# Developing debit and credit methodologies that consider stream functions

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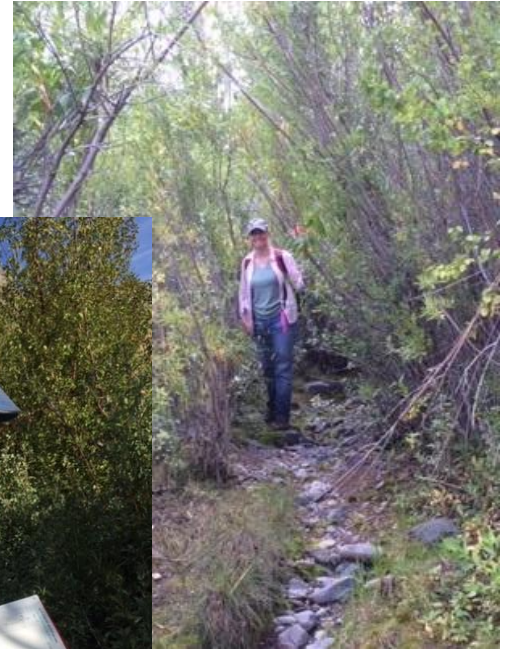
Lessons learned from mitigation and restoration

- In the '80s and '90s, research and experience began to raise important questions about the success and effectiveness of mitigation *(2001; NRC)*
- **Improving effectiveness:** ensure sustainable, ecologically effective projects with improved planning, development, implementation and performance monitoring. *(2008 Mitigation Rule; USEPA and Corps)*
- **Measuring success:** How do we know if stream restoration projects improve stream functions? Need to ask the right questions. *(2016; ELI, Stream Mechanics and TNC)*

2008 Mitigation Rule

"… the amount of required compensatory mitigation must be, to the extent practicable, sufficient to replace lost aquatic resource functions."

"Credits and debits are units of measure… that represent the accrual or attainment of aquatic functions at a mitigation site, or the loss of aquatic functions at an impact site"

*2008 Compensatory Mitigation For Losses of Aquatic Resources Rule
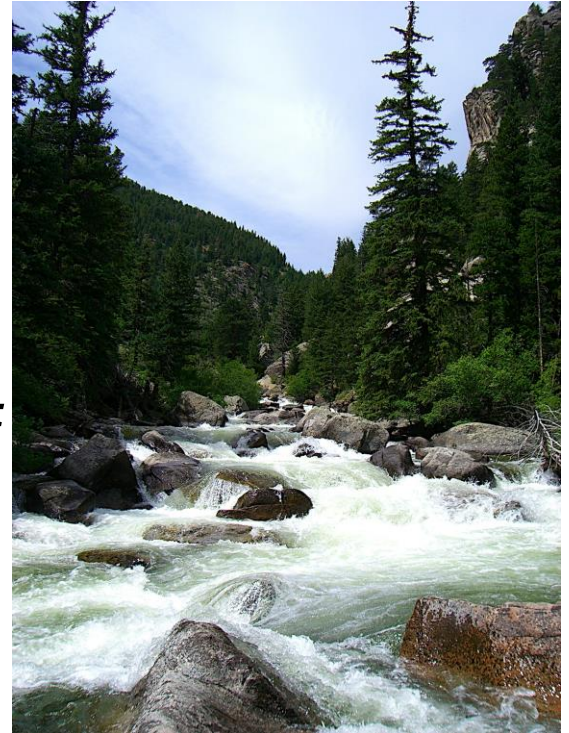
Stream Mitigation Decisions

- Currently a range of approaches throughout the country for calculating credits and debits

- Few debit and credit methods incorporate stream function or condition; availability of assessment methods is often limited.

