Department of
Environment &
Conservation

Tennessee Stream Mitigation Guidelines:
A Functional Loss and Lift Balancing Act

Vena Jones and Jimmy Smith (TDEC)
Josh Frost and Will Worrall (USACE)

ACKNOWLEDGEMENTS

Jimmy Smith, Jonathon Burr, Joshua Frost, Tammy Turley, Will Harman, Cidney Jones, Eric Somerville, Debbie Arnwine, Greg Jennings, Jason Zink, Travis Wiley, Caitlin Elam, Peyton Abernathy, Mark McIntosh, Robert Wayne, Robby Baker, Will Worrall, Ryan Evans, Tim Wilder, Dan Bacon, Kelly Laycock, Terry Horne, West TN River Basin Authority, Memphis District COE, Robb Todd, Robbie Sykes, Stream Design Review Group, Ashley Monroe, and Kim Pilarski-Hall

Why Update the Stream Mitigation Guidelines?

- **Improve** explanation of **what** activities **constitute a loss of resource value** and when is mitigation required.
- Provide a **quantitative and scientifically defensible** framework for how the amount of mitigation required to ensure no net loss will be evaluated.
- **Modernize** what type of activities are eligible for offsetting lost resource value.
- Provide mitigation **site selection** evaluation guidance.
- Improve **performance standards and monitoring**.

Inform us on how to calculate debits and credits.

2004 TN Stream Mitigation Guidelines

- Ratio Based
  - Broad ranges of ratios for credits
  - Describes **activity based crediting-pattern, profile, and dimension**
- Narrative Criteria
  - Does not require baseline information
  - Subjective
  - Creates **crediting drift**
  - Debits
    - Encapsulation 1:1
    - Riprap 0.75:1 for double bank

2012 Draft Stream Mitigation Guidelines

Realized deficiencies in the 2004 mitigation guidelines; qualitative/subjective

- Wanted to be consistent with USACE requirements
- Wanted to align state guidelines with the 2008 Final Rule to the extent practical for TN
- Wanted to establish **functional lift**
- Move away from linear footage/ratio based system

Shortcomings

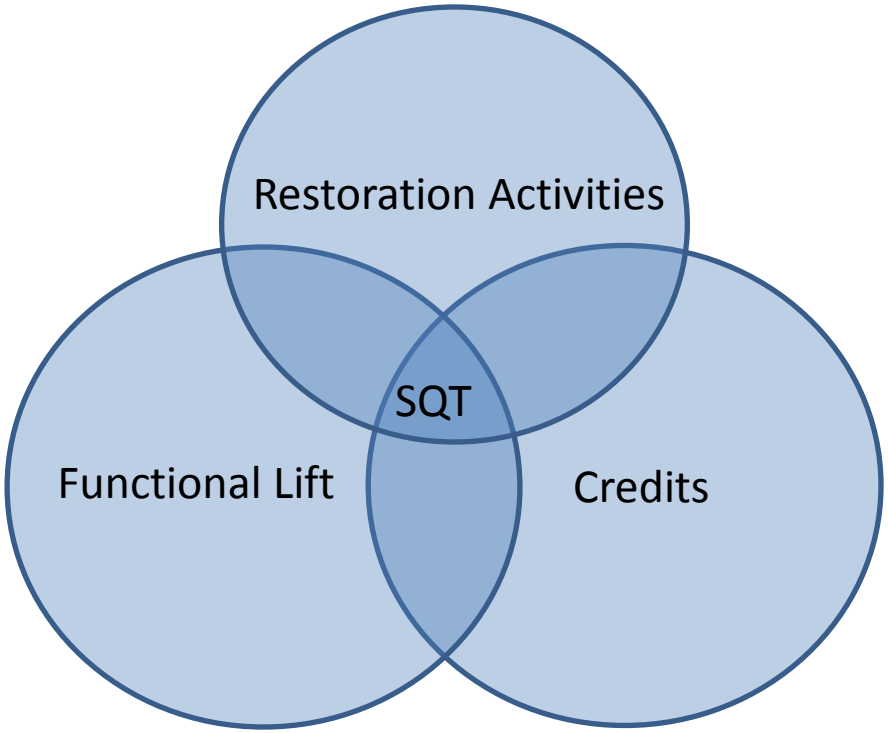
- Received significant comment on efficacy of functional assessment parameters and methods
- Division lacked capacity to create a robust functional assessment

