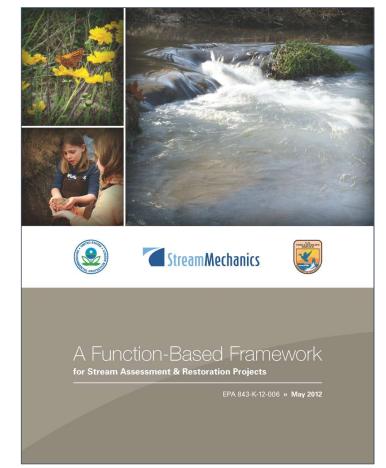
## Colorado Stream Quantification Tool

**Beta Version** 

Julia McCarthy USEPA Region 8

The views expressed in this presentation are those of the author and do not necessarily represent the views or policies of the U.S. Environmental Protection Agency

Function-Based Framework for Stream Assessment and Restoration Projects

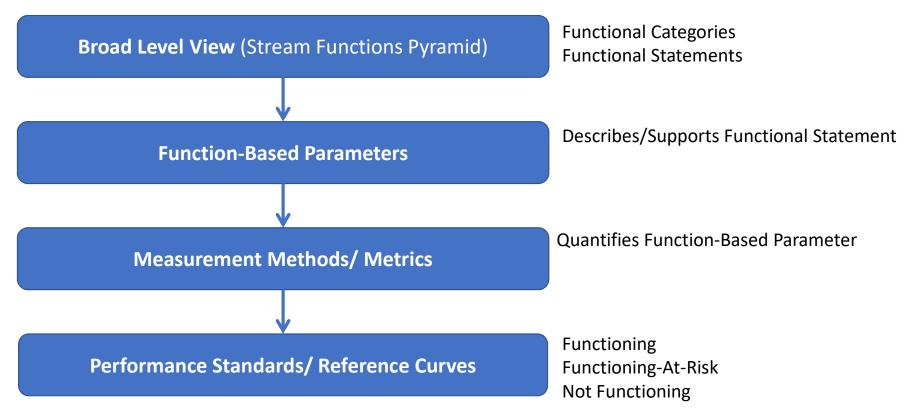


www.stream-mechanics.com

## Function - The physical, chemical, and biological processes that occur in ecosystems.

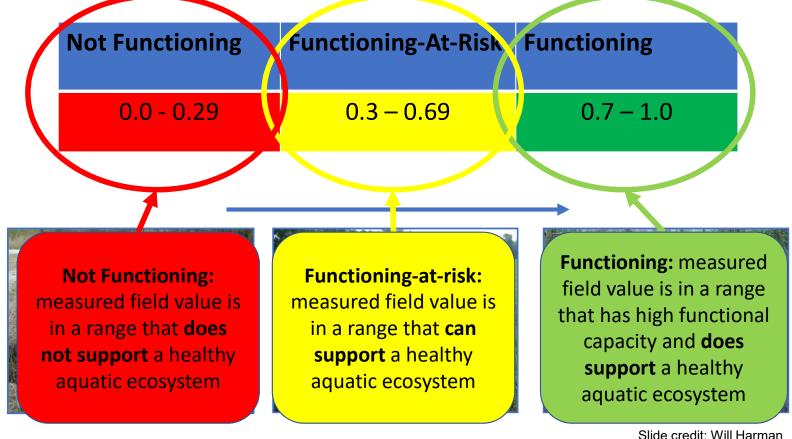
Biological	5 BIOLOGY » Biodiversity and the life his	stories of aquatic and riparian life		
Chemical 4	PHYSICOCHEMICAL » Temperature and oxygen regulation	n; processing of organic matter and nutrients		
	MORPHOLOGY » port of wood and sediment to create o	diverse bed forms and dynamic equilibrium		
	<b>&gt; »</b> ater in the channel, on the floodplain,	, and through sediments		
<b>HYDROLOGY »</b> Transport of water from	the watershed to the channel			
	1	1		
	Geology	Climate	Slide Credit:	Stream Mechanics

#### Stream Functions Pyramid Framework (SFPF)



Slide Credit: Stream Mechanics

# Reference Curves: translating field values into index values

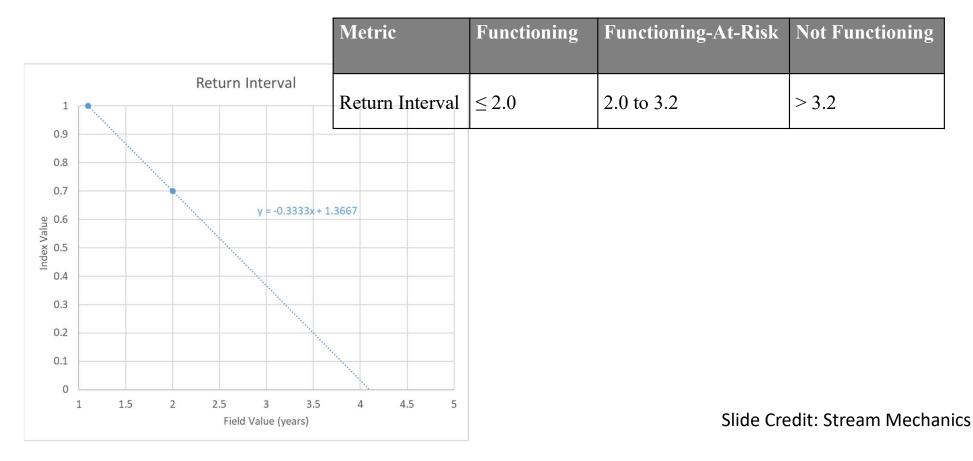


## Reference Standard Condition

- Functioning range of condition for a given metric
- Culturally Unaltered
- Minimal Disturbance
- Not the best attainable!
- Scores of 0.7 to 1.0 in the SQT
- Based on:
  - Values provided in peer-reviewed journals, government documents, books or proceeding papers;
  - Regional datasets; and
  - Best Professional Judgment.



#### Reference Curves: Floodplain Connectivity Example



## Stream Quantification Tools (SQTs)

Wyoming:

- WSQT Beta Version released for public comment August 2017
- WSQT v1.01 released July 2018 with minor updates October 2018

Colorado:

• CSQT Beta Version – released for public comment May 2019

Other SQTs:

- North Carolina (Harman and Jones 2017)
- Tennessee (TDEC 2018)
- Georgia (USACE 2018b)
- Minnesota (2019)

#### Colorado SQT

• **Purpose:** to calculate functional loss and lift associated with stream impacts and restoration projects by quantifying changes between existing and future stream condition at a site.

#### • Uses:

- To inform CWA 404 permitting and mitigation decisions
- To develop monitoring plans and set performance standards.
- To assist in site selection, determining restoration potential, and developing project specific functionbased goals and objectives

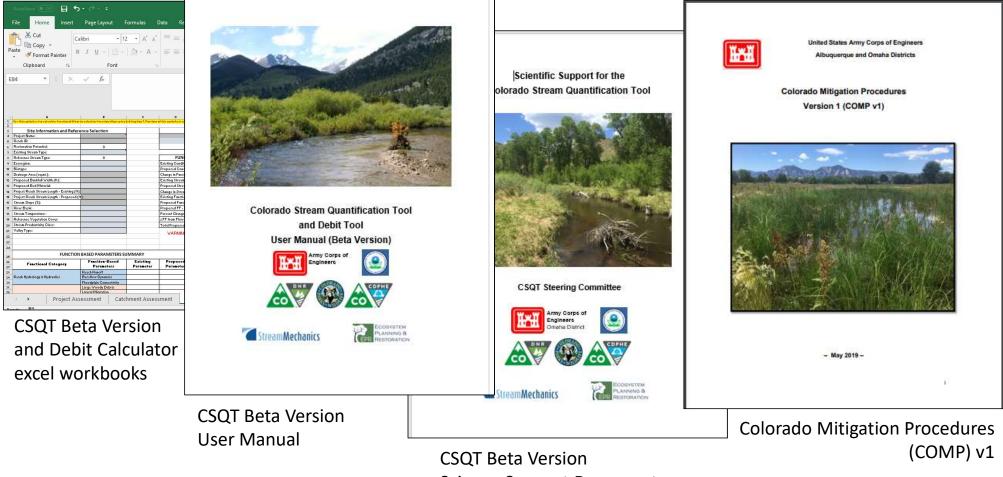


## Colorado SQT

- The Stream Quantification Tool measures reach-scale environmental outcomes of projects - It is NOT a design tool.
- In design, it is important to consider other analyses and watershed processes which are outside the scope of this tool.