  (See ELI's State of Stream Compensatory Mitigation: Science, Policy, and Practice)
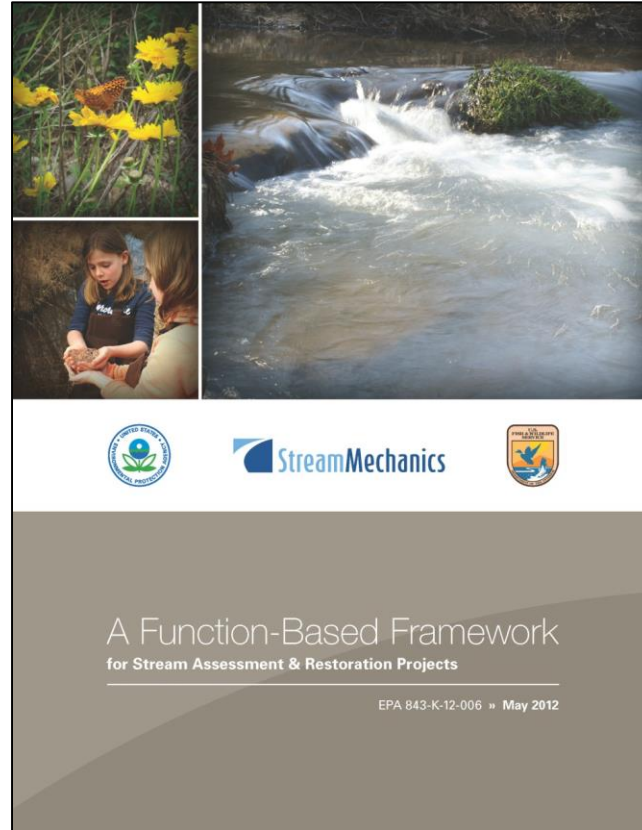
Wyoming Stream Mitigation Procedures v1 (2013)

- Two stream mitigation banks proposed, but no stream crediting/debiting method existed
- WSMP v1 based on Montana's method; modified to better incorporate function.
- Levels of function: functioning, functioning-at-risk and non-functioning, with lift/loss based upon movement between the levels.
- Qualitative assessment methods inform level of function.

Function-Based Framework for Stream Assessment and Restoration Projects

www.stream-mechanics.com

5 **BIOLOGY »**
Biodiversity and the life histories of aquatic and riparian life

4 **PHYSICOCHEMICAL »**
Temperature and oxygen regulation; processing of organic matter and nutrients

3 **GEOMORPHOLOGY »**
Transport of wood and sediment to create diverse bed forms and dynamic equilibrium

2 **HYDRAULIC »**
Transport of water in the channel, on the floodplain, and through sediments

1 **HYDROLOGY »**
Transport of water from the watershed to the channel

Geology   Climate

Table 1. Stream Losses (Debits)

FACTORS	MULTIPLIERS							
Stream Classification (Pg 8)	Class 4		Class 3		Class 2			Class 1
	B	A	D	C or B	D	C	A, AB or B	
	0.1	0.2	0.6	0.8	1.1	1.3	1.5	2.0
Special Resources (Pg 8)	Red Ribbon 0.6		Conservation 1.0		Blue Ribbon 1.0		Wild & Scenic 1.5	T&E Species 2.0
Existing Condition (Pg 9)	Non-Functional 0.50			Deficient 1.5			Functional 2	
Type of Loss (Pg 10)	Partial Functional Loss 1.0			Functional Loss 4.0			Physical Loss 6.0	
Cumulative Impact (Pg 10)	Multiply total length of all stream disturbances (feet) x 0.005.							

