floodprone width, causing major upstrm / dwnstrm deposition.	☐ Human-made constrictions significantly smaller than bankfull width, causing extensive upstrm / dwnstrm deposition and flow bifurcation.
Score: **Historic** ☐	20 19 18 17 16	15 14 13 12 11	10 9 8 7 6	5 4 3 2 1

Adjustment Process	Condition Category: Reference	Good	Fair	Poor
7.3 Widening Channel • Active undermining of bank vegetation on both sides of the channel; many unstable bank overhangs that have little vegetation holding soils together. • Erosion on both right and left banks. • Recently exposed tree roots (fresh roots are 'green' and do not break easily, older roots are brittle and will break easily in your hand). • Fracture lines at the top of the bank that appear as cracks parallel to the river. • Evidence of landslides and mass failures. • Mid-channel bars and side bars may be present. • Urbanization and stormwater outfalls leading to higher rate and duration of runoff and channel enlargement.	☐ Low width/depth ratio ≤ 20 for channel slopes < 4% ≤ 10 for channel slopes ≥ 4%	☐ Low to moderate W/d ratio > 20 ≤ 30 for slopes < 4% > 10 ≤ 12 for slopes ≥ 4%	☐ Moderate to high W/d ratio > 30 ≤ 40 for slopes < 4% > 12 ≤ 20 for slopes ≥ 4%	☐ High width/depth ratio > 40 for channel slopes < 4% > 20 for channel slopes ≥ 4%
	☐ Little to no scour and erosion at the base of both banks. Negligible bank overhangs, fracture lines at top of banks, leaning trees or freshly exposed tree roots.	☐ Minimal to moderate scour and erosion at the base of both banks. Some overhangs, fracture lines at top of banks, leaning trees and freshly exposed tree roots.	☐ Moderate to high scour and erosion at the base of both banks. Many bank overhangs, fracture lines at top of banks, leaning trees and freshly exposed tree roots.	☐ Continuous and laterally extensive scour and erosion at the base of both banks. Continuous bank overhangs, fracture lines at top of banks, leaning trees and freshly exposed tree roots.
	☐ Incision Ratio ≥ 1.0 < 1.2 **and** Where channel slope < 4% Entrenchment ratio > 1.4 Where channel slope ≥ 4% Entrenchment ratio > 1.2	☐ Incision Ratio ≥ 1.2 < 1.4 **and** Where channel slope < 4% Entrenchment ratio > 1.4 Where channel slope ≥ 4% Entrenchment ratio > 1.2	☐ Incision Ratio ≥ 1.4 < 2.0 **and** Where channel slope < 4% Entrenchment ratio > 1.4 Where channel slope ≥ 4% Entrenchment ratio > 1.2	☐ Incision ratio ≥ 2.0 **and** Where channel slope < 4% Entrenchment ratio ≤ 1.4 Where channel slope ≥ 4% Entrenchment ratio ≤ 1.2
	☐ Minor side or delta bars present. Depositional features typically less than half bankfull stage in height.	☐ Single to multiple mid-channel or side bars present. Minor depositional features typically less than half bankfull stage in height.	☐ Multiple unvegetated mid-channel or side bars present. Major sediment buildup at the head of constrictions leading to steep riffles and/or flood chutes.	☐ Multiple unvegetated mid-channel, side or diagonal bars or islands present, splitting or braiding flows even under low flow conditions.
	☐ No known channel and / or flow alterations (i.e., increase in flow and/or change in sediment supply).	☐ Minor increase in watershed input of flows and/or sediment. Episodic (flood) discharges resulting in short-term enlargement.	☐ Major channel and/or flow alterations, increase in flows and/or change in sediment load (increase or decrease).	☐ Major and extensive channel and/or flow alterations, increase in flows and/or change in sediment load (increase or decrease).
Score: **Historic** ☐	20 19 18 17 16	15 14 13 12 11	10 9 8 7 6	5 4 3 2 1
7.4 Change in Planform • Flood chutes present. • Channel avulsions evident or impending. • Change or loss in bed form structure, sometimes resulting in a mix of plane bed and step-pool forms. • Island formation and/or multiple thread channels.	☐ Low bank erosion on outside bends, little or no change in sinuosity within the reach.	☐ Low to moderate lateral bank erosion on outside bends, may include minor change in sinuosity within the reach.	☐ Moderate to high lateral bank erosion on most outside bends, may include moderate change in reach sinuosity.	☐ Extensive lateral bank erosion on most outside bends, may include major change in sinuosity within the reach.
	☐ Little or no evidence sediment buildup, only minor delta or side bars typically less than half bankfull stage in height.	☐ Single to multiple unvegetated mid-channel, delta, or side bars. Some potential for channel avulsion.	☐ Multiple unvegetated mid-channel, delta, or side bars, typically greater than bankfull stage in height. Evidence of past channel avulsion and/or islands.	☐ Multiple and major mid-channel, delta, and/or side bars. Evidence of recent channel avulsion, multiple thread channels, and islands.
	☐ No human-caused alteration of channel planform and / or the width of the floodprone area.	☐ Minor to moderate alteration of channel planform and/or width of the floodprone area resulting from floodplain encroachment, channel straightening, or dredging.	☐ Major alteration of channel planform and/or width of the floodprone area resulting from historic encroachment, dredging, or channel straightening.	☐ Major alteration of channel planform and the width of the floodprone area resulting from recent and extensive encroachment, dredging, and/or channel straightening.
	☐ Human-made constrictions causing only negligible upstream deposition.	☐ Human-made constrictions smaller than floodprone width, causing minor to moderate upstrm / dwnstrm deposition.	☐ Human-made constrictions significantly smaller than floodprone width, causing major upstrm / dwnstrm deposition.	☐ Human-made constrictions significantly smaller than bankfull width, causing extensive major upstrm / dwnstrm deposition and flow bifurcation.
Score: **Historic** ☐	20 19 18 17 16	15 14 13 12 11	10 9 8 7 6	5 4 3 2 1

7.5 Channel Adjustment Scores – Stream Condition – Channel Evolution Stage

Condition / Departure	Reference / N/S	Good / Minor	Fair / Major	Poor / Extreme	STD*	Historic	Condition Rating: (Total Score / 80)	Channel Evolution Stage:
Degradation								
Aggradation								
Widening							**7.6 Stream Condition:**	
Planform								
Sub-totals:					**Total Score:**			

*STD = Stream Type Departure where existing stream type is no longer the same as the reference stream type.

Channel Adjustment Processes: _____

7.7 Stream Sensitivity: Very Low / Low / Moderate / High / Very High / Extreme

* Channel Condition "default" to **poor** – significant flood damage (not able to get accurate channel data) **Y/N ;**

***** Channel Condition default to poor - Due to channel alterations from work in channel after flood: **Y/N**

* Stream Sensitivity "default" to **poor** – significant flood damage (not able to get accurate channel data) **Y/N ;**

* Stream Sensitivity "default" to **poor** Due to channel alterations from work in channel after flood: **Y/N**

VT RAPID GEOMORPHIC ASSESSMENT ----- UNCONFINED STREAMS

For narrow and broad to very broad valley types (confinement ratio ≥ 4) Typically Riffle-pool and Dune-Ripple Stream Types

Stream Name:_____ Segment I.D: _____
Location: _____ Date:_____
_____ Town:_____
Observers: _____ Elevation: _____ ft.
Organization /Agency: _____ Weather:_____
Reference Stream Type _____ ☐ Modified Rain Storm within past 7 days: Y / N
(If alluvial fan or naturally braided system see Handbook Protocols)

Adjustment Process	Condition Category: Reference	Good	Fair	Poor
7.1 Channel Degradation (Incision) • Exposed till or fresh substrate in the stream bed and exposed infrastructure(bridge footings) • New terraces or recently abandoned floodplains. • Headcuts, or nickpoints that are 2-3 times steeper than typical riffle. • Freshly eroded, vertical banks. • Alluvial (river) sediments that are imbricated (stacked like dominoes) high in bank. • Tributary rejuvenation, observed through the presence of nickpoints at or upstream of the mouth of a tributary. • Bars with steep faces, usually occurring on the downstream end of a bar. **Stream Type Departure** ☐ **Type of STD:**_____	☐ Little evidence of localized slope increase or nickpoints.	☐ Minor localized slope increase or nickpoints.	☐ Sharp change in slope, head cuts present, and/or tributaries rejuvenating.	☐ Sharp change in slope and / or multiple head cuts present. Tributaries rejuvenating.
	☐ Incision Ratio ≥ 1.0 < 1.2 **and** Entrenchment ratio > 2.0	☐ Incision Ratio ≥ 1.2 < 1.4 **and** Entrenchment ratio > 2.0	☐ Incision Ratio ≥ 1.4 < 2.0 **and** Entrenchment ratio > 2.0	☐ Incision ratio ≥ 2.0 **OR** Entrenchment ratio ≤ 2.0
	☐ Riffle heads complete and comprised of courser sediments (≥D80). Full complement of expected bed features.	☐ Riffle heads mostly complete. Riffle lengths may appear shorter. Full complement of expected bed features.	☐ Riffles or dunes may appear incomplete; bed profile dominated by runs.	☐ Riffle-pool or ripple-dune features replaced by plane bed features.
	☐ No significant human-caused change in channel confinement or valley type.	☐ Only minor human-caused change in channel confinement but no change in valley type.	☐ Significant human-caused change in channel confinement enough to change valley type, but still unconfined.	☐ Human-caused change in valley type, unconfined or narrow changed to confined.
	☐ No evidence of historic / present channel straightening, gravel mining, dredging and/or channel avulsions.	☐ Evidence of minor bar scalping on a point bar and/or channel avulsion; but minor to no historic channel straightening, gravel mining, or dredging.	☐ Evidence of significant historic channel straightening, dredging, gravel mining and/or channel avulsions.	☐ Extensive historic channel straightening, commercial gravel mining, and/or recent channel avulsion.
	☐ No known flow alterations (i.e., increases in flow or decreases in sediment supply).	☐ Minor flow alterations, some flow increase and/or reduction of sediment load.	☐ Major historic flow alterations, greater flows and/or reduction of sediment load.	☐ Major existing flow alterations, greater flows and/or reduction of sediment load.
Score: **Historic** ☐	20 19 18 17 16	15 14 13 12 11	10 9 8 7 6	5 4 3 2 1
7.2 Channel Aggradation • Shallow pool depths. • Abundant sediment deposition on point bars and mid-channel bars and extensive sediment deposition at obstructions, channel constrictions, and at the upstream end of tight meander bends. Islands may be present. • Most of the channel bed is exposed during typical low flow periods. • High frequency of debris jams. • Coarse gravels, cobbles, and boulders may be embedded with sand/silt and fine gravel. ** This parameter may be a difficult to infeasible to evaluate in ripple-dune stream types **Stream Type Departure** ☐ **Type of STD:**_____	☐ Complete riffle heads and deep pools in riffle-pool systems.** Full complement of expected bed features.	☐ Mostly complete riffles and/or some filling of pools with fine sediment. Pools may only be slightly deeper and wider than runs.**	☐ Incomplete riffles or dunes and dominated by runs. Significant filling of pools with sediment, pools may be absent with runs prevailing.	☐ Riffle-pool or ripple-dune features replaced by plane bed features.
	☐ Minor point or delta bars present. Minor depositional features typically less than half bankfull stage in height.	☐ Single to multiple mid-channel or diagonal bars present. Minor depositional features typically less than half bankfull stage in height.	☐ Multiple unvegetated mid-channel or diagonal bars present. Major sediment buildup at the head of bendways leading to steep riffles and flood chutes.	☐ Multiple unvegetated mid-channel or diagonal bars present splitting or braiding flows even under low flow conditions.
	☐ No apparent increase in fine gravel/sand substrates (pebble count).**	☐ Some increase in fine gravel/sand substrates that may comprise over 50% of the sediments.	☐ Large incr. in fine gravel/ sand substrates that may comprise over 70% of the sediments. Sediment feels soft underfoot.	☐ Homogenous fine gravel/ sand substrates may comprise over 90% of the sediments. Sediment feels soft underfoot.
	☐ Low width/depth ratio ≤ 20 for C or B type channels ≤ 10 for E type channels	☐ Low to moderate W/d ratio >20 ≤ 30 for C or B channels >10 ≤ 12 for E channels	☐ Moderate to high W/d ratio >30 ≤ 40 for C or B channels >12 ≤ 20 for E channels	☐ High width/depth ratio >40 for C or B type channels >20 for E type channels
	☐ No known flow alterations (i.e., decrease in flow or increase in sediment supply).	☐ Minor reduction in flow and/or increase in sediment load. Flood-related sediment working through reach, seen as enlarged bars.	☐ Major historic flow alterations, reduction in flows and / or increase in sediment load.	☐ Major existing flow alterations, extreme reduction in flows and / or increase in sediment load.
	☐ No human-made constrictions causing upstream deposition.	☐ Human-made constrictions smaller than floodprone width, causing minor to moderate upstrm / dwnstrm deposition.	☐ Human-made constrictions significantly smaller than floodprone width, causing major upstrm / dwnstrm deposition.	☐ Human-made constrictions significantly smaller than bankfull width, causing extensive upstrm / dwnstrm deposition and flow bifurcation.
Score: **Historic** ☐	20 19 18 17 16	15 14 13 12 11	10 9 8 7 6	5 4 3 2 1

Adjustment Process	Condition Category: Reference	Good	Fair	Poor
7.3 Widening Channel • Active undermining of bank vegetation on both sides of the channel; many unstable bank overhangs that have little vegetation holding soils together. • Erosion on both right and left banks in riffle sections. • Recently exposed tree roots (fresh roots are 'green' and do not break easily, older roots are brittle and will break easily in your hand). • Fracture lines at the top of the bank that appear as cracks parallel to the river. • Mid-channel bars and side bars may be present. • Urbanization and stormwater outfalls leading to higher rate and duration of runoff and channel enlargement.	☐ Low width/depth ratio ≤ 20 for C or B type channels ≤ 10 for E type channels	☐ Low to moderate W/d ratio >20 ≤ 30 for C or B channels >10 ≤ 12 for E channels	☐ Moderate to high W/d ratio >30 ≤ 40 for C or B channels >12 ≤ 20 for E channels	☐ High width/depth ratio >40 for C or B type channels >20 for E type channels
	☐ Little to no scour and erosion at the base of both banks at the riffle section. Negligible bank overhangs, fracture lines at top of banks, leaning trees or freshly exposed tree roots.	☐ Minimal to moderate scour and erosion at the base of both banks at the riffle section. Some overhangs, fracture lines at top of banks, leaning trees and freshly exposed tree roots.	☐ Moderate to high scour and erosion at the base of both banks at the riffle section. Many bank overhangs, fracture lines at top of banks, leaning trees and freshly exposed tree roots.	☐ Continuous and laterally extensive scour and erosion at the base of both banks at the riffle section. Continuous bank overhangs, fracture lines at top of banks, leaning trees and freshly exposed tree roots.
	☐ Incision Ratio ≥ 1.0 < 1.2 **and** Entrenchment ratio > 2.0	☐ Incision Ratio ≥ 1.2 < 1.4 **and** Entrenchment ratio > 2.0	☐ Incision Ratio ≥ 1.4 < 2.0 **and** Entrenchment ratio > 2.0	☐ Incision ratio ≥ 2.0 **OR** Entrenchment ratio ≤ 2.0
	☐ Minor point or delta bars present. Depositional features less than half bankfull stage in height.	☐ Single to multiple mid-channel or diagonal bars present. Minor depositional features typically less than half bankfull stage in height.	☐ Multiple unvegetated mid-channel or diagonal bars present. Major sediment buildup at the head of bendways leading to steep riffles and flood chutes.	☐ Multiple unvegetated mid-channel or diagonal bars present splitting or braiding flows even under low flow conditions.
	☐ No known channel and / or flow alterations (i.e., increase in flow and / or change in sediment supply).	☐ Minor increase in watershed input of flows or sediment. Episodic (flood) discharges through reach resulting in short-term enlargement.	☐ Major channel and/or flow alterations, increase in flows and/or change in sediment load (increase or decrease).	☐ Major and extensive -channel and/or flow alterations, increase in flows and/or change in sediment load (increase or decrease).
Score: **Historic** ☐	20 19 18 17 16	15 14 13 12 11	10 9 8 7 6	5 4 3 2 1
7.4 Change in Planform • Flood chutes or neck cut-offs may be present. • Channel avulsions may be evident or impending. • Change or loss in bed form structure, sometimes resulting in a mix of plane bed and riffle- pool forms. • Island formation and/or multiple thread channels. • In meandering streams the thalweg, or deepest part of the channel, typically travels from the outside of a meander bend to the outside of the next meander bend. Pools are located on downstream third of the concave bends. Riffles are at the cross-over between the pools on successive bends. During planform adjustments, the thalweg may not line up with or follow this pattern. As a result of the lateral extension of meander bends, additional deposition and scour features may be in a channel length typically occupied by a single riffle-pool sequence.	☐ Low bank erosion on outside bends, little or no change in sinuosity within the reach.	☐ Low to moderate lateral bank erosion on outside bends, may include minor change in sinuosity within the reach.	☐ Moderate to high lateral bank erosion on most outside bends, may include potential neck cut-offs and moderate change in sinuosity.	☐ Extensive lateral bank erosion on most outside bends, may include impending neck cut-offs and major change in sinuosity within the reach.
	☐ Little evidence of flood chutes crossing inside of meander bends, only minor point or delta bars.	☐ Minor flood chutes crossing inside of meander bends, evidence of minor to moderate unvegetated mid-channel, delta, or diagonal bars. Some potential for channel avulsion.	☐ Historic or active flood chutes crossing inside of meander bends, evidence of channel avulsion, islands, and unvegetated mid-channel, delta, or diagonal bars.	☐ Active large flood chutes crossing inside of most meander bends, evidence of recent channel avulsion, multiple thread channels, islands, and unvegetated mid-channel, delta, or diagonal bars.
	☐ No additional deposition and scour features in the channel length typically occupied by a single riffle-pool sequence. Thalweg lined up with planform.	☐ Additional minor deposition and scour features in the channel length typically occupied by a single riffle-pool sequence.	☐ Additional large deposition and scour features in the channel length typically occupied by a single riffle-pool sequence. Thalweg not lined up with planform.	☐ Multiple sequences of large deposition and scour features in the channel length typically occupied by a single riffle-pool sequence.
	☐ No human-caused alteration of channel planform and / or the width of the floodprone area.	☐ Minor to moderate alteration of channel planform and/or width of the floodprone area resulting from floodplain encroachment, channel straightening, or dredging.	☐ Major alteration of channel planform and/or the width of the floodprone area resulting from historic floodplain encroachment, dredging, or channel straightening.	☐ Major alteration of channel planform and width of the floodprone area resulting from recent and extensive floodplain encroachment, dredging, and/or channel straightening.
	☐ Human-made constrictions causing only negligible upstream deposition.	☐ Human-made constrictions smaller than floodprone width, causing minor to moderate upstrm / downstrm deposition.	☐ Human-made constrictions significantly smaller than floodprone width, causing major upstrm / downstrm deposition.	☐ Human-made constrictions significantly smaller than bankfull width, causing extensive and major upstrm / downstrm deposition and flow bifurcation.
Score: **Historic** ☐	20 19 18 17 16	15 14 13 12 11	10 9 8 7 6	5 4 3 2 1

7.5 Channel Adjustment Scores – Stream Condition – Channel Evolution Stage

Condition / Departure	Reference / N/S	Good / Minor	Fair / Major	Poor / Extreme	STD*	Historic	Condition Rating: (Total Score / 80)	Channel Evolution Stage:
Degradation								
Aggradation								
Widening							**7.6 Stream Condition:**	
Planform								

Channel Adjustment Processes: _____

7.7 Stream Sensitivity: Very Low / Low / Moderate / High / Very High / Extreme

* Channel Condition "default" to **poor** – significant flood damage (not able to get accurate channel data) **Y/N ;**

***** Channel Condition default to poor - Due to channel alterations from work in channel after flood: **Y/N**

* Stream Sensitivity "default" to **poor** – significant flood damage (not able to get accurate channel data) **Y/N ;**

* Stream Sensitivity "default" to **poor** Due to channel alterations from work in channel after flood: **Y/N**

VT RAPID GEOMORPHIC ASSESSMENT ----- PLANE BED STREAMS

Typically found in semi-confined to narrow valley types (confinement ratio ≥ 3 and ≤ 5)

Reminder: This RGA form should only be used on streams which are plane bed systems by reference. Many existing plane bed streams in Vermont represent a departure from another stream type.

Stream Name:_____ Segment I.D: _____
Location: _____ Date:_____
_____ Town:_____
Observers: _____ Elevation: _____ ft.
Organization /Agency: _____ Weather:_____
Reference Stream Type _____ ☐ Modified Rain Storm within past 7 days: Y / N
(If alluvial fan or naturally braided system see Handbook Protocols)

Adjustment Process	Condition Category: Reference	Good	Fair	Poor
7.1 Channel Degradation (Incision) • Exposed till or fresh substrate in the stream bed and exposed infrastructure (bridge footings). • New terraces or recently abandoned floodplains. • Headcuts, or nickpoints that are 2-3 times steeper than typical riffle. • Freshly eroded, vertical banks. • Alluvial (river) sediments that are imbricated (stacked like dominoes) high in bank. • Tributary rejuvenation, observed through the presence of nickpoints at or upstream of the mouth of a tributary. **Stream Type Departure** ☐ **Type of STD:**_____	☐ Little evidence of localized slope increase or nickpoints.	☐ Minor localized slope increase or nickpoints.	☐ Sharp change in slope, head cuts present, and/or tributaries rejuvenating.	☐ Sharp change in slope and / or multiple head cuts present. Tributaries rejuvenating.
	☐ Incision ratio ≥ 1.0 < 1.2 **and** Where channel slope > 2% Entrenchment ratio > 1.4 Where channel slope ≤ 2% Entrenchment ratio > 2.0	☐ Incision ratio ≥ 1.2 < 1.4 **and** Where channel slope > 2% Entrenchment ratio > 1.4 Where channel slope ≤ 2% Entrenchment ratio > 2.0	☐ Incision ratio ≥ 1.4 < 2.0 **and** Where channel slope > 2% Entrenchment ratio > 1.4 Where channel slope ≤ 2% Entrenchment ratio > 2.0	☐ Incision ratio ≥ 2.0 **and** Where channel slope > 2% Entrenchment ratio ≤ 1.4 Where channel slope ≤ 2% Entrenchment ratio ≤ 2.0
	☐ No significant human-caused change in channel confinement or valley type.	☐ Only minor human-caused change in channel confinement but no change in valley type.	☐ Significant human-caused change in channel confinement enough to change valley type, but still not narrowly confined.	☐ Human-caused change to a narrowly confined valley type.
	☐ No evidence of historic or present channel straightening, gravel mining, dredging and/or channel avulsions.	☐ Evidence of minor mid-channel bar scalping and/or channel avulsion, but minor to no historic channel straightening, gravel mining or dredging.	☐ Evidence of significant historic channel straightening, dredging, gravel mining and/or channel avulsions.	☐ Extensive historic channel straightening, commercial gravel mining, and/or recent channel avulsion.
	☐ No known flow alterations (i.e., increases in flow or decreases in sediment supply).	☐ Minor flow alterations, some flow increase and/or minor reduction of sediment load.	☐ Major historic flow alterations, greater flows and/or reduction of sediment load.	☐ Major existing flow alterations, greater flows and/or reduction of sediment load.
Score: Historic ☐	20 19 18 17 16	15 14 13 12 11	10 9 8 7 6	5 4 3 2 1
7.2 Channel Aggradation • Very shallow pocket pools around and below boulders. • Abundant sediment deposition on side, point and mid-channel bars and extensive sediment deposition at obstructions, channel constrictions, and at the upstream end of tight bendways. Islands may be present. • Most of the channel bed is exposed during typical low flow periods. • Increased frequency of woody debris in channel. • Coarse gravels, cobbles, and boulders may be embedded with sand/silt and fine gravel. **Stream Type Departure** ☐ **Type of STD:**_____	☐ Minor side, point or delta bars present. Minor depositional features typically less than half bankfull stage in height.	☐ Single to multiple mid-channel or diagonal bars present. Minor depositional features typically less than half bankfull stage in height.	☐ Multiple unvegetated mid-channel or diagonal bars present. Sediment buildup at the head of bendways leading to steep riffles and flood chutes.	☐ Multiple unvegetated mid-channel or diagonal bars present splitting or braiding flows even under low flow conditions.
	☐ No apparent increase in fine gravel/sand substrates (pebble count).	☐ Some increase in fine gravel/sand substrates that may comprise over 50% of the sediments.	☐ Large increase in fine gravel/sand substrates that may comprise over 70% of the sediments. Fine sediment feels soft underfoot.	☐ Homogenous fine gravel/sand substrates may comprise over 90% of the sediments. Fine sediment feels soft underfoot.
	☐ Low width/depth ratio W/d ≤ 20	☐ Low to moderate W/d ratio W/d >20 ≤ 30	☐ Moderate to high W/d ratio W/d >30 ≤ 40	☐ High width/depth ratio W/d >40
	☐ No known flow alterations (i.e., decrease in flow or increase in sediment supply).	☐ Minor reduction in flow and/or increase in sediment load. Flood-related sediment working through reach, seen as enlarged bars.	☐ Major historic flow alterations, reduction in flows and / or increase in sediment load.	☐ Major existing flow alterations, extreme reduction in flows and / or increase in sediment load.
	☐ No human-made constrictions causing upstream deposition.	☐ Human-made constrictions smaller than floodprone width, causing minor to moderate upstrm / dwnstrm deposition.	☐ Human-made constrictions significantly smaller than floodprone width, causing major upstrm / dwnstrm deposition.	☐ Human-made constrictions significantly smaller than bankfull width, causing extensive upstrm / dwnstrm deposition and flow bifurcation.
Score: Historic ☐	20 19 18 17 16	15 14 13 12 11	10 9 8 7 6	5 4 3 2 1

Adjustment Process	Condition Category			
	Reference	**Good**	**Fair**	**Poor**
7.3 Widening Channel • Active undermining of bank vegetation on both sides of the channel; many unstable bank overhangs that have little vegetation holding soils together. • Erosion on both right and left banks in riffle sections. • Recently exposed tree roots (fresh roots are 'green' and do not break easily, older roots are brittle and will break easily in your hand). • Fracture lines at the top of the bank that appear as cracks parallel to the river. • Mid-channel bars and side bars may be present. • Urbanization and stormwater outfalls leading to higher rate and duration of runoff and channel enlargement.	☐ Low width/depth ratio W/d ≤ 20	☐ Low to moderate W/d ratio W/d >20 ≤ 30	☐ Moderate to high W/d ratio W/d >30 ≤ 40	☐ High width/depth ratio W/d >40
	☐ Little to no scour and erosion at the base of both banks. Negligible bank overhangs, fracture lines at top of banks, leaning trees or freshly exposed tree roots.	☐ Minimal to moderate scour and erosion at the base of both banks. Some overhangs, fracture lines at top of banks, leaning trees and freshly exposed tree roots.	☐ Moderate to high scour and erosion at the base of both banks. Many bank overhangs, fracture lines at top of banks, leaning trees and freshly exposed tree roots.	☐ Continuous and laterally extensive scour and erosion at the base of both banks. Continuous bank overhangs, fracture lines at top of banks, leaning trees and freshly exposed tree roots.
	☐ Incision Ratio ≥ 1.0 < 1.2 **and** Where channel slope > 2% Entrenchment ratio > 1.4 Where channel slope ≤ 2% Entrenchment ratio > 2.0	☐ Incision Ratio ≥ 1.2 < 1.4 **and** Where channel slope > 2% Entrenchment ratio > 1.4 Where channel slope ≤ 2% Entrenchment ratio > 2.0	☐ Incision Ratio ≥ 1.4 < 2.0 **and** Where channel slope > 2% Entrenchment ratio > 1.4 Where channel slope ≤ 2% Entrenchment ratio > 2.0	☐ Incision ratio ≥ 2.0 **and** Where channel slope > 2% Entrenchment ratio ≤ 1.4 Where channel slope ≤ 2% Entrenchment ratio ≤ 2.0
	☐ Minor side, point or delta bars present. Minor depositional features typically less than half bankfull stage in height.	☐ Single to multiple mid-channel or diagonal bars present. Minor depositional features typically less than half bankfull stage in height.	☐ Multiple unvegetated mid-channel or diagonal bars present. Sediment buildup at the head of bendways leading to steep riffles and flood chutes.	☐ Multiple unvegetated mid-channel or diagonal bars present splitting or braiding flows even under low flow conditions.
	☐ No known channel and / or flow alterations (i.e., increase in flow and/or change in sediment supply).	☐ Minor increase in watershed input of flows or sediment. Episodic (flood) discharges through reach resulting in short-term enlargement.	☐ Major channel and / or flow alterations, increase in flows and/or change in sediment load (increase or decrease).	☐ Major and extensive -channel and/or flow alterations, increase in flows and / or change in sediment load (increase or decrease).
Score: **Historic** ☐	20 19 18 17 16	15 14 13 12 11	10 9 8 7 6	5 4 3 2 1
7.4 Change in Planform • Flood chutes may be present. • Channel avulsions may be evident or impending. • Change or loss in bed form structure, sometimes resulting in a mix of plane bed and riffle- pool forms. • Island formation and/or multiple thread channels.	☐ Low bank erosion on outside bends, little or no change in sinuosity within the reach.	☐ Low to moderate lateral bank erosion on outside bends, may include minor change in sinuosity within the reach.	☐ Moderate to high lateral bank erosion on most outside bends, may include moderate change in sinuosity.	☐ Extensive lateral bank erosion on most outside bends, may include major change in sinuosity within the reach.
	☐ Little evidence of flood chutes crossing inside of bends, only minor side, point, or delta bars.	☐ Minor flood chutes crossing inside of bends, evidence of single to multiple unvegetated mid-channel, delta, or diagonal bars. Some potential for channel avulsion.	☐ Historic or active flood chutes crossing inside of bends, evidence of channel avulsion, islands, and multiple unvegetated mid-channel, delta, or diagonal bars.	☐ Active large flood chutes, evidence of recent channel avulsion, multiple thread channels, islands, and multiple unvegetated mid-channel, delta, or diagonal bars.
	☐ No human-caused alteration of channel planform and / or the width of the floodprone area.	☐ Minor to moderate alteration of channel planform and/or width of the floodprone area resulting from floodplain encroachment, channel straightening, or dredging.	☐ Major alteration of channel planform and/or the width of the floodprone area resulting from historic floodplain encroachment, dredging, or channel straightening.	☐ Major alteration of channel planform and width of the floodprone area resulting from recent and extensive floodplain encroachment, dredging, and/or channel straightening.
	☐ Human-made constrictions causing only negligible upstream deposition.	☐ Human-made constrictions smaller than floodprone width, causing minor to moderate upstrm / downstrm deposition.	☐ Human-made constrictions significantly smaller than floodprone width, causing major upstrm / downstrm deposition.	☐ Human-made constrictions significantly smaller than bankfull width, causing extensive and major upstrm / downstrm deposition and flow bifurcation.
Score: **Historic** ☐	20 19 18 17 16	15 14 13 12 11	10 9 8 7 6	5 4 3 2 1

7.5 Channel Adjustment Scores – Stream Condition – Channel Evolution Stage

Condition / Departure	Reference / N/S	Good / Minor	Fair / Major	Poor / Extreme	STD*	Historic	Condition Rating: (Total Score / 80)	Channel Evolution Stage:
Degradation								
Aggradation								
Widening							**7.6 Stream Condition:**	
Planform								
Sub-totals:					**Total Score:**			

Channel Adjustment Processes: _____

7.7 Stream Sensitivity: Very Low / Low / Moderate / High / Very High / Extreme

* Channel Condition "default" to **poor** – significant flood damage (not able to get accurate channel data) **Y/N ;**

***** Channel Condition default to poor - Due to channel alterations from work in channel after flood: **Y/N**

* Stream Sensitivity "default" to **poor** – significant flood damage (not able to get accurate channel data) **Y/N ;**

* Stream Sensitivity "default" to **poor** Due to channel alterations from work in channel after flood: **Y/N**

Vermont Stream Geomorphic Assessment
Adjusted Phase 2 Field Forms for Stand-Alone Reach Habitat Assessment (RHA)

*****Yellow cells required for RHA Protocol*****

Field Notes Form for Steps 1 - 5

Cross-Section Worksheet

Field Quick Refer Tables

Quality Assurance Data Sheet

Rapid Habitat Assessment (RHA)

Rapid Geomorphic Assessment (RGA)

Rapid Stream Assessment Field Notes

Stream Name:_____ Segment I.D: _____
Location: _____ Date:_____ ☐ Sub-Reach
_____ Town:_____
Observers: _____ Elevation: _____ ft.
Organization /Agency: _____ Latitude (N/S):_____
USGS Map Name(s):_____ Longitude (E/W): _____
Weather:_____ Drainage Area: _____ sq. mi.
Rain Storm within past 7 days: Y / N Flood history known: Y / N Segment Length: _____ ft.
Segment Not Assessed: W/I/N/G/B/O

1. Valley and River Corridor

1.1 Segmentation: GC/CD/SS/PS/DF/CE/BB/FS/PA/SR/VW/OT/None **1.2 Alluvial Fan (FIT):** Yes/No/UK

1.3 River Corridor Encroachments (FIT)	Reach or Segment Length			1.4 Slope of the Adjacent Terrace or Hillside	
	One Bank	Both Banks	Height from tw	Left Corridor	Right Corridor
Berms				flat (0-3%) hilly (4-8%) steep (9-15%) very steep (16-25%) x-steep (>25%) **Continuous w/bank** A / S / N **Within 1x Wbkf** A / S / N Texture of Exposed Slope till boulder/cobble gravel sand silt clay bedrock other Not Evaluated	flat (0-3%) hilly (4-8%) steep (9-15%) very steep (16-25%) x-steep (>25%) **Continuous w/bank** A / S / N **Within 1x Wbkf** A / S / N Texture of Exposed Slope till boulder/cobble gravel sand silt clay bedrock other Not Evaluated
Roads					
Railroads					
Improved Paths					
Development			NA		

1.5 Confinement *Valley width / Channel width*	1.6 Grade Controls (FIT) ☐ none — Location in Reach (record locations on field map) **Waterfall // Ledge // Dam // Weir** — Fill out height fields for grade controls if applicable →	Total Height (0.0 ft)	Height Above Water Surface (0.0 ft)	Photo Yes / No
Valley Width:_____ ☐ Gorge Estimated / Measured ☐ Human caused change in valley width				
Narrowly Confined (>=1 & < 2)				
Semi-confined (>2 & < 4)				
Narrow (>= 4 & < 6)				
Broad (>= 6 & <10)				
Very Broad (>= 10)				

2. Stream Channel

2.1 Bankfull Width: _____ ft. **2.1a Wetted Width:** _____ ft. **2.1b Ratio (W_{wetted} / W_{bkf}):**_____

2.2 Max. Bankfull Depth: _____ ft. **2.3 Mean Bankfull Depth:**_____ ft.

2.4 Floodprone Width: _____ft. **2.5 Recently Abandoned FP :** _____ ft. **2.6 Ratio W/d_{mean}:**_____

2.7 Entrenchment: _____ **2.8 Incision Ratio:** _____ IR_{hef} :_____ **2.9 Sinuosity:** _____

2.10 Riffles/Steps: complete / eroded / sedimented / NA / NE (partial or none) (diagonal or continuous) **2.11 Riffle/Step Spacing:** _____ ft.