Strategic Planning for Success

- Engage our stakeholders
- Evaluate potential assessment methods
- Establish parallel pathways
  - Education and outreach
  - Incremental and iterative document development
  - Data gathering
  - Tool development
  - Tools to policy

Exploring Options

- Benefits of the Stream Quantification Tool
- Determine numerical existing condition score for impact sites.
- Determine numerical difference between existing and proposed conditions of a stream for mitigation (functional lift).
- Links restoration activities to function-based parameters.
- Incentivize high-quality stream mitigation.
- Inform stream mitigation site selection
- Developing success criteria and a monitoring plan.



Long Term Goals

- **Develop Tools**
  - Stream functional assessment to capture function lift of compensatory mitigation
  - Companion debit calculator
- **Update**
  - Stream Mitigation Guidelines
  - *TDEC rules* on mitigation

Short Term Goals

- **Streamline Process**
  - Bring consistency
    - Banking templates
    - Land Use Protection documents
    - Checklists
    - Mitigation crosswalk
- **Communicate changes**
  - Series of joint education and outreach events over several years
  - Training, webinars and workshops

Develop Tools: Build Consensus and Foundation

- *Measurable. Transparent. Predictable. Repeatable*
- Partner with USACE and IRT to develop/adopt functional assessment guidance tools
- Based on known stream functions
- Inherent relationships in stream channel metrics
- Incorporate TDEC biological and water quality data
- Regionalize as information becomes available

Develop Tools: Data gathering and analysis

- Ecoregion based
- Regional Curves
- Bedforms
- Riparian vegetation
  - Composition
  - Structure
- Biology
- Water Quality

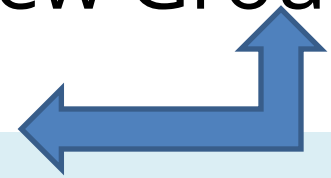
- Establishing Ecological Reference Sites

Develop Regionalized Data From Across TN

- Over 120 sites across the state with multiple levels of data.
- Nearly 60% of those sites have reference data for all five stream categories

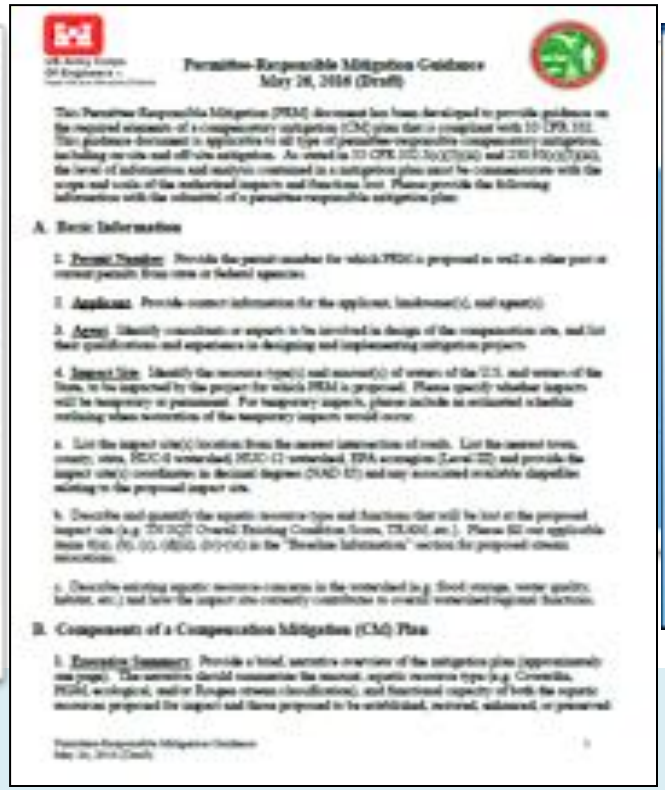
Iterative and Incremental Regionalization