United States Army Corps of Engineers
Omaha District
Wyoming Regulatory Office

WYOMING STREAM MITIGATION PROCEDURE
(WSMP)

– February 2013 –

Table 3. Mitigation Measures (Credits)

| FACTORS	MULTIPLIERS							
Stream Classification (Pg 8)	Class 4		Class 3		Class 2			Class 1
	B	A	D	C or B	D	C	A, AB or B	
	0.1	0.2	0.6	0.8	1.1	1.3	1.5	2.0
Special Resources (Pg 8)	Red Ribbon 0.6		Conservation 1.0		Blue Ribbon 1.0		Wild & Scenic 1.5	T&E Species 2.0
Riparian Buffer (Pg 11)	Total Width of Riparian Buffers ÷ 1000 (+ 0.3 for both sides)							
Net Riparian Improvement (Pg 11)	Minimal 0.2			Moderate 0.7			Substantial 2.5	
Net Stream Improvement (Pg 11)	Minimal 1.5			Moderate 3.5			Substantial 5.0	
Type of Protection (Pg 12)	Deed Restriction 0.5		Permittee Easement 1.0		Agency Owned 1.0		Conservation Easement 3.0	Fee Title 5.0
Timing (Pg 12)	Schedule 3 -1.5			Schedule 2 0.0			Schedule 1 4.0	
Location (Pg 13)	Outside watershed -1.0			Off-Site HUC 8 0.0		Off-Site HUC 10 0.2		On-Site 0.4
Watershed Approach (Pg 13)	1.5							
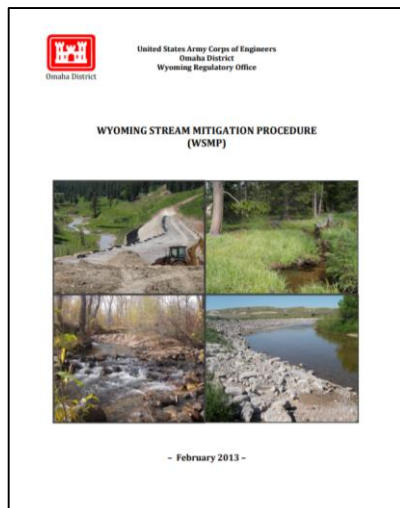
Application of
Wyoming Stream
Mitigation Procedures v1

Dumbell Ranch Site Visit 2013

Wyoming Stream Quantification Tool

Reach Hydrology and Hydraulics

Physicochemical

Geomorphology

Biology
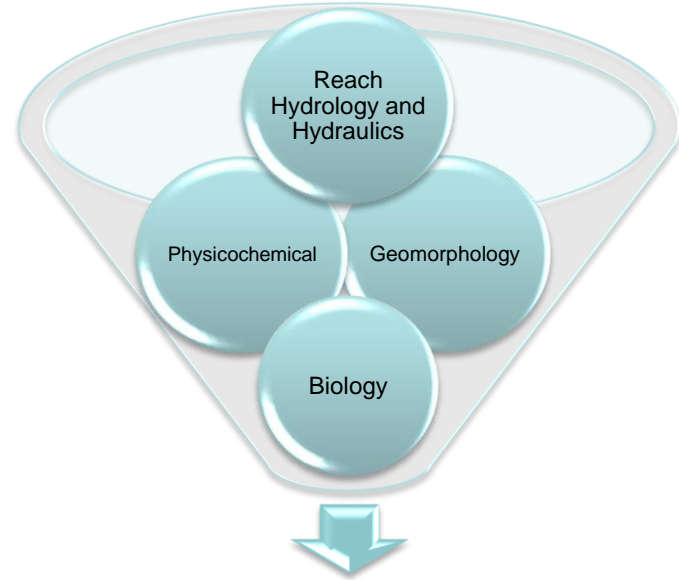
Functional Feet

August 2017: WSQT Beta Version released for public comment
July 2018: WSQT v1.0 released for implementation

Functional Category	Function-Based Parameter	Metric	Field Value
Reach Hydrology & Hydraulics	Reach Runoff	Land Use Coefficient	
		Concentrated Flow Points	
	Flow Alteration	Q_Low, Measured / Q_Low, Expected	
	Floodplain Connectivity	Bank Height Ratio	
		Entrenchment Ratio	
Geomorphology	Large Woody Debris	LWD Index	
	Lateral Migration	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 (%)	
Physicochemical	Temperature	MWAT (°C)	
	Nutrients	Chlorophyll (mg/m2)	
Biology	Macroinvertebrates	WSII	
		RIVPACS	
	Fish	Native Fish Species Richness (% of Expected)	
		SGCN Absent Score	
		Game Species Biomass (% Change)	