2.12 Bed Substrate Composition (percent):

1 Bedrock	2 Boulder >10 in >256 mm	3 Cobble 2.5 - 10 in 64-256 mm	4 Gravel Course 0.6-2.5in 16-64mm	4 Gravel Fine 0.08-0.63in 2-16 mm	5 Sand 0.002-0.1in .062-2mm	6 Silt or Clay (present)	Embeddedness Mean Channel	Embeddedness Mean Margin	2.13 Avg. Size of Largest Particles on:
						Y / N			Bed:_____ Bar:_____ **circle**: inches or millimeters

2.13a % Exp. Substrate:_____

2.14 Stream Type: A G F B E C D 1 2 3 4 5 6 a b c

Cascade Step-Pool Plane Bed Riffle-Pool Ripple-Dune Braided

Stream Type

☐Reference Type

3. Riparian banks, Buffers, and Corridors

3.1	**Typical Bank Slope**		shallow	moderate	steep	undercut	**(evaluate on the higher of the two banks)**								
	Bank Texture-RB	**Lower**	bedrock	boulder/cobble	gravel	sand	silt/clay	mix	cohesive / non-cohesive						
		Upper	bedrock	boulder/cobble	gravel	sand	silt/clay	mix	cohesive / non-cohesive						
	Bank Texture-LB	**Lower**	bedrock	boulder/cobble	gravel	sand	silt/clay	mix	cohesive / non-cohesive						
		Upper	bedrock	boulder/cobble	gravel	sand	silt/clay	mix	cohesive / non-cohesive						
	Bank Erosion (FIT)	**Left**	**Length:** ft. **Height:** ft.				**Bank Revetment Type:**		**Length:** ft.						
		Right	**Length:** ft. **Height:** ft.				**Bank Revetment Type:**		**Length:** ft.						
	Near Bank Vegetation Type	**Trees**	L % cover	Invasive	Conifer	Deciduous	R % cover	Invasive	Conifer	Deciduous					
		Shrubs / Saps.	L % cover	Invasive	WADs	Saplings	R % cover	Invasive	WADs	Saplings					
		Herbs	L % cover	Invasive	Grasses	Forbs	R % cover	Invasive	Grasses	Forbs					
	Bank Canopy	**Left**	76 - 100%	51 - 75%	26 - 50%	1 - 25%	0%	**Channel Canopy**							
		Right	76 - 100%	51 - 75%	26 - 50%	1 - 25%	0%	Open	Closed						
3.2	**Buffer Width (dom/sub) (FIT 0-25 ft)**	**Left**	0 – 25 ft.	26 – 50 ft.	51 – 100 ft.	> 100 ft	none (SD).								
		Right	0 – 25 ft.	26 – 50 ft.	51 – 100 ft.	> 100 ft	none (SD).								
	Buffer Vegetation Type	**Trees**	L % cover	Invasive	Conifer	Deciduous	R % cover	Invasive	Conifer	Deciduous					
		Shrubs / Saps.	L % cover	Invasive	WADs	Saplings	R % cover	Invasive	WADs	Saplings					
		Herbs	L % cover	Invasive	Grasses	Forbs	R % cover	Invasive	Grasses	Forbs					
3.3	**Riparian Corridor (dom/sub)**	**Left**	forest	shrub-sapling	crop/pasture/hay	commercial/industrial	residential	bare	none (SD)						
		Right	forest	shrub-sapling	crop/pasture/hay	commercial/industrial	residential	bare	none (SD)						

4.1 Springs or Seeps: extensive / present / minimum / none / altered

4.2 Adjacent Wetlands: extensive / present / minimum / none / altered **4.3 Flow status:** base / low / avg.

4.4 Current Debris Jams (FIT): # _____ **4.5 Flow Regs. & Withdrawals (FIT):** TYPE: withdrawal / bypass / r-o-r / store & release / none / unk

4.7 Flow Regulation (FIT): SIZE : small / large ; USE: drinking / irrigation, flood-control / hydro-electric / recreation /other

4.6 Upstream/Downstream Flow Regs. : upstream / downstream / both / none

4.7 Stormwater Inputs (FIT): tile drain ___ / road ditch___ / urban stormwater ___ / field ditch ___/ overland flow ___

4.8 Constrictions ☐ none **menu**: instream culvert // bridge // old abutment // bedrock outcrop // other

						Problems (check all that apply)					
Constriction Type (from menu)	**Width** (ft)	**Photo** Yes / No		channel constriction	floodprone constriction	deposition above	deposition below	scour above	scour below	alignment	none
				☐	☐						
				☐	☐						
				☐	☐						
				☐	☐						

4.9 Beaver Dams (FIT): # _____ _____ft. of the segment affected. ☐ Bridge & Culvert Assessments

5. Channel Bed and Planform Changes

(5.0 to 5.3 record on tally sheet)

5.4 Stream Ford or Animal Crossing (FIT): Yes / No

5.5 Channel Alterations (FIT) (circle all that apply): dredging gravel mining commercial mining none

Length of Straightening: _____ (With Windrowing : Yes / No)

Comments:

Sketch Form for Sites – Segments – Reaches

Stream Name:_____ Segment or Site ID: _____
Date:_____ Town:_____
Observers:_____ Elevation: _____ Ft.
Organization /Agency: _____

Site Sketch - see reverse side for sketch codes and tally columns for left and right bank erosion, revetments, and corridor developments and calculating the total length of the segment affected by beaver flowages.

Scale:

Height of bankfull features above water surface (Ft.)

_____ _____ _____ _____ _____ Selected BKF Height

_____ _____ _____ _____ _____ _____

Constrictions α

LWD tally
Debris Jams
Stormwater

Tally Sheet (page 1)

Stream Name:_____ Segment I.D: _____
Location: _____ Date:_____

☐ Sub-Reach

Step 2.1 Height of bankfull above water surface

Bankfull Height	Chan. Wdth	Comments (describe indicators)

Step 5. Channel Bed and Planform Changes

Record actual number of features			Tally
5.1	Depositional Features (Bar Type)	Mid	
		Point	
		Side	
		Diagonal	
		Delta	
		Island	
5.2 FIT	Flood Chutes		
	Neck Cut-offs		
	Channel Avulsions		
	Braiding		
	Migration		
5.3 FIT	Aggrade	Steep Riffles	
	Degrade	Head Cuts	
	Tributary Rejuvenation?	Yes / No	

Step 3.1 Bank Erosion **FIT**

Left Bank Length	Height	Right Bank Length	Height
Total:	**Avg.**	**Total:**	**Avg.**

Step 3.3 Mass Failures and Gullies **FIT**

Mass Fail - Length		**Height**	**Gully** - Length		**Length**
Left	**Right**		**Left**	**Right**	

Step 3.1 Bank Revetment **FIT**

Length	
Left Bank	**Right Bank**
Total:	**Total:**

Step 4.8 Channel Constrictions

	Constriction Type	Width	Photo?	GPS?	Ch. Constr.	FP. Constr.	DA	DB	SA	SB	A	None
1.)												
2.)												
3.)												
4.)												
5.)												

		Tally
Step 2.12	**Large Woody Debris**	
Step 4.4	**Debris Jams**	

Step 2.11	**Riffle/Step Spacing:**		
Step 2.13	**Avg. Largest Particle**	**On Bed:**	**On Bar:**

Step 1.3 River Corridor Encroachments **FIT**

Type	Length		Height of Fill
	One Side	Both Sides	

Step 4.6 Stormwater **FIT**

	Tally
Field Ditch	
Overland Flow	
Road Ditch	
Tile Drain	
Urban Stormwater	
Other	

Tally Sheet (page 2)

Stream Name:_____ Segment I.D: _____
Location: _____ Date:_____

☐ Sub-Reach

Note CPOM, algae, location of fines

6.1 Large Woody Debris and Jams

Rank	D_{large} (ft)	L (w_{bkf})	Tally	#	%
1	0.5 - 1.0	< 0.5			
2	0.5 - 1.0	> 0.5			
3	1.0 - 2.0	< 0.5			
4	1.0 - 2.0	> 0.5			
5	> 2.0	< 0.5			
6	> 2.0	> 0.5			
		Total LWDs			
		# LWDs / mile			
		# Debris jams			
		# Debris jams / mile			

6.2 Pools (note vegetative cover, surface turbulence, fines)

Rank	D (ft)	L,W (w_{bkf})	Tally	#	%
1	1.0 - 2.0	< 0.5			
2	1.0 - 2.0	> 0.5			
3	2.0 - 3.0	< 0.5			
4	2.0 - 3.0	> 0.5			
5	> 3.0	< 0.5			
6	> 3.0	> 0.5			
7	> 3.0	≥ 1.0			
		Total pools			
		# Pools / mile			

6.3 Refuge Areas / Connections

ID	Location	Q_{access}	Notes
	in / out	low / bkf	
	in / out	low / bkf	
	in / out	low / bkf	
	in / out	low / bkf	
	in / out	low / bkf	
	in / out	low / bkf	
	in / out	low / bkf	

6.4 Undercut Banks (note stability, overhanging vegetation)

Rank	D_{max} (ft)	L (ft)	Tally	#	%
1	0.5 – 1.0	< 2.0			
2	0.5 – 1.0	> 2.0			
3	1.0 – 2.0	< 2.0			
4	1.0 – 2.0	> 2.0			
5	>2.0	< 2.0			
6	>2.0	> 2.0			
		Total undercuts			
		# undercut banks / mile			

Cross-Section Worksheet

Stream Name:_____ Reach-Segment: _____
Location: _____ Date:_____
Observers: _____

Comments:

BKF Height

Cross-Section Notes Codes

LTER = Left Terrace	RTER = Right Terrace	TW = Thalweg
LFPA = Left Flood Plane	RFPA = Right Flood Plane	LPIN = Left Pin
LTOB = Left Top of Bank	RTOB = Right Top of Bank	RPIN = Right Pin
LBF = Left Bankfull Stage	RBF = Right Bankfull Stage	
LEW = Left Edge of Water	REW = Right Edge of Water	
RAF = Recently Abandoned Floodplain		

Cross-sections - Number and Location Description:

Note	Distance	Depth	Note	Distance	Depth	Note	Distance	Depth

Bankfull Width		Bankfull Width		Bankfull Width	
Max. Depth		Max. Depth		Max. Depth	
Mean Depth		Mean Depth		Mean Depth	
Floodprone Width		Floodprone Width		Floodprone Width	
Low Bank Height		Low Bank Height		Low Bank Height	
Width/depth Ratio		Width/depth Ratio		Width/depth Ratio	
Entrenchment		Entrenchment		Entrenchment	
Incision Ratio		Incision Ratio		Incision Ratio	
Wetted Width		Wetted Width		Wetted Width	

Drawing of Typical Cross-Section

Size Class	Millimeters	Inches	Relative Size			Distribution of 100 Particles			Percent	
1-Bedrock	> 4096	> 160	Bigger than a VW Bug							
2-Boulder	256 – 4096	10.1 – 160	Basketball to VW Bug							
3-Cobble	64 – 256	2.5 – 10.1	Tennis ball to basketball							
4-Coarse Gravel	16 – 64	0.63 – 2.5	Marble to tennis ball							
4-Fine Gravel	2 – 16	0.08 – 0.63	Pepper corn to marble							
5-Sand or Smaller	< 2.00	< 0.08	Smaller than a pepper corn							
Embeddedness	Ch1	Ch2	Ch3	Ch4	Ch5	Ma1	Ma2	Ma3	Ma4	Ma5
Largest mobile particles	Bd1	Bd2	Bd3	Bd4	Bd5	Br1	Br2	Br3	Br4	Br5

VTANR REACH HABITAT ASSESSMENT ----- RIFFLE-POOL STREAM TYPE

(Also use this form for dune-ripple stream type.)

Stream Name:_____ Segment I.D: _____
Location: _____ Date:_____
_____ Town:_____
Observers: _____ Elevation: _____ ft.
Organization /Agency: _____ Latitude (N/S):_____
USGS Map Name(s):_____ Longitude (E/W): _____
Weather:_____ Drainage Area: _____ sq. mi.
Flow: base / low / avg. Storm within past 7 days: Y / N Segment Length: _____ ft.

Habitat Parameter	Condition (Departure) Category																			
	Reference (None)					**Good (Minor)**					**Fair (Major)**					**Poor (Severe)**				
6.1 Woody Debris Cover LWD size rank variable only used if ≥ 10 pieces	☐ LWD pieces / mile > 100 ☐ LWD size rank 3-6 >50% ☐ debris jams / mile > 5 ☐ high woody debris recruitment potential ☐ CPOM present in channel and margins					☐ 100 ≥ LWD / mile > 50 ☐ 50 ≥ LWD rank 3-6 > 25% ☐ 5 ≥ jams / mile > 3 ☐ moderate woody debris recruitment potential ☐ CPOM limited in channel and present in margins					☐ 50 ≥ LWD / mile > 25 ☐ 25 ≥ LWD rank 3-6 > 10% ☐ 3 ≥ jams / mile > 1 ☐ low woody debris recruitment potential ☐ CPOM limited in both channel and margins					☐ LWD / mile ≤ 25 ☐ LWD size rank 3-6 ≤ 10% ☐ debris jams absent ☐ no woody debris recruitment potential ☐ CPOM absent				
SCORE	20	19	18	17	16	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1
6.2 Bed Substrate Cover *fines: sand if d_{50} ≥ gravel, otherwise silt. (Dune-ripple stream type: Fining only.)	☐ riffle embeddedness < 20% margin embeddedness < 40% ☐ fining* < 10% ☐ Riffle stability index < 70% ☐ sediment apparently stable & sorted ☐ substrate free of dense algae growth					☐ 20 ≤ emb_{riffle} < 40% 40 ≤ emb_{margin} < 60% ☐ 10 ≤ fining* < 20% ☐ 70 ≤ RSI < 80% ☐ some evidence of sediment mobility & lack of sorting ☐ small substrate patches covered by dense algae growth					☐ 40 ≤ emb_{riffle} < 75% 60 ≤ emb_{margin} < 80% ☐ 20 ≤ fining* < 40% ☐ 80 ≤ RSI < 90% ☐ major evidence of sediment mobility & lack of sorting ☐ large substrate patches covered by dense algae growth					☐ riffle embeddedness ≥ 75% margin embeddedness ≥ 80% ☐ fining* ≥ 40% ☐ RSI ≥ 90% ☐ sediments unstable, unsorted, soft underfoot ☐ most of substrate covered by dense algae growth				
SCORE	20	19	18	17	16	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1
6.3 Scour and Deposition Features (Dune-ripple stream type: Only evaluate pools and ripples.) *Depth-velocity combinations* *fast-shallow* *fast-deep* *slow-shallow* *slow-deep* *(cutoffs: 1.0 fps, 1.5 ft)* Pool size rank variable only used if ≥ 5 pools	☐ pools / mile > 40 ☐ pool size rank 3-7 >50% ☐ good cover > 75% of total pool surface area ☐ riffle (ripple) coverage > 25% reach area, distinctly formed and complete ☐ 5 ≤ riffle spacing ≤ 7 bankfull channel widths (w_{bkf}) ☐ well-defined riffle-run-pool-glide pattern with all four depth-velocity combinations present ☐ finer deposition located entirely in slack water below larger substrates/debris, and along margins					☐ 40 ≥ pools / mile > 20 ☐ 50 ≥ pool rank 3-7 > 25% ☐ 75 ≥ good cover > 50% of total pool surface area ☐ 25 ≥ riffle coverage > 10% reach area, moderately well formed and complete ☐ 3 ≤ riffle spacing < 5, or 7 < riffle spacing ≤ 10 x w_{bkf} ☐ well-defined riffle-run-pool-glide pattern with three depth-velocity combinations dominant ☐ finer deposition located in slack water below larger substrates/debris, signs of mid-channel accumulation					☐ 20 ≥ pools / mile > 10 ☐ 25 ≥ pool rank 3-7 > 10% ☐ 50 ≥ good cover > 25% of total pool surface area ☐ 25 ≥ riffle coverage > 10% reach area, poorly formed and incomplete ☐ 1 ≤ riffle spacing < 3, or 10 < riffle spacing ≤ 12 x w_{bkf} ☐ moderately defined riffle-run-pool-glide pattern with two depth-velocity combinations dominant ☐ very large depositional features below larger substrates/debris, abundant mid-channel accumulation					☐ pools / mile ≤ 10 ☐ pool size rank 3-7 ≤ 10% ☐ good cover ≤ 25% of total pool surface area ☐ riffle (ripple) coverage ≤ 10% reach area, or mostly indistinct ☐ riffle spacing ≥ 12 bankfull channel widths ☐ poorly defined riffle-run-pool-glide pattern with one depth-velocity combination dominant ☐ finer deposition throughout channel, even filling pools, larger substrates almost buried **or** bed largely incised				
SCORE	20	19	18	17	16	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1
6.4 Channel Morphology	☐ width/depth < 15, natural ☐ entrenchment ratio ≥ 1.4, incision ratio < 1.2, good floodplain access ☐ no evidence of channel alteration					☐ 15 ≤ w / d < 25, widening ☐ entrenchment ratio ≥ 1.4, 1.2 ≤ incision ratio < 1.4, reduced floodplain access ☐ evidence of minor historic channel alteration					☐ 25 ≤ w / d < 40, widening ☐ entrenchment ratio ≥ 1.4, 1.4 ≤ incision ratio < 2.0, limited floodplain access ☐ major historic or minor recent channel alteration					☐ w / d > 40, over-widening ☐ entrenchment ratio < 1.4 **or** incision ratio ≥ 2.0, floodplain access unlikely ☐ extensive historic or major recent channel alteration				
SCORE	20	19	18	17	16	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1

Habitat Parameter	Condition (Departure) Category			
	Reference (None)	**Good (Minor)**	**Fair (Major)**	**Poor (Severe)**
6.5 Hydrologic Characteristics	☐ wetted width / W_{bkf} > 0.75 ☐ exposed substrate < 20% ☐ adjacent springs, seeps, and wetlands extensive ☐ no known flow alteration	☐ 0.75 ≥ W_{wet} / W_{bkf} > 0.50 ☐ 20 ≤ exp. substrate < 40% ☐ adjacent springs, seeps, and wetlands present ☐ minor flow alteration likely due to flow regulation and/or land use changes	☐ 0.50 ≥ W_{wet} / W_{bkf} > 0.25 ☐ 40 ≤ exp. substrate < 60% ☐ adjacent springs, seeps, and wetlands minimal ☐ major flow alteration likely due to flow regulation and/or land use changes	☐ W_{wet} / W_{bkf} ≤ 0.25 ☐ exposed substrate ≥ 60% ☐ adjacent springs, seeps, and wetlands absent or altered ☐ runoff characteristics completely altered due to flow regulation and storm water influence
SCORE	20 19 18 17 16	15 14 13 12 11	10 9 8 7 6	5 4 3 2 1
6.6 Connectivity Tend towards a higher/lower score for natural/man-made obstructions	☐ no obstructions in reach that block longitudinal movement of aquatic species over all but the lowest flows ☐ system obstructions absent ☐ abundant low **and** high flow refuge	☐ one or two small low flow obstructions present in reach that block movement of aquatic species ☐ limited system obstructions ☐ abundant refuge, with low **or** high flow refuge limited	☐ one or two small to medium bankfull obstructions present in reach that block movement of aquatic species ☐ system obstructions present ☐ limited low **and** high flow refuge	☐ more than two bankfull obstructions present in reach that block movement of aquatic species ☐ many system obstructions ☐ refuge absent
SCORE	20 19 18 17 16	15 14 13 12 11	10 9 8 7 6	5 4 3 2 1
6.7 River Banks Select different boxes for LB and RB if necessary	☐ bank erosion <10%, typical of natural conditions, little or no bank revetments ☐ bank vegetation > 90% in tree, shrub and herb layers, diverse assemblages, plants create good cover and roots help stabilize bank	☐ 10 ≤ bank erosion < 30%, infrequent small areas, some bank revetments ☐ 90 ≥ bank vegetation > 75% in each layer, diverse assemblages, plants create good cover and roots help stabilize bank	☐ 30 ≤ bank erosion < 60%, mod. unstable banks, and/or extensive bank revetments ☐ 75 ≥ bank vegetation > 50%, in two of three layers, reduced diversity, plants create limited cover and roots do not stabilize bank	☐ bank erosion ≥ 60%, banks unstable, extensive erosion, and failing bank revetments ☐ bank vegetation ≤ 50% in two of three layers, limited diversity, plants create no cover and roots do not stabilize bank
Undercut size rank variable only used if ≥ 5 undercuts	☐ bank canopy > 90% ☐ undercut banks / mile > 30 ☐ undercut bank size rank 3-6 > 50%	☐ 90 ≥ bank canopy > 75% ☐ 30 ≥ undercuts / mile > 15 ☐ 50 ≥ undercut bank size rank 3-6 > 25%	☐ 75 ≥ bank canopy > 50% ☐ 15 ≥ undercuts / mile > 5 ☐ 25 ≥ undercut bank size rank 3-6 > 10%	☐ bank canopy ≤ 50% ☐ undercuts / mile ≤ 5 ☐ undercut bank size rank 3-6 ≤ 10%
(score each bank)	☐ undercut banks with mostly stable boundaries, abundant overhanging vegetation, and consistent water adjacency ☐ no mass failures in valley	☐ undercuts with some unstable boundaries or reduced overhanging vegetation, and consistent water adjacency ☐ 1 mass failure in valley	☐ undercuts with some unstable boundaries or reduced overhanging vegetation, and reduced water adjacency ☐ 1 - 2 mass failures in valley	☐ undercuts with mostly unstable boundaries, no overhanging vegetation, and reduced water adjacency ☐ ≥ 3 mass failures in valley
SCORE _____ (LB)	Left Bank 10 9	8 7 6	5 4 3	2 1
SCORE _____ (RB)	Right Bank 10 9	8 7 6	5 4 3	2 1
6.8 Riparian Area Select different boxes for LB and RB if necessary	☐ buffer width > 150 ft ☐ rip. vegetation > 75% in tree, shrub and herb layers, diverse assemblages, no invasives, maximum channel canopy	☐ 150 ≥ buffer width > 100 ft ☐ 75 ≥ rip. veg. > 50% in each layer, one plant type absent, minimal invasives, maximum channel canopy	☐ 100 ≥ buffer width > 50 ft ☐ 75 ≥ rip. veg. > 50% in each layer, several types absent, altered patches, invasives present, reduced canopy	☐ buffer width ≤ 50 ft ☐ rip. veg. ≤ 50% in each layer, several types absent, large altered areas, invasives present, reduced canopy
(score each side of the channel)	☐ river corridor development and infrastructure absent	☐ river corridor development and infrastructure minimal	☐ river corridor development and infrastructure common	☐ river corridor development and infrastructure abundant
SCORE _____ (LB)	Left Bank 10 9	8 7 6	5 4 3	2 1
SCORE _____ (RB)	Right Bank 10 9	8 7 6	5 4 3	2 1

6.9 Score: front _____ + back _____ = total _____

Percentage: total score _____ x (100 / 160) = _____

Overall Physical Habitat Condition: _____

SHTD ☐ Existing Stream Habitat Type: _____

Score	*Percentage*	*Condition (Departure)*
136 – 160	**85 – 100**	Reference (None)
104 – 135	**65 – 84**	Good (Minor)
56 – 103	**35 – 64**	Fair (Major)
0 – 55	**0 – 34**	Poor (Severe)

VTANR REACH HABITAT ASSESSMENT ----- STEP-POOL STREAM TYPE

(Also use this form for cascade and bedrock stream types.)

Stream Name:_____ Segment I.D: _____
Location: _____ Date:_____
_____ Town:_____
Observers: _____ Elevation: _____ ft.
Organization /Agency: _____ Latitude (N/S):_____
USGS Map Name(s):_____ Longitude (E/W): _____
Weather:_____ Drainage Area: _____ sq. mi.
Flow: base / low / avg. Storm within past 7 days: Y / N Segment Length: _____ ft.

Habitat Parameter	Condition (Departure) Category			
	Reference (None)	**Good (Minor)**	**Fair (Major)**	**Poor (Severe)**
6.1 Woody Debris Cover LWD size rank variable only used if ≥ 10 pieces	□ LWD pieces / mile > 200 □ LWD size rank 3-6 >75% □ debris jams / mile > 25 □ high woody debris recruitment potential □ CPOM present in channel and margins	□ 200 ≥ LWD / mile > 100 □ 75 ≥ LWD rank 3-6 > 50% □ 25 ≥ jams / mile > 15 □ moderate woody debris recruitment potential □ CPOM limited in channel and present in margins	□ 100 ≥ LWD / mile > 50 □ 50 ≥ LWD rank 3-6 > 25% □ 15 ≥ jams / mile > 5 □ low woody debris recruitment potential □ CPOM limited in both channel and margins	□ LWD / mile ≤ 50 □ LWD size rank 3-6 ≤ 25% □ jams / mile ≤ 5 □ no woody debris recruitment potential □ CPOM absent
SCORE	20 19 18 17 16	15 14 13 12 11	10 9 8 7 6	5 4 3 2 1
6.2 Bed Substrate Cover *fines: sand if d_{50} ≥ gravel, otherwise silt.	□ pool embeddedness < 25% margin embeddedness < 40% □ fining* < 10% □ sediment apparently stable & sorted □ substrate free of dense algae growth	□ 25 ≤ emb_{pool} < 50% 40 ≤ emb_{margin} < 60% □ 10 ≤ fining* < 20% □ some evidence of sediment mobility & lack of sorting □ small substrate patches covered by dense algae growth	□ 50 ≤ emb_{pool} < 75% 60 ≤ emb_{margin} < 80% □ 20 ≤ fining* < 40% □ major evidence of sediment mobility & lack of sorting □ large substrate patches covered by dense algae growth	□ pool embeddedness ≥ 75% margin embeddedness ≥ 80% □ fining* ≥ 40% □ sediments unstable, unsorted, soft underfoot □ most of substrate covered by dense algae growth
SCORE	20 19 18 17 16	15 14 13 12 11	10 9 8 7 6	5 4 3 2 1
6.3 Scour and Deposition Features *Depth-velocity combinations* *fast-shallow* *fast-deep* *slow-shallow* *slow-deep* *(cutoffs: 1.0 fps, 1.5 ft)* Pool size rank variable only used if ≥ 5 pools (Cascade and bedrock stream types: Do not evaluate variables related to step pattern.)	□ pools / mile > 70 □ pool size rank 3-7 >50% □ good cover > 75% of total pool surface area □ steps are distinctly formed, complete and stable □ 5 ≤ step spacing ≤ 7 bankfull channel widths (w_{bkf}) □ more than two depth-velocity combinations present □ finer deposition located entirely in slack water below larger substrates/debris, and along margins	□ 70 ≥ pools / mile > 50 □ 50 ≥ pool rank 3-7 > 25% □ 75 ≥ good cover > 50% of total pool surface area □ steps are moderately well formed, complete and stable □ 3 ≤ step spacing < 5, or 7 < step spacing ≤ 10 x w_{bkf} □ two depth-velocity combinations present □ finer deposition located in slack water below larger substrates/debris, signs of mid-channel accumulation	□ 50 ≥ pools / mile > 30 □ 25 ≥ pool rank 3-7 > 10% □ 50 ≥ good cover > 25% of total pool surface area □ steps are poorly formed, incomplete and unstable □ 1 ≤ step spacing < 3, or 10 < step spacing ≤ 15 x w_{bkf} □ one or two depth-velocity combinations present □ very large depositional features below larger substrates/debris, abundant mid-channel accumulation	□ pools / mile ≤ 30 □ pool size rank 3-7 ≤ 10% □ good cover over ≤ 25% of total pool surface area □ steps are indistinct or absent, or very unstable □ step spacing ≥ 15 bankfull channel widths □ one depth-velocity combination present □ finer deposition throughout channel, even filling pools, larger substrates almost buried **or** bed largely incised
SCORE	20 19 18 17 16	15 14 13 12 11	10 9 8 7 6	5 4 3 2 1
6.4 Channel Morphology	□ width/depth < 12, natural □ entrenchment ratio ≥ 1.2, incision ratio < 1.2, good floodplain access □ no evidence of channel alteration	□ 12 ≤ w / d < 15, widening □ entrenchment ratio ≥ 1.2, 1.2 ≤ incision ratio < 1.4, reduced floodplain access □ evidence of minor historic channel alteration	□ 15 ≤ w / d < 25, widening □ entrenchment ratio ≥ 1.2, 1.4 ≤ incision ratio < 2.0, limited floodplain access □ major historic or minor recent alteration	□ w / d ≥ 25, over-widening □ entrenchment ratio < 1.2 **or** incision ratio ≥ 2.0, floodplain access unlikely □ extensive historic or major recent alteration
SCORE	20 19 18 17 16	15 14 13 12 11	10 9 8 7 6	5 4 3 2 1

Habitat Parameter	Condition (Departure) Category																			
	Reference (None)					**Good (Minor)**					**Fair (Major)**					**Poor (Severe)**				
6.5 Hydrologic Characteristics	□ wetted width / W_{bkf} > 0.75 □ exposed substrate < 10% □ adjacent springs, seeps, and wetlands extensive □ no known flow alteration					□ 0.75 ≥ W_{wet} / W_{bkf} > 0.50 □ 10 ≤ exp. substrate < 30% □ adjacent springs, seeps, and wetlands present □ minor flow alteration likely due to flow regulation and/or land use changes					□ 0.50 ≥ W_{wet} / W_{bkf} > 0.25 □ 30 ≤ exp. substrate < 50% □ adjacent springs, seeps, and wetlands minimal □ major flow alteration likely due to flow regulation and/or land use changes					□ W_{wet} / W_{bkf} ≤ 0.25 □ exposed substrate ≥ 50% □ adjacent springs, seeps, and wetlands absent or altered □ runoff characteristics completely altered due to flow regulation and storm water influence				
SCORE	20	19	18	17	16	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1
6.6 Connectivity Tend towards a higher/lower score for natural/man-made obstructions	□ no obstructions in reach that block longitudinal movement of aquatic species over all but the lowest flows □ system obstructions absent □ abundant low **and** high flow refuge					□ one or two small low flow obstructions present in reach that block movement of aquatic species □ limited system obstructions □ abundant refuge, with low **or** high flow refuge limited					□ one or two small to medium bankfull obstructions present in reach that block movement of aquatic species □ system obstructions present □ limited low **and** high flow refuge					□ more than two bankfull obstructions present in reach that block movement of aquatic species □ many system obstructions □ refuge absent				
SCORE	20	19	18	17	16	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1
6.7 River Banks Select different boxes for LB and RB if necessary Undercut size rank variable only used if ≥ 5 undercuts **(score each bank)**	□ bank erosion <10%, typical of natural conditions, little or no bank revetments □ bank vegetation > 90% in tree, shrub and herb layers, diverse assemblages, plants create good cover and roots help stabilize bank □ bank canopy > 90% □ undercut banks / mile > 15 □ undercut bank size rank 3-6 > 50% □ undercut banks with mostly stable boundaries, abundant overhanging vegetation, and consistent water adjacency □ no mass failures in valley					□ 10 ≤ bank erosion < 20%, infrequent small areas, some bank revetments □ 90 ≥ bank vegetation > 75% in each layer, diverse assemblages, plants create good cover and roots help stabilize bank □ 90 > bank canopy > 80% □ 15 ≥ undercuts / mile > 10 □ 50 ≥ undercut bank size rank 3-6 > 25% □ undercuts with some unstable boundaries or reduced overhanging vegetation, and consistent water adjacency □ 1 mass failure in valley					□ 20 ≤ bank erosion < 50%, mod. unstable banks, and/or extensive bank revetments □ 75 ≥ bank vegetation > 50%, in two of three layers, reduced diversity, plants create limited cover and roots do not stabilize bank □ 80 ≥ bank canopy > 60% □ 10 ≥ undercuts / mile > 5 □ 25 ≥ undercut bank size rank 3-6 > 10% □ undercuts with some unstable boundaries or reduced overhanging vegetation, and reduced water adjacency □ 1 - 2 mass failures in valley					□ bank erosion ≥ 50%, banks unstable, extensive erosion, and failing bank revetments □ bank vegetation ≤ 50% in two of three layers, limited diversity, plants create no cover and roots do not stabilize bank □ bank canopy ≤ 60% □ undercuts / mile ≤ 5 □ undercut bank size rank 3-6 ≤ 10% □ undercuts with mostly unstable boundaries, no overhanging vegetation, and reduced water adjacency □ > 3 mass failures in valley				
SCORE _____ (LB)	Left Bank	10	9			8	7	6			5	4	3			2			1	
SCORE _____ (RB)	Right Bank	10	9			8	7	6			5	4	3			2			1	
6.8 Riparian Area Select different boxes for LB and RB if necessary **(score each side of the channel)**	□ buffer width > 200 ft □ rip. vegetation > 90% in tree, shrub and herb layers, diverse assemblages, no invasives, maximum channel canopy □ river corridor development and infrastructure absent					□ 200 ≥ buffer width > 150 ft □ 90 ≥ rip. veg. > 75% in each layer, one plant type absent, minimal invasives, maximum channel canopy □ river corridor development and infrastructure minimal					□ 150 ≥ buffer width > 100 ft □ 75 ≥ rip. veg. > 50% in each layer, several types absent, altered patches, invasives present, reduced canopy □ river corridor development and infrastructure common					□ buffer width ≤ 100 ft □ rip. veg. ≤ 50% in each layer, several types absent, large altered areas, invasives present, reduced canopy □ river corridor development and infrastructure abundant				
SCORE _____ (LB)	Left Bank	10	9			8	7	6			5	4	3			2			1	
SCORE _____ (RB)	Right Bank	10	9			8	7	6			5	4	3			2			1	

6.9 Score: front _____ + back _____ = total _____

Percentage: total score _____ x (100 / 160) = _____

Overall Physical Habitat Condition: _____

SHTD □ Existing Stream Habitat Type: _____

Score	*Percentage*	*Condition (Departure)*
136-160	**85 – 100**	Reference (None)
104 – 135	**65 – 84**	Good (Minor)
56 – 103	**35 – 64**	Fair (Major)
0 – 55	**0 – 34**	Poor (Severe)

VTANR REACH HABITAT ASSESSMENT ----- PLANE BED STREAM TYPE

Stream Name:_____ Segment I.D: _____
Location: _____ Date:_____
_____ Town:_____
Observers: _____ Elevation: _____ ft.
Organization /Agency: _____ Latitude (N/S):_____
USGS Map Name(s):_____ Longitude (E/W): _____
Weather:_____ Drainage Area: _____ sq. mi.
Flow: base / low / avg. Storm within past 7 days: Y / N Segment Length: _____ ft.