- Mitigation Assessment Team (MAT)
  - Internal working group of IRT
  - TDEC, USACE, & EPA
- MAT broken into parameter driven mini teams
  - Review and analyze existing data
  - Research and gather new data
  - Incorporate TN specific data into performance curves from Stream Quantification Tool
- Stream Design Review Group
- All members of IRT



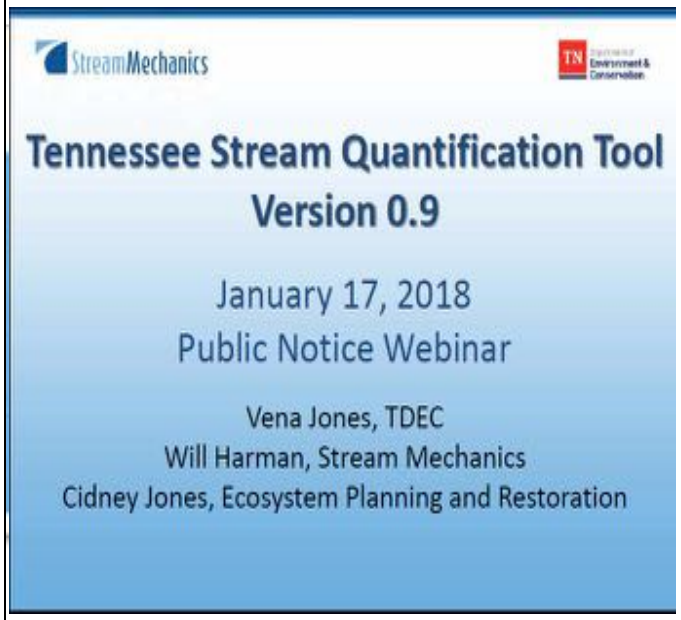
Streamline Process & Communicate Change

- TDEC and the USACE developed a series of workshops, delivered across the state for all stakeholders focused on small changes, introduce concepts on big changes and keep an open line of communication. Three years of "Joint Education Outreach Events" from 2015-2018.


Permittee-Responsible Mitigation Guidance
May 26, 2016 (Draft)

A. Basic Information

B. Components of a Compensation Mitigation (CM) Plan



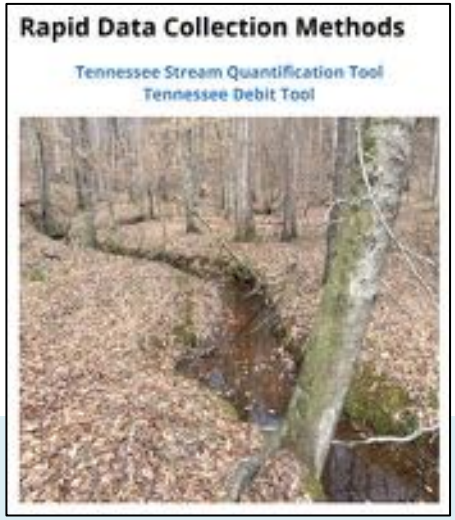
Communicate Change- In the Classroom

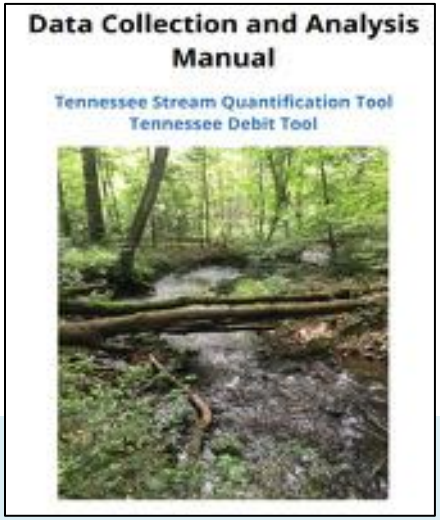
- Provided webinars with national experts
- In house workshops
- Conferences
- Seminars