Functional categories & statements

WSQT v1.01

Functional Category	Function-Based Parameter	Metric	Field Value
Reach Hydrology & Hydraulics	Reach Runoff	Land Use Coefficient	
		Concentrated Flow Points	
	Flow Alteration	Q_Low, Measured / Q_Low, Expected	
	Floodplain Connectivity	Bank Height Ratio	
		Entrenchment Ratio	
Geomorphology	Large Woody Debris	LWD Index	
		No. of LWD	
	Lateral Migration	Greenline	
		Dominant	
		Percent	
		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 (%)	
Physicochemical	Temperature	MWAT ($^{\circ}$C)	
	Nutrients	Chlorophyll (mg/m2)	
Biology	Macroinvertebrates	WSII	
		RIVPACS	
	Fish	Native Fish Species Richness (% of Expected)	
		SGCN Absent Score	
		Game Species Biomass (% Change)	

Parameters describe and support functional statements

WSQT v1.01

Functional Category	Function-Based Parameter	Metric	Field Value
Reach Hydrology & Hydraulics	Reach Runoff	Land Use Coefficient	
		Concentrated Flow Points	
	Flow Alteration	Q_Low, Measured / Q_Low, Expected	
	Floodplain Connectivity	Bank Height Ratio	
		Entrenchment Ratio	
Geomorphology	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 (%)	
Physicochemical	Temperature	MWAT (^{o}C)	
	Nutrients	Chlorophyll (mg/m2)	
Biology	Macroinvertebrates	WSII	
		MVPACS	
	Fish	Native Fish Species Richness (% of Expected)	
		SGCN Absent Score	
		Game Species Biomass (% Change)	

Metrics are used to quantify parameters

WSQT v1.01

Functional Category	Function-Based Parameter	Metric	Field Value
Reach Hydrology & Hydraulics			
		...cted	
		No. of LWD Pieces/ 100 meters	
Geomorphology	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 (%)	
Physicochemical	Temperature	MWAT ($^{\circ}$C)	
	Nutrients	Chlorophyll (mg/m2)	
Biology	Macroinvertebrates	WSII	
		RIVPACS	
	Fish	Native Fish Species Richness (% of Expected)	
		SGCN Absent Score	
		Game Species Biomass (% Change)	

Reference Curves are derived from existing data sources to characterize functional capacity. These relationships are used to translates field values into index scores.

WSQT v1.0

Functional Category	Function-Based Parameter	Parameter	Category	Category
Reach Hydrology & Hydraulics	Reach Runoff	0.54	0.56	Functioning At Risk
	Flow Alteration			
	Floodplain Connectivity	0.57		
Geomorphology	Large Woody Debris	0.16	0.54	sk
	Lateral Migration	0.54		
	Bed Material Characterization			
	Bed Form Diversity	1.00		
	Plan Form	0.30		
	Riparian Vegetation	0.72		
Physicochemical	Temperature	0.68	0.68	Functioning At Risk
	Nutrients			
Biology	Macroinvertebrates	0.54	0.69	Functioning At Risk
	Fish	0.85		

Index values for each metric are averaged for a parameter score

Parameter scores are averaged for a category score

Functional category scores are weighted and summed to create an overall reach score

WSQT v1.01

Existing Condition:

Proposed Condition:

SCORE — Existing Condition Score: 0.21 — Proposed Condition Score: 0.75

 X   QUANTITY — Existing Stream Length: 1600 Ft — Proposed Stream Length: 1640 Ft

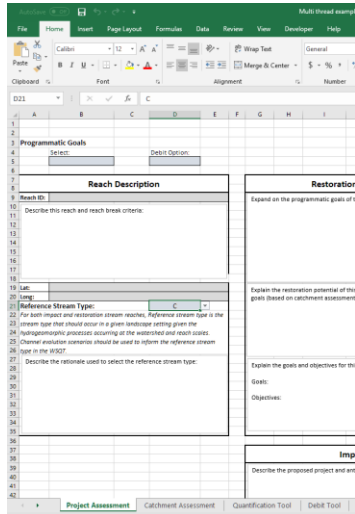**FUNCTIONAL FEET (FF)** FF = 336 Functional Feet — FF = 1,230 Functional Feet
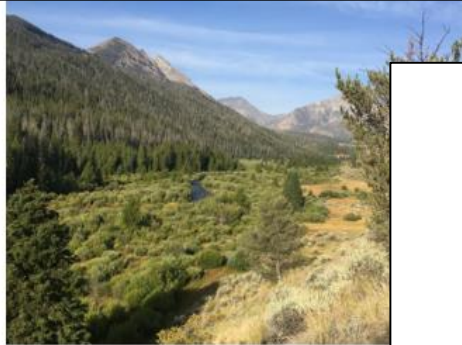
Functional Change (ΔFunctional Feet) = 1,230 – 336 = 894

WSQT: Uses

- **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 function-based goals and objectives

Wyoming SQT and Related Documents

WSQT v1.01
excel workbook

WSQT v1.0
User Manual

WSQT v1.0
Science Support Document

Wyoming Stream Mitigation
Procedures (WSMP) v2

Debit and Credit Adjustment Factors

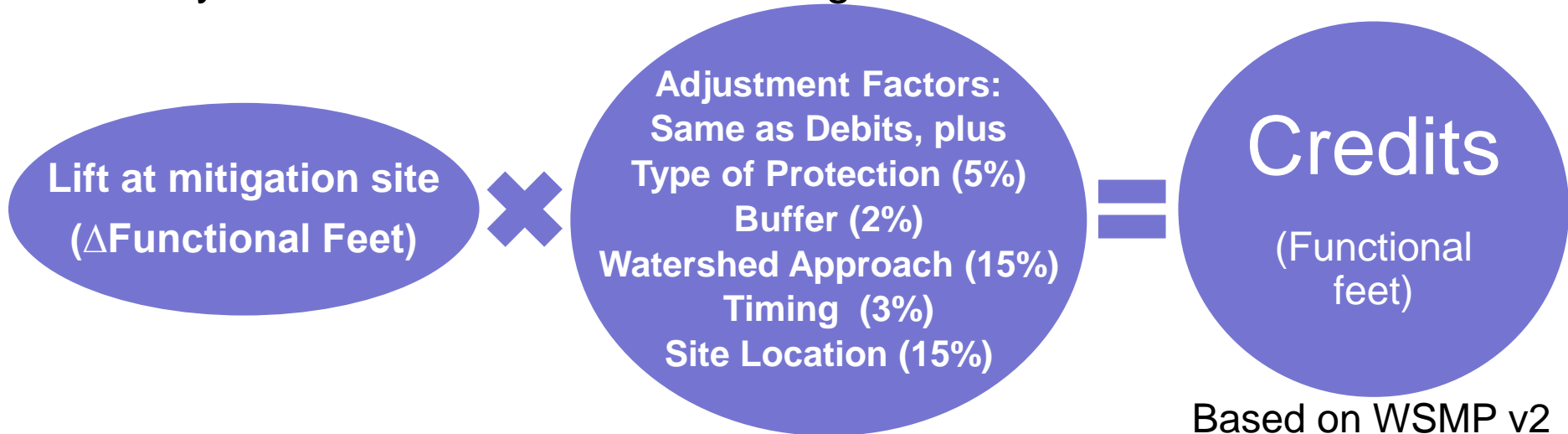| #	Factor	Lower Standards	Normal Standards	Higher Standards	Adjustments
1	Designated Uses 1	Aquatic Life Only (Class 3)	Aquatic Life and Fisheries (Class 2)	Outstanding Waters (Class 1)	5%
2	Special Resources 1		No	Wild & Scenic, T&E Species, Blue Ribbon, Red Ribbon, Conservation	2%
3	Secondary Effects 1	Negative	None	Positive	3%
4	Type of Protection 2		Deed Restriction, Permittee Easement, Agency Owned	Fee Title, Conservation Easement	5%
5	Buffer 2		None	Yes	2%
6	Watershed Approach 2		No	Yes	15%
7	Timing 2*	Schedule 3	Schedule 2	Schedule 1	3%
8	Site Location 2*	Off-Site	On-Site		15%