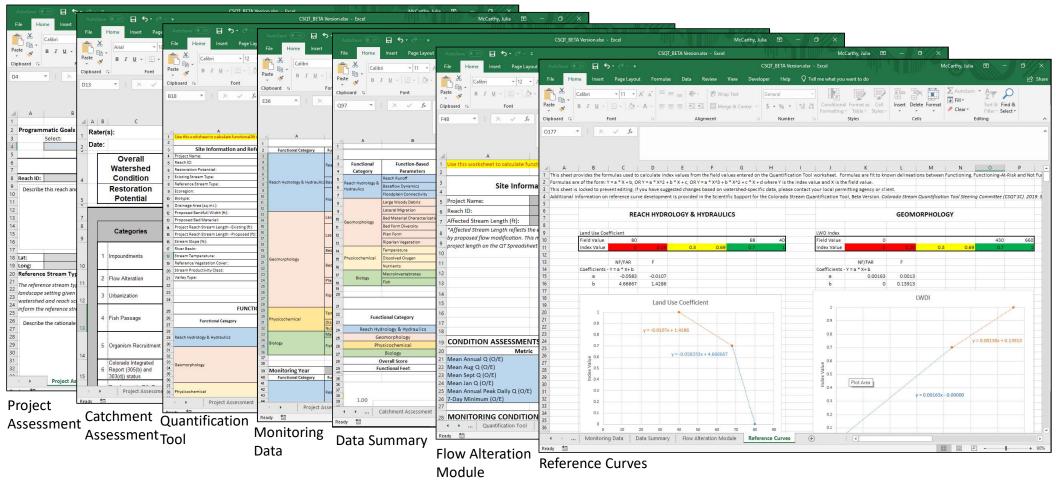


#### Colorado SQT and Related Documents



Science Support Document

#### CSQT Beta Version\*

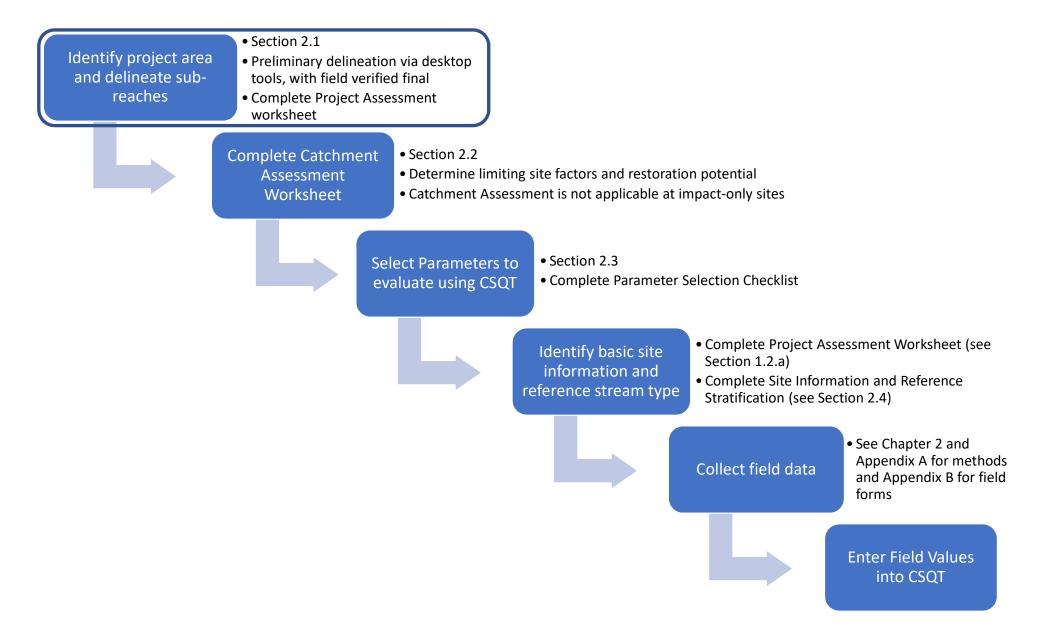


\*Use this workbook in reaches where an improved stream condition is anticipated and monitoring will be completed

#### CSQT Debit Calculator Beta Version\*

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3 Select:	2		1				1'
4	3 Site Information and Reference Sele     4 Project Name:	.e					17
5 - · p · · ·	4 Project Name: 5 Reach ID:	A	A 1 Use this worksheet to calculate funct				'
7 Reach Description	6 Restoration Potential:	4	1 Use this worksneet to calculate runce		F G H 1		0 P 🔺
8 Reach ID:	7 Existing Stream Type:		12			n Tool worksheet. Formulas are fit to known delineations between Functioning, Func	Inctioning-At-Risk and Not Fui
9 Describe this reach and reach break criteria:	8 Reference Stream Type:	A B	3 Site Informa	a 2 Formulas are of the form: Y = a * X + b, OR Y = a * X^2 + b * X + c, OR Y = a * ) 3 This sheet is locked to prevent editing. If you have suggested changes base			"
10 Describe this reach and reach break oncerta.	9 Ecoregion: 10 Biotype:	1 Use this worksheet to calculate functional loss using de	del 4	3 This sheet is locked to prevent editing. If you have suggested changes base		ntact your local permitting agency or client. am Quantification Tool, Beta Version, <i>Colorado Stream Quantification Tool Steering C</i> u	- Committee (CSOTSC) 2019 S
11	10 Biotype: 11 Drainage Area (sq.mi.):	2	5 Project Name:	4 Additional mormation on reference carve deteropment of protect	Sciencific support for the colorado at 1	Quantification root, beta version, colorodo on com quantification root	commutee (cour so). Loss.
12	11 Drainage Area (sq.mi.): 12 Proposed Bankfull Width (ft):	3 Site Information	6 Reach ID:			CEC MORPHOLOCY	
13	12 Proposed Bankfull Width (It): 13 Proposed Bed Material:	4 Permit Number:	7 Affected Stream Length (ft):	7 REACH HYDROLOGY & HYDR	RAULICS	GEOMORPHOLOGY	
14	14 Project Reach Stream Length - Existing (ft):	5 Project Name:		4 8			
15	15 Project Reach Stream Length - Proposed (ft):	6 Reach ID:	*Affected Stream Length reflects the e by proposed flow modification. This m	9 Land Use Coefficient		LWD Index	
16	16 Stream Slope (%):	7 Debit Option:	9 project length on the QT Spreadsheet		68 40	Field Value 0	430 660
17	17 River Basin:	8 Existing Stream Length (ft):	10	21 11 Index Value 0 0.29 0.3	0.69 0.7 1	Index Value 0 0.29 0.3 0.69	0.7 1
18 Lat:	18 Stream Temperature:	9 Proposed Stream Length (ft):		12 13 NE/FAR F		NF/FAR F	
19 Long:	19 Reference Vegetation Cover: 20 Stream Productivity Class:	10 Outstanding Water:		13 NF/FAR F 14 Coefficients - Y = a * X+ b		Coefficients - Y = a * X+ b	
20 Reference Stream Type:	20 Stream Productivity Class: 21 Valley Type:	11		15 a -0.0583 -0.0107		a 0.00163 0.0013	
21 The reference stream type is the stream type that should on		1	13	16 b 4.66667 1.4286		b 0 0.13913	
22 landscape setting given the hydrogeomorphic processes occ		12	114	17			
23 watershed and reach scales. Channel evolution scenarios sh		13		18 Land Use Coefficient		LWDI	
inform the reference stream type in the CSQT.	25 FUNCTION BASED P	D p 13 Impact Severity Tier:		19 Land Use Coefficient		1	
25	28 Function			21		0.9	
26 Describe the rationale used to select the reference stream				0.9		69	and the second s
27	28 Reach Hydrology & Hydraulics Baseflow D		18	23 0.8 y = -0.0107x + 1.4286	Au,	0.8	
28	29 Reach Hydrology & Hydraulics Baseflow D 30 Floodplain		19 CONDITION ASSESSMENTS	<b>FS</b> 24 0.7	The second secon		= 0.00130x + 0.13913
29	31 Large Wool	Vood	20 Metric	25 0.7		0.7	
31	32 33 Bed Materi		21 Mean Annual Q (O/E)	26 y = -0.058333x + 4.0	4666667	0.6	
32	34 Bed Form D	rm D 17	22 Mean Aug Q (O/E)	27 7 8 0.5			
	35 Plan Form	rm 18 a PCS	23 Mean Sept Q (O/E)	29 5 04	1	8 0.5	
Project Assessment     Catchment Assessment	en 36 Riparian Ve 37 Temperatu	in Ve 19 0.00	24 Mean Jan Q (O/E)	30		Plot Area	
La . 45	38 Physicochemical Dissolved C	red C 20	25 Mean Annual Peak Daily Q (O/E)	31 0.3		- 0.4 y = 0.00163x - 0.00000	
P - ! +	Project Assessment Catchme	21 Impact Severity Tier Multiplier (a)	26 7-Day Minimum (O/E)	32 0.2		0.3 Y = 0.00163x - 0.00000	
Project		Project Assessment   Qua	27	33			
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\*Use this workbook to evaluate reaches where adverse impacts (i.e., loss) will occur