Communicate Change- Field Training

Develop Tools: The TN SQT

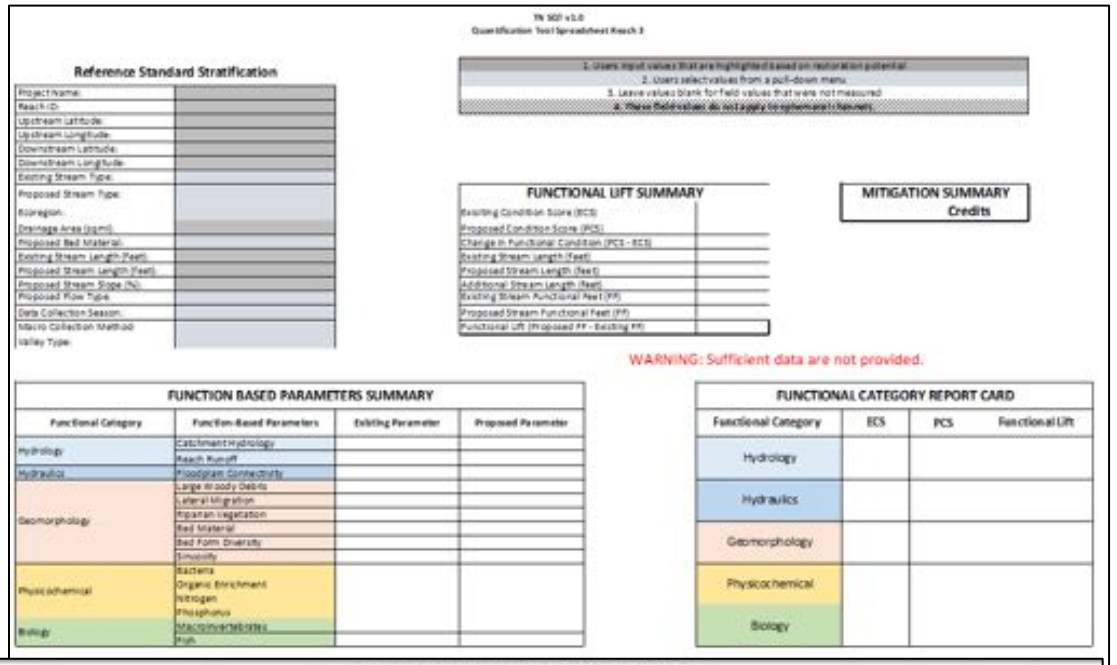
- TN SQT User Manual
  - How to use the SQT Workbook.
- Rapid Data Collection Methods Manual
  - How to rapidly collect data without surveying equipment.
- Detailed Data Collection and Analysis Manual
  - Explains thorough data collection.
- Science Support and Rationale (Coming Soon)





Regionalized TN Stream Quantification Tool

- Workbook Tabs
  - Project Assessment
  - Watershed Assessment
  - Parameter Selection Guide
  - Quantification Tool
  - Monitoring Data
  - Data Summary
  - Reference Standards



Reference Standard Stratification

Project Name:	
Reach ID:	
Upstream Latitude:	
Upstream Longitude:	
Downstream Latitude:	
Downstream Longitude:	
Existing Stream Type:	
Proposed Stream Type:	
Ecoregion:	
Drainage Area (sqmi):	
Proposed Bed Material:	
Existing Stream Length (Feet):	
Proposed Stream Length (Feet):	
Proposed Stream Slope (%):	
Proposed Flow Type:	
Data Collection Season:	
Macro Collection Method:	
Valley Type:	

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

FUNCTIONAL LIFT SUMMARY

Existing Condition Score (ECS)	
Proposed Condition Score (PCS)	
Change in Functional Condition (PCS - ECS)	
Existing Stream Length (Feet)	
Proposed Stream Length (Feet)	
Additional Stream Length (Feet)	
Existing Stream Functional Feet (FF)	
Proposed Stream Functional Feet (FF)	
Functional Lift (Proposed FF - Existing FF)	

MITIGATION SUMMARY
Credits

WARNING: Sufficient data are not provided.