Habitat Parameter	Condition (Departure) Category																			
	Reference (None)					Good (Minor)					Fair (Major)					Poor (Severe)				
6.1 Woody Debris Cover LWD size rank variable only used if ≥ 10 pieces	☐ LWD pieces / mile > 50 ☐ LWD size rank 3-6 >50% ☐ debris jams / mile > 5 ☐ high woody debris recruitment potential ☐ CPOM present in channel and margins					☐ 50 ≥ LWD / mile > 25 ☐ 50 ≥ LWD rank 3-6 > 25% ☐ 5 ≥ jams / mile > 3 ☐ moderate woody debris recruitment potential ☐ CPOM limited in channel and present in margins					☐ 25 ≥ LWD / mile > 10 ☐ 25 ≥ LWD rank 3-6 > 10% ☐ 3 ≥ jams / mile > 1 ☐ low woody debris recruitment potential ☐ CPOM limited in both channel and margins					☐ LWD / mile ≤ 10 ☐ LWD size rank 3-6 ≤ 10% ☐ debris jams absent ☐ no woody debris recruitment potential ☐ CPOM absent				
SCORE	20	19	18	17	16	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1
6.2 Bed Substrate Cover *fines: sand if d_{50} ≥ gravel, otherwise silt.	☐ run embeddedness < 20% margin embeddedness < 40% ☐ fining* < 10% ☐ sediment apparently stable & sorted ☐ imbrication limited, or mostly with the short axis of particles overlapping in the direction of flow ☐ substrate free of dense algae growth					☐ 20 ≤ emb_{run} < 40% 40 ≤ emb_{margin} < 60% ☐ 10 ≤ fining* < 20% ☐ some evidence of sediment mobility & lack of sorting ☐ imbrication moderate, mostly with the short axis of particles overlapping in the direction of flow ☐ small substrate patches covered by dense algae growth					☐ 40 ≤ emb_{run} < 75% 60 ≤ emb_{margin} < 80% ☐ 20 ≤ fining* < 40% ☐ major evidence of sediment mobility & lack of sorting ☐ imbrication moderate, mostly with the long axis of particles overlapping in the direction of flow ☐ large substrate patches covered by dense algae growth					☐ run embeddedness ≥ 75% margin embeddedness ≥ 80% ☐ fining* ≥ 40% ☐ sediments unstable, unsorted, soft underfoot ☐ imbrication extensive, mostly with the long axis of particles overlapping in the direction of flow ☐ most of substrate covered by dense algae growth				
SCORE	20	19	18	17	16	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1
6.3 Scour and Deposition Features *Depth-velocity combinations* *fast-shallow* *fast-deep* *slow-shallow* *slow-deep* *(cutoffs: 1.0 fps, 1.5 ft)* Pool size rank variable only used if ≥ 5 pools	☐ pool formation evident, with ≥50% pool size rank 3-7 ☐ widespread riffle formation ☐ more than two depth-velocity combinations present ☐ meandering thalweg clearly identifiable in cross section, with evidence of side and lateral bar formation ☐ finer deposition located entirely in slack water below larger substrates/debris, and along margins					☐ pool formation evident, with <50% pool size rank 3-7 ☐ moderate riffle formation ☐ two depth-velocity combinations present ☐ meandering thalweg moderately identifiable in cross section, with some evidence of bar formation ☐ finer deposition located in slack water below larger substrates/debris, signs of mid-channel accumulation					☐ limited trace of pool formation ☐ limited riffle formation ☐ one or two depth-velocity combinations present ☐ meandering thalweg barely identifiable in the cross section, with minimal evidence of bar formation ☐ very large depositional features below larger substrates/debris, abundant mid-channel accumulation					☐ pool formation completely absent ☐ no riffle formation ☐ one depth-velocity combination present ☐ meandering thalweg not identifiable in the cross section, with no evidence of bar formation ☐ finer deposition throughout channel, even filling pools, larger substrates almost buried **or** bed largely incised				
SCORE	20	19	18	17	16	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1
6.4 Channel Morphology	☐ width/depth < 15, natural ☐ entrenchment ratio ≥ 1.4, incision ratio < 1.2, good floodplain access ☐ no evidence of channel alteration					☐ 15 ≤ w / d < 25, widening ☐ entrenchment ratio ≥ 1.4, 1.2 ≤ incision ratio < 1.4, reduced floodplain access ☐ evidence of minor historic channel alteration					☐ 25 ≤ w /d < 40, widening ☐ entrenchment ratio ≥ 1.4, 1.4 ≤ incision ratio < 2.0, limited floodplain access ☐ major historic or minor recent channel alteration					☐ w /d ≥ 40, over-widening ☐ entrenchment ratio < 1.4 **or** incision ratio ≥ 2.0, floodplain access unlikely ☐ extensive historic or major recent channel alteration				
SCORE	20	19	18	17	16	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1

Habitat Parameter	Condition (Departure) Category																			
	Reference (None)					**Good (Minor)**					**Fair (Major)**					**Poor (Severe)**				
6.5 Hydrologic Characteristics	☐ wetted width / W_{bkf} > 0.75 ☐ exposed substrate < 20% ☐ adjacent springs, seeps, and wetlands extensive ☐ no known flow alteration					☐ 0.75 ≥ W_{wet} / W_{bkf} > 0.50 ☐ 20 ≤ exp. substrate < 40% ☐ adjacent springs, seeps, and wetlands present ☐ minor flow alteration likely due to flow regulation and/or land use changes					☐ 0.50 ≥ W_{wet} / W_{bkf} > 0.25 ☐ 40 ≤ exp. substrate < 60% ☐ adjacent springs, seeps, and wetlands minimal ☐ major flow alteration likely due to flow regulation and/or land use changes					☐ W_{wet} / W_{bkf} ≤ 0.25 ☐ exposed substrate ≥ 60% ☐ adjacent springs, seeps, and wetlands altered or absent ☐ runoff characteristics completely altered due to flow regulation and storm water influence				
SCORE	20	19	18	17	16	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1
6.6 Connectivity Tend towards a higher/lower score for natural/man-made obstructions	☐ no obstructions in reach that block longitudinal movement of aquatic species over all but the lowest flows ☐ system obstructions absent ☐ abundant low **and** high flow refuge					☐ one or two small low flow obstructions present in reach that block movement of aquatic species ☐ limited system obstructions ☐ abundant refuge, with low **or** high flow refuge limited					☐ one or two small to medium bankfull obstructions present in reach that block movement of aquatic species ☐ system obstructions present ☐ limited low **and** high flow refuge					☐ more than two bankfull obstructions present in reach that block movement of aquatic species ☐ many system obstructions ☐ refuge absent				
SCORE	20	19	18	17	16	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1
6.7 River Banks Select different boxes for LB and RB if necessary Undercut size rank variable only used if ≥ 5 undercuts **(score each bank)**	☐ bank erosion <10%, typical of natural conditions, little or no bank revetments ☐ bank vegetation > 90% in tree, shrub and herb layers, diverse assemblages, plants create good cover and roots help stabilize bank ☐ bank canopy > 90% ☐ undercut banks / mile > 20 ☐ undercut bank size rank 3-6 > 50% ☐ undercut banks with mostly stable boundaries, abundant overhanging vegetation, and consistent water adjacency ☐ no mass failures in valley					☐ 10 ≤ bank erosion < 30%, infrequent small areas, some bank revetments ☐ 90 ≥ bank vegetation > 75% in each layer, diverse assemblages, plants create good cover and roots help stabilize bank ☐ 90 ≥ bank canopy > 75% ☐ 20 ≥ undercuts / mile > 15 ☐ 50 ≥ undercut bank size rank 3-6 > 25% ☐ undercuts with some unstable boundaries or reduced overhanging vegetation, and consistent water adjacency ☐ 1 mass failure in valley					☐ 30 ≤ bank erosion < 60%, mod. unstable banks, and/or extensive bank revetments ☐ 75 ≥ bank vegetation > 50%, in two of three layers, reduced diversity, plants create limited cover and roots do not stabilize bank ☐ 75 ≥ bank canopy > 50% ☐ 15 ≥ undercuts / mile > 5 ☐ 25 ≥ undercut bank size rank 3-6 > 10% ☐ undercuts with some unstable boundaries or reduced overhanging vegetation, and reduced water adjacency ☐ 1 - 2 mass failures in valley					☐ bank erosion ≥ 60%, banks unstable, extensive erosion, and failing bank revetments ☐ bank vegetation ≤ 50% in two of three layers, limited diversity, plants create no cover and roots do not stabilize bank ☐ bank canopy ≤ 50% ☐ undercuts / mile ≤ 5 ☐ undercut bank size rank 3-6 ≤ 10% ☐ undercuts with mostly unstable boundaries, no overhanging vegetation, and reduced water adjacency ☐ > 3 mass failures in valley				
SCORE _____ (LB)	Left Bank	10	9			8	7	6			5	4	3			2	1			
SCORE _____ (RB)	Right Bank	10	9			8	7	6			5	4	3			2	1			
6.8 Riparian Area Select different boxes for LB and RB if necessary **(score each side of the channel)**	☐ buffer width > 150 ft ☐ rip. vegetation > 75% in tree, shrub and herb layers, diverse assemblages, no invasives, maximum channel canopy ☐ river corridor development and infrastructure absent					☐ 150 ≥ buffer width > 100 ft ☐ 75 ≥ rip. veg. > 50% in each layer, one plant type absent, minimal invasives, maximum channel canopy ☐ river corridor development and infrastructure minimal					☐ 100 ≥ buffer width > 50 ft ☐ 75 ≥ rip. veg. > 50% in each layer, several types absent, altered patches, invasives present, reduced canopy ☐ river corridor development and infrastructure common					☐ buffer width ≤ 50 ft ☐ rip. veg. ≤ 50% in each layer, several types absent, large altered areas, invasives present, reduced canopy ☐ river corridor development and infrastructure abundant				
SCORE _____ (LB)	Left Bank	10	9			8	7	6			5	4	3			2	1			
SCORE _____ (RB)	Right Bank	10	9			8	7	6			5	4	3			2	1			

6.9 Score: front _____ + back _____ = total _____

Percentage: total score _____ x (100 / 160) = _____

Overall Physical Habitat Condition: _____

SHTD ☐ Existing Stream Habitat Type: _____

Score	*Percentage*	*Condition (Departure)*
136 – 160	**85 – 100**	Reference (None)
104 – 135	**65 – 84**	Good (Minor)
56 – 103	**35 – 64**	Fair (Major)
0 – 55	**0 – 34**	Poor (Severe)

VTANR REACH HABITAT ASSESSMENT ----- BRAIDED STREAM TYPE

(Also use this form for alluvial fans.)

Stream Name:_____ Segment I.D: _____
Location: _____ Date:_____
_____ Town:_____
Observers: _____ Elevation: _____ ft.
Organization /Agency: _____ Latitude (N/S):_____
USGS Map Name(s):_____ Longitude (E/W): _____
Weather:_____ Drainage Area: _____ sq. mi.
Flow: base / low / avg. Storm within past 7 days: Y / N Segment Length: _____ ft.

Habitat Parameter	Condition (Departure) Category				
	Reference (None)	**Good (Minor)**	**Fair (Major)**	**Poor (Severe)**	
6.1 Woody Debris Cover LWD size rank variable only used if ≥ 10 pieces	☐ LWD pieces / mile > 100 ☐ LWD size rank 3-6 >50% ☐ debris jams / mile > 5 ☐ high woody debris recruitment potential ☐ CPOM present in channel and margins	☐ 100 ≥ LWD / mile > 50 ☐ 50 ≥ LWD rank 3-6 > 25% ☐ 5 ≥ jams / mile > 3 ☐ moderate woody debris recruitment potential ☐ CPOM limited in channel and present in margins	☐ 50 ≥ LWD / mile > 25 ☐ 25 ≥ LWD rank 3-6 > 10% ☐ 3 ≥ jams / mile > 1 ☐ low woody debris recruitment potential ☐ CPOM limited in both channel and margins	☐ LWD / mile ≤ 25 ☐ LWD size rank 3-6 ≤ 10% ☐ debris jams absent ☐ no woody debris recruitment potential ☐ CPOM absent	
SCORE	20 19 18 17 16	15 14 13 12 11	10 9 8 7 6	5 4 3 2 1	
6.2 Bed Substrate Cover *fines: sand if d_{50} ≥ gravel, otherwise silt.	☐ riffle embeddedness < 20% margin embeddedness < 40% ☐ fining* < 10% ☐ Riffle stability index < 70% ☐ sediment apparently stable & sorted ☐ substrate free of dense algae growth	☐ 20 ≤ emb_{riffle} < 40% 40 ≤ emb_{margin} < 60% ☐ 10 ≤ fining* < 20% ☐ 70 ≤ RSI < 80% ☐ some evidence of sediment mobility & lack of sorting ☐ small substrate patches covered by dense algae growth	☐ 40 ≤ emb_{riffle} < 75% 60 ≤ emb_{margin} < 80% ☐ 20 ≤ fining* < 40% ☐ 80 ≤ RSI < 90% ☐ major evidence of sediment mobility & lack of sorting ☐ large substrate patches covered by dense algae growth	☐ riffle embeddedness ≥ 75% margin embeddedness ≥ 80% ☐ fining* ≥ 40% ☐ RSI ≥ 90% ☐ sediments unstable, unsorted, soft underfoot ☐ most of substrate covered by dense algae growth	
SCORE	20 19 18 17 16	15 14 13 12 11	10 9 8 7 6	5 4 3 2 1	
6.3 Scour and Deposition Features *Depth-velocity combinations* *fast-shallow* *fast-deep* *slow-shallow* *slow-deep* *(cutoffs: 1.0 fps, 1.5 ft)* Pool size rank variable only used if ≥ 5 pools	☐ pools / mile > 40 ☐ pool size rank 3-7 >50% ☐ good cover > 75% of total pool surface area ☐ riffle coverage > 25% reach area, distinctly formed and complete ☐ 5 ≤ riffle spacing ≤ 7 bankfull channel widths (w_{bkf}) ☐ well-defined riffle-run-pool-glide pattern with all four depth-velocity combinations present ☐ stable bars, vegetative cover on depositional features ≥ 50%, particles well-sorted	☐ 40 ≥ pools / mile > 20 ☐ 50 ≥ pool rank 3-7 > 25% ☐ 75 ≥ good cover > 50% of total pool surface area ☐ 25 ≥ riffle coverage > 10% reach area, moderately well formed and complete ☐ 3 ≤ riffle spacing < 5, or 7 < riffle spacing ≤ 10 x w_{bkf} ☐ well-defined riffle-run-pool-glide pattern with three depth-velocity combinations dominant ☐ mostly stable bars, vegetative cover on depositional features 50-25%, particles moderately sorted	☐ 20 ≥ pools / mile > 10 ☐ 25 ≥ pool rank 3-7 > 10% ☐ 50 ≥ good cover > 25% of total pool surface area ☐ 25 ≥ riffle coverage > 10% reach area, poorly formed and incomplete ☐ 1 ≤ riffle spacing < 3, or 10 < riffle spacing ≤ 12 x w_{bkf} ☐ moderately defined riffle-run-pool-glide pattern with two depth-velocity combinations dominant ☐ unstable bars present, vegetative cover on depositional features 25-10%, particles minimally sorted	☐ pools / mile ≤ 10 ☐ pool size rank 3-7 ≤ 10% ☐ good cover ≤ 25% of total pool surface area ☐ riffle coverage ≤ 10% reach area, or mostly indistinct or absent ☐ riffle spacing ≥ 12 bankfull channel widths ☐ poorly defined riffle-run-pool-glide pattern with one depth-velocity combination dominant ☐ mostly unstable bars, vegetative cover on depositional features < 10%, particles not sorted	
SCORE	20 19 18 17 16	15 14 13 12 11	10 9 8 7 6	5 4 3 2 1	
6.4 Channel Morphology	☐ width/depth < 30, natural ☐ entrenchment ratio ≥ 2.0, incision ratio < 1.0, good floodplain access ☐ no evidence of channel alteration	☐ 30 ≤ w/ d < 40, widening ☐ entrenchment ratio ≥ 2.0, 1.0 ≤ incision ratio < 1.2, reduced floodplain access ☐ evidence of minor historic channel alteration	☐ 40 ≤ w / d < 50, widening ☐ entrenchment ratio ≥ 2.0, 1.2 ≤ incision ratio < 1.4, limited floodplain access ☐ major historic or minor recent channel alteration	☐ w / d ≥ 50, over-widening ☐ entrenchment ratio < 2.0 **or** incision ratio ≥ 1.4, floodplain access unlikely ☐ extensive historic or major recent channel alteration	
SCORE	20 19 18 17 16	15 14 13 12 11	10 9 8 7 6	5 4 3 2 1	

Habitat Parameter	Condition (Departure) Category			
	Reference (None)	**Good (Minor)**	**Fair (Major)**	**Poor (Severe)**
6.5 Hydrologic Characteristics	□ wetted width / W_{bkf} > 0.50 □ exposed substrate < 50% □ adjacent springs, seeps, and wetlands extensive □ no known flow alteration	□ 0.50 ≥ W_{wet} / W_{bkf} > 0.30 □ 50 ≤ exp. substrate < 60% □ adjacent springs, seeps, and wetlands present □ minor flow alteration likely due to flow regulation and/or land use changes	□ 0.30 ≥ W_{wet} / W_{bkf} > 0.10 □ 60 ≤ exp. substrate < 70% □ adjacent springs, seeps, and wetlands minimal □ major flow alteration likely due to flow regulation and/or land use changes	□ W_{wet} / W_{bkf} ≤ 0.10 □ exposed substrate ≥ 70% □ adjacent springs, seeps, and wetlands absent or altered □ runoff characteristics completely altered due to flow regulation and storm water influence
SCORE	20 19 18 17 16	15 14 13 12 11	10 9 8 7 6	5 4 3 2 1
6.6 Connectivity Tend towards a higher/lower score for natural/man-made obstructions	□ no obstructions in reach that block longitudinal movement of aquatic species over all but the lowest flows □ system obstructions absent □ abundant low **and** high flow refuge	□ one or two small low flow obstructions present in reach that block movement of aquatic species □ limited system obstructions □ abundant refuge, with low **or** high flow refuge limited	□ one or two small to medium bankfull obstructions present in reach that block movement of aquatic species □ system obstructions present □ limited low **and** high flow refuge	□ more than two bankfull obstructions present in reach that block movement of aquatic species □ many system obstructions □ refuge absent
SCORE	20 19 18 17 16	15 14 13 12 11	10 9 8 7 6	5 4 3 2 1
6.7 River Banks Select different boxes for LB and RB if necessary	□ bank erosion <10%, typical of natural conditions, little or no bank revetments □ bank vegetation > 90% in tree, shrub and herb layers, diverse assemblages, plants create good cover and roots help stabilize bank	□ 10 ≤ bank erosion < 30%, infrequent small areas, some bank revetments □ 90 ≥ bank vegetation > 75% in each layer, diverse assemblages, plants create good cover and roots help stabilize bank	□ 30 ≤ bank erosion < 60%, mod. unstable banks, and/or extensive bank revetments □ 75 ≥ bank vegetation > 50%, in two of three layers, reduced diversity, plants create limited cover and roots do not stabilize bank	□ bank erosion ≥ 60%, banks unstable, extensive erosion, and failing bank revetments □ bank vegetation ≤ 50% in two of three layers, limited diversity, plants create no cover and roots do not stabilize bank
Undercut size rank variable only used if ≥ 5 undercuts	□ bank canopy > 90% □ undercut banks / mile > 30 □ undercut bank size rank 3-6 > 50%	□ 90 ≥ bank canopy > 75% □ 30 ≥ undercuts / mile > 15 □ 50 ≥ undercut bank size rank 3-6 > 25%	□ 75 ≥ bank canopy > 50% □ 15 ≥ undercuts / mile > 5 □ 25 ≥ undercut bank size rank 3-6 > 10%	□ bank canopy ≤ 50% □ undercuts / mile ≤ 5 □ undercut bank size rank 3-6 ≤ 10%
(score each bank)	□ undercut banks with mostly stable boundaries, abundant overhanging vegetation, and consistent water adjacency □ no mass failures in valley	□ undercuts with some unstable boundaries or reduced overhanging vegetation, and consistent water adjacency □ 1 mass failure in valley	□ undercuts with some unstable boundaries or reduced overhanging vegetation, and reduced water adjacency □ 1 - 2 mass failures in valley	□ undercuts with mostly unstable boundaries, no overhanging vegetation, and reduced water adjacency □ > 3 mass failures in valley
SCORE ___ (LB)	Left Bank 10 9	8 7 6	5 4 3	2 1
SCORE ___ (RB)	Right Bank 10 9	8 7 6	5 4 3	2 1
6.8 Riparian Area Select different boxes for LB and RB if necessary	□ buffer width > 150 ft □ rip. vegetation > 75% in tree, shrub and herb layers, diverse assemblages, no invasives, maximum channel canopy	□ 150 ≥ buffer width > 100 ft □ 75 ≥ rip. veg. > 50% in each layer, one plant type absent, minimal invasives, maximum channel canopy	□ 100 ≥ buffer width > 50 ft □ 75 ≥ rip. veg. > 50% in each layer, several types absent, altered patches, invasives present, reduced canopy	□ buffer width ≤ 50 ft □ rip. veg. ≤ 50% in each layer, several types absent, large altered areas, invasives present, reduced canopy
(score each side of the channel)	□ river corridor development and infrastructure absent	□ river corridor development and infrastructure minimal	□ river corridor development and infrastructure common	□ river corridor development and infrastructure abundant
SCORE ___ (LB)	Left Bank 10 9	8 7 6	5 4 3	2 1
SCORE ___ (RB)	Right Bank 10 9	8 7 6	5 4 3	2 1

6.9 Score: front _____ + back _____ = total _____

Percentage: total score _____ x (100 / 160) = _____

Overall Physical Habitat Condition: _____

SHTD □ Existing Stream Habitat Type: _____

Score	*Percentage*	*Condition (Departure)*
136 – 160	**85 – 100**	Reference (None)
104 – 135	**65 – 84**	Good (Minor)
56 – 103	**35 – 64**	Fair (Major)
0 – 55	**0 – 34**	Poor (Severe)

VTANR REACH HABITAT ASSESSMENT ----- RIFFLE-POOL STREAM TYPE

(Also use this form for dune-ripple stream type.)

Stream Name:_____ Segment I.D: _____
Location: _____ Date:_____
_____ Town:_____
Observers: _____ Elevation: _____ ft.
Organization /Agency: _____ Latitude (N/S):_____
USGS Map Name(s):_____ Longitude (E/W): _____
Weather:_____ Drainage Area: _____ sq. mi.
Flow: base / low / avg. Storm within past 7 days: Y / N Segment Length: _____ ft.

Habitat Parameter	Condition (Departure) Category																			
	Reference (None)					**Good (Minor)**					**Fair (Major)**					**Poor (Severe)**				
6.1 Woody Debris Cover LWD size rank variable only used if ≥ 10 pieces	☐ LWD pieces / mile > 100 ☐ LWD size rank 3-6 >50% ☐ debris jams / mile > 5 ☐ high woody debris recruitment potential ☐ CPOM present in channel and margins					☐ 100 ≥ LWD / mile > 50 ☐ 50 ≥ LWD rank 3-6 > 25% ☐ 5 ≥ jams / mile > 3 ☐ moderate woody debris recruitment potential ☐ CPOM limited in channel and present in margins					☐ 50 ≥ LWD / mile > 25 ☐ 25 ≥ LWD rank 3-6 > 10% ☐ 3 ≥ jams / mile > 1 ☐ low woody debris recruitment potential ☐ CPOM limited in both channel and margins					☐ LWD / mile ≤ 25 ☐ LWD size rank 3-6 ≤ 10% ☐ debris jams absent ☐ no woody debris recruitment potential ☐ CPOM absent				
SCORE	20	19	18	17	16	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1
6.2 Bed Substrate Cover *fines: sand if d_{50} ≥ gravel, otherwise silt. (Dune-ripple stream type: Fining only.)	☐ riffle embeddedness < 20% margin embeddedness < 40% ☐ fining* < 10% ☐ Riffle stability index < 70% ☐ sediment apparently stable & sorted ☐ substrate free of dense algae growth					☐ 20 ≤ emb_{riffle} < 40% 40 ≤ emb_{margin} < 60% ☐ 10 ≤ fining* < 20% ☐ 70 ≤ RSI < 80% ☐ some evidence of sediment mobility & lack of sorting ☐ small substrate patches covered by dense algae growth					☐ 40 ≤ emb_{riffle} < 75% 60 ≤ emb_{margin} < 80% ☐ 20 ≤ fining* < 40% ☐ 80 ≤ RSI < 90% ☐ major evidence of sediment mobility & lack of sorting ☐ large substrate patches covered by dense algae growth					☐ riffle embeddedness ≥ 75% margin embeddedness ≥ 80% ☐ fining* ≥ 40% ☐ RSI ≥ 90% ☐ sediments unstable, unsorted, soft underfoot ☐ most of substrate covered by dense algae growth				
SCORE	20	19	18	17	16	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1
6.3 Scour and Deposition Features (Dune-ripple stream type: Only evaluate pools and ripples.) *Depth-velocity combinations* *fast-shallow* *fast-deep* *slow-shallow* *slow-deep* *(cutoffs: 1.0 fps, 1.5 ft)* Pool size rank variable only used if ≥ 5 pools	☐ pools / mile > 40 ☐ pool size rank 3-7 >50% ☐ good cover > 75% of total pool surface area ☐ riffle (ripple) coverage > 25% reach area, distinctly formed and complete ☐ 5 ≤ riffle spacing ≤ 7 bankfull channel widths (w_{bkf}) ☐ well-defined riffle-run-pool-glide pattern with all four depth-velocity combinations present ☐ finer deposition located entirely in slack water below larger substrates/debris, and along margins					☐ 40 ≥ pools / mile > 20 ☐ 50 ≥ pool rank 3-7 > 25% ☐ 75 ≥ good cover > 50% of total pool surface area ☐ 25 ≥ riffle coverage > 10% reach area, moderately well formed and complete ☐ 3 ≤ riffle spacing < 5, or 7 < riffle spacing ≤ 10 x w_{bkf} ☐ well-defined riffle-run-pool-glide pattern with three depth-velocity combinations dominant ☐ finer deposition located in slack water below larger substrates/debris, signs of mid-channel accumulation					☐ 20 ≥ pools / mile > 10 ☐ 25 ≥ pool rank 3-7 > 10% ☐ 50 ≥ good cover > 25% of total pool surface area ☐ 25 ≥ riffle coverage > 10% reach area, poorly formed and incomplete ☐ 1 ≤ riffle spacing < 3, or 10 < riffle spacing ≤ 12 x w_{bkf} ☐ moderately defined riffle-run-pool-glide pattern with two depth-velocity combinations dominant ☐ very large depositional features below larger substrates/debris, abundant mid-channel accumulation					☐ pools / mile ≤ 10 ☐ pool size rank 3-7 ≤ 10% ☐ good cover ≤ 25% of total pool surface area ☐ riffle (ripple) coverage ≤ 10% reach area, or mostly indistinct ☐ riffle spacing ≥ 12 bankfull channel widths ☐ poorly defined riffle-run-pool-glide pattern with one depth-velocity combination dominant ☐ finer deposition throughout channel, even filling pools, larger substrates almost buried **or** bed largely incised				
SCORE	20	19	18	17	16	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1
6.4 Channel Morphology	☐ width/depth < 15, natural ☐ entrenchment ratio ≥ 1.4, incision ratio < 1.2, good floodplain access ☐ no evidence of channel alteration					☐ 15 ≤ w / d < 25, widening ☐ entrenchment ratio ≥ 1.4, 1.2 ≤ incision ratio < 1.4, reduced floodplain access ☐ evidence of minor historic channel alteration					☐ 25 ≤ w / d < 40, widening ☐ entrenchment ratio ≥ 1.4, 1.4 ≤ incision ratio < 2.0, limited floodplain access ☐ major historic or minor recent channel alteration					☐ w / d > 40, over-widening ☐ entrenchment ratio < 1.4 **or** incision ratio ≥ 2.0, floodplain access unlikely ☐ extensive historic or major recent channel alteration				
SCORE	20	19	18	17	16	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1

Habitat Parameter	Condition (Departure) Category			
	Reference (None)	**Good (Minor)**	**Fair (Major)**	**Poor (Severe)**
6.5 Hydrologic Characteristics	☐ wetted width / W_{bkf} > 0.75 ☐ exposed substrate < 20% ☐ adjacent springs, seeps, and wetlands extensive ☐ no known flow alteration	☐ 0.75 ≥ W_{wet} / W_{bkf} > 0.50 ☐ 20 ≤ exp. substrate < 40% ☐ adjacent springs, seeps, and wetlands present ☐ minor flow alteration likely due to flow regulation and/or land use changes	☐ 0.50 ≥ W_{wet} / W_{bkf} > 0.25 ☐ 40 ≤ exp. substrate < 60% ☐ adjacent springs, seeps, and wetlands minimal ☐ major flow alteration likely due to flow regulation and/or land use changes	☐ W_{wet} / W_{bkf} ≤ 0.25 ☐ exposed substrate ≥ 60% ☐ adjacent springs, seeps, and wetlands absent or altered ☐ runoff characteristics completely altered due to flow regulation and storm water influence
SCORE	20 19 18 17 16	15 14 13 12 11	10 9 8 7 6	5 4 3 2 1
6.6 Connectivity Tend towards a higher/lower score for natural/man-made obstructions	☐ no obstructions in reach that block longitudinal movement of aquatic species over all but the lowest flows ☐ system obstructions absent ☐ abundant low **and** high flow refuge	☐ one or two small low flow obstructions present in reach that block movement of aquatic species ☐ limited system obstructions ☐ abundant refuge, with low **or** high flow refuge limited	☐ one or two small to medium bankfull obstructions present in reach that block movement of aquatic species ☐ system obstructions present ☐ limited low **and** high flow refuge	☐ more than two bankfull obstructions present in reach that block movement of aquatic species ☐ many system obstructions ☐ refuge absent
SCORE	20 19 18 17 16	15 14 13 12 11	10 9 8 7 6	5 4 3 2 1
6.7 River Banks Select different boxes for LB and RB if necessary	☐ bank erosion <10%, typical of natural conditions, little or no bank revetments ☐ bank vegetation > 90% in tree, shrub and herb layers, diverse assemblages, plants create good cover and roots help stabilize bank	☐ 10 ≤ bank erosion < 30%, infrequent small areas, some bank revetments ☐ 90 ≥ bank vegetation > 75% in each layer, diverse assemblages, plants create good cover and roots help stabilize bank	☐ 30 ≤ bank erosion < 60%, mod. unstable banks, and/or extensive bank revetments ☐ 75 ≥ bank vegetation > 50%, in two of three layers, reduced diversity, plants create limited cover and roots do not stabilize bank	☐ bank erosion ≥ 60%, banks unstable, extensive erosion, and failing bank revetments ☐ bank vegetation ≤ 50% in two of three layers, limited diversity, plants create no cover and roots do not stabilize bank
Undercut size rank variable only used if ≥ 5 undercuts	☐ bank canopy > 90% ☐ undercut banks / mile > 30 ☐ undercut bank size rank 3-6 > 50%	☐ 90 ≥ bank canopy > 75% ☐ 30 ≥ undercuts / mile > 15 ☐ 50 ≥ undercut bank size rank 3-6 > 25%	☐ 75 ≥ bank canopy > 50% ☐ 15 ≥ undercuts / mile > 5 ☐ 25 ≥ undercut bank size rank 3-6 > 10%	☐ bank canopy ≤ 50% ☐ undercuts / mile ≤ 5 ☐ undercut bank size rank 3-6 ≤ 10%
(score each bank)	☐ undercut banks with mostly stable boundaries, abundant overhanging vegetation, and consistent water adjacency ☐ no mass failures in valley	☐ undercuts with some unstable boundaries or reduced overhanging vegetation, and consistent water adjacency ☐ 1 mass failure in valley	☐ undercuts with some unstable boundaries or reduced overhanging vegetation, and reduced water adjacency ☐ 1 - 2 mass failures in valley	☐ undercuts with mostly unstable boundaries, no overhanging vegetation, and reduced water adjacency ☐ ≥ 3 mass failures in valley
SCORE _____ (LB)	Left Bank 10 9	8 7 6	5 4 3	2 1
SCORE _____ (RB)	Right Bank 10 9	8 7 6	5 4 3	2 1
6.8 Riparian Area Select different boxes for LB and RB if necessary	☐ buffer width > 150 ft ☐ rip. vegetation > 75% in tree, shrub and herb layers, diverse assemblages, no invasives, maximum channel canopy	☐ 150 ≥ buffer width > 100 ft ☐ 75 ≥ rip. veg. > 50% in each layer, one plant type absent, minimal invasives, maximum channel canopy	☐ 100 ≥ buffer width > 50 ft ☐ 75 ≥ rip. veg. > 50% in each layer, several types absent, altered patches, invasives present, reduced canopy	☐ buffer width ≤ 50 ft ☐ rip. veg. ≤ 50% in each layer, several types absent, large altered areas, invasives present, reduced canopy
(score each side of the channel)	☐ river corridor development and infrastructure absent	☐ river corridor development and infrastructure minimal	☐ river corridor development and infrastructure common	☐ river corridor development and infrastructure abundant
SCORE _____ (LB)	Left Bank 10 9	8 7 6	5 4 3	2 1
SCORE _____ (RB)	Right Bank 10 9	8 7 6	5 4 3	2 1

6.9 Score: front _____ + back _____ = total _____

Percentage: total score _____ x (100 / 160) = _____

Overall Physical Habitat Condition: _____

SHTD ☐ Existing Stream Habitat Type: _____

Score	*Percentage*	*Condition (Departure)*
136 – 160	**85 – 100**	Reference (None)
104 – 135	**65 – 84**	Good (Minor)
56 – 103	**35 – 64**	Fair (Major)
0 – 55	**0 – 34**	Poor (Severe)

VTANR REACH HABITAT ASSESSMENT ----- STEP-POOL STREAM TYPE

(Also use this form for cascade and bedrock stream types.)