#### Delineating project reaches

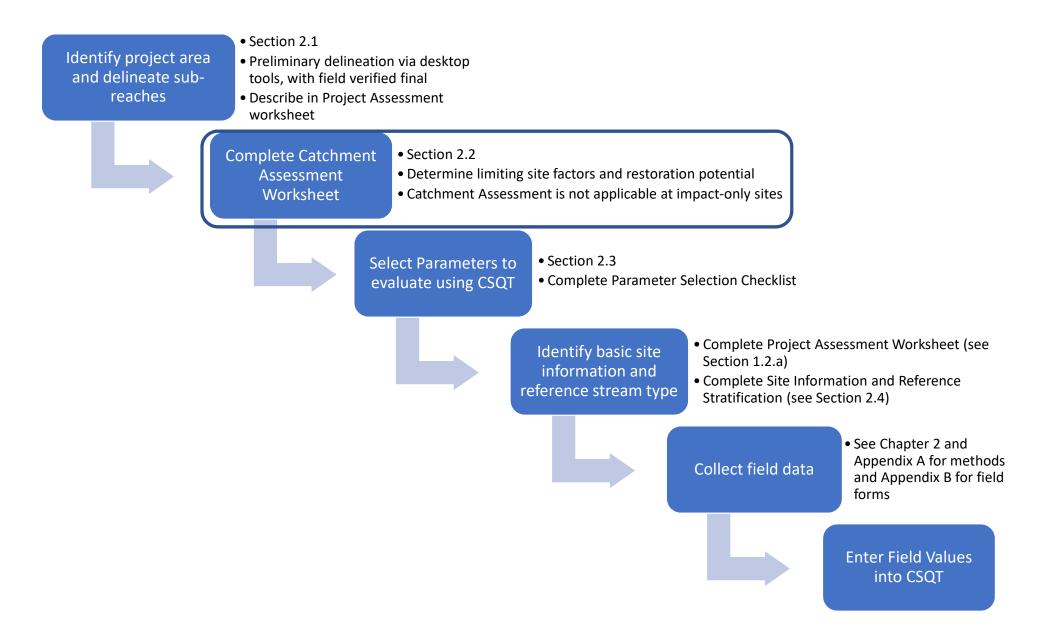
A project area should be broken into more than one project reach where there are:

- Multiple streams, e.g. tributaries vs. main stem.
- A tributary confluence.
- Changes to valley morphology, stream type or bed material composition.
- Diversion dams or other flow modification structures on the stream (separate reaches upstream and downstream of the structure; the structure would also be its own reach).
- Distinct changes in the level of anthropogenic modifications, such as narrowed riparian width from road embankments, concrete lined channels, dams, stabilization, or culverts/pipes.
- Differences in the magnitude of impact or mitigation approach (e.g., enhancement vs. restoration) within the project area.

An explanation of reach breaks should be included in the Reach Description section of the Project Assessment worksheet.



Step 1:
Reach segmentation based on physical characteristics
For example: Valley type, stream type, and restoration approach.
Reach Assessments: • Reach runoff and plan form • Armoring (if applicable to assess lateral migration)
Step 2:
Sub-Reach
20 times bankfull width or 2 meander wavelengths
FLOW
Sub-Reach Assessments: Floodplain connectivity, lateral migration, bed material characterization, bed form diversity, and riparian vegetation
<ul> <li>LWD is assessed for a 100m segment within the sub-reach</li> <li>Physicochemical and Biological parameters are sampled within the sub-reach</li> </ul>



#### **Restoration Potential**

The level of restoration that can be achieved based on catchment conditions, results of the reach assessment and project constraints.





#### **Restoration Potential**

# Full(Aqua)Partial can improvebiology, but not back to<br/>a reference standard<br/>condition.

Slide Credit: Stream Mechanics

#### Function-Based Goals and Objectives

- Goals explain the functional problem and state why the project is being pursued.
  - Programmatic
  - Design
- Objectives
  - Explain **how** the goals will be achieved.
  - List function-based parameters that will be manipulated in order to see lift.