FUNCTION BASED PARAMETERS SUMMARY

Functional Category	Function-Based Parameters	Existing Parameter	Proposed Parameter
Hydrology	Catchment Hydrology		
	Reach Runoff		
Hydraulics	Floodplain Connectivity		
Geomorphology	Large Woody Debris		
	Lateral Migration		
	Riparian Vegetation		
	Bed Material		
	Bed Form Diversity		
	Sinuosity		
Physicochemical	Bacteria		
	Organic Enrichment		
	Nitrogen		
	Phosphorus		
Biology	Macroinvertebrates		
	Fish		

FUNCTIONAL CATEGORY REPORT CARD

Functional Category	ECS	PCS	Functional Lift
Hydrology			
Hydraulics			
Geomorphology			
Physicochemical			
Biology			

FUNCTION BASED PARAMETERS SUMMARY

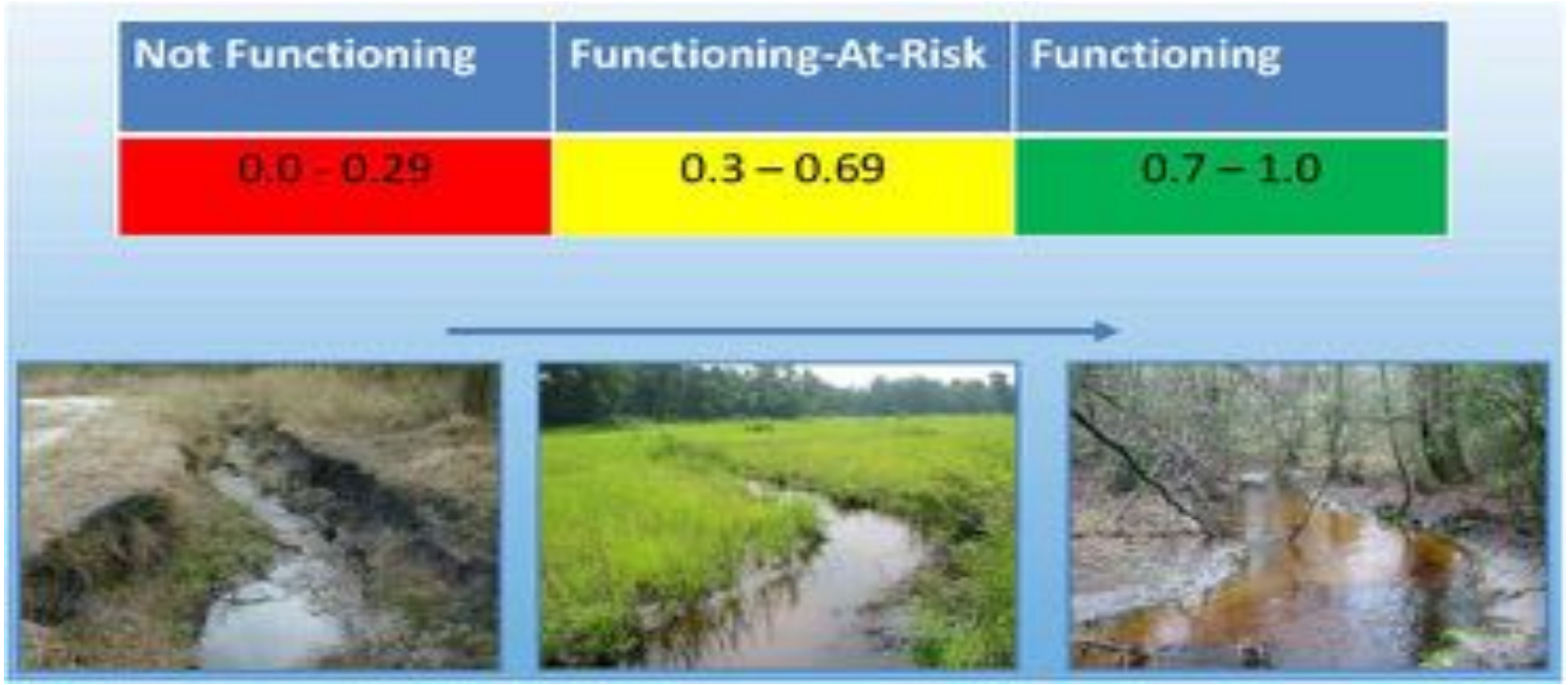
Functional Category	Function-Based Parameters	Existing Parameter	Proposed Parameter	As-Built	Monitoring Year 2	3	5
Hydrology	Catchment Hydrology						
	Reach Runoff						
Hydraulics	Floodplain Connectivity						
Geomorphology	Large Woody Debris						
	Lateral Migration						
	Riparian Vegetation						
	Bed Material Characterization						
	Bed Form Diversity						
	Plan Form						
Physicochemical	Bacteria						
	Organic Enrichment						
	Nitrogen						
	Phosphorus						
Biology	Macroinvertebrates						
	Fish						