Stream Name:_____ Segment I.D: _____
Location: _____ Date:_____
_____ Town:_____
Observers: _____ Elevation: _____ ft.
Organization /Agency: _____ Latitude (N/S):_____
USGS Map Name(s):_____ Longitude (E/W): _____
Weather:_____ Drainage Area: _____ sq. mi.
Flow: base / low / avg. Storm within past 7 days: Y / N Segment Length: _____ ft.

Habitat Parameter	Condition (Departure) Category			
	Reference (None)	**Good (Minor)**	**Fair (Major)**	**Poor (Severe)**
6.1 Woody Debris Cover LWD size rank variable only used if ≥ 10 pieces	□ LWD pieces / mile > 200 □ LWD size rank 3-6 >75% □ debris jams / mile > 25 □ high woody debris recruitment potential □ CPOM present in channel and margins	□ 200 ≥ LWD / mile > 100 □ 75 ≥ LWD rank 3-6 > 50% □ 25 ≥ jams / mile > 15 □ moderate woody debris recruitment potential □ CPOM limited in channel and present in margins	□ 100 ≥ LWD / mile > 50 □ 50 ≥ LWD rank 3-6 > 25% □ 15 ≥ jams / mile > 5 □ low woody debris recruitment potential □ CPOM limited in both channel and margins	□ LWD / mile ≤ 50 □ LWD size rank 3-6 ≤ 25% □ jams / mile ≤ 5 □ no woody debris recruitment potential □ CPOM absent
SCORE	20 19 18 17 16	15 14 13 12 11	10 9 8 7 6	5 4 3 2 1
6.2 Bed Substrate Cover *fines: sand if d_{50} ≥ gravel, otherwise silt.	□ pool embeddedness < 25% margin embeddedness < 40% □ fining* < 10% □ sediment apparently stable & sorted □ substrate free of dense algae growth	□ 25 ≤ emb_{pool} < 50% 40 ≤ emb_{margin} < 60% □ 10 ≤ fining* < 20% □ some evidence of sediment mobility & lack of sorting □ small substrate patches covered by dense algae growth	□ 50 ≤ emb_{pool} < 75% 60 ≤ emb_{margin} < 80% □ 20 ≤ fining* < 40% □ major evidence of sediment mobility & lack of sorting □ large substrate patches covered by dense algae growth	□ pool embeddedness ≥ 75% margin embeddedness ≥ 80% □ fining* ≥ 40% □ sediments unstable, unsorted, soft underfoot □ most of substrate covered by dense algae growth
SCORE	20 19 18 17 16	15 14 13 12 11	10 9 8 7 6	5 4 3 2 1
6.3 Scour and Deposition Features *Depth-velocity combinations* *fast-shallow* *fast-deep* *slow-shallow* *slow-deep* *(cutoffs: 1.0 fps, 1.5 ft)* Pool size rank variable only used if ≥ 5 pools (Cascade and bedrock stream types: Do not evaluate variables related to step pattern.)	□ pools / mile > 70 □ pool size rank 3-7 >50% □ good cover > 75% of total pool surface area □ steps are distinctly formed, complete and stable □ 5 ≤ step spacing ≤ 7 bankfull channel widths (w_{bkf}) □ more than two depth-velocity combinations present □ finer deposition located entirely in slack water below larger substrates/debris, and along margins	□ 70 ≥ pools / mile > 50 □ 50 ≥ pool rank 3-7 > 25% □ 75 ≥ good cover > 50% of total pool surface area □ steps are moderately well formed, complete and stable □ 3 ≤ step spacing < 5, or 7 < step spacing ≤ 10 x w_{bkf} □ two depth-velocity combinations present □ finer deposition located in slack water below larger substrates/debris, signs of mid-channel accumulation	□ 50 ≥ pools / mile > 30 □ 25 ≥ pool rank 3-7 > 10% □ 50 ≥ good cover > 25% of total pool surface area □ steps are poorly formed, incomplete and unstable □ 1 ≤ step spacing < 3, or 10 < step spacing ≤ 15 x w_{bkf} □ one or two depth-velocity combinations present □ very large depositional features below larger substrates/debris, abundant mid-channel accumulation	□ pools / mile ≤ 30 □ pool size rank 3-7 ≤ 10% □ good cover over ≤ 25% of total pool surface area □ steps are indistinct or absent, or very unstable □ step spacing ≥ 15 bankfull channel widths □ one depth-velocity combination present □ finer deposition throughout channel, even filling pools, larger substrates almost buried **or** bed largely incised
SCORE	20 19 18 17 16	15 14 13 12 11	10 9 8 7 6	5 4 3 2 1
6.4 Channel Morphology	□ width/depth < 12, natural □ entrenchment ratio ≥ 1.2, incision ratio < 1.2, good floodplain access □ no evidence of channel alteration	□ 12 ≤ w / d < 15, widening □ entrenchment ratio ≥ 1.2, 1.2 ≤ incision ratio < 1.4, reduced floodplain access □ evidence of minor historic channel alteration	□ 15 ≤ w / d < 25, widening □ entrenchment ratio ≥ 1.2, 1.4 ≤ incision ratio < 2.0, limited floodplain access □ major historic or minor recent alteration	□ w / d ≥ 25, over-widening □ entrenchment ratio < 1.2 **or** incision ratio ≥ 2.0, floodplain access unlikely □ extensive historic or major recent alteration
SCORE	20 19 18 17 16	15 14 13 12 11	10 9 8 7 6	5 4 3 2 1

Habitat Parameter	Condition (Departure) Category																			
	Reference (None)					**Good (Minor)**					**Fair (Major)**					**Poor (Severe)**				
6.5 Hydrologic Characteristics	□ wetted width / W_{bkf} > 0.75 □ exposed substrate < 10% □ adjacent springs, seeps, and wetlands extensive □ no known flow alteration					□ 0.75 ≥ W_{wet} / W_{bkf} > 0.50 □ 10 ≤ exp. substrate < 30% □ adjacent springs, seeps, and wetlands present □ minor flow alteration likely due to flow regulation and/or land use changes					□ 0.50 ≥ W_{wet} / W_{bkf} > 0.25 □ 30 ≤ exp. substrate < 50% □ adjacent springs, seeps, and wetlands minimal □ major flow alteration likely due to flow regulation and/or land use changes					□ W_{wet} / W_{bkf} ≤ 0.25 □ exposed substrate ≥ 50% □ adjacent springs, seeps, and wetlands absent or altered □ runoff characteristics completely altered due to flow regulation and storm water influence				
SCORE	20	19	18	17	16	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1
6.6 Connectivity Tend towards a higher/lower score for natural/man-made obstructions	□ no obstructions in reach that block longitudinal movement of aquatic species over all but the lowest flows □ system obstructions absent □ abundant low **and** high flow refuge					□ one or two small low flow obstructions present in reach that block movement of aquatic species □ limited system obstructions □ abundant refuge, with low **or** high flow refuge limited					□ one or two small to medium bankfull obstructions present in reach that block movement of aquatic species □ system obstructions present □ limited low **and** high flow refuge					□ more than two bankfull obstructions present in reach that block movement of aquatic species □ many system obstructions □ refuge absent				
SCORE	20	19	18	17	16	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1
6.7 River Banks Select different boxes for LB and RB if necessary Undercut size rank variable only used if ≥ 5 undercuts **(score each bank)**	□ bank erosion <10%, typical of natural conditions, little or no bank revetments □ bank vegetation > 90% in tree, shrub and herb layers, diverse assemblages, plants create good cover and roots help stabilize bank □ bank canopy > 90% □ undercut banks / mile > 15 □ undercut bank size rank 3-6 > 50% □ undercut banks with mostly stable boundaries, abundant overhanging vegetation, and consistent water adjacency □ no mass failures in valley					□ 10 ≤ bank erosion < 20%, infrequent small areas, some bank revetments □ 90 ≥ bank vegetation > 75% in each layer, diverse assemblages, plants create good cover and roots help stabilize bank □ 90 > bank canopy > 80% □ 15 ≥ undercuts / mile > 10 □ 50 ≥ undercut bank size rank 3-6 > 25% □ undercuts with some unstable boundaries or reduced overhanging vegetation, and consistent water adjacency □ 1 mass failure in valley					□ 20 ≤ bank erosion < 50%, mod. unstable banks, and/or extensive bank revetments □ 75 ≥ bank vegetation > 50%, in two of three layers, reduced diversity, plants create limited cover and roots do not stabilize bank □ 80 ≥ bank canopy > 60% □ 10 ≥ undercuts / mile > 5 □ 25 ≥ undercut bank size rank 3-6 > 10% □ undercuts with some unstable boundaries or reduced overhanging vegetation, and reduced water adjacency □ 1 - 2 mass failures in valley					□ bank erosion ≥ 50%, banks unstable, extensive erosion, and failing bank revetments □ bank vegetation ≤ 50% in two of three layers, limited diversity, plants create no cover and roots do not stabilize bank □ bank canopy ≤ 60% □ undercuts / mile ≤ 5 □ undercut bank size rank 3-6 ≤ 10% □ undercuts with mostly unstable boundaries, no overhanging vegetation, and reduced water adjacency □ > 3 mass failures in valley				
SCORE _____ (LB)	Left Bank	10	9			8	7	6			5	4	3			2			1	
SCORE _____ (RB)	Right Bank	10	9			8	7	6			5	4	3			2			1	
6.8 Riparian Area Select different boxes for LB and RB if necessary **(score each side of the channel)**	□ buffer width > 200 ft □ rip. vegetation > 90% in tree, shrub and herb layers, diverse assemblages, no invasives, maximum channel canopy □ river corridor development and infrastructure absent					□ 200 ≥ buffer width > 150 ft □ 90 ≥ rip. veg. > 75% in each layer, one plant type absent, minimal invasives, maximum channel canopy □ river corridor development and infrastructure minimal					□ 150 ≥ buffer width > 100 ft □ 75 ≥ rip. veg. > 50% in each layer, several types absent, altered patches, invasives present, reduced canopy □ river corridor development and infrastructure common					□ buffer width ≤ 100 ft □ rip. veg. ≤ 50% in each layer, several types absent, large altered areas, invasives present, reduced canopy □ river corridor development and infrastructure abundant				
SCORE _____ (LB)	Left Bank	10	9			8	7	6			5	4	3			2			1	
SCORE _____ (RB)	Right Bank	10	9			8	7	6			5	4	3			2			1	

6.9 Score: front _____ + back _____ = total _____

Percentage: total score _____ x (100 / 160) = _____

Overall Physical Habitat Condition: _____

SHTD □ Existing Stream Habitat Type: _____

Score	*Percentage*	*Condition (Departure)*
136-160	**85 – 100**	Reference (None)
104 – 135	**65 – 84**	Good (Minor)
56 – 103	**35 – 64**	Fair (Major)
0 – 55	**0 – 34**	Poor (Severe)

VTANR REACH HABITAT ASSESSMENT ----- PLANE BED STREAM TYPE

Stream Name:_____ Segment I.D: _____
Location: _____ Date:_____
_____ Town:_____
Observers: _____ Elevation: _____ ft.
Organization /Agency: _____ Latitude (N/S):_____
USGS Map Name(s):_____ Longitude (E/W): _____
Weather:_____ Drainage Area: _____ sq. mi.
Flow: base / low / avg. Storm within past 7 days: Y / N Segment Length: _____ ft.

Habitat Parameter	Condition (Departure) Category																			
	Reference (None)					Good (Minor)					Fair (Major)					Poor (Severe)				
6.1 Woody Debris Cover LWD size rank variable only used if ≥ 10 pieces	☐ LWD pieces / mile > 50 ☐ LWD size rank 3-6 >50% ☐ debris jams / mile > 5 ☐ high woody debris recruitment potential ☐ CPOM present in channel and margins					☐ 50 ≥ LWD / mile > 25 ☐ 50 ≥ LWD rank 3-6 > 25% ☐ 5 ≥ jams / mile > 3 ☐ moderate woody debris recruitment potential ☐ CPOM limited in channel and present in margins					☐ 25 ≥ LWD / mile > 10 ☐ 25 ≥ LWD rank 3-6 > 10% ☐ 3 ≥ jams / mile > 1 ☐ low woody debris recruitment potential ☐ CPOM limited in both channel and margins					☐ LWD / mile ≤ 10 ☐ LWD size rank 3-6 ≤ 10% ☐ debris jams absent ☐ no woody debris recruitment potential ☐ CPOM absent				
SCORE	20	19	18	17	16	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1
6.2 Bed Substrate Cover *fines: sand if d_{50} ≥ gravel, otherwise silt.	☐ run embeddedness < 20% margin embeddedness < 40% ☐ fining* < 10% ☐ sediment apparently stable & sorted ☐ imbrication limited, or mostly with the short axis of particles overlapping in the direction of flow ☐ substrate free of dense algae growth					☐ 20 ≤ emb_{run} < 40% 40 ≤ emb_{margin} < 60% ☐ 10 ≤ fining* < 20% ☐ some evidence of sediment mobility & lack of sorting ☐ imbrication moderate, mostly with the short axis of particles overlapping in the direction of flow ☐ small substrate patches covered by dense algae growth					☐ 40 ≤ emb_{run} < 75% 60 ≤ emb_{margin} < 80% ☐ 20 ≤ fining* < 40% ☐ major evidence of sediment mobility & lack of sorting ☐ imbrication moderate, mostly with the long axis of particles overlapping in the direction of flow ☐ large substrate patches covered by dense algae growth					☐ run embeddedness ≥ 75% margin embeddedness ≥ 80% ☐ fining* ≥ 40% ☐ sediments unstable, unsorted, soft underfoot ☐ imbrication extensive, mostly with the long axis of particles overlapping in the direction of flow ☐ most of substrate covered by dense algae growth				
SCORE	20	19	18	17	16	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1
6.3 Scour and Deposition Features *Depth-velocity combinations* *fast-shallow* *fast-deep* *slow-shallow* *slow-deep* *(cutoffs: 1.0 fps, 1.5 ft)* Pool size rank variable only used if ≥ 5 pools	☐ pool formation evident, with ≥50% pool size rank 3-7 ☐ widespread riffle formation ☐ more than two depth-velocity combinations present ☐ meandering thalweg clearly identifiable in cross section, with evidence of side and lateral bar formation ☐ finer deposition located entirely in slack water below larger substrates/debris, and along margins					☐ pool formation evident, with <50% pool size rank 3-7 ☐ moderate riffle formation ☐ two depth-velocity combinations present ☐ meandering thalweg moderately identifiable in cross section, with some evidence of bar formation ☐ finer deposition located in slack water below larger substrates/debris, signs of mid-channel accumulation					☐ limited trace of pool formation ☐ limited riffle formation ☐ one or two depth-velocity combinations present ☐ meandering thalweg barely identifiable in the cross section, with minimal evidence of bar formation ☐ very large depositional features below larger substrates/debris, abundant mid-channel accumulation					☐ pool formation completely absent ☐ no riffle formation ☐ one depth-velocity combination present ☐ meandering thalweg not identifiable in the cross section, with no evidence of bar formation ☐ finer deposition throughout channel, even filling pools, larger substrates almost buried **or** bed largely incised				
SCORE	20	19	18	17	16	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1
6.4 Channel Morphology	☐ width/depth < 15, natural ☐ entrenchment ratio ≥ 1.4, incision ratio < 1.2, good floodplain access ☐ no evidence of channel alteration					☐ 15 ≤ w / d < 25, widening ☐ entrenchment ratio ≥ 1.4, 1.2 ≤ incision ratio < 1.4, reduced floodplain access ☐ evidence of minor historic channel alteration					☐ 25 ≤ w /d < 40, widening ☐ entrenchment ratio ≥ 1.4, 1.4 ≤ incision ratio < 2.0, limited floodplain access ☐ major historic or minor recent channel alteration					☐ w /d ≥ 40, over-widening ☐ entrenchment ratio < 1.4 **or** incision ratio ≥ 2.0, floodplain access unlikely ☐ extensive historic or major recent channel alteration				
SCORE	20	19	18	17	16	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1

Habitat Parameter	Condition (Departure) Category																			
	Reference (None)					**Good (Minor)**					**Fair (Major)**					**Poor (Severe)**				
6.5 Hydrologic Characteristics	☐ wetted width / W_{bkf} > 0.75 ☐ exposed substrate < 20% ☐ adjacent springs, seeps, and wetlands extensive ☐ no known flow alteration					☐ 0.75 ≥ W_{wet} / W_{bkf} > 0.50 ☐ 20 ≤ exp. substrate < 40% ☐ adjacent springs, seeps, and wetlands present ☐ minor flow alteration likely due to flow regulation and/or land use changes					☐ 0.50 ≥ W_{wet} / W_{bkf} > 0.25 ☐ 40 ≤ exp. substrate < 60% ☐ adjacent springs, seeps, and wetlands minimal ☐ major flow alteration likely due to flow regulation and/or land use changes					☐ W_{wet} / W_{bkf} ≤ 0.25 ☐ exposed substrate ≥ 60% ☐ adjacent springs, seeps, and wetlands altered or absent ☐ runoff characteristics completely altered due to flow regulation and storm water influence				
SCORE	20	19	18	17	16	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1
6.6 Connectivity Tend towards a higher/lower score for natural/man-made obstructions	☐ no obstructions in reach that block longitudinal movement of aquatic species over all but the lowest flows ☐ system obstructions absent ☐ abundant low **and** high flow refuge					☐ one or two small low flow obstructions present in reach that block movement of aquatic species ☐ limited system obstructions ☐ abundant refuge, with low **or** high flow refuge limited					☐ one or two small to medium bankfull obstructions present in reach that block movement of aquatic species ☐ system obstructions present ☐ limited low **and** high flow refuge					☐ more than two bankfull obstructions present in reach that block movement of aquatic species ☐ many system obstructions ☐ refuge absent				
SCORE	20	19	18	17	16	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1
6.7 River Banks Select different boxes for LB and RB if necessary Undercut size rank variable only used if ≥ 5 undercuts **(score each bank)**	☐ bank erosion <10%, typical of natural conditions, little or no bank revetments ☐ bank vegetation > 90% in tree, shrub and herb layers, diverse assemblages, plants create good cover and roots help stabilize bank ☐ bank canopy > 90% ☐ undercut banks / mile > 20 ☐ undercut bank size rank 3-6 > 50% ☐ undercut banks with mostly stable boundaries, abundant overhanging vegetation, and consistent water adjacency ☐ no mass failures in valley					☐ 10 ≤ bank erosion < 30%, infrequent small areas, some bank revetments ☐ 90 ≥ bank vegetation > 75% in each layer, diverse assemblages, plants create good cover and roots help stabilize bank ☐ 90 ≥ bank canopy > 75% ☐ 20 ≥ undercuts / mile > 15 ☐ 50 ≥ undercut bank size rank 3-6 > 25% ☐ undercuts with some unstable boundaries or reduced overhanging vegetation, and consistent water adjacency ☐ 1 mass failure in valley					☐ 30 ≤ bank erosion < 60%, mod. unstable banks, and/or extensive bank revetments ☐ 75 ≥ bank vegetation > 50%, in two of three layers, reduced diversity, plants create limited cover and roots do not stabilize bank ☐ 75 ≥ bank canopy > 50% ☐ 15 ≥ undercuts / mile > 5 ☐ 25 ≥ undercut bank size rank 3-6 > 10% ☐ undercuts with some unstable boundaries or reduced overhanging vegetation, and reduced water adjacency ☐ 1 - 2 mass failures in valley					☐ bank erosion ≥ 60%, banks unstable, extensive erosion, and failing bank revetments ☐ bank vegetation ≤ 50% in two of three layers, limited diversity, plants create no cover and roots do not stabilize bank ☐ bank canopy ≤ 50% ☐ undercuts / mile ≤ 5 ☐ undercut bank size rank 3-6 ≤ 10% ☐ undercuts with mostly unstable boundaries, no overhanging vegetation, and reduced water adjacency ☐ > 3 mass failures in valley				
SCORE _____ (LB)	Left Bank	10	9			8	7	6			5	4	3			2	1			
SCORE _____ (RB)	Right Bank	10	9			8	7	6			5	4	3			2	1			
6.8 Riparian Area Select different boxes for LB and RB if necessary **(score each side of the channel)**	☐ buffer width > 150 ft ☐ rip. vegetation > 75% in tree, shrub and herb layers, diverse assemblages, no invasives, maximum channel canopy ☐ river corridor development and infrastructure absent					☐ 150 ≥ buffer width > 100 ft ☐ 75 ≥ rip. veg. > 50% in each layer, one plant type absent, minimal invasives, maximum channel canopy ☐ river corridor development and infrastructure minimal					☐ 100 ≥ buffer width > 50 ft ☐ 75 ≥ rip. veg. > 50% in each layer, several types absent, altered patches, invasives present, reduced canopy ☐ river corridor development and infrastructure common					☐ buffer width ≤ 50 ft ☐ rip. veg. ≤ 50% in each layer, several types absent, large altered areas, invasives present, reduced canopy ☐ river corridor development and infrastructure abundant				
SCORE _____ (LB)	Left Bank	10	9			8	7	6			5	4	3			2	1			
SCORE _____ (RB)	Right Bank	10	9			8	7	6			5	4	3			2	1			

6.9 Score: front _____ + back _____ = total _____

Percentage: total score _____ x (100 / 160) = _____

Overall Physical Habitat Condition: _____

SHTD ☐ Existing Stream Habitat Type: _____

Score	*Percentage*	*Condition (Departure)*
136 – 160	**85 – 100**	Reference (None)
104 – 135	**65 – 84**	Good (Minor)
56 – 103	**35 – 64**	Fair (Major)
0 – 55	**0 – 34**	Poor (Severe)

VTANR REACH HABITAT ASSESSMENT ----- BRAIDED STREAM TYPE

(Also use this form for alluvial fans.)

Stream Name:_____ Segment I.D: _____
Location: _____ Date:_____
_____ Town:_____
Observers: _____ Elevation: _____ ft.
Organization /Agency: _____ Latitude (N/S):_____
USGS Map Name(s):_____ Longitude (E/W): _____
Weather:_____ Drainage Area: _____ sq. mi.
Flow: base / low / avg. Storm within past 7 days: Y / N Segment Length: _____ ft.

Habitat Parameter	Condition (Departure) Category				
	Reference (None)	**Good (Minor)**	**Fair (Major)**	**Poor (Severe)**	
6.1 Woody Debris Cover LWD size rank variable only used if ≥ 10 pieces	☐ LWD pieces / mile > 100 ☐ LWD size rank 3-6 >50% ☐ debris jams / mile > 5 ☐ high woody debris recruitment potential ☐ CPOM present in channel and margins	☐ 100 ≥ LWD / mile > 50 ☐ 50 ≥ LWD rank 3-6 > 25% ☐ 5 ≥ jams / mile > 3 ☐ moderate woody debris recruitment potential ☐ CPOM limited in channel and present in margins	☐ 50 ≥ LWD / mile > 25 ☐ 25 ≥ LWD rank 3-6 > 10% ☐ 3 ≥ jams / mile > 1 ☐ low woody debris recruitment potential ☐ CPOM limited in both channel and margins	☐ LWD / mile ≤ 25 ☐ LWD size rank 3-6 ≤ 10% ☐ debris jams absent ☐ no woody debris recruitment potential ☐ CPOM absent	
SCORE	20 19 18 17 16	15 14 13 12 11	10 9 8 7 6	5 4 3 2 1	
6.2 Bed Substrate Cover *fines: sand if d_{50} ≥ gravel, otherwise silt.	☐ riffle embeddedness < 20% margin embeddedness < 40% ☐ fining* < 10% ☐ Riffle stability index < 70% ☐ sediment apparently stable & sorted ☐ substrate free of dense algae growth	☐ 20 ≤ emb_{riffle} < 40% 40 ≤ emb_{margin} < 60% ☐ 10 ≤ fining* < 20% ☐ 70 ≤ RSI < 80% ☐ some evidence of sediment mobility & lack of sorting ☐ small substrate patches covered by dense algae growth	☐ 40 ≤ emb_{riffle} < 75% 60 ≤ emb_{margin} < 80% ☐ 20 ≤ fining* < 40% ☐ 80 ≤ RSI < 90% ☐ major evidence of sediment mobility & lack of sorting ☐ large substrate patches covered by dense algae growth	☐ riffle embeddedness ≥ 75% margin embeddedness ≥ 80% ☐ fining* ≥ 40% ☐ RSI ≥ 90% ☐ sediments unstable, unsorted, soft underfoot ☐ most of substrate covered by dense algae growth	
SCORE	20 19 18 17 16	15 14 13 12 11	10 9 8 7 6	5 4 3 2 1	
6.3 Scour and Deposition Features *Depth-velocity combinations* *fast-shallow* *fast-deep* *slow-shallow* *slow-deep* *(cutoffs: 1.0 fps, 1.5 ft)* Pool size rank variable only used if ≥ 5 pools	☐ pools / mile > 40 ☐ pool size rank 3-7 >50% ☐ good cover > 75% of total pool surface area ☐ riffle coverage > 25% reach area, distinctly formed and complete ☐ 5 ≤ riffle spacing ≤ 7 bankfull channel widths (w_{bkf}) ☐ well-defined riffle-run-pool-glide pattern with all four depth-velocity combinations present ☐ stable bars, vegetative cover on depositional features ≥ 50%, particles well-sorted	☐ 40 ≥ pools / mile > 20 ☐ 50 ≥ pool rank 3-7 > 25% ☐ 75 ≥ good cover > 50% of total pool surface area ☐ 25 ≥ riffle coverage > 10% reach area, moderately well formed and complete ☐ 3 ≤ riffle spacing < 5, or 7 < riffle spacing ≤ 10 x w_{bkf} ☐ well-defined riffle-run-pool-glide pattern with three depth-velocity combinations dominant ☐ mostly stable bars, vegetative cover on depositional features 50-25%, particles moderately sorted	☐ 20 ≥ pools / mile > 10 ☐ 25 ≥ pool rank 3-7 > 10% ☐ 50 ≥ good cover > 25% of total pool surface area ☐ 25 ≥ riffle coverage > 10% reach area, poorly formed and incomplete ☐ 1 ≤ riffle spacing < 3, or 10 < riffle spacing ≤ 12 x w_{bkf} ☐ moderately defined riffle-run-pool-glide pattern with two depth-velocity combinations dominant ☐ unstable bars present, vegetative cover on depositional features 25-10%, particles minimally sorted	☐ pools / mile ≤ 10 ☐ pool size rank 3-7 ≤ 10% ☐ good cover ≤ 25% of total pool surface area ☐ riffle coverage ≤ 10% reach area, or mostly indistinct or absent ☐ riffle spacing ≥ 12 bankfull channel widths ☐ poorly defined riffle-run-pool-glide pattern with one depth-velocity combination dominant ☐ mostly unstable bars, vegetative cover on depositional features < 10%, particles not sorted	
SCORE	20 19 18 17 16	15 14 13 12 11	10 9 8 7 6	5 4 3 2 1	
6.4 Channel Morphology	☐ width/depth < 30, natural ☐ entrenchment ratio ≥ 2.0, incision ratio < 1.0, good floodplain access ☐ no evidence of channel alteration	☐ 30 ≤ w/ d < 40, widening ☐ entrenchment ratio ≥ 2.0, 1.0 ≤ incision ratio < 1.2, reduced floodplain access ☐ evidence of minor historic channel alteration	☐ 40 ≤ w / d < 50, widening ☐ entrenchment ratio ≥ 2.0, 1.2 ≤ incision ratio < 1.4, limited floodplain access ☐ major historic or minor recent channel alteration	☐ w / d ≥ 50, over-widening ☐ entrenchment ratio < 2.0 **or** incision ratio ≥ 1.4, floodplain access unlikely ☐ extensive historic or major recent channel alteration	
SCORE	20 19 18 17 16	15 14 13 12 11	10 9 8 7 6	5 4 3 2 1	

Habitat Parameter	Condition (Departure) Category			
	Reference (None)	**Good (Minor)**	**Fair (Major)**	**Poor (Severe)**
6.5 Hydrologic Characteristics	□ wetted width / W_{bkf} > 0.50 □ exposed substrate < 50% □ adjacent springs, seeps, and wetlands extensive □ no known flow alteration	□ 0.50 ≥ W_{wet} / W_{bkf} > 0.30 □ 50 ≤ exp. substrate < 60% □ adjacent springs, seeps, and wetlands present □ minor flow alteration likely due to flow regulation and/or land use changes	□ 0.30 ≥ W_{wet} / W_{bkf} > 0.10 □ 60 ≤ exp. substrate < 70% □ adjacent springs, seeps, and wetlands minimal □ major flow alteration likely due to flow regulation and/or land use changes	□ W_{wet} / W_{bkf} ≤ 0.10 □ exposed substrate ≥ 70% □ adjacent springs, seeps, and wetlands absent or altered □ runoff characteristics completely altered due to flow regulation and storm water influence
SCORE	20 19 18 17 16	15 14 13 12 11	10 9 8 7 6	5 4 3 2 1
6.6 Connectivity Tend towards a higher/lower score for natural/man-made obstructions	□ no obstructions in reach that block longitudinal movement of aquatic species over all but the lowest flows □ system obstructions absent □ abundant low **and** high flow refuge	□ one or two small low flow obstructions present in reach that block movement of aquatic species □ limited system obstructions □ abundant refuge, with low **or** high flow refuge limited	□ one or two small to medium bankfull obstructions present in reach that block movement of aquatic species □ system obstructions present □ limited low **and** high flow refuge	□ more than two bankfull obstructions present in reach that block movement of aquatic species □ many system obstructions □ refuge absent
SCORE	20 19 18 17 16	15 14 13 12 11	10 9 8 7 6	5 4 3 2 1
6.7 River Banks Select different boxes for LB and RB if necessary	□ bank erosion <10%, typical of natural conditions, little or no bank revetments □ bank vegetation > 90% in tree, shrub and herb layers, diverse assemblages, plants create good cover and roots help stabilize bank	□ 10 ≤ bank erosion < 30%, infrequent small areas, some bank revetments □ 90 ≥ bank vegetation > 75% in each layer, diverse assemblages, plants create good cover and roots help stabilize bank	□ 30 ≤ bank erosion < 60%, mod. unstable banks, and/or extensive bank revetments □ 75 ≥ bank vegetation > 50%, in two of three layers, reduced diversity, plants create limited cover and roots do not stabilize bank	□ bank erosion ≥ 60%, banks unstable, extensive erosion, and failing bank revetments □ bank vegetation ≤ 50% in two of three layers, limited diversity, plants create no cover and roots do not stabilize bank
Undercut size rank variable only used if ≥ 5 undercuts	□ bank canopy > 90% □ undercut banks / mile > 30 □ undercut bank size rank 3-6 > 50%	□ 90 ≥ bank canopy > 75% □ 30 ≥ undercuts / mile > 15 □ 50 ≥ undercut bank size rank 3-6 > 25%	□ 75 ≥ bank canopy > 50% □ 15 ≥ undercuts / mile > 5 □ 25 ≥ undercut bank size rank 3-6 > 10%	□ bank canopy ≤ 50% □ undercuts / mile ≤ 5 □ undercut bank size rank 3-6 ≤ 10%
(score each bank)	□ undercut banks with mostly stable boundaries, abundant overhanging vegetation, and consistent water adjacency □ no mass failures in valley	□ undercuts with some unstable boundaries or reduced overhanging vegetation, and consistent water adjacency □ 1 mass failure in valley	□ undercuts with some unstable boundaries or reduced overhanging vegetation, and reduced water adjacency □ 1 - 2 mass failures in valley	□ undercuts with mostly unstable boundaries, no overhanging vegetation, and reduced water adjacency □ > 3 mass failures in valley
SCORE ___ (LB)	Left Bank 10 9	8 7 6	5 4 3	2 1
SCORE ___ (RB)	Right Bank 10 9	8 7 6	5 4 3	2 1
6.8 Riparian Area Select different boxes for LB and RB if necessary	□ buffer width > 150 ft □ rip. vegetation > 75% in tree, shrub and herb layers, diverse assemblages, no invasives, maximum channel canopy	□ 150 ≥ buffer width > 100 ft □ 75 ≥ rip. veg. > 50% in each layer, one plant type absent, minimal invasives, maximum channel canopy	□ 100 ≥ buffer width > 50 ft □ 75 ≥ rip. veg. > 50% in each layer, several types absent, altered patches, invasives present, reduced canopy	□ buffer width ≤ 50 ft □ rip. veg. ≤ 50% in each layer, several types absent, large altered areas, invasives present, reduced canopy
(score each side of the channel)	□ river corridor development and infrastructure absent	□ river corridor development and infrastructure minimal	□ river corridor development and infrastructure common	□ river corridor development and infrastructure abundant
SCORE ___ (LB)	Left Bank 10 9	8 7 6	5 4 3	2 1
SCORE ___ (RB)	Right Bank 10 9	8 7 6	5 4 3	2 1