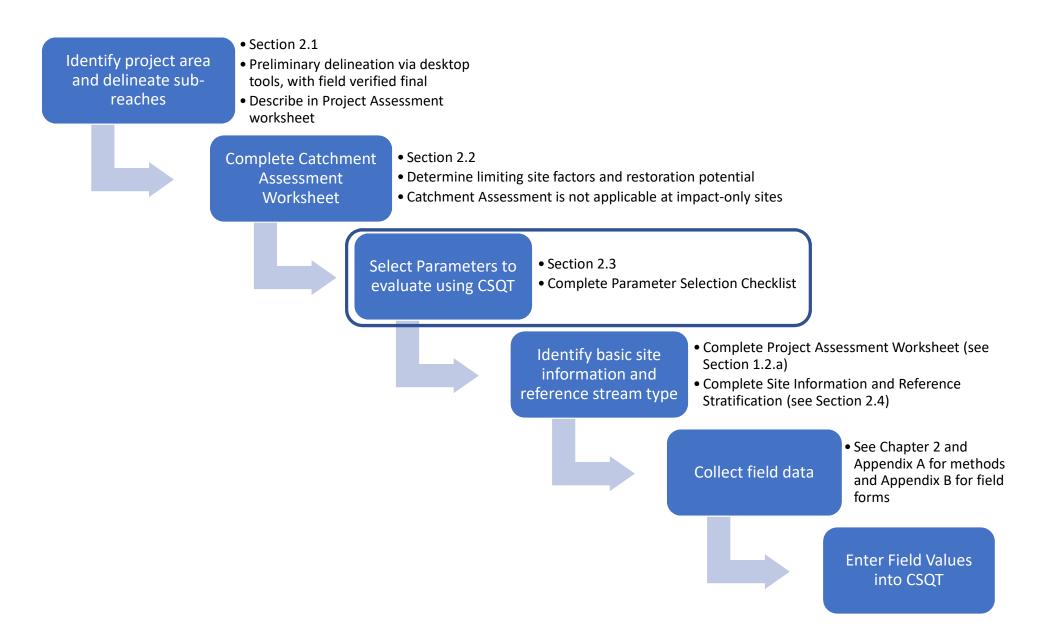
Slide Credit: Stream Mechanics

#### CSQT Beta Version\*

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grammatic Goals	Rate	r(s):				
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h ID:	4	Overall Watershed Condition		Describe how any Categories rated as Poor were co	nsidered in the selection of the restoration potential of	of the reach:
scribe this reach and	5	Restoration Potential				
	7		CA	TCHMENT ASSESSMENT		
	8			Description of Catchment Condition		Rating
	9	Categories	Poor	Fair	Good	(P/F/G)
;	10	1 Impoundments	Project area located less than 1 mile upstream or downstream of an impoundment; or impoundments are less proximate, but have adverse effects within the project area.	Project area is located 1 mile or more upstream or downstream of an impoundment.	No impoundment upstream or downstream of project reach.	
rence Stream Type eference stream type	11	2 Flow Alteration	Substantial reduction or augmentation to one or more aspects of natural flow regime.	Moderate reduction or augmentation to one or more aspects of natural flow regime.	Little or no reduction or augmentation of natural flow regime.	
	12	3 Urbanization	Urban or rapidly urbanizing with ongoing or imminent large scale development.	Low density or rural communities or slow urban or suburban growth.	Predominantly natural land cover; or rural.	
			inninient laige seale aereiephient.	i grown grown		
rshed and reach sc m the reference stre scribe the rationale		4 Fish Passage	Reach isolated by upstream and downstream anthropogenic barriers within 10 miles; or barriers otherwise severely affect fish populations within the project reach.	Reach isolated by upstream OR downstream anthropogenic barrier within 10 miles; or barriers otherwise have moderate effects on fish populations within the project reach.	No anthropogenic barriers within 10 miles upstream or downstream of the reach; or barriers otherwise have no effect on fish populations within a project reach.	
rshed and reach so m the reference stre scribe the rationale	13	4 Fish Passage 5 Organism Recruitment	Reach isolated by upstream and downstream anthropogenic barriers within 10 miles; or barriers otherwise severely affect fish populations within the project reach. Channel immediately upstream or downstream of project reach (i.e., within 14 mor 0.62 mi) is concrete, piped, or hardened.	Reach isolated by upstream OR downstream anthropogenic barrier within 10 miles; or barriers of herwise have moderate effects on fish populations within the project reach. Channel immediately upstream or downstream of project reach (i.e., within 1 km or 0.52 mi) native bed and bank material that is highly embedded by fine sediment.	or downstream of the reach; or barriers otherwise have no effect on fish populations within a project	
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Assessment

\*Use this workbook in reaches where an improved stream condition is anticipated and monitoring will be completed



## CSQT Beta Version Parameters and Metrics

Functional Category	Function-Based Parameter	Metric
		Land Use Coefficient
	Reach Runoff	Impervious Cover (%)
	Reach Runott	Concentrated Flow Points (#/1000 LF)
		Water Quality Capture Volume
Peach Hydrology & Hydroylice	Racoflow Dynamics	Average Velocity (fps)
Reach Hydrology & Hydraulics	cs Baseflow Dynamics	Average Depth (ft)
		Return Interval (yr)
	Elecatelain Connectivity	Bank Height Ratio
	Floodplain Connectivity 🗙	Entrenchment Ratio
		Percent Side Channels (%)

Starred parameters are recommended at every site; additional parameters and metrics should be selected based upon a project's restoration potential and function-based goals and objectives.

#### CSQT Beta Version Parameters and Metrics

	Large Woody Debris	LWD Index
		No. of LWD Pieces/ 100 meters
		Greenline Stability Rating
	Lateral Migration 🛧	Dominant BEHI/NBS
		Percent Streambank Erosion (%)
		Percent Armoring (%)
	Bed Material Characterization	Size Class Pebble Count Analyzer (p-value)
Geomorphology	Bed Form Diversity ★	Pool Spacing Ratio
		Pool Depth Ratio
		Percent Riffle (%)
		Aggradation Ratio
	Plan Form	Sinuosity
		Riparian Width (%)
	Riparian Vegetation 🗡	Woody Vegetation Cover (%)
		Herbaceous Vegetation Cover (%)
		Percent Native Cover (%)

Starred parameters are recommended at every site; additional parameters and metrics should be selected based upon a project's restoration potential and function-based goals and objectives.

## CSQT Beta Version Parameters and Metrics

Dhusiaachamisal	Temperature	Daily Maximum Temperature (°C) MWAT (°C)
Physicochemical	Dissolved Oxygen	Dissolved Oxygen Concentration (mg/L)
	Nutrients	Chlorophyll a (mg/m2)
	Macroinvertebrates	CO MMI
Biology		Native Fish Species Richness (% of Expected)
Diology	Fish	SGCN Absent Score
		Wild Trout Biomass (% Change)

 $\bigstar$ 

Starred parameters are recommended at every site; additional parameters and metrics should be selected based upon a project's restoration potential and function-based goals and objectives.

Project: Reach ID:

#### Colorado Stream Quantification Tool Parameter Selection Checklist

	Function-Based Parameter	Metric(s)	Datasheets for Field-based Metrics
1	Reach Runoff*	Land Use Coefficient (D) AND Concentrated Flow Points (#)	Project Reach Form Section II(b)**
		ar	
		Impervious Cover (D) AND Concentrated Flow Points (F)	Project Reach Form Section II(b)**
		ar	
		Water Quality Capture Volume (D)	
		In the second	in the second
	Baseflow Dynamics	Optional: Velocity AND Average Depth (D/F)	Cress Section Form
		11	1
2		Bank Height Ratio AND Entrenchment Ratio (F)	Cross Section Form OR Rapid Survey
	200200000000000000000000000000000000000		Form**
	Floodplain Connectivity*	ar	1
		Return Interval (D) AND Entrenchment Ratio (F)	Cross Section Form
		Optional: Percent Side Channels (F)	Project Reach Form Section II(d)**
-			
H		Optional: UWD index (F)	LWDI Form or fillable workbook**
	Large Woody Debris (LWD)	a	-
_		Optional: No. of LWD Pieces/ 100 meters (F)	Project Reach Form Section VI**
-			
2		LJ Dominant BEHI/NBS AND Percent Streambank Erosion (F)	Lateral Migration Form**
1	Lateral Migration*	47	
		Greenine Stability Rating (F)	Available in Winward (2000)
		Optional: Percent Armoning (F)	Project Reach Form Section II(c)**
_			
	Sed Material Characterizatio	ILL Optional: Percent Armoning (F)	Project Reach Form Section ((c)** Pebble Count Form
	Bed Material Characterizatio	n 🔲 Optional: Size Class Pebble Count Analyzer (F)	Pebble Count Form
	8ed Material Characterizatio		Pebble Count Form
	Bed Material Characterizatio Bed Form Diversity*	n 🔲 Optional: Size Class Pebble Count Analyzer (F)	Pebble Court Form Longitudinal Survey OR Rapid Survey Form**
		n 🔲 Optional: Size Class Pebble Count Analyzer (F)	Pebble Count Form Longitudinal Survey OR Rapid Surve Form** Cross Section Form OR Rapid Survey
		Optional: Spe Class Pebble Count Analyzer (F)     Pool Spacing Ratio AND Pool Depth Ratio AND Percent Riffle* (F)	Pebble Court Form Longitudinal Survey OR Rapid Survey Form**
	Bed Form Diversity*	Optionol: Spe Class Pebble Count Analyzer (F)     Pool Spacing Ratio AND Pool Depth Ratio AND Percent Niffle* (F)     Optionol: Aggradation Ratio (F)	Pebble Count Form Longitudinal Survey OR Aspid Surve Form** Cross Section Form OR Rapid Surve Form**
		Optional: Spe Class Pebble Count Analyzer (F)     Pool Spacing Ratio AND Pool Depth Ratio AND Percent Riffle* (F)	Pebble Count Form Longitudinal Survey OR Aspid Surve Form** Cross Section Form OR Rapid Surve Form**
	Bed Form Diversity*	Optional: Size Class Pebble Count Analyzer (F)     Optional: Size Class Pebble Count Analyzer (F)     Optional: Aggradation Ratio (F)     Optional: Sinussity (F)	Pebble Count Form Longitudinal Survey OR Rapid Surve Form** Oross Section Form OR Rapid Surve Form** Project Reach Form Section II(e)**
	Bed Form Diversity*	Optional: Size Class Pebble Count Analyzer (F)     Optional: Size Class Pebble Count Analyzer (F)     Optional: Aggradation Ratio (F)     Optional: Aggradation Ratio (F)     Optional: Sinussity (F)     Riperian Width (D/F) AND Woody Vegetation Cover (F) AND	Pebble Count Form Longitudinal Survey OR Rapid Surve Form** Cross Section Form OR Rapid Surve
	Bed Form Diversity*	Optional: Size Class Pebble Count Analyzer (F)     Optional: Size Class Pebble Count Analyzer (F)     Optional: Aggradation Ratio (F)     Optional: Sinusity (F)	Pebble Count Form Longitudinal Survey OR Rapid Surve Form** Cross Section Form OR Rapid Surve Form** Project Reach Form Section II(e)** Inperian Width and Riparian Vegotati
	Bed Form Diversity* (Plan Form Siparian Vegetation*	Optional: Spe Class Pebble Count Analyzer (F)     Optional: Spe Class Pebble Count Analyzer (F)     Optional: Aggradation Ratio (F)     Optional: Sinusity (F)     Optional: Sinusity (F)     Riparian Width (D/F) AND Woody Vegetation Cover (F) AND     Herbaceous Vegetation Cover (F) AND Percent Native Cover (F)*	Pebble Count Form Longibutinal Survey OR Rapid Surve Form** Oross Section Form OR Rapid Surve Form** Project Reach Form Section II(e)** Niparian Width and Riparian Vegetati Forms**
	Bed Form Diversity*	Optional: Spe Class Pebble Count Analyzer (F)     Optional: Spe Class Pebble Count Analyzer (F)     Optional: Aggradation Ratio (F)     Optional: Sinusity (F)     Optional: Sinusity (F)     Planetan Width (D/F) AND Woody Vegetation Cover (F) AND     Merbacanus Vegetation Cover (F) AND Percent Native Cover (F)*     Optional: Daily Maximum Temperature (F) AND Maximum Weekly	Pebble Count Form Longitudinal Survey OR Rapid Surve Form** Cross Section Form OR Rapid Surve Form** Project Reach Form Section II(e)** Inperian Width and Riparian Vegetat
	Bed Form Diversity* (Plan Form Siparian Vegetation*	Optional: Spe Class Pebble Count Analyzer (F)     Optional: Spe Class Pebble Count Analyzer (F)     Optional: Aggradation Ratio (F)     Optional: Sinusity (F)     Optional: Sinusity (F)     Riparian Width (D/F) AND Woody Vegetation Cover (F) AND     Herbaceous Vegetation Cover (F) AND Percent Native Cover (F)*	Pebble Count Form Longibutinal Survey OR Rapid Surve Form** Oross Section Form OR Rapid Surve Form** Project Reach Form Section II(e)** Niparian Width and Riparian Vegetati Forms**
	Bed Form Diversity* Plan Form Riparian Vegetation* Temperature	Optional: Size Class Pebble Count Analyzer (F)     Optional: Size Class Pebble Count Analyzer (F)     Optional: Aggradation Ratio (F)     Optional: Sinusity (F)     Riparian Width (D(F) AND Woody Vegetation Cover (F) AND     Herbaceous Vegetation Cover (F) AND Percent Native Cover (F)*     Optional: Oaily Maximum Temperature (F) AND Maximum Weekly     Average Temperature (F)	Pubble Count Form Longitudinal Survey OR Rapid Surve Form** Cross Section Form OR Rapid Surve Form** Project Reach Form Section II(e)** Nparian Width and Riparian Vegetati Forms** Sensor Log
	Bed Form Diversity* (Plan Form Siparian Vegetation*	Optional: Spe Class Pebble Count Analyzer (F)     Optional: Spe Class Pebble Count Analyzer (F)     Optional: Aggradation Ratio (F)     Optional: Sinusity (F)     Optional: Sinusity (F)     Planetan Width (D/F) AND Woody Vegetation Cover (F) AND     Merbacanus Vegetation Cover (F) AND Percent Native Cover (F)*     Optional: Daily Maximum Temperature (F) AND Maximum Weekly	Pebble Count Form Longibutinal Survey OR Rapid Surve Form** Oross Section Form OR Rapid Surve Form** Project Reach Form Section II(e)** Niparian Width and Riparian Vegetati Forms**
	Bed Form Diversity* Plan Form Riparian Vegetation* Temperature	Optional: Size Class Pebble Count Analyzer (F)     Optional: Size Class Pebble Count Analyzer (F)     Optional: Aggradation Ratio (F)     Optional: Aggradation Ratio (F)     Optional: Sinussity (F)     Riparian Width (D/F) AND Woody Vegetation Cover (F) AND     Herbscenus Vegetation Cover (F) AND Percent Native Cover (F)*     Optional: Only Maximum Temperature (F) AND Maximum Weekly     Average Temperature (F)     Optional: Dissolved Oxygen Concentration (F)	Pebble Count Form Longibudinal Survey OR Rapid Surve Form** Cross Section Form OR Rapid Surve Form** Project Reach Form Section It(e)** Inperian Width and Riparian Vegotati Sorms* Sensor Log Sensor Log
	Bed Form Diversity* Plan Form Riparian Vegetation* Temperature Dissolved Oxygen	Optional: Size Class Pebble Count Analyzer (F)     Optional: Size Class Pebble Count Analyzer (F)     Optional: Aggradation Ratio (F)     Optional: Sinusity (F)     Riparian Width (D(F) AND Woody Vegetation Cover (F) AND     Herbaceous Vegetation Cover (F) AND Percent Native Cover (F)*     Optional: Oaily Maximum Temperature (F) AND Maximum Weekly     Average Temperature (F)	Pebble Count Form Longibudinal Survey OR Rapid Surve Form** Cross Section Form OR Rapid Surve Form** Project Reach Form Section It(e)** Inperian Width and Riparian Vegotati Sorms* Sensor Log Sensor Log
	Bed Form Diversity* Plan Form Riparian Vegetation* Temperature Dissolved Oxygen	Optional: Size Class Pebble Count Analyzer (F)     Optional: Size Class Pebble Count Analyzer (F)     Optional: Aggradation Ratio (F)     Optional: Aggradation Ratio (F)     Optional: Sinussity (F)     Riparian Width (D/F) AND Woody Vegetation Cover (F) AND     Herbscenus Vegetation Cover (F) AND Percent Native Cover (F)*     Optional: Only Maximum Temperature (F) AND Maximum Weekly     Average Temperature (F)     Optional: Dissolved Oxygen Concentration (F)	Pebble Count Form Longitudinal Survey OR Rapid Surve Form** Cross Section Form OR Rapid Surve Form** Project Reach Form Section II(e)** Riparian Width and Riparian Vegetati Forms** Sensor Log Sensor Log Physicochemical and Biology Form
	Bed Form Diversity* Plan Form Riparian Vegetation* Temperature Dissolved Oxygen Nutrients	Optional: Size Class Pebble Count Analyzer (F)     Optional: Size Class Pebble Count Analyzer (F)     Optional: Aggradation Ratio (F)     Optional: Sinusity (F)     Riparian Width (D/F) AND Woody Vegetation Cover (F) AND     Herbecams Vegetation Cover (F) AND Percent Native Cover (F)*     Optional: Daily Maximum Temperature (F) AND Maximum Weekly     Average Temperature (F)     Optional: Dissolved Oxygen Concentration (F)     Optional: Chicrophyllia (F)	Pebble Count Form Longitudinal Survey OR Rapid Surve Form** Cross Section Form OR Rapid Surve Form** Project Reach Form Section II(e)** Riparian Width and Riparian Vegetati Forms** Sensor Log Sensor Log Physicochemical and Biology Form
	Bed Form Diversity* Plan Form Riparian Vegetation* Temperature Dissolved Oxygen Nutrients	Optional: Size Class Pebble Count Analyzer (F)     Optional: Size Class Pebble Count Analyzer (F)     Optional: Aggradation Ratio (F)     Optional: Sinusity (F)     Riparian Width (D/F) AND Woody Vegetation Cover (F) AND     Herbecams Vegetation Cover (F) AND Percent Native Cover (F)*     Optional: Daily Maximum Temperature (F) AND Maximum Weekly     Average Temperature (F)     Optional: Dissolved Oxygen Concentration (F)     Optional: Chicrophyllia (F)	Pubble Count Form Longitudinal Survey OR Rapid Surve Form** Cross Section Form OR Rapid Surve Form** Project Reach Form Section II(e)** Nparian Width and Riparian Vegetati Forms** Sensor Log