Factor Notes: 1 Ecological Services Factor applies to impact and mitigation sites; 2 Administrative Factor applies to mitigation sites; *affected by relationship to impact site.

How many credits do I need to purchase?

Loss at impact site (∆Functional Feet) ✕ **Adjustment Factors: Designated Uses (5%) Special Resources (2%) Secondary Effects (3%)** = **Debits (Functional feet)**
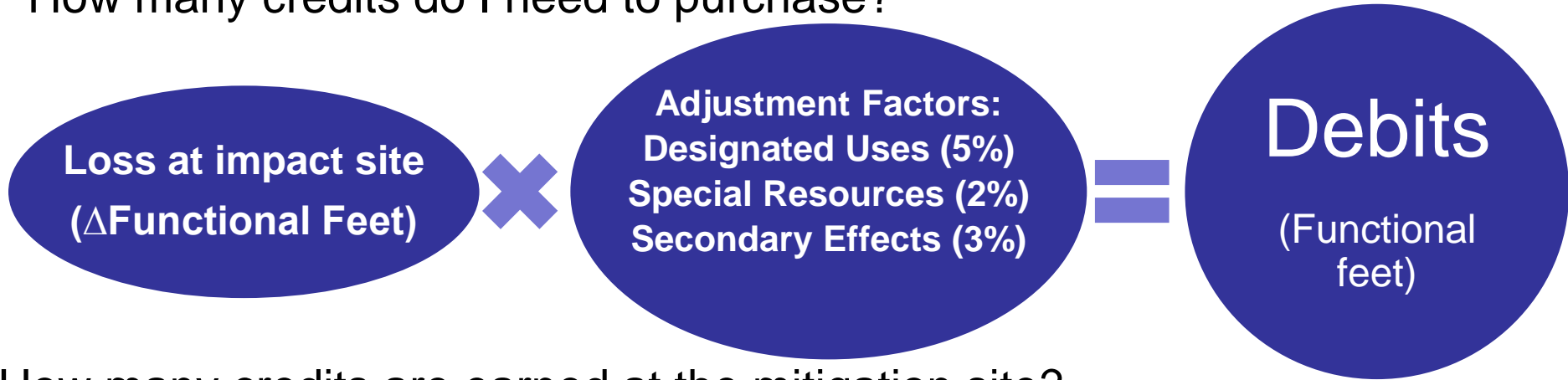
How many credits are earned at the mitigation site?

Lift at mitigation site (∆Functional Feet) ✕ **Adjustment Factors: Same as Debits, plus Type of Protection (5%) Buffer (2%) Watershed Approach (15%) Timing (3%) Site Location (15%)** = **Credits (Functional feet)**

Based on WSMP v2

Proposed bank:

- In conservation watershed (+2%)
- Conservation easement (+5%), including an additional buffer area (+2%)
- 20% of credits available as advance credits upon signing the instrument.

Existing = 336 Functional Feet

Proposed = 1,230 Functional Feet

Functional Change (ΔFunctional Feet) = 1,230 – 336 = 894 FF

Initial Credits = 894 * (1+(0.02 +0.02+ 0.05)) = 974.5 FF

Timing adjustment:

  20% at Schedule 3 = 194.6 * (1-0.03) = 188.8 FF

  80% at Schedule 1 = 779.9 * (1+0.03) = 803.3 FF

Final Credit Availability = 188.8 + 803.3 = **992.1 FF**

Based on WSMP v2

Questions?

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