6.9 Score: front _____ + back _____ = total _____

Percentage: total score _____ x (100 / 160) = _____

Overall Physical Habitat Condition: _____

SHTD □ Existing Stream Habitat Type: _____

Score	*Percentage*	*Condition (Departure)*
136 – 160	**85 – 100**	Reference (None)
104 – 135	**65 – 84**	Good (Minor)
56 – 103	**35 – 64**	Fair (Major)
0 – 55	**0 – 34**	Poor (Severe)

VT RAPID GEOMORPHIC ASSESSMENT ----- CONFINED STREAMS

For narrowly and semi-confined valley types (confinement ratio < 4)

Stream Name:_____ Segment I.D: _____
Location: _____ Date:_____
_____ Town:_____
Observers: _____ Elevation: _____ ft.
Organization /Agency: _____ Weather:_____
Reference Stream Type _____ ☐ Modified Rain Storm within past 7 days: Y / N
(If bedrock controlled gorge, alluvial fan, or naturally braided system see Handbook Protocols)

Adjustment Process	Condition Category: Reference	Good	Fair	Poor
7.1 Channel Degradation (Incision) • Exposed till or fresh substrate in the stream bed and exposed infrastructure (bridge footings). • New terraces or recently abandoned flood prone areas. • Headcuts, or nickpoints significantly steeper bed segment and comprised of smaller bed material than typical steps. • Freshly eroded, vertical banks. • Alluvial sediments that are imbricated (stacked like dominoes) high in the bank. • Tributary rejuvenation, observed through the presence of nickpoints at or upstream of the mouth of a tributary. • Depositional features with steep faces, usually occurring on the downstream end. **Stream Type Departure** ☐ **Type of STD:**_____	☐ Little evidence of localized slope increase or nickpoints.	☐ Minor localized slope increase or nickpoints.	☐ Sharp change in slope, head cuts present, and/or tributaries rejuvenating.	☐ Sharp change in slope and / or multiple head cuts present. Tributaries rejuvenating.
	☐ Incision Ratio ≥ 1.0 < 1.2 **and** Where channel slope < 4% Entrenchment ratio > 1.4 Where channel slope ≥ 4% Entrenchment ratio > 1.2	☐ Incision Ratio ≥ 1.2 < 1.4 **and** Where channel slope < 4% Entrenchment ratio > 1.4 Where channel slope ≥ 4% Entrenchment ratio > 1.2	☐ Incision Ratio ≥ 1.4 < 2.0 **and** Where channel slope < 4% Entrenchment ratio > 1.4 Where channel slope ≥ 4% Entrenchment ratio > 1.2	☐ Incision ratio ≥ 2.0 **and** Where channel slope < 4% Entrenchment ratio ≤ 1.4 Where channel slope ≥ 4% Entrenchment ratio ≤ 1.2
	☐ Step-pool systems have full complement of expected bed features, steps complete with coarser sediment (≥ D80).	☐ Step-pool systems have full complement of expected bed features, steps mostly complete.	☐ Step-pool systems with incomplete (eroded) steps, dominated by runs.	☐ Step-pool bed features eroded and replaced by plane bed features.
	☐ No significant human-caused change in channel confinement.	☐ Only minor human-caused change in channel confinement.	☐ Significant human-caused change in channel confinement but no change in valley type.	☐ Human caused change in valley type.
	☐ No evidence of historic / present channel straightening, dredging, and/or channel avulsions.	☐ Evidence of minor historic dredging and/or channel avulsion.	☐ Evidence of significant historic channel straightening, dredging, or gravel mining, and/or channel avulsions.	☐ Extensive historic channel straightening, commercial gravel mining, and/or recent channel avulsions.
	☐ No known flow alterations (i.e., increases in flow and/or decreases in sediment supply).	☐ Some increase in flow and/or minor reduction of sediment load.	☐ Major historic flow alterations, greater flows and/or reduction of sediment load.	☐ Major existing flow alterations, greater flows and/or reduction of sediment load.
Score: **Historic** ☐	20 19 18 17 16	15 14 13 12 11	10 9 8 7 6	5 4 3 2 1
7.2 Channel Aggradation • Shallow pool depths. • Abundant sediment deposition on side bars and unvegetated mid-channel bars and extensive sediment deposition at obstructions, channel constrictions. Islands may be present • Most of the channel bed is exposed during typical low flow periods. • Coarse gravels, cobbles, and boulders may be embedded with sand/silt and fine gravel. **Stream Type Departure** ☐ **Type of STD:**_____	☐ Step-pool systems have full complement of expected bed features, complete steps and deep pools.	☐ Step-pool systems with full complement of bed features. Pools filling with fine sediment and may be only slightly deeper and wider than runs.	☐ Step-pool systems with incomplete steps, dominated by runs. Pools filling with fine sediment and may be absent with runs prevailing.	☐ Step-pool bed features are filled with sediment and stream appears as a plane bed.
	☐ Minor side or delta bars present. Minor depositional features typically less than half bankfull stage in height.	☐ Single to multiple mid-channel, side or diagonal bars present. Minor depositional features typically less than bankfull stage in height.	☐ Multiple unvegetated mid-channel, side or diagonal bars present. Sediment buildup at constrictions leading to steep riffles and/or flood chutes.	☐ Multiple unvegetated mid-channel, side or diagonal bars or islands present, splitting or braiding flows even under low flow conditions.
	☐ No apparent increase in gravel / sand substrates (pebble count).	☐ Some increase in small gravel / sand substrates that may comprise over 50% of the sediments.	☐ Large increase in gravel / sand substrates that may comprise over 70% of the sediments.	☐ Homogenous gravel/sand substrates may comprise over 90% of the sediments. Fine sediment feels soft underfoot.
	☐ Low width/depth ratio ≤ 20 for channel slopes < 4% ≤ 12 for channel slopes ≥ 4%	☐ Low to moderate W/d ratio > 20 ≤ 30 for slopes < 4% > 12 ≤ 20 for slopes ≥ 4%	☐ Moderate to high W/d ratio > 30 ≤ 40 for slopes < 4% > 20 ≤ 30 for slopes ≥ 4%	☐ High width/depth ratio > 40 for channel slopes < 4% > 30 for channel slopes ≥ 4%
	☐ No known flow alterations (i.e., decrease in flow and/or increase in sediment supply).	☐ Minor reduction in flow and / or increase in sediment load. Flood-related sediment working through reach, seen as enlarged bars.	☐ Major historic flow alterations, reduction in flows and / or increase in sediment load.	☐ Major existing flow alterations, extreme reduction in flows and / or increase in sediment load.
	☐ No human-made constrictions causing upstream deposition.	☐ Human-made constrictions smaller than floodprone width, causing minor to moderate upstrm / dwnstrm deposition.	☐ Human-made constrictions significantly smaller than floodprone width, causing major upstrm / dwnstrm deposition.	☐ Human-made constrictions significantly smaller than bankfull width, causing extensive upstrm / dwnstrm deposition and flow bifurcation.
Score: **Historic** ☐	20 19 18 17 16	15 14 13 12 11	10 9 8 7 6	5 4 3 2 1

Adjustment Process	Condition Category: Reference	Good	Fair	Poor
7.3 Widening Channel • Active undermining of bank vegetation on both sides of the channel; many unstable bank overhangs that have little vegetation holding soils together. • Erosion on both right and left banks. • Recently exposed tree roots (fresh roots are 'green' and do not break easily, older roots are brittle and will break easily in your hand). • Fracture lines at the top of the bank that appear as cracks parallel to the river. • Evidence of landslides and mass failures. • Mid-channel bars and side bars may be present. • Urbanization and stormwater outfalls leading to higher rate and duration of runoff and channel enlargement.	☐ Low width/depth ratio ≤ 20 for channel slopes < 4% ≤ 10 for channel slopes ≥ 4%	☐ Low to moderate W/d ratio > 20 ≤ 30 for slopes < 4% > 10 ≤ 12 for slopes ≥ 4%	☐ Moderate to high W/d ratio > 30 ≤ 40 for slopes < 4% > 12 ≤ 20 for slopes ≥ 4%	☐ High width/depth ratio > 40 for channel slopes < 4% > 20 for channel slopes ≥ 4%
	☐ Little to no scour and erosion at the base of both banks. Negligible bank overhangs, fracture lines at top of banks, leaning trees or freshly exposed tree roots.	☐ Minimal to moderate scour and erosion at the base of both banks. Some overhangs, fracture lines at top of banks, leaning trees and freshly exposed tree roots.	☐ Moderate to high scour and erosion at the base of both banks. Many bank overhangs, fracture lines at top of banks, leaning trees and freshly exposed tree roots.	☐ Continuous and laterally extensive scour and erosion at the base of both banks. Continuous bank overhangs, fracture lines at top of banks, leaning trees and freshly exposed tree roots.
	☐ Incision Ratio ≥ 1.0 < 1.2 **and** Where channel slope < 4% Entrenchment ratio > 1.4 Where channel slope ≥ 4% Entrenchment ratio > 1.2	☐ Incision Ratio ≥ 1.2 < 1.4 **and** Where channel slope < 4% Entrenchment ratio > 1.4 Where channel slope ≥ 4% Entrenchment ratio > 1.2	☐ Incision Ratio ≥ 1.4 < 2.0 **and** Where channel slope < 4% Entrenchment ratio > 1.4 Where channel slope ≥ 4% Entrenchment ratio > 1.2	☐ Incision ratio ≥ 2.0 **and** Where channel slope < 4% Entrenchment ratio ≤ 1.4 Where channel slope ≥ 4% Entrenchment ratio ≤ 1.2
	☐ Minor side or delta bars present. Depositional features typically less than half bankfull stage in height.	☐ Single to multiple mid-channel or side bars present. Minor depositional features typically less than half bankfull stage in height.	☐ Multiple unvegetated mid-channel or side bars present. Major sediment buildup at the head of constrictions leading to steep riffles and/or flood chutes.	☐ Multiple unvegetated mid-channel, side or diagonal bars or islands present, splitting or braiding flows even under low flow conditions.
	☐ No known channel and / or flow alterations (i.e., increase in flow and/or change in sediment supply).	☐ Minor increase in watershed input of flows and/or sediment. Episodic (flood) discharges resulting in short-term enlargement.	☐ Major channel and/or flow alterations, increase in flows and/or change in sediment load (increase or decrease).	☐ Major and extensive channel and/or flow alterations, increase in flows and/or change in sediment load (increase or decrease).
Score: **Historic** ☐	20 19 18 17 16	15 14 13 12 11	10 9 8 7 6	5 4 3 2 1
7.4 Change in Planform • Flood chutes present. • Channel avulsions evident or impending. • Change or loss in bed form structure, sometimes resulting in a mix of plane bed and step-pool forms. • Island formation and/or multiple thread channels.	☐ Low bank erosion on outside bends, little or no change in sinuosity within the reach.	☐ Low to moderate lateral bank erosion on outside bends, may include minor change in sinuosity within the reach.	☐ Moderate to high lateral bank erosion on most outside bends, may include moderate change in reach sinuosity.	☐ Extensive lateral bank erosion on most outside bends, may include major change in sinuosity within the reach.
	☐ Little or no evidence sediment buildup, only minor delta or side bars typically less than half bankfull stage in height.	☐ Single to multiple unvegetated mid-channel, delta, or side bars. Some potential for channel avulsion.	☐ Multiple unvegetated mid-channel, delta, or side bars, typically greater than bankfull stage in height. Evidence of past channel avulsion and/or islands.	☐ Multiple and major mid-channel, delta, and/or side bars. Evidence of recent channel avulsion, multiple thread channels, and islands.
	☐ No human-caused alteration of channel planform and / or the width of the floodprone area.	☐ Minor to moderate alteration of channel planform and/or width of the floodprone area resulting from floodplain encroachment, channel straightening, or dredging.	☐ Major alteration of channel planform and/or width of the floodprone area resulting from historic encroachment, dredging, or channel straightening.	☐ Major alteration of channel planform and the width of the floodprone area resulting from recent and extensive encroachment, dredging, and/or channel straightening.
	☐ Human-made constrictions causing only negligible upstream deposition.	☐ Human-made constrictions smaller than floodprone width, causing minor to moderate upstrm / dwnstrm deposition.	☐ Human-made constrictions significantly smaller than floodprone width, causing major upstrm / dwnstrm deposition.	☐ Human-made constrictions significantly smaller than bankfull width, causing extensive major upstrm / dwnstrm deposition and flow bifurcation.
Score: **Historic** ☐	20 19 18 17 16	15 14 13 12 11	10 9 8 7 6	5 4 3 2 1

7.5 Channel Adjustment Scores – Stream Condition – Channel Evolution Stage

Condition / Departure	Reference / N/S	Good / Minor	Fair / Major	Poor / Extreme	STD*	Historic	Condition Rating: (Total Score / 80)	Channel Evolution Stage:
Degradation								
Aggradation								
Widening							**7.6 Stream Condition:**	
Planform								
Sub-totals:					**Total Score:**			

*STD = Stream Type Departure where existing stream type is no longer the same as the reference stream type.

Channel Adjustment Processes: _____

7.7 Stream Sensitivity: Very Low / Low / Moderate / High / Very High / Extreme

* Channel Condition "default" to **poor** – significant flood damage (not able to get accurate channel data) **Y/N ;**

***** Channel Condition default to poor - Due to channel alterations from work in channel after flood: **Y/N**

* Stream Sensitivity "default" to **poor** – significant flood damage (not able to get accurate channel data) **Y/N ;**

* Stream Sensitivity "default" to **poor** Due to channel alterations from work in channel after flood: **Y/N**

VT RAPID GEOMORPHIC ASSESSMENT ----- UNCONFINED STREAMS

For narrow and broad to very broad valley types (confinement ratio ≥ 4) Typically Riffle-pool and Dune-Ripple Stream Types

Stream Name:_____ Segment I.D: _____
Location: _____ Date:_____
_____ Town:_____
Observers: _____ Elevation: _____ ft.
Organization /Agency: _____ Weather:_____
Reference Stream Type _____ ☐ Modified Rain Storm within past 7 days: Y / N
(If alluvial fan or naturally braided system see Handbook Protocols)

Adjustment Process	Condition Category: Reference	Good	Fair	Poor
7.1 Channel Degradation (Incision) • Exposed till or fresh substrate in the stream bed and exposed infrastructure(bridge footings) • New terraces or recently abandoned floodplains. • Headcuts, or nickpoints that are 2-3 times steeper than typical riffle. • Freshly eroded, vertical banks. • Alluvial (river) sediments that are imbricated (stacked like dominoes) high in bank. • Tributary rejuvenation, observed through the presence of nickpoints at or upstream of the mouth of a tributary. • Bars with steep faces, usually occurring on the downstream end of a bar. **Stream Type Departure** ☐ **Type of STD:**_____	☐ Little evidence of localized slope increase or nickpoints.	☐ Minor localized slope increase or nickpoints.	☐ Sharp change in slope, head cuts present, and/or tributaries rejuvenating.	☐ Sharp change in slope and / or multiple head cuts present. Tributaries rejuvenating.
	☐ Incision Ratio ≥ 1.0 < 1.2 **and** Entrenchment ratio > 2.0	☐ Incision Ratio ≥ 1.2 < 1.4 **and** Entrenchment ratio > 2.0	☐ Incision Ratio ≥ 1.4 < 2.0 **and** Entrenchment ratio > 2.0	☐ Incision ratio ≥ 2.0 **OR** Entrenchment ratio ≤ 2.0
	☐ Riffle heads complete and comprised of courser sediments (≥D80). Full complement of expected bed features.	☐ Riffle heads mostly complete. Riffle lengths may appear shorter. Full complement of expected bed features.	☐ Riffles or dunes may appear incomplete; bed profile dominated by runs.	☐ Riffle-pool or ripple-dune features replaced by plane bed features.
	☐ No significant human-caused change in channel confinement or valley type.	☐ Only minor human-caused change in channel confinement but no change in valley type.	☐ Significant human-caused change in channel confinement enough to change valley type, but still unconfined.	☐ Human-caused change in valley type, unconfined or narrow changed to confined.
	☐ No evidence of historic / present channel straightening, gravel mining, dredging and/or channel avulsions.	☐ Evidence of minor bar scalping on a point bar and/or channel avulsion; but minor to no historic channel straightening, gravel mining, or dredging.	☐ Evidence of significant historic channel straightening, dredging, gravel mining and/or channel avulsions.	☐ Extensive historic channel straightening, commercial gravel mining, and/or recent channel avulsion.
	☐ No known flow alterations (i.e., increases in flow or decreases in sediment supply).	☐ Minor flow alterations, some flow increase and/or reduction of sediment load.	☐ Major historic flow alterations, greater flows and/or reduction of sediment load.	☐ Major existing flow alterations, greater flows and/or reduction of sediment load.
Score: **Historic** ☐	20 19 18 17 16	15 14 13 12 11	10 9 8 7 6	5 4 3 2 1
7.2 Channel Aggradation • Shallow pool depths. • Abundant sediment deposition on point bars and mid-channel bars and extensive sediment deposition at obstructions, channel constrictions, and at the upstream end of tight meander bends. Islands may be present. • Most of the channel bed is exposed during typical low flow periods. • High frequency of debris jams. • Coarse gravels, cobbles, and boulders may be embedded with sand/silt and fine gravel. ** This parameter may be a difficult to infeasible to evaluate in ripple-dune stream types **Stream Type Departure** ☐ **Type of STD:**_____	☐ Complete riffle heads and deep pools in riffle-pool systems.** Full complement of expected bed features.	☐ Mostly complete riffles and/or some filling of pools with fine sediment. Pools may only be slightly deeper and wider than runs.**	☐ Incomplete riffles or dunes and dominated by runs. Significant filling of pools with sediment, pools may be absent with runs prevailing.	☐ Riffle-pool or ripple-dune features replaced by plane bed features.
	☐ Minor point or delta bars present. Minor depositional features typically less than half bankfull stage in height.	☐ Single to multiple mid-channel or diagonal bars present. Minor depositional features typically less than half bankfull stage in height.	☐ Multiple unvegetated mid-channel or diagonal bars present. Major sediment buildup at the head of bendways leading to steep riffles and flood chutes.	☐ Multiple unvegetated mid-channel or diagonal bars present splitting or braiding flows even under low flow conditions.
	☐ No apparent increase in fine gravel/sand substrates (pebble count).**	☐ Some increase in fine gravel/sand substrates that may comprise over 50% of the sediments.	☐ Large incr. in fine gravel/ sand substrates that may comprise over 70% of the sediments. Sediment feels soft underfoot.	☐ Homogenous fine gravel/ sand substrates may comprise over 90% of the sediments. Sediment feels soft underfoot.
	☐ Low width/depth ratio ≤ 20 for C or B type channels ≤ 10 for E type channels	☐ Low to moderate W/d ratio >20 ≤ 30 for C or B channels >10 ≤ 12 for E channels	☐ Moderate to high W/d ratio >30 ≤ 40 for C or B channels >12 ≤ 20 for E channels	☐ High width/depth ratio >40 for C or B type channels >20 for E type channels
	☐ No known flow alterations (i.e., decrease in flow or increase in sediment supply).	☐ Minor reduction in flow and/or increase in sediment load. Flood-related sediment working through reach, seen as enlarged bars.	☐ Major historic flow alterations, reduction in flows and / or increase in sediment load.	☐ Major existing flow alterations, extreme reduction in flows and / or increase in sediment load.
	☐ No human-made constrictions causing upstream deposition.	☐ Human-made constrictions smaller than floodprone width, causing minor to moderate upstrm / dwnstrm deposition.	☐ Human-made constrictions significantly smaller than floodprone width, causing major upstrm / dwnstrm deposition.	☐ Human-made constrictions significantly smaller than bankfull width, causing extensive upstrm / dwnstrm deposition and flow bifurcation.
Score: **Historic** ☐	20 19 18 17 16	15 14 13 12 11	10 9 8 7 6	5 4 3 2 1

Adjustment Process	Condition Category: Reference	Good	Fair	Poor
7.3 Widening Channel • Active undermining of bank vegetation on both sides of the channel; many unstable bank overhangs that have little vegetation holding soils together. • Erosion on both right and left banks in riffle sections. • Recently exposed tree roots (fresh roots are 'green' and do not break easily, older roots are brittle and will break easily in your hand). • Fracture lines at the top of the bank that appear as cracks parallel to the river. • Mid-channel bars and side bars may be present. • Urbanization and stormwater outfalls leading to higher rate and duration of runoff and channel enlargement.	☐ Low width/depth ratio ≤ 20 for C or B type channels ≤ 10 for E type channels	☐ Low to moderate W/d ratio >20 ≤ 30 for C or B channels >10 ≤ 12 for E channels	☐ Moderate to high W/d ratio >30 ≤ 40 for C or B channels >12 ≤ 20 for E channels	☐ High width/depth ratio >40 for C or B type channels >20 for E type channels
	☐ Little to no scour and erosion at the base of both banks at the riffle section. Negligible bank overhangs, fracture lines at top of banks, leaning trees or freshly exposed tree roots.	☐ Minimal to moderate scour and erosion at the base of both banks at the riffle section. Some overhangs, fracture lines at top of banks, leaning trees and freshly exposed tree roots.	☐ Moderate to high scour and erosion at the base of both banks at the riffle section. Many bank overhangs, fracture lines at top of banks, leaning trees and freshly exposed tree roots.	☐ Continuous and laterally extensive scour and erosion at the base of both banks at the riffle section. Continuous bank overhangs, fracture lines at top of banks, leaning trees and freshly exposed tree roots.
	☐ Incision Ratio ≥ 1.0 < 1.2 **and** Entrenchment ratio > 2.0	☐ Incision Ratio ≥ 1.2 < 1.4 **and** Entrenchment ratio > 2.0	☐ Incision Ratio ≥ 1.4 < 2.0 **and** Entrenchment ratio > 2.0	☐ Incision ratio ≥ 2.0 **OR** Entrenchment ratio ≤ 2.0
	☐ Minor point or delta bars present. Depositional features less than half bankfull stage in height.	☐ Single to multiple mid-channel or diagonal bars present. Minor depositional features typically less than half bankfull stage in height.	☐ Multiple unvegetated mid-channel or diagonal bars present. Major sediment buildup at the head of bendways leading to steep riffles and flood chutes.	☐ Multiple unvegetated mid-channel or diagonal bars present splitting or braiding flows even under low flow conditions.
	☐ No known channel and / or flow alterations (i.e., increase in flow and / or change in sediment supply).	☐ Minor increase in watershed input of flows or sediment. Episodic (flood) discharges through reach resulting in short-term enlargement.	☐ Major channel and/or flow alterations, increase in flows and/or change in sediment load (increase or decrease).	☐ Major and extensive -channel and/or flow alterations, increase in flows and/or change in sediment load (increase or decrease).
Score: **Historic** ☐	20 19 18 17 16	15 14 13 12 11	10 9 8 7 6	5 4 3 2 1
7.4 Change in Planform • Flood chutes or neck cut-offs may be present. • Channel avulsions may be evident or impending. • Change or loss in bed form structure, sometimes resulting in a mix of plane bed and riffle- pool forms. • Island formation and/or multiple thread channels. • In meandering streams the thalweg, or deepest part of the channel, typically travels from the outside of a meander bend to the outside of the next meander bend. Pools are located on downstream third of the concave bends. Riffles are at the cross-over between the pools on successive bends. During planform adjustments, the thalweg may not line up with or follow this pattern. As a result of the lateral extension of meander bends, additional deposition and scour features may be in a channel length typically occupied by a single riffle-pool sequence.	☐ Low bank erosion on outside bends, little or no change in sinuosity within the reach.	☐ Low to moderate lateral bank erosion on outside bends, may include minor change in sinuosity within the reach.	☐ Moderate to high lateral bank erosion on most outside bends, may include potential neck cut-offs and moderate change in sinuosity.	☐ Extensive lateral bank erosion on most outside bends, may include impending neck cut-offs and major change in sinuosity within the reach.
	☐ Little evidence of flood chutes crossing inside of meander bends, only minor point or delta bars.	☐ Minor flood chutes crossing inside of meander bends, evidence of minor to moderate unvegetated mid-channel, delta, or diagonal bars. Some potential for channel avulsion.	☐ Historic or active flood chutes crossing inside of meander bends, evidence of channel avulsion, islands, and unvegetated mid-channel, delta, or diagonal bars.	☐ Active large flood chutes crossing inside of most meander bends, evidence of recent channel avulsion, multiple thread channels, islands, and unvegetated mid-channel, delta, or diagonal bars.
	☐ No additional deposition and scour features in the channel length typically occupied by a single riffle-pool sequence. Thalweg lined up with planform.	☐ Additional minor deposition and scour features in the channel length typically occupied by a single riffle-pool sequence.	☐ Additional large deposition and scour features in the channel length typically occupied by a single riffle-pool sequence. Thalweg not lined up with planform.	☐ Multiple sequences of large deposition and scour features in the channel length typically occupied by a single riffle-pool sequence.
	☐ No human-caused alteration of channel planform and / or the width of the floodprone area.	☐ Minor to moderate alteration of channel planform and/or width of the floodprone area resulting from floodplain encroachment, channel straightening, or dredging.	☐ Major alteration of channel planform and/or the width of the floodprone area resulting from historic floodplain encroachment, dredging, or channel straightening.	☐ Major alteration of channel planform and width of the floodprone area resulting from recent and extensive floodplain encroachment, dredging, and/or channel straightening.
	☐ Human-made constrictions causing only negligible upstream deposition.	☐ Human-made constrictions smaller than floodprone width, causing minor to moderate upstrm / downstrm deposition.	☐ Human-made constrictions significantly smaller than floodprone width, causing major upstrm / downstrm deposition.	☐ Human-made constrictions significantly smaller than bankfull width, causing extensive and major upstrm / downstrm deposition and flow bifurcation.
Score: **Historic** ☐	20 19 18 17 16	15 14 13 12 11	10 9 8 7 6	5 4 3 2 1

7.5 Channel Adjustment Scores – Stream Condition – Channel Evolution Stage

Condition / Departure	Reference / N/S	Good / Minor	Fair / Major	Poor / Extreme	STD*	Historic	Condition Rating: (Total Score / 80)	Channel Evolution Stage:
Degradation								
Aggradation								
Widening							**7.6 Stream Condition:**	
Planform								

Channel Adjustment Processes: _____

7.7 Stream Sensitivity: Very Low / Low / Moderate / High / Very High / Extreme

* Channel Condition "default" to **poor** – significant flood damage (not able to get accurate channel data) **Y/N ;**

***** Channel Condition default to poor - Due to channel alterations from work in channel after flood: **Y/N**

* Stream Sensitivity "default" to **poor** – significant flood damage (not able to get accurate channel data) **Y/N ;**

* Stream Sensitivity "default" to **poor** Due to channel alterations from work in channel after flood: **Y/N**

VT RAPID GEOMORPHIC ASSESSMENT ----- PLANE BED STREAMS

Typically found in semi-confined to narrow valley types (confinement ratio ≥ 3 and ≤ 5)

Reminder: This RGA form should only be used on streams which are plane bed systems by reference. Many existing plane bed streams in Vermont represent a departure from another stream type.

Stream Name:_____ Segment I.D: _____
Location: _____ Date:_____
_____ Town:_____
Observers: _____ Elevation: _____ ft.
Organization /Agency: _____ Weather:_____
Reference Stream Type _____ ☐ Modified Rain Storm within past 7 days: Y / N
(If alluvial fan or naturally braided system see Handbook Protocols)

Adjustment Process	Condition Category: Reference	Good	Fair	Poor
7.1 Channel Degradation (Incision) • Exposed till or fresh substrate in the stream bed and exposed infrastructure (bridge footings). • New terraces or recently abandoned floodplains. • Headcuts, or nickpoints that are 2-3 times steeper than typical riffle. • Freshly eroded, vertical banks. • Alluvial (river) sediments that are imbricated (stacked like dominoes) high in bank. • Tributary rejuvenation, observed through the presence of nickpoints at or upstream of the mouth of a tributary. **Stream Type Departure** ☐ **Type of STD:**_____	☐ Little evidence of localized slope increase or nickpoints.	☐ Minor localized slope increase or nickpoints.	☐ Sharp change in slope, head cuts present, and/or tributaries rejuvenating.	☐ Sharp change in slope and / or multiple head cuts present. Tributaries rejuvenating.
	☐ Incision ratio ≥ 1.0 < 1.2 **and** Where channel slope > 2% Entrenchment ratio > 1.4 Where channel slope ≤ 2% Entrenchment ratio > 2.0	☐ Incision ratio ≥ 1.2 < 1.4 **and** Where channel slope > 2% Entrenchment ratio > 1.4 Where channel slope ≤ 2% Entrenchment ratio > 2.0	☐ Incision ratio ≥ 1.4 < 2.0 **and** Where channel slope > 2% Entrenchment ratio > 1.4 Where channel slope ≤ 2% Entrenchment ratio > 2.0	☐ Incision ratio ≥ 2.0 **and** Where channel slope > 2% Entrenchment ratio ≤ 1.4 Where channel slope ≤ 2% Entrenchment ratio ≤ 2.0
	☐ No significant human-caused change in channel confinement or valley type.	☐ Only minor human-caused change in channel confinement but no change in valley type.	☐ Significant human-caused change in channel confinement enough to change valley type, but still not narrowly confined.	☐ Human-caused change to a narrowly confined valley type.
	☐ No evidence of historic or present channel straightening, gravel mining, dredging and/or channel avulsions.	☐ Evidence of minor mid-channel bar scalping and/or channel avulsion, but minor to no historic channel straightening, gravel mining or dredging.	☐ Evidence of significant historic channel straightening, dredging, gravel mining and/or channel avulsions.	☐ Extensive historic channel straightening, commercial gravel mining, and/or recent channel avulsion.
	☐ No known flow alterations (i.e., increases in flow or decreases in sediment supply).	☐ Minor flow alterations, some flow increase and/or minor reduction of sediment load.	☐ Major historic flow alterations, greater flows and/or reduction of sediment load.	☐ Major existing flow alterations, greater flows and/or reduction of sediment load.
Score: Historic ☐	20 19 18 17 16	15 14 13 12 11	10 9 8 7 6	5 4 3 2 1
7.2 Channel Aggradation • Very shallow pocket pools around and below boulders. • Abundant sediment deposition on side, point and mid-channel bars and extensive sediment deposition at obstructions, channel constrictions, and at the upstream end of tight bendways. Islands may be present. • Most of the channel bed is exposed during typical low flow periods. • Increased frequency of woody debris in channel. • Coarse gravels, cobbles, and boulders may be embedded with sand/silt and fine gravel. **Stream Type Departure** ☐ **Type of STD:**_____	☐ Minor side, point or delta bars present. Minor depositional features typically less than half bankfull stage in height.	☐ Single to multiple mid-channel or diagonal bars present. Minor depositional features typically less than half bankfull stage in height.	☐ Multiple unvegetated mid-channel or diagonal bars present. Sediment buildup at the head of bendways leading to steep riffles and flood chutes.	☐ Multiple unvegetated mid-channel or diagonal bars present splitting or braiding flows even under low flow conditions.
	☐ No apparent increase in fine gravel/sand substrates (pebble count).	☐ Some increase in fine gravel/sand substrates that may comprise over 50% of the sediments.	☐ Large increase in fine gravel/sand substrates that may comprise over 70% of the sediments. Fine sediment feels soft underfoot.	☐ Homogenous fine gravel/sand substrates may comprise over 90% of the sediments. Fine sediment feels soft underfoot.
	☐ Low width/depth ratio W/d ≤ 20	☐ Low to moderate W/d ratio W/d >20 ≤ 30	☐ Moderate to high W/d ratio W/d >30 ≤ 40	☐ High width/depth ratio W/d >40
	☐ No known flow alterations (i.e., decrease in flow or increase in sediment supply).	☐ Minor reduction in flow and/or increase in sediment load. Flood-related sediment working through reach, seen as enlarged bars.	☐ Major historic flow alterations, reduction in flows and / or increase in sediment load.	☐ Major existing flow alterations, extreme reduction in flows and / or increase in sediment load.
	☐ No human-made constrictions causing upstream deposition.	☐ Human-made constrictions smaller than floodprone width, causing minor to moderate upstrm / dwnstrm deposition.	☐ Human-made constrictions significantly smaller than floodprone width, causing major upstrm / dwnstrm deposition.	☐ Human-made constrictions significantly smaller than bankfull width, causing extensive upstrm / dwnstrm deposition and flow bifurcation.
Score: Historic ☐	20 19 18 17 16	15 14 13 12 11	10 9 8 7 6	5 4 3 2 1