	Different: Mean Annual Flow	Sensor Log
	Optional: Mean August AND September Flow	Sensor Log
Flow Alteration Module	Optional: Mean January Flow	Sensor Log
	Optional: Mean Annual Peak Daily Flow	Sensor Log
	Optional: 7-Day Minimum	Sensor Log

\* Include in all assessments

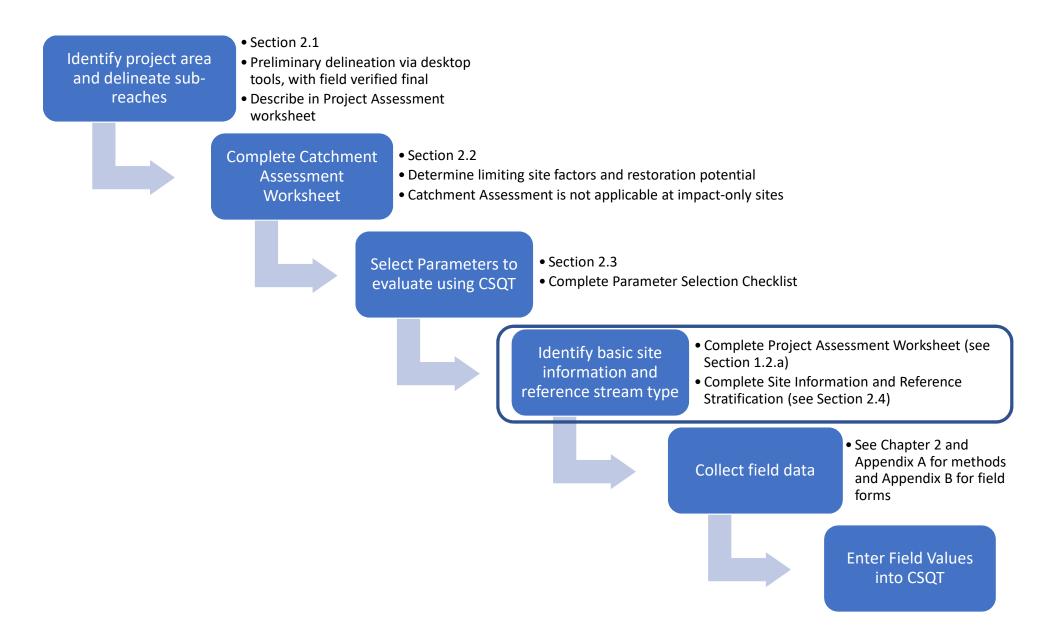
\*\* Field values can be entered directly from field forms into CSQT; all other metrics require additional post-processing or analysis to calculate values.

(D) indicates metrics are calculated using desistop methods

(F) indicates metrics are calculated or verified using field methods

Applicable Parameters	Perennial	Intermittent	Ephemeral	Multi-thread Channels
Reach Runoff	Х	X	Х	Х
Base Flow Dynamics	Х	X		Х
Floodplain Connectivity	X	X	Х	X
Large Wood	X	X	Х	X
Lateral Migration	X	X	Х	X
Bed Material	X	X	Х	Х
Bedform Diversity	X	X		
Planform	X	X		
Riparian Vegetation	X	X	Х	Х
Temperature	Х	Where		X
Dissolved Oxygen	X	baseflows		Х
Nutrients	Х	extend through		Х
Macroinvertebrates	Х	index period		Х
Fish	Х	X		Х
Flow Alteration Module	Х			

Alternate field methodologies may be needed for some metrics when applied in multi-thread and non-wadeable stream systems.



#### **Basic Site Information**

Site Information and Reference Selection			
Project Name:	Halfmoon Example		
Reach ID:	1		
Restoration Potential:	Partial		
Existing Stream Type:	С		
Reference Stream Type:	Ва		
Ecoregion:	Mountains		
Biotype:	1		
Drainage Area (sq.mi.):	23.4		
Proposed Bankfull Width (ft):	25		
Proposed Bed Material:	Gravel		
Project Reach Stream Length - Existing (ft):	1000		
Project Reach Stream Length - Proposed (ft):	1200		
Stream Slope (%):	0.5		
River Basin:	Arkansas		
Stream Temperature:	WS-I		
Reference Vegetation Cover:	Forested		
Stream Productivity Class:	Moderate		
Valley Type:	Confined Alluvial		

Basic Site Information is entered on the Quantification Tool worksheet.

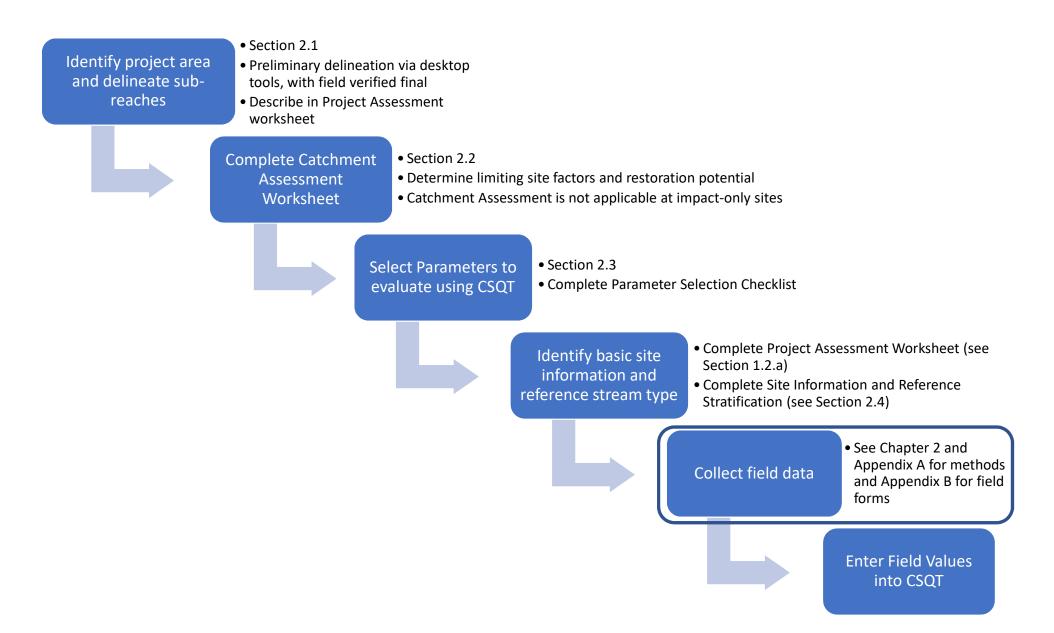
Information on each entry can be found in Section 2.4 of the CSQT User Manual.

#### Reference Stream Type

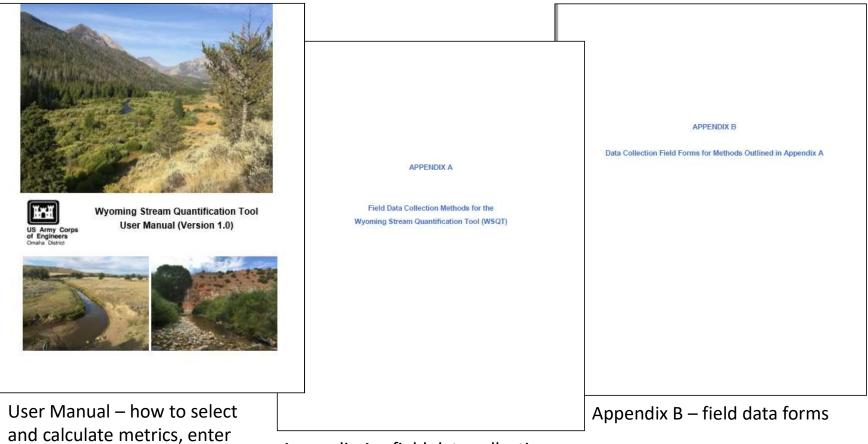
Stream Evolution Model Stages	Corresponding Rosgen
(Cluer and Thorne 2013)	Stream Types
Stage 0 - Anastomosing	DA
Stage 1 – Sinuous Single Thread	C, E
Stage 2 - Channelized	C, E, → Gc
Stage 3 - Degradation	Gc
Stage 3a – Arrested Degradation	$Gc \longrightarrow F \longrightarrow Bc$
Stage 4 – Degradation and Widening	Gc → F
Stage 5 – Aggradation and Widening	F→ C
Stage 6 – Quasi Equilibrium	C, E
Stage 7 – Laterally Active	C, E, F
Stage 8 - Anastomosing	DA

Reference Stream Type is entered on the Project Assessment worksheet, which also includes space to describe rationale used to select reference stream type.

Information on determining stream type can be found in Section 2.4 of the CSQT User Manual.



#### Colorado SQT User Manual



Appendix A – field data collection methods

data into tool, and calculate

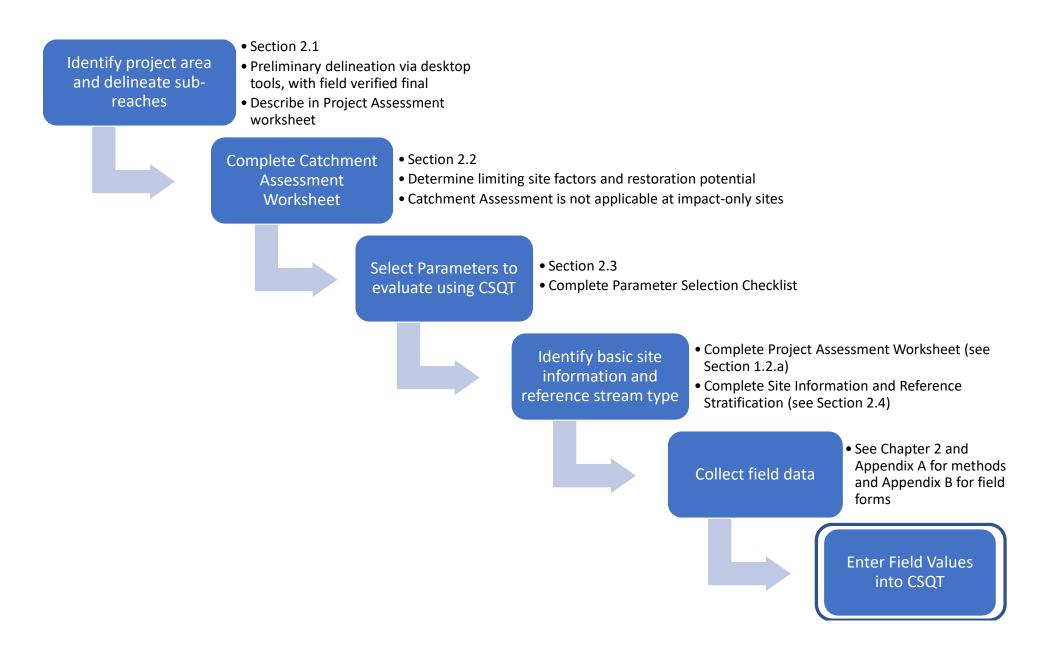
functional lift/loss

## Appendix B Field Forms

- Parameter Selection Checklist
- Project Reach Form
- Longitudinal Survey Form
- Standard Cross-Section Form
- Rapid Survey Form
- Lateral Migration Form
- Riparian Width Form
- Riparian Veg Form
- Physicochemical and Biological Form
- Pebble Count Form
- Sensor Log

Note: The Parameter Selection Checklist indicates which forms should be completed for each selected metric

Project Name:	nformation		
Reach ID:			
Dialnage Area (sq. mi.):			
Flow Type:		Shading Key	
River Basin:	100	Desktop Value	
Valley Type:		Fidd Value	
Stream Reachlength (ft):			
Latitude			
Longitude:			
Rea	ach Walk		
Difference between bankfull (BKF) stage			
and water surface (WS) (ff)	+ $+$		+
Difference between BKF stage and WS (ft)			
Average or cansensus value from reach walk.	1 1		
Number Concentrated Flow Points			
Concentrated Flow Points/ 1,000 L.F.			
Length of Armoning on banks (fr	-	T T	T T
debidebidebidebidebi			-
Total (ft)			
Percent Armoning (%)			
Length of Side Channels (f	1		5 5
Total(ft)			
Percent Side Channels (%)		10 (N	20 0
Valley length (ft)			
Stream Length (ft)			
Sinuosity			
STRUCKY			
Identification of Re	epresentative	Sub-Reach	
Representative Sub Reach Length		20*Bankfull Width	
At least 20x the Bankfull Width		20"Banktuli Width	
Latitude of downstream extent:	50 E	÷.	·:-:-:-:-:-:-:
Longitude of downstream extent:			
Longitude of downstream extent:			
Sub-Reach Survey Method			
Longtudinal Profile & Cross Section			
n Rapid Survey			