Adjustment Process	Condition Category			
	Reference	**Good**	**Fair**	**Poor**
7.3 Widening Channel • Active undermining of bank vegetation on both sides of the channel; many unstable bank overhangs that have little vegetation holding soils together. • Erosion on both right and left banks in riffle sections. • Recently exposed tree roots (fresh roots are 'green' and do not break easily, older roots are brittle and will break easily in your hand). • Fracture lines at the top of the bank that appear as cracks parallel to the river. • Mid-channel bars and side bars may be present. • Urbanization and stormwater outfalls leading to higher rate and duration of runoff and channel enlargement.	☐ Low width/depth ratio W/d ≤ 20	☐ Low to moderate W/d ratio W/d >20 ≤ 30	☐ Moderate to high W/d ratio W/d >30 ≤ 40	☐ High width/depth ratio W/d >40
	☐ Little to no scour and erosion at the base of both banks. Negligible bank overhangs, fracture lines at top of banks, leaning trees or freshly exposed tree roots.	☐ Minimal to moderate scour and erosion at the base of both banks. Some overhangs, fracture lines at top of banks, leaning trees and freshly exposed tree roots.	☐ Moderate to high scour and erosion at the base of both banks. Many bank overhangs, fracture lines at top of banks, leaning trees and freshly exposed tree roots.	☐ Continuous and laterally extensive scour and erosion at the base of both banks. Continuous bank overhangs, fracture lines at top of banks, leaning trees and freshly exposed tree roots.
	☐ Incision Ratio ≥ 1.0 < 1.2 **and** Where channel slope > 2% Entrenchment ratio > 1.4 Where channel slope ≤ 2% Entrenchment ratio > 2.0	☐ Incision Ratio ≥ 1.2 < 1.4 **and** Where channel slope > 2% Entrenchment ratio > 1.4 Where channel slope ≤ 2% Entrenchment ratio > 2.0	☐ Incision Ratio ≥ 1.4 < 2.0 **and** Where channel slope > 2% Entrenchment ratio > 1.4 Where channel slope ≤ 2% Entrenchment ratio > 2.0	☐ Incision ratio ≥ 2.0 **and** Where channel slope > 2% Entrenchment ratio ≤ 1.4 Where channel slope ≤ 2% Entrenchment ratio ≤ 2.0
	☐ Minor side, point or delta bars present. Minor depositional features typically less than half bankfull stage in height.	☐ Single to multiple mid-channel or diagonal bars present. Minor depositional features typically less than half bankfull stage in height.	☐ Multiple unvegetated mid-channel or diagonal bars present. Sediment buildup at the head of bendways leading to steep riffles and flood chutes.	☐ Multiple unvegetated mid-channel or diagonal bars present splitting or braiding flows even under low flow conditions.
	☐ No known channel and / or flow alterations (i.e., increase in flow and/or change in sediment supply).	☐ Minor increase in watershed input of flows or sediment. Episodic (flood) discharges through reach resulting in short-term enlargement.	☐ Major channel and / or flow alterations, increase in flows and/or change in sediment load (increase or decrease).	☐ Major and extensive -channel and/or flow alterations, increase in flows and / or change in sediment load (increase or decrease).
Score: **Historic** ☐	20 19 18 17 16	15 14 13 12 11	10 9 8 7 6	5 4 3 2 1
7.4 Change in Planform • Flood chutes may be present. • Channel avulsions may be evident or impending. • Change or loss in bed form structure, sometimes resulting in a mix of plane bed and riffle- pool forms. • Island formation and/or multiple thread channels.	☐ Low bank erosion on outside bends, little or no change in sinuosity within the reach.	☐ Low to moderate lateral bank erosion on outside bends, may include minor change in sinuosity within the reach.	☐ Moderate to high lateral bank erosion on most outside bends, may include moderate change in sinuosity.	☐ Extensive lateral bank erosion on most outside bends, may include major change in sinuosity within the reach.
	☐ Little evidence of flood chutes crossing inside of bends, only minor side, point, or delta bars.	☐ Minor flood chutes crossing inside of bends, evidence of single to multiple unvegetated mid-channel, delta, or diagonal bars. Some potential for channel avulsion.	☐ Historic or active flood chutes crossing inside of bends, evidence of channel avulsion, islands, and multiple unvegetated mid-channel, delta, or diagonal bars.	☐ Active large flood chutes, evidence of recent channel avulsion, multiple thread channels, islands, and multiple unvegetated mid-channel, delta, or diagonal bars.
	☐ No human-caused alteration of channel planform and / or the width of the floodprone area.	☐ Minor to moderate alteration of channel planform and/or width of the floodprone area resulting from floodplain encroachment, channel straightening, or dredging.	☐ Major alteration of channel planform and/or the width of the floodprone area resulting from historic floodplain encroachment, dredging, or channel straightening.	☐ Major alteration of channel planform and width of the floodprone area resulting from recent and extensive floodplain encroachment, dredging, and/or channel straightening.
	☐ Human-made constrictions causing only negligible upstream deposition.	☐ Human-made constrictions smaller than floodprone width, causing minor to moderate upstrm / downstrm deposition.	☐ Human-made constrictions significantly smaller than floodprone width, causing major upstrm / downstrm deposition.	☐ Human-made constrictions significantly smaller than bankfull width, causing extensive and major upstrm / downstrm deposition and flow bifurcation.
Score: **Historic** ☐	20 19 18 17 16	15 14 13 12 11	10 9 8 7 6	5 4 3 2 1

7.5 Channel Adjustment Scores – Stream Condition – Channel Evolution Stage

Condition / Departure	Reference / N/S	Good / Minor	Fair / Major	Poor / Extreme	STD*	Historic	Condition Rating: (Total Score / 80)	Channel Evolution Stage:
Degradation								
Aggradation								
Widening							**7.6 Stream Condition:**	
Planform								
Sub-totals:					**Total Score:**			

Channel Adjustment Processes: _____

7.7 Stream Sensitivity: Very Low / Low / Moderate / High / Very High / Extreme

* Channel Condition "default" to **poor** – significant flood damage (not able to get accurate channel data) **Y/N ;**

***** Channel Condition default to poor - Due to channel alterations from work in channel after flood: **Y/N**

* Stream Sensitivity "default" to **poor** – significant flood damage (not able to get accurate channel data) **Y/N ;**

* Stream Sensitivity "default" to **poor** Due to channel alterations from work in channel after flood: **Y/N**

Vermont Stream Geomorphic Assessment

Appendix G

Bridge and Culvert Assessment

Vermont Agency of Natural Resources
March, 2009

Table of Contents

Introduction

The *ANR Bridge and Culvert Assessment* includes protocols and an on-line database for a coarse-screen assessment of stream crossing structures that can be conducted at a watershed-scale. The assessments are fairly rapid, involving only a few simple measurements, with minimal time devoted to each structure (15 to 30 minutes each). Assessment results entered into the ANR on-line bridge and culvert database can be used to "red-flag" structures that are potential barriers to fish and wildlife movement and/or flood or erosion hazards. This appendix includes methods for analyzing geomorphic and habitat-related bridge and culvert data using standard database reports.

ANR has also adopted survey protocols developed by the U.S. Forest Service that are designed to further evaluate structures "red-flagged" by the coarse-screen assessment. The survey protocols verify and further define problems associated with sediment transport and/or fish and wildlife habitat, including fish passage concerns. The surveys involve more detailed observations and accurate measurement of elevations using survey equipment. Survey protocols are not included in this appendix. Please contact the DEC River Management Program or Department of Fish and Wildlife for more information on conducting surveys of stream crossing structures.

ANR Bridge and Culvert Assessments provide a useful data set, especially when completed in conjunction with Phase 1 and Phase 2 Stream Geomorphic Assessments, for understanding which stream crossing structures within a watershed are:

- Subject to failure as a result of systemic channel adjustments that are occurring due to stressors unrelated to the structure;
- Subject to failure due to the disruption of fluvial geomorphic processes caused by the structure being inadequately designed and/or poorly located; and/or
- Subject to obstructing fish and wildlife movements and migrations within streams and along river corridors due to the structure being inadequately designed and/or poorly located.

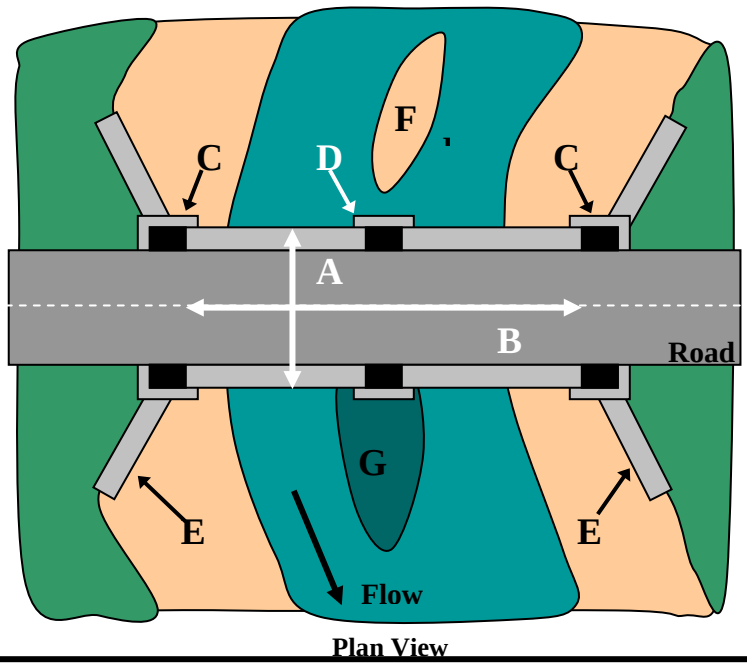
Getting Started

Coordination: CONTACT THE DEC RIVER MANAGEMENT PROGRAM REGIONAL SCIENTIST http://www.anr.state.vt.us/dec/waterq/rivers/htm/rv_geoassess-contact.htm to make sure that the assessment you are conducting is coordinated with previous or pending assessments of the same structures.

Field equipment requirements: A tape measure, depth rod, clipboard, field map (USGS topographic map), and field form are required to complete the field assessments. Field forms are included on pages G23 and G25. A GPS unit is also recommended for determining latitude and longitude and collecting spatial data. See pages G5 and G15 for more discussion on collecting GPS data points at bridges and culverts.

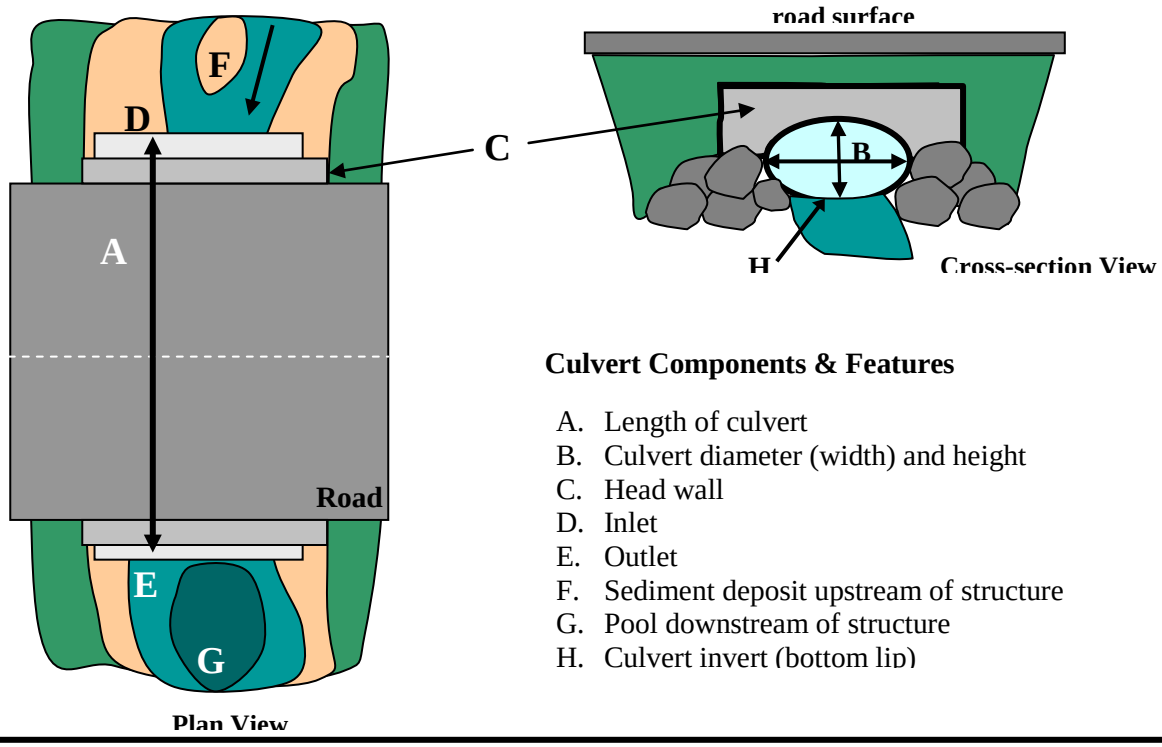
Read the Protocols: Before going into the field, read the protocols on the following pages in order to understand the assessment parameters and how to complete the field form. If you have questions, contact the River Management Program regional scientists for clarifications **before** collecting data.

The following diagrams show structure components and common channel features referred to in the protocols.



Bridge / Arch Components & Features

A. Length of structure
B. Span (width) of structure
C. Abutments
D. Bridge pier
E. Wingwalls
F. Sediment deposit upstream of structure
G. Scour hole inside and/or immediately downstream of structure



Culvert Components & Features

A. Length of culvert
B. Culvert diameter (width) and height
C. Head wall
D. Inlet
E. Outlet
F. Sediment deposit upstream of structure
G. Pool downstream of structure
H. Culvert invert (bottom lip)

Completing the Field Form

There are separate field forms for culverts and bridges/arches. If you are evaluating a bridge or arch, use the appropriate form and circle the structure type at the top of the field form. The following structure type definitions apply to this protocol:

Bridge = A structure that supports a roadway over a waterbody by means of abutments and sometimes piers and does **not** have a constructed bottom.

Arch = A structure that supports a roadway over a waterbody by means of a half pipe or open box embedded in fill and supported by footers and does **not** have a constructed bottom.

Culvert = A structure that supports a roadway over a waterbody by means of a complete pipe or box embedded in fill that **always** has a constructed bottom and does **not** have abutments or piers. Common culvert types include circular (round), elliptical (squashed round), and box.

General Header Info

The header contains several parameters that are shared with VTrans local road inventories. The data for these boxes may already be available and can be used to complete the field form header if local road inventories have been completed for the structure. Double-check the accuracy of this data when completing your assessment, especially if the local road inventory data is several years old, as structures may have been replaced or altered since the time of the inventory.

Field Map #: This is an optional field – you may choose not to use it. On the top right corner of each field form a space is provided for you to assign a convenient tracking number for each structure in the assessment. This number is used solely for coordinating the field work component of the assessment and is not stored in the database. There are no specific rules for assigning the number. You may choose whatever is convenient for you to track the structures as you complete the assessment in the field. If local ID numbers are available (see below) you may find these to be sufficient for organizing field work and data forms.

SGA-DMS ID: This is the unique identifier (primary key) for all structures in the ANR Bridge and Culvert database. This ID is created when you enter data into the ANR Online Data Management System (DMS). The information you will need to create this ID includes:

- Owner Site: From the drop down menu select whether the structure is owned by another state, the state of Vermont, a town or a private entity and whether the structure length is less than six feet, between six and twenty feet or greater than 20 feet.

- Highway Number: The highway number is a number between one and four digits. The source of the highway number is the RTNO attribute field of the TransRoad_RDS layer which is available at http://www.vcgi.org/dataware/?layer=TransRoad_RDS. If the highway number listed in the RTNO field of the TransRoad_RDS layer is less than four digits (this will often be the case on town highways) pad the number with zeroes. On private or public roads that do not have aVtrans assigned Town Highway Number use 0000.

- Town: Select the town in which the structure exists from the dropdown menu.

- Transportation System: From the dropdown menu select whether the structure serves a private, town or state transportation system (the interstate system are owned by the state).

Structure Number (Struct_Num): This is the global unique identifier (primary key field) for all data exchanged via the Vermont Bridge and Culvert Data Exchange Standards, including the VOBCIT and the

TRANSTRUC geospatial bridge and culvert databases (Vermont Data Exchange Standard 2007). The inclusion of Struct_Num in the ANR bridge and culvert database allows for ANR bridge and culvert data to be joined with these databases to support multi-resource state and municipal-level management of stream crossings. Structures are assigned structure numbers when they are inventoried by Vtrans. The source for the Struct_Num is the Tran_Struct layer available from VCGI at http://www.vcgi.org/dataware/?layer=transtruc. If a structure is not included in the Tran_Struct layer leave this field blank.

Observers Organization/Agency: Name of observer(s) collecting the data and the organizations or agencies to which the observers belong.

Date: Record the date you collect the data in the field.

Town: Record the town(s) in which the structure is located.

Phase 1 Project: This refers to the ANR Phase 1 watershed assessment projects that have been or are being completed. A listing of Phase 1 projects is available on the ANR data management system website. This information can be filled out at the time of data entry if not available during fieldwork.

Location: Describe the location of the structure, using nearby landmarks and road mileage distances. The location narrative should be sufficient to help future surveyors to locate the structures in the field. **Example:** Bridge is located on Cross Road 5 miles south of intersection of Mountain Rd. and Cross Rd.

Latitude (N/S) and Longitude (E/W): Latitude and longitude are north/south and east/west values, respectively, recorded in decimal degrees. This information should be collected with a GPS unit. Most GPS units give you the option of viewing lat/long data in decimal degrees. The lat/long information can then be read directly from the GPS unit and recorded on the data sheet. In addition, for those structures that are not already included in the State database or a town local road inventory, it is strongly encouraged that you collect data with a GPS to capture the location of the structures in order to create a spatial data set. **Work with your regional planning commission to determine appropriate GPS protocols and to process data into a spatial data layer.** Additional information on basic GPS protocols is available from VCGI.

Reach VTID: Enter the VTID (state geographic reach number) assigned to the reach in which the structure is located. VTID numbers are assigned to all reaches for which an ANR Phase 1 watershed assessment has been completed. The VTID is comprised of the 10-digit Hydrologic Unit Code (HUC) of the watershed plus a unique 4-digit numeric suffix assigned chronologically as reaches are created. Leave this field blank if a Phase 1 assessment has not been completed for the watershed in which you are conducting an ANR Bridge and Culvert Assessment.

Road Name: Record the full E911 road name, consistent with the *VGIS Road Standard*. E911 road names can be obtained from the "E911 /RDS" data layer available from VCGI. The database contains drop-down menus of road names by town.

Road Type: Record the type of road on which the structure is located:

Gravel = Road surface is packed gravel
Paved = Road surface is paved with tar or other surface material other than dirt
Trail = A travel lane not used, or no longer used, by cars. May accommodate foot traffic or recreational motor vehicles (i.e., snow mobiles or ATVs)
Railroad = Active or abandoned railroad bed

Stream Name: Name of the waterbody the structure crosses, as printed on the USGS topographic map. It is also helpful to note the name of the receiving water in parentheses after the stream name.

High Flow Stage: Circle yes or no to indicate whether the stream flow is higher than average, such as occurs after rains or snowmelt. Circle **yes** when the flow elevation is at or above the halfway point between the bed of the channel and the top of the banks. Water may appear more turbid than usual due to recent runoff event. Documenting high flows helps with data interpretation, as the stage and turbidity of the discharge may obscure features such as sediment deposits and culvert outlet drop heights. **It is highly recommended that bridge/culvert assessments be conducted during typical summer low flow conditions.**

Channel Width: Record the bankfull width of the **reference** channel, measured across the channel at the bankfull flow elevation, which is considered to be the flood height that occurs on an annual to biannual basis (See Appendix K). You may also choose to estimate the bankfull channel width using the Vermont regional hydraulic geometry curve (HGC) developed by the ANR River Management Program – see Appendix J. At this time the curves are recommended for estimating channel width only on streams and rivers that are similar to those from which the curves were developed, including mid-to-large sized streams in unconfined, moderate to gentle gradient, alluvial settings. Where Phase 1 assessments have been completed, HGC-calculated channel widths are available for those reaches in such settings. The Vermont HGC channel width equation is:

$$W = 13.1(X)^{0.44}$$, where X = drainage area in sq. mi.

Round the calculated value to the nearest foot.

Refer to Phase 1 Step 2.7 for more information on determining channel width using the Vermont HGC.

On small, steep streams in confined or narrow valleys, **measured** bankfull widths will likely be more accurate than those produced by the Vermont regional HGC. Using a tape measure, determine the width of the channel at a location away from the structure that does not show evidence of being impacted by the stream crossing structure. If banks are nearly vertical, simply measure from top-of-bank to top-of-bank. If banks are stepped or more moderately sloped (see Figure 1), use depositional features, scour lines, and, to a lesser extent, the height of woody vegetation to help determine the bankfull elevation at which to measure the **reference** condition channel width. See Appendix K for more information on determining bankfull elevation and width).

Figure 1. Bankfull elevation on a steep upland stream at which bankfull channel width measurements are taken.

Structure skewed to roadway: Indicate whether the structure is skewed (or angled) in comparison to the roadway by circling "yes" or "no" where indicated on the field form. Keep in mind when measuring the structure span/diameter that if the structure is installed at an angle under the roadway the structure opening(s) may have been cut or built at an angle, resulting in a structure opening that is larger than the span/diameter inside the structure. Be sure to measure the actual inside span/diameter of the structure perpendicular to the stream channel.

Bridge/Arch Header

Structure Width (road width): Record the width of the bridge or arch in feet. This is the structure dimension measured across the roadway. In most cases this measurement will be the same as the road width. See component "A" in the bridge diagram on page G3.

Structure Clearance (height): Record in feet the clearance beneath the bridge/arch by measuring the distance from the water surface (at time of survey) to the underside of the top of the structure.

Structure Span (width): Record in feet the cross-sectional span of the bridge as measured on the road surface. For arches measure the span at the bottom of the arch curve, at or near where the arch sits on its footers (see Figure 2). Where there are multiple arches at one crossing add the structures' width measurements together and record a total combined width.

Figure 2. Measuring arch span and clearance.

Structure Material: Circle the type of material of which the structure is constructed: aluminum, wrought iron, cast iron, concrete, masonry (arches) & slabs, pre-stressed concrete/post-tensioned, steel, timber, or other.

Number of bridge piers or # arches at crossing: Record the number of piers supporting the bridge or the number of arch structures at the crossing. Piers are support structures within the span of the structure, not the abutments supporting the ends of the structure. Though there is usually only one arch per road crossing, there can also be two or more installed side-by-side.

Culvert Header

Culvert Length: Using a tape measure, record the length of the culvert to the nearest foot.

Culvert Height: Using a depth rod and/or tape measure, record the height of the culvert in decimal feet to the nearest tenth of feet. For circular culverts the height measurement will be the same as the width measurement. A depth rod is usually a better tool than a tape measure for measuring culvert height, as it can be held straight in the stream flow without being swept downstream. If multiple culverts are present record an average of their heights. Note in the comments section if one pipe is significantly larger than the other(s).

Culvert Width (diameter): Using a tape measure, record the width (or diameter) of the culvert in decimal feet to the nearest tenth of feet. Where there are multiple culverts at one crossing add the structures' width measurements together and record a total combined width. Do not include overflow pipes in the total culvert width (see below). If a structure is installed at an angle under the roadway such that the structure opening(s) has been cut or built at an angle, resulting in a larger opening than the width (diameter) inside the structure, be sure to measure the actual inside width perpendicular to the stream channel.

Culvert Material: Circle the type of material of which the culvert is constructed: concrete, plastic corrugated, plastic smooth, tank, steel corrugated, stone, aluminum corrugated, other, mixed.

Number of culverts at crossing: Record the number of culverts installed at the road crossing. Though there is usually only one culvert per road crossing, there can also be two or more installed side-by-side. Count all culverts that are installed at or below the bankfull elevation. Do not count overflow pipes (see below) or nearby culverts carrying tributary or road drainage flows (i.e. those not installed to carry the main stream flow).

Overflow pipes: Overflow pipes are typically smaller in dimension than the main culvert(s) at a stream crossing and are usually installed at a higher elevation. In this protocol, all culverts located above the bankfull elevation are considered overflow pipes. **Do not include overflow pipes when determining the number of culverts at the crossing.** Indicate the presence or absence of overflow pipes on the field form by circling "Y" or "N" in the appropriate space. Also, do not include the width(s) of overflow pipe(s) when determining total culvert width (see above).

Geomorphic and Fish Passage Data

General Data

Floodplain filled by roadway approaches: Circle the approximate amount of floodplain filled up to or above the flood prone elevation by the roadway approaches on either side of the structure. The **flood prone elevation** is the height equal to 2 times the maximum bankfull channel depth measured above the streambed (see Phase 2, Step 2.7).

Entirely = More than ¾ of the floodplain width is occupied by approach ramps (see Figure 4)
Partially = Between ¼ and ¾ of the floodplain width is occupied by approach ramps (see Figure 3)
Not Significant = Less than ¼ of the floodplain width is occupied by approach ramps

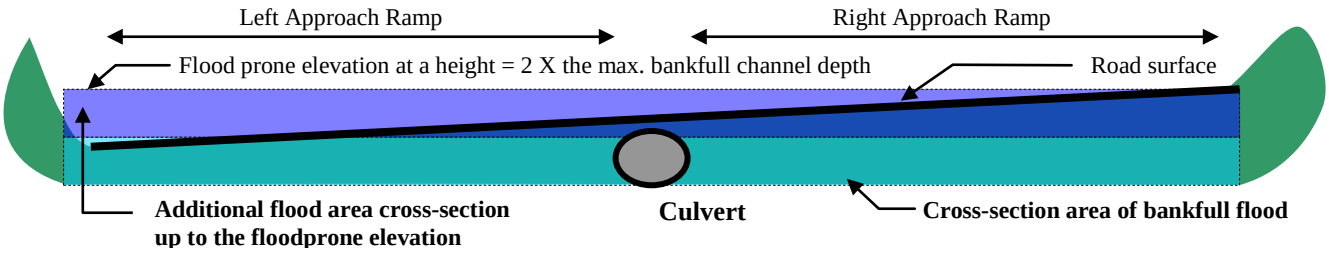


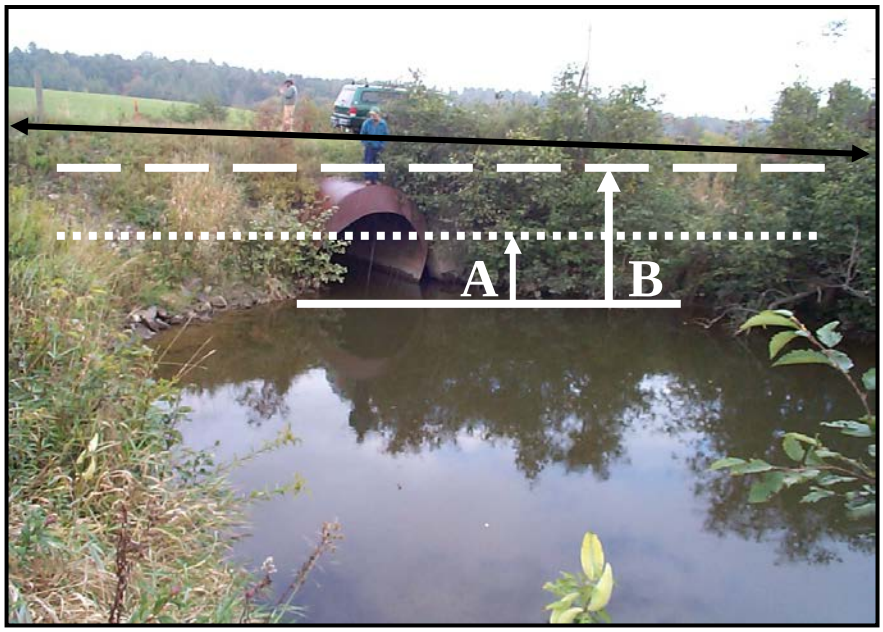
Figure 3. Valley cross-section where the left and right approach ramps partially occupy floodprone area.

Figure 4. Cross-section view of culvert site where the left and right approach ramps entirely occupy the floodprone area.

Solid Black Line = elevation of road surface and approaches to culvert site

Dashed White Line = flood prone elevation at a height that is 2 X the maximum bankfull channel depth (height **B** as measured from the bed)

Dotted White Line = maximum depth from the stream bed to the elevation of bankfull (height **A**). See Channel Width discussion.



Structure located at a significant break in valley slope: Circle "yes" if the structure is located on a stream segment of relatively gentle-gradient that is within 1/3 mile downstream of a significantly steeper segment of stream. Use a topographic map to assist with this evaluation. If you do not have a topo map or the forest cover obscures your view of upstream topography, circle "unsure" on the field form. Significant changes in channel slope are usually reflective of breaks in valley slope and may result in a dramatic decrease in the stream's sediment transport capacity. A structure may be particularly prone to failure if it is located on an alluvial fan or similar high deposition area.

Culvert slope as compared with channel slope: Circle whether the culvert slope, as compared to the channel slope, is significantly higher, lower, or the same. This is a visual estimate intended to red flag locations where the culvert was placed at a noticeably different slope than that of the channel.

Upstream Data

Is structure opening partially obstructed by: Circle all the types of material that are obstructing any part of the structure's opening.

Wood debris = Woody material such as logs, branches, and trees
Sediment = Soil and rocks, typically transported and deposited by the stream.
Note: *If the entire culvert bottom is filled with sediment, this is not considered an obstruction of the structure opening. The retention of sediment throughout the length of a culvert usually facilitates the passage of fish and wildlife through the structure and is an indication that the structure is maintaining sediment transport. Only record sediment as an obstruction if it fills some of the structure opening and results in a drop of the water flow down into the culvert.*
Deformation = Crushed, bent, or broken structure covering structure opening
None = No part of structure opening is covered

Steep riffle present immediately upstream of structure: Indicate yes or no whether a steep riffle spans or nearly spans the cross-section of the stream immediately upstream of the structure opening. Steep riffles are a wedge of sediment that has deposited across the stream as a result of the backwater that occurs during high water events at inadequately sized structures. Steep riffles located just upstream of the structure opening are not recorded as an obstruction of the opening and they may not appear as a mid-channel bar, however they are indicative of a depositional process that is being caused or exacerbated by the structure, similar to the process that leads to the formation of a mid-channel bar.

Figure 5. Steep riffle spanning the channel cross-section immediately upstream of the structure opening.

If channel avulses: Looking upstream, imagine the stream flowing up and out of the channel at the structure due to an obstruction, high flows, or both. Before eventually re-entering the channel at some point downstream, will the stream flow:

Cross Road = re-entering the channel immediately downstream of the structure. This typically occurs when the road approaches are higher in elevation than the road surface at the crossing;

Follow Road = traveling down the ditch or shoulder of the road for a distance before leaving the road vicinity and traveling overland to re-enter the stream channel.

Unsure = the topography in the vicinity of the crossing is too subtle to ascertain whether the stream will cross the roadway immediately returning to the channel or follow the road for some distance before re-entering the channel.

If the "Follow Road" option is chosen, estimate in feet the distance the stream would follow the road before reentering the stream channel.

Angle of stream flow approaching structure: Circle the type of angle that best describes the way that the stream flow is entering the structure.

Sharp bend = Severe angle of entry, 45 to 90 degree bend (see Figure 6)

Mild bend = Gentle angle of entry, 5 to 45 degree bend (see Figure 6)

Naturally straight = flow enters the structure straight-on with no channelization evident

Channelized straight = Channel was modified to a straight planform and flow enters the structure straight-on. Indicators of channelization include: armored stream banks, channel just upstream of straightened section is naturally sinuous, or documentation of past channel-straightening activities.

Figure 6. Mild (above) and sharp (right) angles of stream flow to bridge structures.

Downstream Data

Water depth in culvert: At the culvert invert, measure the depth of the water in the culvert to the nearest tenth of foot at the time of survey.

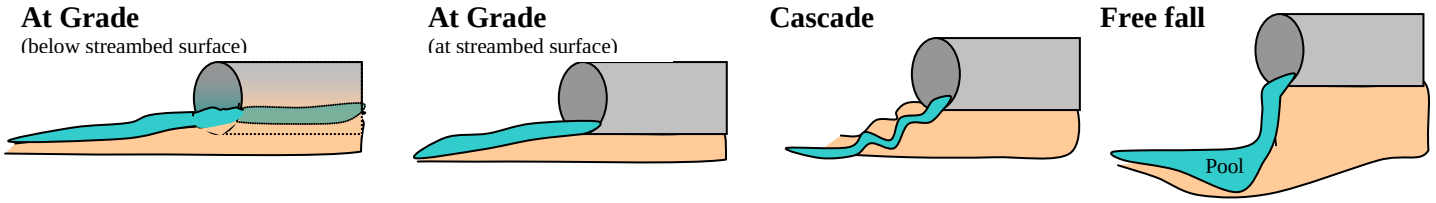
Culvert outlet invert: Circle the descriptor that best describes the water surface profile as it exits the outlet of the culvert:

Partially Backwatered or At grade = The invert of the culvert outlet is at or below the streambed surface, and the streambed immediately downstream of the culvert outlet is of a gradient typical to the channel at the structure site. If the channel immediately downstream of the structure outlet is much steeper than the typical channel gradient at the site, then the outlet condition should be described as a cascade.

Cascade = The invert of the culvert outlet is above the stream bed surface and the flow spills out of the culvert onto a steep section of rip rap or stream bed (typically bedrock or large boulders). To be considered a cascade, the streambed immediately downstream of the culvert outlet should be substantially steeper than the general stream gradient at the structure site. Stream flow over the cascade may be sheet flow (as in over bedrock) or dispersed flow (as in splashing off riprap or large boulders). Typically, steep riffles composed of cobble and/or gravel are not considered cascades. The following must also be true to classify a cascade:

- Cascade must extend ≥1 foot in length beyond the culvert invert, measured longitudinally along the cascade.
- Flow exiting the culvert must drop < 1 foot before hitting the cascade below. Flows dropping ≥ 1 ft. before hitting a cascade are considered "free fall" (see below).

Free fall = The invert of the culvert outlet is above the stream bed surface and the flow spills vertically out of the culvert down to the water surface (commonly referred to as a "perched" culvert). If the flow falls vertically from the culvert outlet and then hits a cascade, it is still considered "free fall" if the vertical drop from the outlet invert to the streambed (cascade) below is ≥ 1 foot.



Backwater Length (only for culverts that are partially backwatered): With a measuring tape measure the horizontal distance from the culvert outlet to the upstream extent of the backwatered flow. Backwatered flow has greater depth, lower velocity and lower slope than the incoming flow and is not turbulent.

Outlet drop (invert to water surface): With a depth rod, measure the vertical distance, to the nearest tenth of foot, from the outlet invert to the water's surface at the time of survey (see Figure 7). If the culvert flow spills onto a cascade, measure the **vertical** distance from the outlet invert to the water's surface **just downstream** of the cascade.

Figure 7. Measuring culvert outlet drop.

Pool immediately downstream of structure: Circle yes or no to indicate if a pool is directly below the outlet of the structure. If the culvert flows onto a cascade (as defined above) then answer "no" to this question.

Pool depth at point of stream flow entry (Applicable only if a pool is present directly below the outlet): At the point where the stream flow enters the pool measure the depth from the water surface to the stream bed to the nearest tenth of foot.

Pool maximum depth (Applicable only if a pool is present directly below the outlet): At the point of maximum pool depth estimate the pool depth. If the estimated depth is less than four feet measure the distance from the water surface to the stream bed to the nearest tenth of foot. If the estimated depth is greater than four feet simply record it as such.