Land Use Coefficient Impervious Cover (%) Concentrated Flow Points (#/1000 LF) Water Quality Capture Volume Average Velocity (fps) Average Depth (ft) Return Interval (yr)		-
Average Velocity (fps) Average Depth (ft) Return Interval (yr)		-
Return Interval (yr)		
Bank Height Ratio Entrenchment Ratio Percent Side Channels (%)		
LWD Index No. of LWD Pieces/ 100 meters		
Greenline Stability Rating Dominant BEHI/NBS Percent Streambank Erosion (%) Percent Armoring (%)		
on Size Class Pebble Count Analyzer (p-value)	1	
Pool Spacing Ratio Pool Depth Ratio Percent Riffle (%) Aggradation Ratio		
Sinuosity	0	
Riparian Width (%) Woody Vegetation Cover (%) Herbaceous Vegetation Cover (%) Percent Native Cover (%)		
Daily Maximum Temperature (°C) MWAT (°C)		
Dissolved Oxygen Concentration (mg/L)		
Chlorophyll a (mg/m2)	ſ.	
CO MMI	ā.	
Native Fish Species Richness (% of Expected) SGCN Absent Score		
	Dissolved Oxygen Concentration (mg/L) Chlorophyll a (mg/m2) CO MMI Native Fish Species Richness (% of Expected) SGCN Absent Score	Dissolved Oxygen Concentration (mg/L) Chlorophyll a (mg/m2) CO MMI Native Fish Species Richness (% of Expected)

Field Values are calculated, then entered into the Existing Condition section of the Quantification Tool worksheet

#### Estimating Proposed Condition Field Values

- Field values are entered into the Proposed Condition section of the Quantification Tool worksheet.
- Proposed condition field values should consist of reasonable values for restored and impacted conditions. Users should rely on available data to estimate proposed condition field values, including project design studies and calculations, drawings, field investigations, and best available science.
- The same parameters used to calculate the existing condition score must also be used to estimate the proposed condition score.
- Proposed condition scores need to be verified using as-built and post-project monitoring data

Function-Based Parameter	nction-Based Parameter Metric		
Reach Runoff	Land Use Coefficient Impervious Cover (%) Concentrated Flow Points (#/1000 LF) Water Quality Capture Volume		
Baseflow Dynamics	Average Velocity (fps) Average Depth (ft)		
Floodplain Connectivity	Return Interval (yr) Bank Height Ratio Entrenchment Ratio Percent Side Channels (%)		
Large Woody Debris	LWD Index No. of LWD Pieces/ 100 meters		
Lateral Migration	Greenline Stability Rating Dominant BEHI/NBS Percent Streambank Erosion (%) Percent Armoring (%)		
Bed Material Characterization	Size Class Pebble Count Analyzer (p-value)		
Bed Form Diversity	Pool Spacing Ratio Pool Depth Ratio Percent Riffle (%) Aggradation Ratio		
Plan Form	Sinuosity		
Riparian Vegetation	Riparian Width (%) Woody Vegetation Cover (%) Herbaceous Vegetation Cover (%) Percent Native Cover (%)		
Temperature	Daily Maximum Temperature (°C) MWAT (°C)		
Dissolved Oxygen	Dissolved Oxygen Concentration (mg/L)		
Nutrients	Chlorophyli a (mg/m2)		
Macroinvertebrates	COMMI		
Fish	Native Fish Species Richness (% of Expected) SGCN Absent Score Wild Trout Biomass (% Change)		

Functional Category	Function-Based Parameter	Parameter	Category	Category
	Reach Runoff	0.46		
Reach Hydrology & Hydraulics	Baseflow Dynamics	0.59	0.50	Functioning At Risk
	Floodplain Connectivity 0.44			
	Large Woody Debris	0.16		
	Lateral Migration	0.30		< <u> </u>
	Bed Material Characterization			
eomorphology	Bed Form Diversity	0.23	0.31	Functioning At Risk
	Plan Form	0.36		
	Riparian Vegetation	0.49		
hysicochemical	Temperature	0.39	0.40	Functioning
nysicucineniicai	Dissolved Oxygen	0.47	0.40	At Risk
	Nutrients	0.35		
	Macroinvertebrates	0.07		
iology	Fish	0.19	0.13	Not Functioning

FUNCTIONAL CHANGE SUMMARY					
Existing Condition Score (ECS)	0.44				
Proposed Condition Score (PCS)	0.75				
Change in Functional Condition (PCS - ECS)	0.31				
Existing Stream Length (ft)	2000				
Proposed Stream Length (ft)	2500				
Change in Stream Length (ft)	500				
Existing Functional Feet (FF)	880				
Proposed Functional Feet (FF)	1875				
Proposed FF - Existing FF (ΔFF)	995				
Percent Change in FF (%)	113%				
ΔFF from Flow Alteration Module	441.70				
Total Proposed FF - Existing FF (ΔFF)	1436.70				
FUNCTIONAL CATEGORY REPORT					

#### FUNCTIONAL CATEGORY REPORT CARD

Functional Category	ECS	PCS	Functional Change
Reach Hydrology & Hydraulics	0.50	0.80	0.30
Geomorphology	0.33	0.80	0.47
Physicochemical	0.40	0.65	0.25
Biology	0.13	0.15	0.02

#### FUNCTION BASED PARAMETERS SUMMARY

Functional Category	Function-Based Parameters	Existing Parameter	Proposed Parameter
	Reach Runoff	0.46	0.46
Reach Hydrology & Hydraulics	Baseflow Dynamics	0.59	1.00
	Floodplain Connectivity	0.44	0.94
	Large Woody Debris	0.16	0.32
	Lateral Migration	0.40	1.00
Geomorphology	Bed Material Characterization		
	Bed Form Diversity	0.23	0.89
	Plan Form	0.36	1.00
	Riparian Vegetation	0.49	0.80
Physicochemical	Temperature	0.39	0.89
	Dissolved Oxygen	0.47	0.70
	Nutrients	0.35	0.35
Piology	Macroinvertebrates	0.07	0.12
Biology	Fish	0.19	0.19





#### **Existing Condition:**

SCORE Existing Condition Score: 0.21

X QUANTITY Existing Stream Length: 1600 Ft

**FUNCTIONAL FEET (FF)** FF = 336 Functional Feet

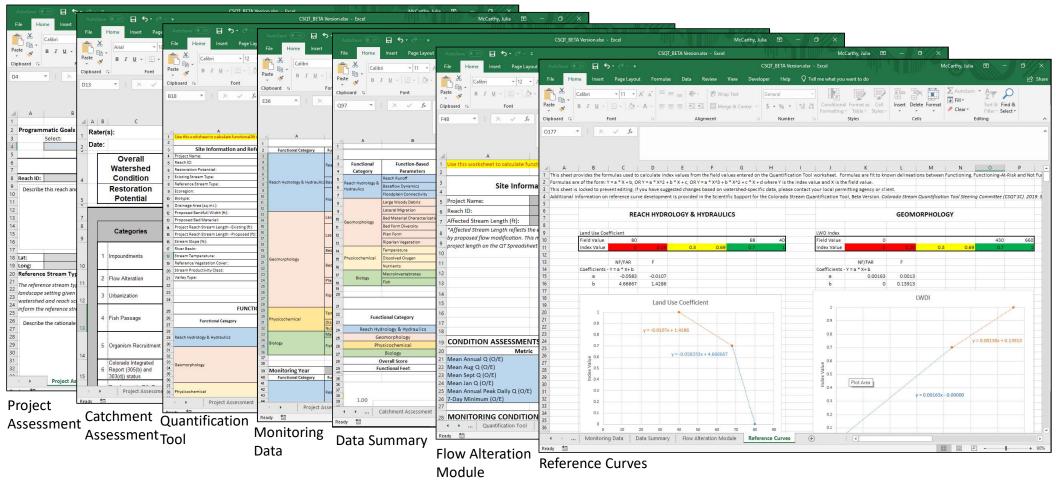
#### **Proposed Condition:**

Proposed Condition Score: 0.75 Proposed Stream Length: 1640 Ft FF = 1,230 Functional Feet



Slide credit: Will Harman

#### CSQT Beta Version\*



\*Use this workbook in reaches where an improved stream condition is anticipated and monitoring will be completed