Downstream bank heights are substantially higher than upstream bank heights: Circle yes or no to indicate whether stream bank heights downstream of the structure are greater than bank heights upstream of the structure. This is an indication that bed degradation may have occurred downstream of the structure.

Stepped Footers: Indicate yes if there is evidence that more than one set of footers was poured (out of concrete) or constructed to support the bridge abutments or arch. Stepped footers that are poured of concrete have the appearance of a stair step (Figure 8). Footers are retrofitted in this way in an attempt to stop the failure of the structure due to streambed scour around and below the structure that occurs after initial installation of the structure.

Figure 8. Stepped footers on an arch.

Upstream - Downstream - In Structure Table

Completing the Upstream/Downstream/In Structure table on the field form requires evaluating the channel and riparian area adjacent to the structure. In general, consider an area extending 100 feet upstream or downstream from the structure. On larger rivers, this length of channel should be viewable from the road, but on smaller streams it may require walking down into the channel.

Dominant Bed Material at structure: Circle the sediment size class that covers the majority of the stream bed area upstream of, downstream of, and within the structure. If the streambed is not visible, choose "unknown." If larger materials are embedded with fine sediment, such as cobbles embedded with silt-sand, record the dominant bed material as cobble even if the silt-sand fraction seems to be in equal proportion to the cobble.

		Millimeters	Inches	Relative Size
0	**None**	Applies to culverts where the absence of natural stream substrates within the culvert is the dominant condition		
1	**Bedrock**	> 4096	> 160	Bigger than a Volkswagen Bug
2	**Boulder**	256 - 4096	10.1 - 160	Basketball to Volkswagen Bug
3	**Cobble**	64 – 256	2.5 - 10.1	Tennis ball to basketball
4	**Gravel**	2 – 64	0.08 – 2.5	Pepper corn to tennis ball
5	**Silt-Sand**	< 2.00	< 0.08	Silt size to pepper corn
UK	**Unknown**	Applies when the stream bed is not visible due to deep or turbid water or darkness within the structure		

Bedrock present in channel at structure: Indicate yes (Y) or no (N) whether there is any bedrock visible in the channel upstream or downstream of the structure. For bridge and arches also note if there is any bedrock within the structure.

Material throughout: For culverts, indicate yes (Y) or no (N) whether natural stream substrates exist over the entire length of the streambed through the culvert.

Sediment deposit types: Circle the type of sediment deposits observed upstream, downstream, and in the structure. Depositional features are further defined in Appendix Q Glossary.

Mid-channel bar = Areas of sediment deposition (bars) built up above the streambed elevation of the nearby area, located in the channel away from the banks and generally found in areas where the channel runs straight

Point bar = Bars that are adjacent to the bank typically occurring on the inside edge of meander bends

Delta bar = Sediment deposits where a tributary enters a mainstem channel, often fan-shaped

Side bar = Unvegetated sediment deposits located along the margins of the channel in locations other than the inside of channel meander bends (not point bars)

None = No sediment deposits seen

Elevation of sediment deposits greater than or equal to ½ bankfull elevation: Circle yes or no whether sediment deposits observed upstream, downstream, and in the structure fill the channel to an elevation that is greater than or equal to half of the bankfull elevation (Figure 9).

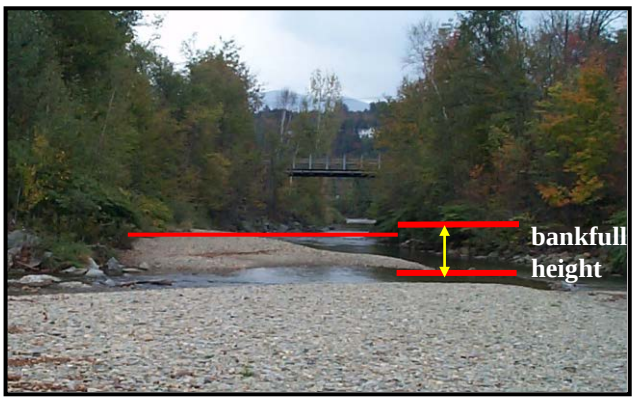


Figure 9. Example of sediment deposit upstream of an undersized bridge that has built to an elevation greater than ½ the bankfull height.

Bank erosion: Circle the degree of bank erosion observed upstream and downstream of the structure. Note that raw substrate occurring below the bankfull elevation is not considered erosion, unless associated with active bank failures, fractures, slabbing or undercutting.

High = Nearly continuous erosion along banks, especially on medium to high banks

Low = Occasional erosion along banks, mostly found on low banks

None = No bank erosion evident

Hard bank armoring: If hard bank armoring is present, circle the general condition of the armoring observed upstream and downstream of the structure. If armoring is not present, circle "none".

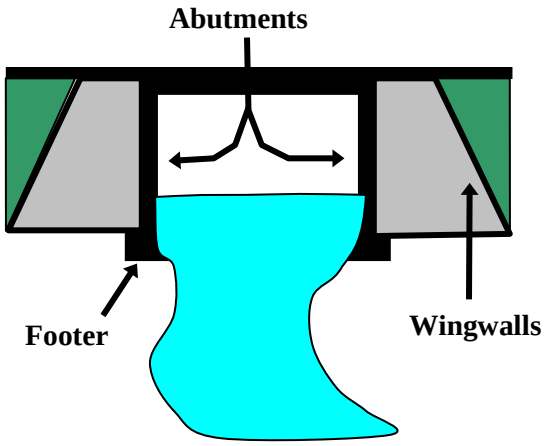
Intact = Hard bank armoring is not falling into stream, there are few missing or out of place pieces of armoring material

Failing = Parts of the hard bank armoring are falling into the stream, missing, or out of place

None = No hard bank armoring present

Unknown = Unable to assess the condition or presence of hard bank armoring

Streambed scour causing structural undermining around/under: Circle the structure or part of structure that is affected by scour. Scour is the erosive action of running water in streams, which excavates and carries away material from the bed and banks. Indicators of scour are: exposed areas of structure that are typically covered by stream bed material (e.g., bridge footings), leaning or hanging structures, water visibly flowing under or to the side of the inlet of a culvert, and deep water along one or both sides of a bridge or arch when the bed feature through the structure is a riffle.



Culvert = Structure that supports a roadway over a waterbody by means of a complete pipe or box embedded in fill that **always** has a constructed bottom and does **not** have abutments or piers.

Abutments = Bridge end support structures

Footers = Support structures under bridge abutments, the ends of an arch, or the invert of a culvert

Wing walls = Concrete, wooden, or metal walls that flare out from the side of the opening of the bridge, arch, or culvert
None = No scour is seen around/under structure

Beaver dam near structure: Indicate yes or no whether a beaver dam is located within 100 feet upstream or downstream of the structure.

Distance from structure to beaver dam: Enter the estimated distance, in feet, from the structure opening to the beaver dam.

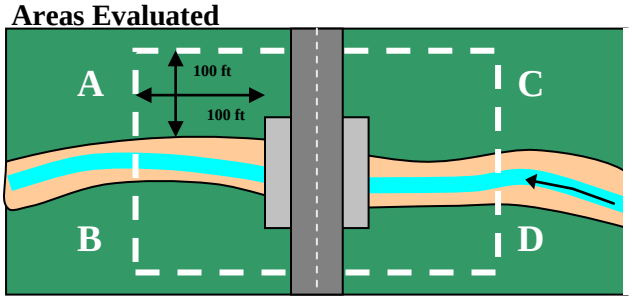
Wildlife Data

Dominant vegetation type: Record the dominant type of vegetation in the riparian area on the upstream left and right banks and the downstream left and right banks (left and right banks are determined facing downstream). For this evaluation consider an area extending 100 ft. along the stream from the end of the structure and 100 ft. out from the top of the bank.

Vegetation Types

C = coniferous forest
D = deciduous forest
M = mixed forest
S = shrub/sapling
H = herbaceous/grass
B = bare
R = road embankment

Areas Evaluated



A. Downstream – Right Bank
B. Downstream – Left Bank
C. Upstream – Right bank
D. Upstream – Left Bank

Does a band of shrub/forest vegetation that is at least 50' wide start within 25' of structure and extend 500'or more up/downstream? Record yes or no for both banks upstream and downstream of the structure to indicate whether a **continuous** wooded riparian area (dominated by trees and/or shrubs) that is at least 50 feet wide (extending from the top of bank out perpendicular to the stream) begins within 25' of the structure edge and continues for 500 feet or more along the stream edge. Such wooded areas along streams are often used as travel corridors for some wildlife species. The purpose of this parameter is to determine whether the structure is located in an area that abuts potentially viable wildlife travel corridors.

Road-killed wildlife within ¼ mile of structure? Indicate whether or not you observed dead wildlife along or adjacent to the road within a ¼ mile of the structure by circling **none** on the field form if no road-killed wildlife was observed or by listing the **species** of road-kill observed. This does not have to be an intensive survey in the road ditches or down the embankments, but rather a documentation of any road kills observed by chance in the course of accessing the structure and conducting the rest of the assessment. Below is a list of species that are of particular concern and should be recorded if observed. Species not on this list need not be recorded, though you may choose to note them under "comments" if you wish.

The database includes a menu of species choices, including:

none, amphibians (group road mortality only), **bear, beaver, bobcat, coyote, deer, fisher, fox, , large birds** (turkey, hawk, owl, waterfowl), **mink, moose, otter, small mammals** (mouse, vole, shrew, squirrel)**, turtle,** and **unsure** .

Use the "unsure" menu choice if you do not know the species or if you cannot identify the species due to damage and/or decay. Multiple recordings are possible in the database by simply selecting all the species observed.

Wildlife sign and species observed near/inside structure? Record any visible wildlife sign outside of the structure (either upstream or downstream) and inside the structure. Consider an area extending 100 feet

upstream and downstream of the structure on both right and left banks, including the channel bed and banks. This does not have to be an exhaustive survey, but rather a documentation of any wildlife sign observed in the course of conducting the rest of the assessment. If you are experienced in identifying wildlife sign, record the species that made the sign. If you do not know the species write, "unsure".

The DMS includes a menu of sign types, including:

none, tracks, scat, den holes, carcass (not road-killed)**, feeding signs, mark trees, rub/rut pits, bedding sites, hair,** and **sightings**.

The above sign types are paired with the following list of species in the database:

none, mink, deer, moose, bear, beaver, bobcat, otter, fisher, and **unsure**. Use the "unsure" menu choice if you do not know which species made the sign.

Multiple recordings are possible in the database by simply selecting all the species and sign types observed. The above list of species includes those that are of particular concern and should be recorded if observed. Species not on this list need not be recorded, though you may choose to note them under "comments" if you wish.

Note: If you see a carcass that is obviously road-killed, do not double count it by recording it for this parameter. Only record it in the road-kill parameter (above). Carcasses that are not obviously road-kills should be recorded here and not in the road-kill parameter.

Spatial data collected with GPS: Circle yes or no to indicate whether or not spatial data was collected with a GPS unit to document the location of the structure. Only circle yes here if you are actually collecting data points and planning to process the data to create a spatial data layer. Do not circle yes if you are only using a GPS unit to determine latitude and longitude for the purposes of completing the field form header.

Photos: Circle yes or no to indicate whether or not photos were taken at the site. Taking photos is highly recommended. You can use the back of the field form as a photo log. Record roll and frame number and photo perspective (ex., downstream view of inlet, upstream view of outlet) for each photo taken at the site. The following photo views are recommended:

- Upstream view of stream above structure
- Downstream view of structure inlet
- Upstream view of structure outlet
- Downstream view of stream below structure
- Evidence of wildlife use
- Any features or parameters on the field form that you have questions about or are not sure how to answer

Be sure to include scale in your photos, such as a person or a depth rod, especially when photographing the structure openings.

Comments: This space provides an opportunity to note observations about the site that have not been captured by the other parameters. You may also want to qualify any of the decisions that you made in choosing from the menus offered under each parameter. If a VTrans bridge and culvert survey is not being completed at the same time, make observations about the condition of the structure if possible. Finally, if any protocol described in the handbook is unclear given the conditions at your site, make a note of this to inform the VT Agency of Natural Resources on how this protocol can serve you better.

On-line DMS B&C Database and Standard Reports

There are several standard reports built into the database that are useful for analyzing the geomorphic compatibility and fish and wildlife passage concerns of the structures assessed. The five standard database reports are:

1. **Bridge and Culvert Summary Reports** – an output of all assessment data gathered at an individual structure, presented in a format similar to the assessment field form;

2. **Geomorphic Compatibility Screen**– ranks the geomorphic incompatibility of each structure;

3. **Failure Modes Report –**lists probable failure modes and existing problems, sorted by town and road name or by stream name;

4. **Failure Modes Report – Problem Causes** – displays data for each structure that explains the predicted failure modes and existing problems related to fluvial geomorphic incompatibility;

5. **Culvert Aquatic Organism Passage Report** – lists whether culverts definitely block, potentially block, or do not block aquatic organism passage, sorted by town and road name or by stream name. Bridges are not evaluated for aquatic organism passage because in almost all cases they do not obstruct the movement of aquatic organisms;

6. **Retrofit Potential Report** – lists the feasibility of retrofitting an existing structure to decrease its impact to aquatic organism migration;

7. **AOP Habitat Potential Connectivity Screen -** calculates the potential full network and mainstem stream lengths reconnected with AOP improvements at a particular culvert;

8. **Wildlife Passage Suitability Report** – lists structures potentially suitable to facilitate terrestrial wildlife movement under roadways, sorted by town and road name or by stream name;

Ideally, these reports, when combined with VTrans culvert inventory data, will help town road managers and State Transportation Engineers to prioritize the replacement and/or maintenance of VTrans and ANR "critical" structures. (VTrans "Critical" structures are those scoring 6 or less on VTrans' condition inventories.) These reports are also valuable to watershed planners, fish and wildlife biologists, and others working with transportation officials to plan for, budget, and process regulatory permits for structure replacements and retro-fits with the goal of avoiding future problems by enhancing the compatibility of structures with the geomorphic processes and habitat functions at stream crossings. Following is a detailed discussion of the standard database reports.

Geomorphic Compatibility Screen

The screening tool has been developed based on the disruption of natural sediment/debris transport, hydrology, and deviation from natural channel dimensions. For example, identification and a qualitative description of excessive upstream aggradation and downstream channel incision during an assessment are used as a measure of the presence and degree of sediment discontinuity. A structure's deviation from the natural channel width, slope, and alignment indicates departure from natural stream conditions.

The five variables (i.e., percent bankfull width, sediment and debris continuity, slope, approach angle, and bank erosion) are each scored on a scale from 0 to 5, with 5 indicating full geomorphic compatibility between the structure and the channel and 0 indicating complete incompatible due to a strong departure from a natural

condition. Some variables (i.e., slope and approach angle) do not have scores for each level of the 0 to 5 range due to limited possible values in the assessment. In these cases, the range of conditions was reviewed and the most appropriate scores were selected to describe the condition represented by the variable. The score for all variables is summed, out of a total possible score of 25, to represent an overall score indicating the level of geomorphic compatibility between the structure and stream. For more information see the Vermont Culvert Geomorphic Compatibility Screening Tool report.

Category Name	Screen Score	Threshold Conditions	Description of structure-channel geomorphic compatibility
Fully compatible	20<GC≤25	n/a	Structure fully compatible with natural channel form and process. There is a low risk of failure. No replacement anticipated over the lifetime of the structure. A similar structure is recommended when replacement is needed.
Mostly compatible	15<GC≤20	n/a	Structure mostly compatible with current channel form and process. There is a low risk of failure. No replacement anticipated over the lifetime of the structure. Minor design adjustments recommended when replacement is needed to make fully compatible.
Partially compatible	10<GC≤15	n/a	Structure compatible with either current form or process, but not both. Compatibility likely short term. There is a moderate risk of structure failure and replacement may be needed. Re-design suggested to improve geomorphic compatibility.
Mostly incompatible	5<GC≤10	% Bankfull Width + Approach Angle scores ≤ 2	Structure mostly incompatible with current form and process, with a moderate to high risk of structure failure. Re-design and replacement planning should be initiated to improve geomorphic compatibility.
Fully incompatible	0≤GC≤5	% Bankfull Width + Approach Angle scores ≤ 2 **AND** Sediment Continuity + Erosion and Armoring scores ≤ 2	Structure fully incompatible with channel and high risk of failure. Re-design and replacement should be performed as soon as possible to improve geomorphic compatibility.

Structure Failure Modes Report

This report describes the failure modes of structures identified, or "red-flagged," as being incompatible with the geomorphic processes of the stream. The report is available sorted by road within a town or by stream. The report contains twelve major columns of information (see Figure 10). The first six columns list failure modes F1 through F6. The next six columns list problems P1 through P6. The database queries the data and places an "X" in each column for which the data indicate that the failure mode may potentially occur and/or the existing problem is documented. These failure modes and problems are discussed in detail below.

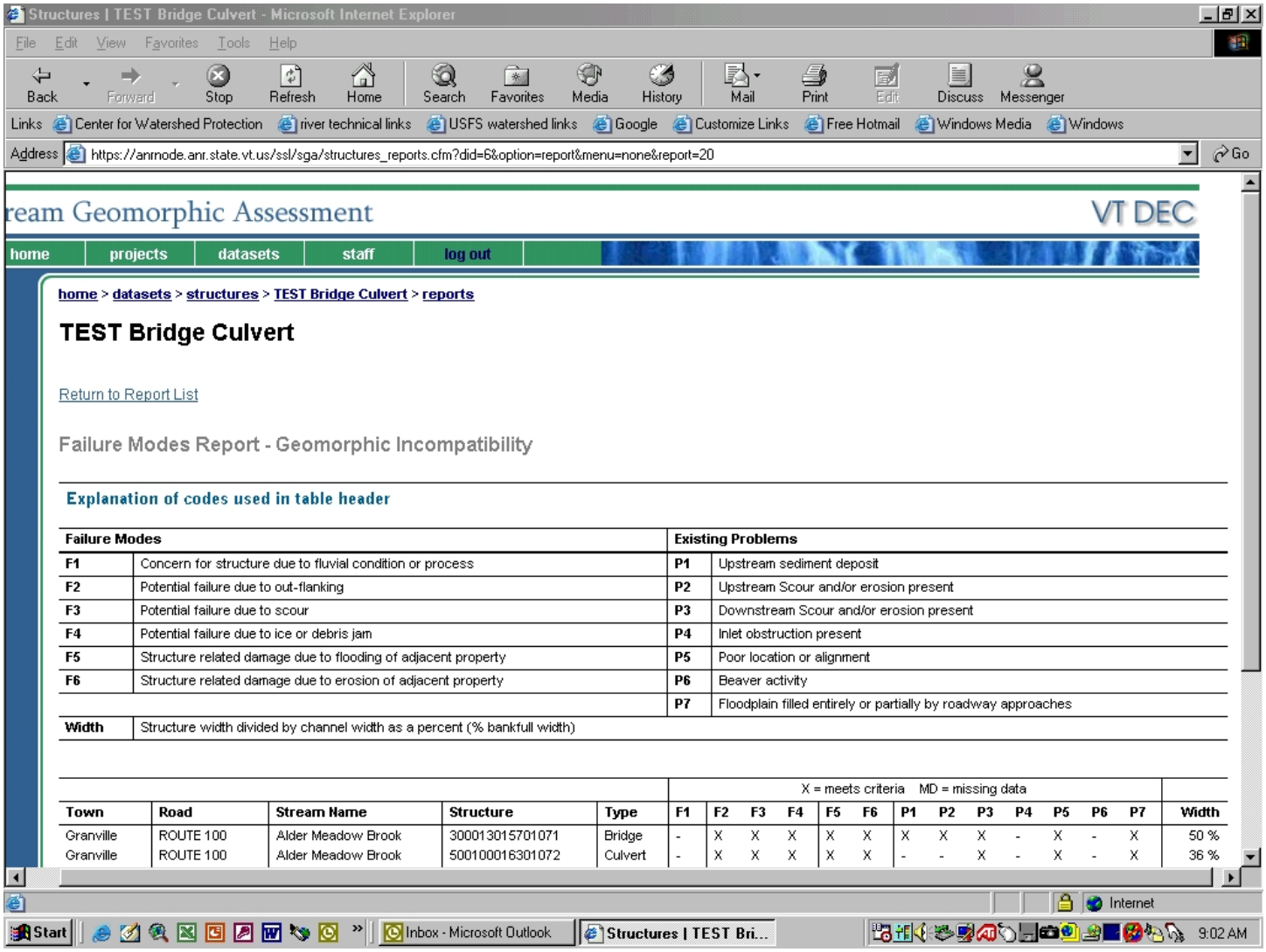


Figure 10. Example layout of the Failure Modes Report

Potential Failure due to Outflanking – is typically associated with an undersized structure with inadequate sediment conveyance. Sediment accumulation upstream of the structure leads to outflanking during flood conditions when the enlarged stream cannot flow through the structure. The potential for failure due to outflanking also exists when the stream is a high sediment load system (as evidenced by large sediment deposits upstream of the structure inlet) and the structure is poorly located just downstream of a significant change in the valley slope.

Potential Failure due to Scour – may be caused by inadequate structure sizing as well, but may also result from having the wrong type of structure or one that has been poorly located or aligned with the stream flow. Culverts or bridge components may fail when scour leads to substantial undermining of the structure.

Potential Failure due to ice or debris jam –may be the result of inadequate sizing and sediment discontinuity at the structure, or due to location and/or alignment problems.

Structure related damage due to flooding of adjacent property – may be caused when the structure and the roadway approaches create enough of a dam during high flows to cause the backup of flood water and inundation-related damage to upstream adjacent property.

Structure related damage due to erosion of adjacent property – will be very common when structure failure is indicated due to geomorphic incompatibility. Erosion of road shoulders, stream banks, and other property may be observed both upstream and downstream of bridge and culvert structures.

Existing Problems: The database query will place an "X" in columns P1 through P6 where data indicate that existing problems may contribute to the potential failure mode(s) listed. This data is particularly useful in interpreting why the potential failure modes exist. For instance, a structure that is indicated to have a potential for failure due to outflanking may exhibit existing problem P1, "upstream sediment deposit", (Figure 11). Documenting existing problems is useful in prioritizing structure replacements and/or repairs. For example, , an bridge that is undersized and is documented to be currently experiencing scour may be a higher priority due to potential failure caused by scour than a bridge that, while undersized, is not currently documented to have scour around/under the structure.

Figure 11. Outflanking Failure at undersized culvert where upstream sediment deposits were observed.

Structure Width vs. Channel Width: The last column in the report contains a ratio of the structure span/diameter divided by the stream bankfull width (represented as percentage). When this number is less than 100%, the structure span or diameter is less than the width of the channel and, along with other observations, may indicate potential failure. If it is 75% or less the structure is significantly undersized and all three potential failure modes may occur.

Problem Causes Report

This report displays data for each structure that explains the predicted failure modes and existing problems related to fluvial geomorphic incompatibility. The report is available sorted by road within a town or by stream. The report contains fourteen columns of data (Figure 12) that are grouped in relation to the problem to which they pertain. For example, the problem of upstream sediment deposition may be indicated by three different data fields: structure openings obstructed with sediment, upstream sediment deposits greater than half bankfull height, and steep riffle present upstream of structure. Evaluating how many of these conditions are present at the structure gives more insight as to the potential severity of the upstream sediment deposition problem. This report can be used to help further prioritize structures in need of attention due to fluvial geomorphic incompatibility.

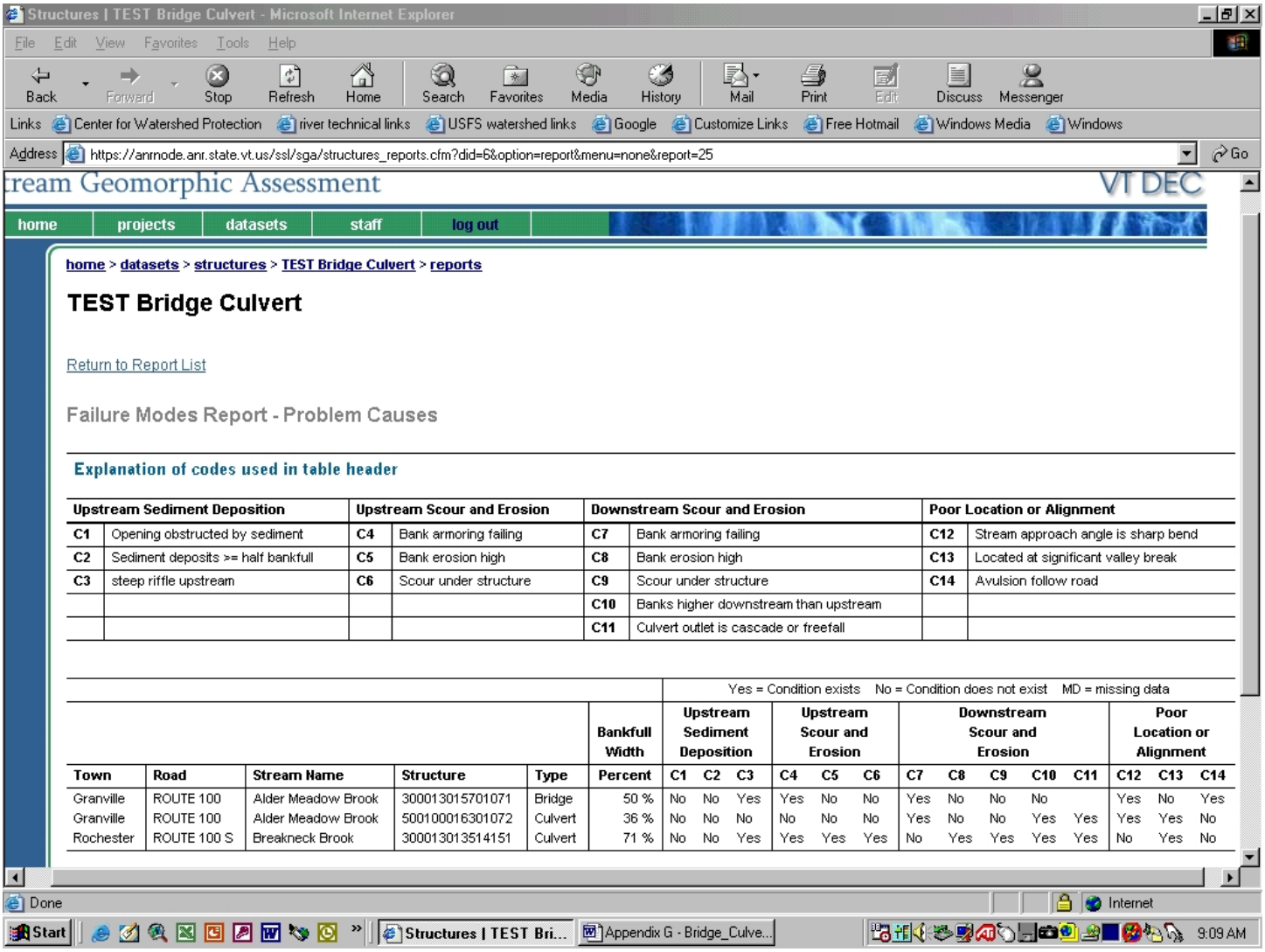


Figure 12. Example layout of the Failure Modes Report – Problem Causes.

Culvert Aquatic Organism Passage Coarse Screen

The *AOP Coarse Screen* characterizes the expected level of AOP based on a set of physical measures of the culvert and adjacent stream during low flow conditions. This first level of screen is useful at the watershed and subwatershed scales to observe regional conditions and to begin to identify structures having the most impact on species of interest. The *AOP Coarse Screen* is similar in format to other coarse screens commonly used in the United States (e.g., Taylor and Love, 2002; Clarkin et al., 2005). For more information see the Vermont Aquatic Organism Passage Screening Tool report.

The *AOP Coarse Screen* is a broad screen to determine the likely level of passage at a culvert under low flow conditions. Based on previously collected structure assessment data, the screen classifies structures into the following categories (Table 2-1):

- Full AOP for all aquatic organisms (green),
- Reduced AOP for all aquatic organisms (gray),
- No AOP for all aquatic organisms except adult salmonids (orange), or
- No AOP for all aquatic organisms including adult salmonids (red).

Table 2-1
The AOP Coarse Screen

VT Aquatic Organism Passage Coarse Screen	Full AOP	Reduced AOP	No AOP	
Updated 2/25/2008	for all aquatic organisms	for all aquatic organisms	for all aquatic organisms except adult salmonids	for all aquatic organisms including adult salmonids
AOP Function Variables / Values	Green (if all are true)	Gray (if any are true)	Orange	Red
Culvert outlet invert type	at grade OR backwatered	cascade	free fall AND	free fall AND
Outlet drop (ft)	= 0		> 0 , < 1 ft OR	≥ 1 ft OR
Downstream pool present			= yes (= yes AND	= no OR (= yes AND
Downstream pool entrance depth / outlet drop			n/m ≥ 1)	n/a < 1) OR
Water depth in culvert at outlet (ft)				< 0.3 ft
Number of culverts at crossing	1	> 1		
Structure opening partially obstructed	= none	≠ none		
Sediment throughout structure	yes	no		

Notes:
Assessment completed during low flows.
Outlet drop = invert of structure to water surface.
Pool present variable is used alone if pool depths are not measured.
n/m = not measured.
n/a = not applicable.

Figure 13. Example layout of the Aquatic Organism Passage Report.

Note that only culverts are evaluated for the potential to block aquatic organism movement, because in almost all cases bridges and arches do not block the ability of organisms to move up and down the stream channel. There may be a few rare situations where bridges or arches restrict aquatic organism passage, such as when a bridge constricts flow over a bedrock dominated streambed, resulting in impassable stream flow velocities; however, these situations are likely rare. If you do note such situations and are planning to evaluate aquatic organism passage in detail, be sure to include these structures in future surveys of red and gray structures.

Culvert Retrofit Potential Screen

The primary constraints for AOP at a given structure are generally driven by the magnitude of the culvert's length, outlet drop and constriction (% bankfull width). The *AOP Retrofit Potential Screen* estimates the potential to improve AOP at a culvert with *Reduced AOP* or *No AOP* (i.e., coarse screen category gray, orange or red). For each assessed culvert, a retrofit potential category of low (L), medium (M), or high (H) (Table 3-1A) is assigned for each of strong, moderate, and weak swimming / leaping ability groups (Table 3-1B). A high retrofit potential indicates that the culvert is more likely to be improved, while moderate and low retrofit potential indicate increasing challenges for AOP enhancements at the structure. Each structure is assigned a 3-letter retrofit potential category corresponding to the retrofit potential for the strong, moderate and weak swimming groups (i.e., strong-moderate-weak, LLL, MLL, MML, MMM, HML, HMM, HHM, HHH). For more information see the Vermont Culvert Geomorphic Compatibility Screening Tool report.

AOP Habitat Connectivity Potential Screen

The Connectivity Potential Report is based on a GIS-based analysis to calculate the potential full network and mainstem stream lengths reconnected with AOP improvements at culverts. The full database of culverts can be analyzed for upstream full network and mainstem distance to the next barrier or stream source. This level of information will be updated annually as the culvert database increases in size with more assessments and answer general questions about stream fragmentation. ArcMap (ESRI, 2006) and the RivEx Vector River Network Tool (Hornby, 2008) are used to find distances and results are transferred to Excel for basic calculations and data organization. The values of the screening variables can be conveniently viewed on a local catchment GIS map along with the retrofit potential category. GIS maps containing screen results are useful for locating structures along the drainage network and examining the density of blockages. For more information see the Vermont Culvert Geomorphic Compatibility Screening Tool report.

Wildlife Passage Suitability Report

This report lists structures potentially suitable to facilitate terrestrial wildlife movement under roadways. The report can be sorted by town and road name or by stream name.

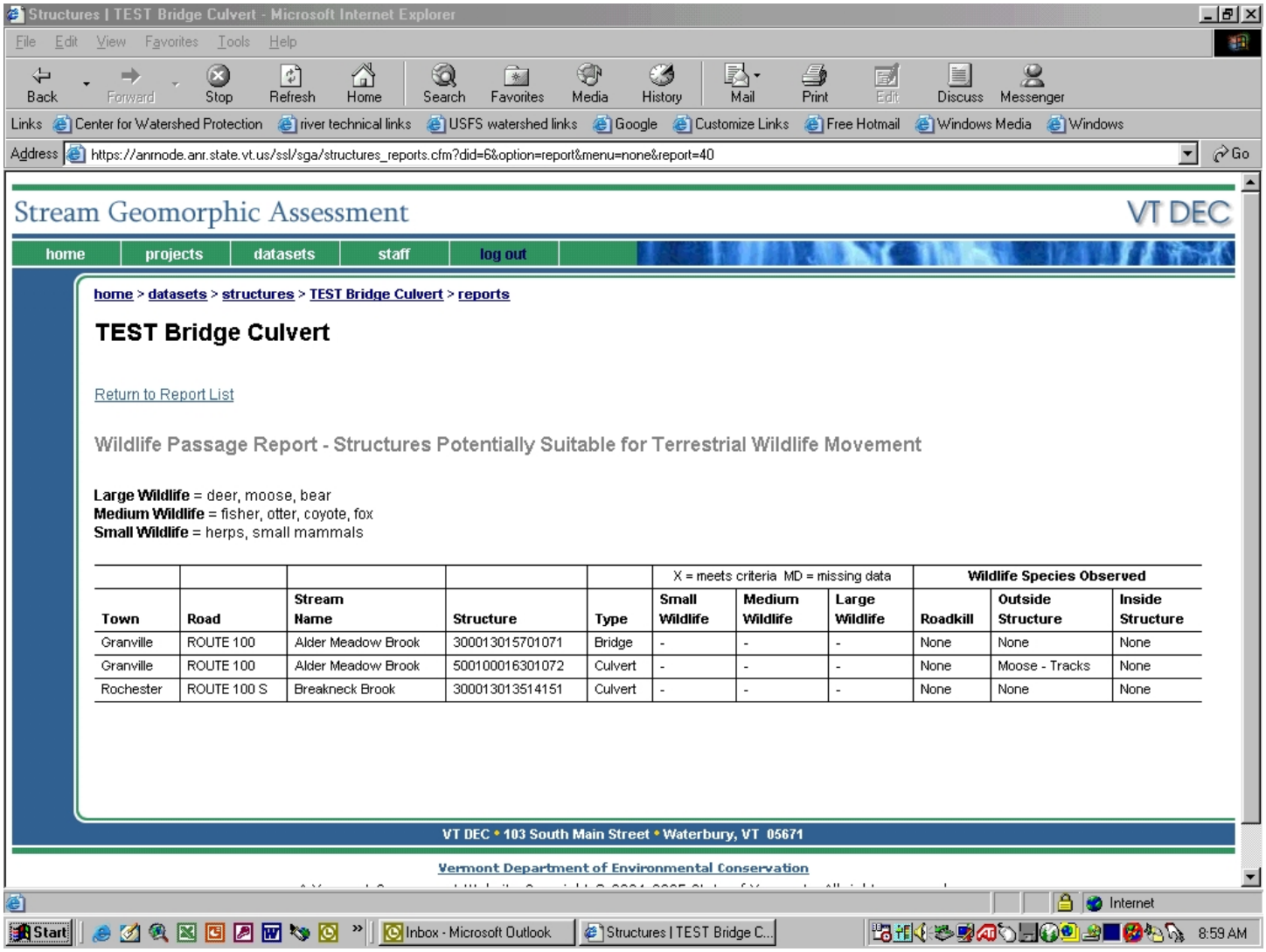


Figure 14. Example layout of the Wildlife Suitability Passage Report.

The three right columns list all species for which road-kill or wildlife sign was recorded at/near the structure and potentially indicate that wildlife are using the structure for crossing, or are crossing the road in the vicinity of the structure. These columns help prioritize structures for improving wildlife movement across transportation corridors. Note, however that there is abundant additional information about wildlife habitats available; including several GIS data layers, which should be considered in such prioritization efforts. If you are evaluating wildlife movement and road crossing barriers in detail, you should contact the Vermont Fish and Wildlife Department's district wildlife biologists for assistance.

Bridge & Arch Assessment Field Form- Geomorphic & Habitat Parameters

Structure Type: **bridge / arch** Field Map # _____

SGAStructure ID				Struct_Num	
Observer(s) / Organization(s)				Date	
Town				Phase 1 Project	
Location				Longitude (E/W)	
Reach VTID				Latitude (N/S)	
Road Name				Road Type	**paved gravel trail railroad**
Stream Name				High Flow Stage	**yes no**
Channel Width **curve measured**	(ft.)	Structure Material	**aluminum, wrought iron, cast iron** **concrete** **masonry (arches) & slabs** **prestressed concrete/post-tensioned** **steel** **timber** **other**	Structure skewed to roadway	**yes no**
Structure Width (road width)	(ft.)			Structure Clearance	(ft.)
Structure Span	(ft.)			# of bridge piers or # arches at crossing	

Geomorphic and Fish Passage Data

General

Floodplain filled by roadway approaches: **entirely** **partially** **not significant**

Structure located at a significant break in valley slope: **yes** **no** **unsure**

Upstream

Is structure opening partially obstructed by (circle all that apply): **wood debris** **sediment** **deformation** **none**

Steep riffle present immediately upstream of structure: **yes** **no**

If channel avulses, stream will: **cross road** **follow road** **unsure**

Estimated distance avulsion would follow road: _____ (feet)

Angle of stream flow approaching structure: **sharp bend** **mild bend** **naturally straight** **channelized straight**

Downstream

Pool immediately downstream of structure: **yes** **no**
Maximum pool depth: _____ (0.0 feet or >4feet)
Downstream bank heights are substantially higher than upstream bank heights: **yes** **no**
Stepped footers: **yes** **no**

Geomorphic and Fish Passage Data	**UPSTREAM**	**DOWNSTREAM**	**IN STRUCTURE**
Dominant bed material at structure	**1 2 3 4 5 UK** bedrock present: **yes no**	**1 2 3 4 5 UK** bedrock present: **yes no**	**1 2 3 4 5 UK** bedrock present: **yes no**
Sediment deposit types	**none delta side point mid-channel**	**none delta side point mid-channel**	**none delta side point mid-channel**
Elevation of sediment deposits is greater than or equal to ½ bankfull elevation:	**yes no**	**yes no**	**yes no**
Bank erosion	**high low none**	**high low none**	
Hard bank armoring	**intact failing none unknown**	**intact failing none unknown**	
Streambed scour causing undermining around/under structure (circle all that apply)	**none abutments footers wing walls**	**none abutments footers wing walls**	
Beaver dam near structure Distance from structure to dam	**yes no** **distance: _____ ft.**	**yes no** **distance: _____ ft.**	

Bed Material Codes
1-bedrock
2-boulder
3-cobble
4-gravel
5-sand
UK-unknown

Wildlife Data (left/right bank determined facing downstream)	**LEFT**	**RIGHT**	**LEFT**	**RIGHT**
Dominant vegetation type				
Does a band of shrub/forest vegetation that is at least 50' wide start within 25' of structure and extend 500'or more up/downstream?	**yes no**	**yes no**	**yes no**	**yes no**

Vegetation Type Codes
C-coniferous forest
D-deciduous forest
M-mixed forest
S-shrub/sapling
H-herbaceous/grass
B-bare
R-road embankment

Road-killed wildlife within ¼ mile of structure? (circle none or list species)	**species:** **none**

Wildlife sign and species observed near (up/downstream) and inside structure (circle none or list species and sign types)	**Outside Structure**		**Inside Structure**	
	species (none)	**sign**	**species (none)**	**sign**

Spatial data collected w/GPS: **yes no** Photos taken: **yes no** Please fill out photo log below	**Comments:**

Roll and Frame #	**Photo View**	**Description of Features in Photo**

Culvert Assessment Field Form - Geomorphic & Habitat Parameters

Field Map # _____

SGA Structure ID				Struct_Num	
Observer(s) / Organization(s)				Date	
Town				Phase 1 Project	
Location				Longitude (E/W)	
Reach VTID				Latitude (N/S)	
Road Name				Road Type	**paved gravel trail railroad**
Stream Name				High Flow Stage	**yes no**
Channel Width **curve measured**	(ft.)	Culvert Material	**concrete** **plastic corrugated** **plastic smooth** **tank** **steel corrugated** **stone** **aluminum corrugated** **other** **mixed**	Structure skewed to roadway	**yes no**
Culvert Length	(ft.)			Culvert Height	(ft.)
Culvert Width	(ft.)			# of culverts at crossing	
				Overflow pipe(s)	**yes no**

Geomorphic and Fish Passage Data

General

Floodplain filled by roadway approaches: **entirely** **partially** **not significant**

Structure located at a significant break in valley slope: **yes** **no** **unsure**

Culvert slope as compared with the channel slope is: **higher** **lower** **same**

Upstream

Is structure opening partially obstructed by (circle all that apply): **wood debris** **sediment** **deformation** **none**

Steep riffle present immediately upstream of structure: **yes** **no**

If channel avulses, stream will: **cross road** **follow road** **unsure**

Estimated distance avulsion would follow road: _____ (feet)

Angle of stream flow approaching structure: **sharp bend** **mild bend** **naturally straight** **channelized straight**

Downstream

Water depth in culvert (at outlet): _____ (0.0 feet)

Culvert outlet invert: **partially backwatered or at grade** **cascade** **free fall**

Backwater Length (measured from outlet): _____ (0.0 feet)

Outlet drop (invert to water surface): _____ (0.0 feet)

Pool present immediately downstream of structure: **yes** **no**

Pool depth at point of streamflow entry: _____ (0.0 feet)

Maximum pool depth: _____ (0.0 feet or >4feet)

Downstream bank heights are substantially higher than upstream bank heights: **yes** **no**

Geomorphic and Fish Passage Data	**UPSTREAM**	**DOWNSTREAM**	**IN STRUCTURE**
Dominant bed material at structure	**1 2 3 4 5 UK** bedrock present: **yes no**	**1 2 3 4 5 UK** bedrock present: **yes no**	**0 1 2 3 4 5 UK** material throughout: **yes no**
Sediment deposit types	**none delta side point mid-channel**	**none delta side point mid-channel**	**none delta side point mid-channel**
Elevation of sediment deposits is greater than or equal to ½ bankfull elevation:	**yes no**	**yes no**	**yes no**
Bank erosion	**high low none**	**high low none**	
Hard bank armoring	**intact failing none unknown**	**intact failing none unknown**	
Streambed scour causing undermining around/under structure (circle all that apply)	**none culvert footer wing walls**	**none culvert footer wing walls**	
Beaver dam near structure Distance from structure to dam	**yes no** **distance: _____ ft.**	**yes no** **distance: _____ ft.**	

Bed Material Codes
0-none
1-bedrock
2-boulder
3-cobble
4-gravel
5-sand
UK-unknown

Wildlife Data (left/right bank determined facing downstream)	**LEFT**	**RIGHT**	**LEFT**	**RIGHT**
Dominant vegetation type				
Does a band of shrub/forest vegetation that is at least 50' wide start within 25' of structure and extend 500'or more up/downstream?	**yes no**	**yes no**	**yes no**	**yes no**

Vegetation Type Codes
C-coniferous forest
D-deciduous forest
M-mixed forest
S-shrub/sapling
H-herbaceous/grass
B-bare
R-road embankment

Road-killed wildlife within ¼ mile of structure? (circle none or list species)	**species:** **none**

Wildlife sign and species observed near (up/downstream) and inside structure (circle none or list species and sign types)	**Outside Structure**		**Inside Structure**	
	species (none)	**sign**	**species (none)**	**sign**

Spatial data collected w/GPS: **yes no** Photos taken: **yes no** Please fill out photo log below	**Comments:**

Roll and Frame #	**Photo View**	**Description of Features in Photo**

Vermont Stream Geomorphic Assessment

Appendix K

Identification of Bankfull Stage

Vermont Agency of Natural Resources
April, 2004

Identification of Bankfull Stage

Use of Bankfull to Delineate the Channel

Consistent measurement of river dimensions, that are comparable between sites and over time, first requires a method for consistently delineating river channel limits. Because the flow level may change from day to day or minute to minute, the river cannot be defined as the wetted area at the time of assessment.

Instead of using wetted area at a given time to define the river it is more appropriate to define the size of the river based upon the channel. The channel limits can be defined by the bankfull stage: or the point at which the flow just begins to enter the active floodplain (Leopold, 1994). Use of the bankfull stage is beneficial because it has hydrologic and morphologic significance which render it a consistent benchmark for comparison between sites that is identifiable in the field.

Hydrological Significance of Bankfull: Flow measurements conducted on gaged rivers around the world show that the bankfull stage has a recurrence interval of 1.5 years on average. This means that in any given year there is a 67% chance that the river will rise to or overtop the active floodplain. Because the bankfull flow equates to approximately the 1.5 year flow, on many rivers we can use the bankfull stage as a benchmark from which to measure channel size for a consistent comparison between sites.

Morphological Significance of Bankfull: Long term bed load and flow measurements have shown that it is the bankfull flow that transports the greatest amount of material over time (Leopold, 1994). While larger flow events transport greater quantities per event and smaller flow events occur more frequently, it is the bankfull flow that is sufficiently effective and sufficiently frequent to perform the greatest amount of work in maintaining channel shape and is thus also referred to as the "effective discharge" or "channel forming flow." Because the bankfull flow does the greatest amount of work informing the channel, the bankfull stage is identifiable in the field.

The Active Floodplain: A channel is said to be at bankfull stage when it is just about to flood the active floodplain. Thus the active floodplain defines the limits of the bankfull channel. The active floodplain is defined as the flat portion of the valley adjacent to the channel that is constructed by the present river in the present climate (Leopold, 1994). The phrase "by the present river in the present climate" is especially important because if the river degrades or incises, what was formerly the floodplain is abandoned and becomes a terrace or abandoned floodplain. It is therefore important to be able to distinguish the active floodplain from abandoned terraces when identifying bankfull stage. Thinking in terms of stage of channel evolution will help in this process.

Indicators of Bankfull Stage

The following physical features that result from the erosion and deposition associated with the bankfull flow serve as indicators of the bankfull stage.

- Nearly flat top of developing point bars: as the channel migrates across the valley it builds the active floodplain in its wake through the development of point bars. The top of the point bar is the active floodplain.
- Flat depositional benches or lateral bars: On straighter sections of river will often exist as lateral bars. These bars may also represent the active floodplain.
- Location of change on the bank from steep to more gentle slope: On reaches of river that are not prone to active floodplain building, the break in bank slope often corresponds to the bankfull stage.

- Lower extent of persistent woody vegetation: Because of the fairly frequent occurrence of bankfull all but the most water tolerant tree species (alder and willow) will not typically grow within the bankfull channel.
- Erosion or scour features: On steeper gradient, naturally entrenched rivers the active floodplain may be intermittent in occurrence or altogether not present. In this case it becomes necessary to rely on erosional features along the banks as indicators of the flow stage that performs the most work. Because erosion can be caused by many processes such as ice scour and may not be related at all to the stage of the bankfull flow these features should be relied upon only when absolutely necessary.

The following photos show bankfull indicators that were used in development of the VT Regional Hydraulic Geometry Curves.

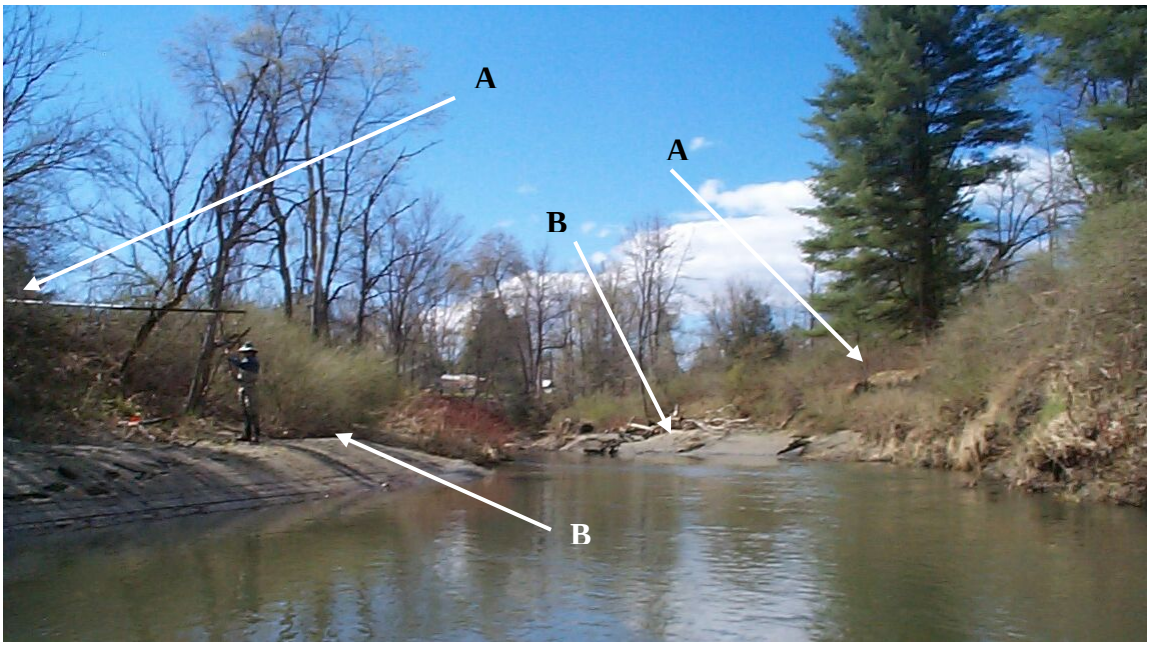


Figure 1 Embryonic active floodplain developing in incised channel. Stage IV of channel evolution.
a. Abandoned floodplain
b. Active floodplain indicating bankfull stage

Figure 2 Well developed lateral bar indicating bankfull stage.

Figure 3 Close up of Figure 2. Survey rod shows slope (nearly flat) of the lateral bar surface.

Figure 4 Lateral bar indicating bankfull stage. Note that the upslope flag is location of bankfull stage. At this location the slope of the bar surface becomes nearly flat. Also note the woody vegetation line at that point.

Figure 5 Removed view of Figure 4. Note that the most significant break in slope is disregarded for the location on the bank where the slope becomes flat and a change in vegetation occurs.

Figure 6 Bench feature indicating bankfull. Survey rod shows the slope of the bench surface.

Figure 7 Example of a well developed floodplain in a system characterized by boulder size boundary material.

Protocol for Identification of Bankfull

You should never rely upon one indicator of bankfull as definitive evidence of the bankfull stage. Any individual piece of evidence can be misleading (Leopold 1994). Observing as many bankfull indicators as can be found in the reach is the best procedure. Following the protocol below will help assure correct identification of the bankfull stage.

1. Walk the entire reach flagging indicators of bankfull stage. Avoid areas of bedrock, rip rap, bridge footings or other physical constraints. Remember that on incised channels the most evident flat valley surface may be an abandoned terrace. Rely on local knowledge and common sense as a guide in deciding whether it is realistic that a particular elevation is inundated nearly every year.
2. The elevation of each indicator above the current water surface should be consistent within 0.5 feet. If a particular indicator is not within this range it is probably not a good indicator of the bankfull stage.
3. Calculate the average height above water surface for the bankfull indicators identified. This value may be used to determine the bankfull stage at a location within the reach at which there are no strong bankfull indicators.
4. VT DEC has developed hydraulic geometry curves which plot bankfull channel dimensions on stable streams as a function of drainage area. Once the bankfull stage has been identified, quickly measure the bankfull width and compare to the VT DEC hydraulic geometry curves to help verify the correct bankfull elevation.

For further discussion on the identification of bankfull indicators and the processes that create these indicators see: Dunne and Leopold (1978); Leopold and Maddock (1953); Emmett (1975); Harrelson et.al. (1994); Rosgen (1996).

References

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3. Harrelson, Cheryl C., C.L. Rawlins, and J. Potyondy. 1994. Stream channel reference sites: an illustrated guide to field technique. General Technical Report RM-245. Fort Collins, CO: U.S. Department of Agriculture, Forest Service, Rocky Mountain Forest and Range Experiment Station. 61p.

4. Leopold, Luna. 1994. A View of the River. Harvard University Press, Cambridge, MA.

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Vermont Stream Geomorphic Assessment

Appendix M

Delineation of Stream Bed Features

Vermont Agency of Natural Resources
April, 2004

Delineation of Stream Bed Features

Geomorphic Significance of Stream Bed Features

Classifying stream bed features is one of the more challenging tasks in a stream geomorphic assessment. Nearly all significant changes in bed gradient and depth may be important to survey, especially from a habitat perspective, but only certain bed features may be significant from a fluvial geomorphic perspective. While a small scour pool around a boulder in a riffle-pool stream may be significant fish habitat, that feature may not be a significant pool from a geomorphic perspective. Biologists are interested in the existence of pools and the habitat they provide. Geomorphologists are concerned with the fluvial processes that create pools and their longevity. While conducting a geomorphic survey, focus on how a feature was formed and whether it is biologically and/or geomorphically significant. For all features surveyed, take care to label those features that are significant geomorphically on both your field notes and on the DMS spreadsheet.

Generally speaking geomorphically significant features are those that are formed by the erosion and deposition of material at bankfull flows consistent with the current balance between the watershed inputs and the energy grade of the stream. As such, geomorphically significant features typically comprise the entire bankfull width of the channel and persist so long as the current equilibrium conditions of the bankfull channel persists. Geomorphically significant features can be thought of as those that play a formative role in the long-term average characteristics of the channel.

Identification of Bed Features

If a feature is determined to be geomorphically significant it will need to be specifically denoted. If it is not significant then it is part of the larger feature in which it lies. Classifying a feature begins with identifying the feature's beginning and end points, observing its characteristics and reconsidering its geomorphic significance. A list of bed feature types with defining characteristics found in riffle-pool streams is given below and represented diagrammatically in Figure 1.

- **Riffles**: the sections of the bed with the steepest slopes and shallowest depths at flows below bankfull. Riffles typically occur at the cross over locations and have a poorly defined thalweg.
- **Runs**: differ from riffles in that depth of flow is typically greater and slope of the bed is less than that of riffles. Runs will often have a well defined thalweg.
- **Pools**: are the deepest locations of the reach. Water surface slope of pools at below bankfull flows is near zero. Pools are often located at the outside of meander bends.
- **Glides**: are located immediately downstream of pools. The slope of the channel bed through a glide is negative while the slope of the water surface is positive. The head of the glide can be difficult to identify. Use the following characteristics to help you locate the head of the glide:
    - the location of increased flow velocity coming out of the pool,
    - the location at which the steeply sloped bed rising out of the pool decreases to a lesser gradient,
    - the location at which the thalweg coming out of the pool becomes less well defined and essentially fades completely.
    - the location which is approximately same elevation as the tail of the run.
- **Other**: This category is provided to accommodate the unstable short lived bed feature such as a zone of aggradation that you do not want to lump with stable features.

There is a typical but by no means absolutely predictable sequencing of bed features found on riffle-pool streams. Riffles will most often be followed by runs. Runs may transition back to riffles but more often are followed by pools. By definition glides begin at the downstream end of pools and end at the upstream end of a riffle or run. Use this expected sequence to help type individual features but do not let it override characteristics of slope and depth and the existence of a well defined thalweg.

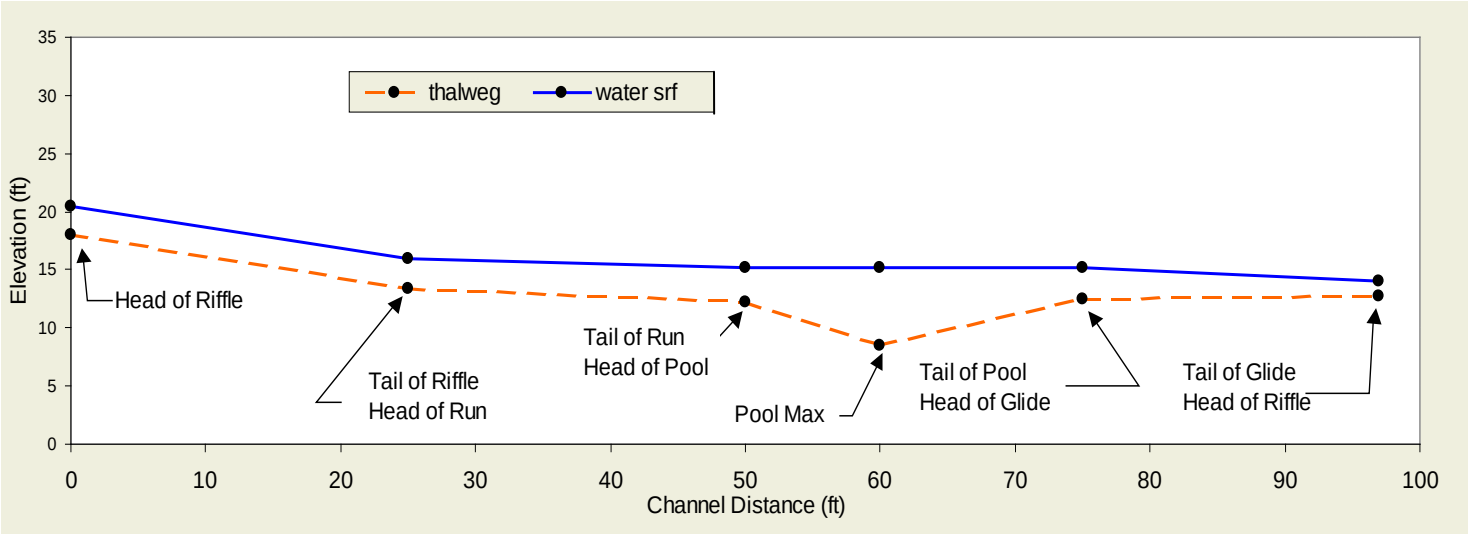

Figure 1 Typical slope and depth characteristics and sequencing of bed features in a riffle-pool stream.

Step-pool systems may contain all of the bed features listed above although typically riffles are replaced by steps which most commonly transition directly into pools. Riffles and runs may exist in lower gradient segments of step-pool reaches. Due to the abundance of boulders, step-pool streams often contain a high number of scour pools. Generally speaking, it is the pools that are associated with step features and not scour pools around randomly located boulders that are significant.

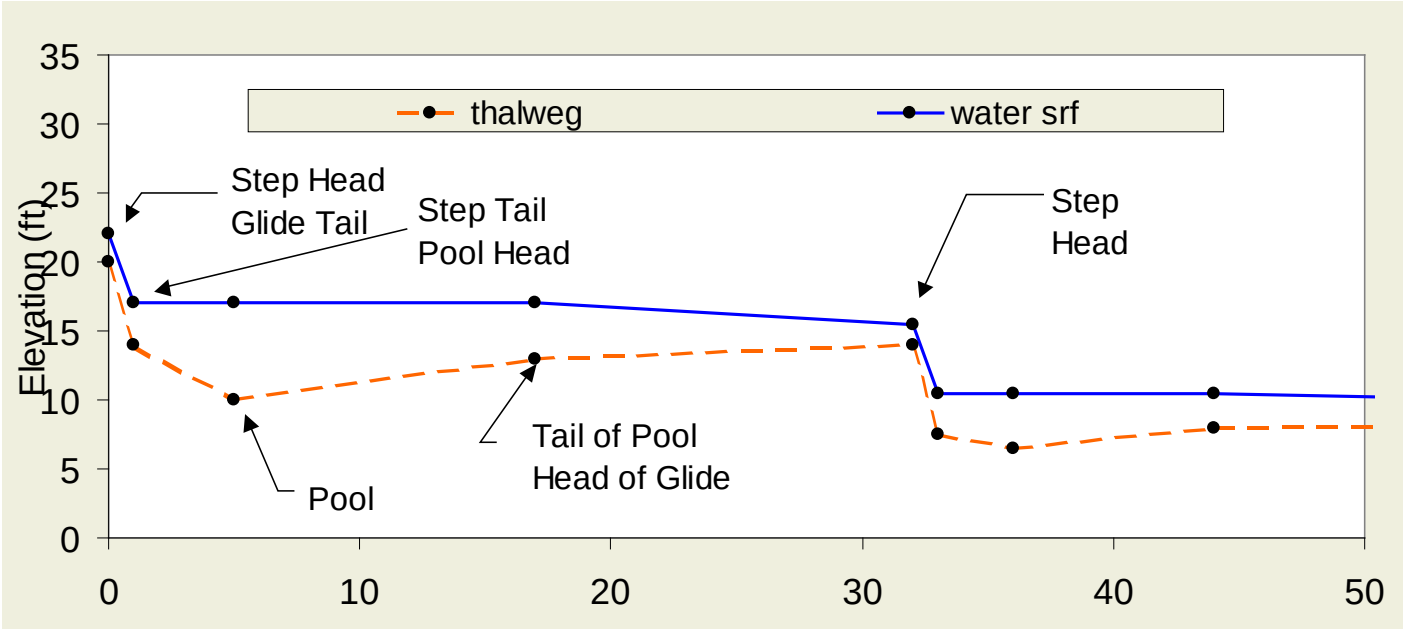

Figure 2 Typical slope and depth characteristics and sequencing of bed features in a step pool stream.

Plane bed streams by definition are featureless and do not have a distinct sequence of bed features such as riffles and pools. When surveying the longitudinal profile of plane bed streams, take elevations at stations spaced at a distance equivalent to one bankfull width. Be sure to code the profile stations as plane bed (PB). To take advantage of the weighted pebble count and roughness coefficient calculations of the DMS spreadsheet, place plane bed pebble count data into the riffle pebble count section of the materials worksheet.

In vertically adjusting systems, bed forms may be encountered that look like that of a plane bed stream, but are not formed by the same fluvial processes that create a plane bed system. For instance, in degraded streams, bed features may be scoured away; while in aggraded streams, bed features may be "drowned out" by the deposition of fine sediment. In other situations, bed features may be formed by an anomalous scour or deposition process (e.g., those found at confluences or bank slumps). For these cases, a category labeled "other" has been created on the profile, cross-section, and pebble count field forms and DMS worksheets. By placing pebble count data in the "other" data entry table, these materials will not included in the weighted pebble count and roughness coefficient calculations. The advantage of the "other" category is being able to compare data from anomalous or unstable sites with those of reference bed features and cross-sections.

To: Fluvial geomorphic consultants conducting VT Stream Geomorphic Assessments (Phase 2) and preparing River Corridor Plans

From: Vermont DEC Rivers Program

Date: May 2012

RE: **SGA Protocols on Rivers Affected by Major Flooding**

Tropical Storm Irene has had a major effect on the current geomorphology of many of Vermont's rivers. These rivers will continue to undergo physical adjustments as they respond to changes associated with both the flood magnitude and the flood recovery work conducted within the river corridor. We recognize that field characteristics normally assessed during SGA may now be unusually transient, and in many cases, it will be difficult to tease apart short-term and longer-term adjustments and, ultimately, geomorphic condition. Therefore, we are submitting the following cautions and considerations for groups who are conducting SGA (phase 2) on rivers with significant post-flood characteristics. We request your thoughtful, professional expertise to ensure that SGA data will be most useful to river corridor planning and mapping efforts and for river corridor management for stream equilibrium condition. We welcome your thoughts, suggestions, and interpretations.

1. **Checking In.** Once assessment is underway, work with your regional river scientist to report problems, ask questions, or make suggestions about capturing specific situations. We request you submit some reach data early for Rivers staff to look at to determine if other approaches are needed.
2. **Bankfull and Incision Ratios.** Following major flooding, bankfull features may be difficult or impossible to identify along some reaches. One to two-year flows may not meet the same elevation as features that were previously associated with bankfull. These "old" bankfull features may or may not still be present. "New" bankfull features may not yet be present, or at least, certainty about their associated discharge may be low.

   Please attempt to identify bankfull indicators when possible, following SGA Handbook protocols, by observing benches and scour lines (ideally observing water levels during spring flows). If there is not a good bankfull feature, and/or you are not sure what to use for bankfull to determine other RGA data, take more points along your cross-section to give more detail to the cross-section. This cross-section detail will help support judgments that may need to be made with uncertain data (e.g. if the VT Hydraulic Geometry Curves are used to determine what type of cross-sectional area/depth/etc. may be expected in that channel). Please specify what you used for bankfull features in your notes and cross-section worksheets.

An incision ratio will be calculated as usual but an alternate measure for channel enlargement should also be used when channel dimensions have been significantly altered and/or corroborating bankfull indicators are not present.

Note this method is NEW to SGA protocols:

The **channel enlargement measure (*E*)** is a comparison of the channel's cross sectional area from the current top of bank (A_{tob}) to the cross sectional area predicted by the Vermont regional hydraulic geometry curve (A_{curve}) as a percentage, using this equation:

$$E = A_{tob}/A_{curve} \times 100$$

An approximate value of 100% for *E* could be interpreted as a clue that the stream channel may have retained equilibrium capacity. A value of 300%, for example, could indicate channel enlargement. However, there are obvious problems with this method because of limitations of the regional hydraulic geometry curve (see Appendix J of SGA Handbook). Also, this measure alone will not directly indicate degree of incision or floodplain access. This method is simply another descriptor to help qualify the data.

The DMS will provide a space to enter any channel enlargement measures that are calculated.

3. **Dredged/braided areas.** At the time of assessment, some stream reaches may be significantly dredged with piled stream sediments or multiple channels associated with in-stream work. Segment out these areas if they are >500' long. If it is not possible to identify bankfull elevation, then take a descriptive cross section without identifying bankfull. Having these cross sections in the SGA database is still vital to understanding the geomorphic condition of the reach. Taking multiple cross sections in highly impacted reaches is encouraged. For areas <500', highlight those locations in your notes and comments; if you have time, cross-sections in these areas can be helpful, too, to demonstrate how much modification/impact has occurred as compared to the surrounding reach or segment that may have less impacts.
4. **Channel Dimensions.** For each cross section, note the following:
    - Were channel dimensions significantly changed by major flooding? (Yes/No/Unknown)
    - Were channel dimensions significantly changed by human alteration associated with flood recovery efforts (e.g., reshaping of banks by yellow machines)? (Yes/No/Unknown)

    Record your answers to these questions on cross-section field forms and in uploaded cross section spreadsheets. We are creating a place in the DMS to enter this information, as well as other information relating to major flood effects.
5. **"Highly Altered" Segments.** When bankfull elevation can't be identified and/or existing stream type is difficult to determine, the RGA condition may default to Poor for the segment. Sensitivity may also default to Extreme (discuss with your Regional River Scientist if you wish to assign Extreme sensitivity on a "highly altered" segment). Though a segment may default to poor/extreme conditions, complete as many questions in the RGA as possible to help characterize the type of adjustments that are most likely to be occurring and/or likely to occur in the segment.

6. **Phase 2 photos.** When taking photographs, be sure to include major features within the river corridor that tell the story of the flood's effects (e.g., berms, large bars, stockpiles of sediment, debris, damaged infrastructure, erosion). **Please include GPS coordinates for the location of each photograph.**
7. **Berms.** For new berms, please note if berm material appears to originate from channel-extracted material or from deposits pushed out of fields (e.g. farm clearing) or other notes of interest. There is a description field in FIT where these details can be recorded. This information will help document where/what/why/how a berm may have been created in that area and what options may be available for corridor planning projects.
8. **Woody debris.** Counts of woody debris pieces may be estimated in areas of heavily piled wood. Photos and comments of noteworthy debris that are significant for habitat, channel adjustment, or floodplain forests are helpful.
9. **Corridor Planning.** When preparing river corridor plans and identifying projects, always keep in mind the longer term goal of managing toward stream equilibrium. River Corridor Plans will be of particular interest to communities that have recently experienced major flooding. We encourage you to…
    - Be alert for areas where further remediation or monitoring efforts may still be needed and note recommendations that you think would be most critical to the river's long term stability.
    - Keep in mind that maintaining/improving floodplain access in key locations will be an important aspect of the shared goals of river corridor planning and flood resiliency. For example, RCP reports may benefit from maps which highlight existing floodplain access or opportunities for improved floodplain access.
    - Recommend and **prioritize** opportunities to improve crossing structures. Use information about recent structure losses and replacements when possible.
    - Strive to present project recommendations in a clear, usable format and place them in the context of allowing stream processes to move toward dynamic equilibrium.