FUNCTIONAL CATEGORY REPORT CARD

Functional Category	ECS	PCS	As-Built	Monitoring Year 2	3	5
Hydrology						
Hydraulics						
Geomorphology						
Physicochemical						
Biology						
Overall Score	0	0	0	0.00	0.00	0.00
Functional Feet	0	0	0	0	0	0

TN Department of Environment & Conservation

Scoring

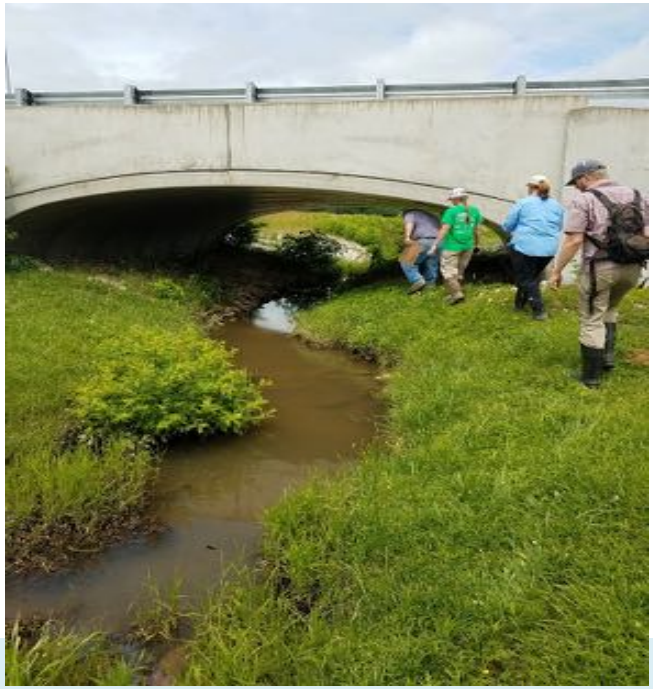


- Scoring system for each stream category, parameter, measurement method, and overall score is based on a range of 0-1.0.

Develop- TN Debit Tool a Companion to TNSQT

- Impacts to Waters of the State and WOTUS range from minimal to significant
- Debit Tool determines the amount of loss based on specific impact type and existing stream condition (ECS)
- Objective, consistent, transparent method for evaluating debits, or amount of compensatory mitigation required for impacts

SIGNIFICANT



MINIMAL

Debit Tool –Creating a Companion to the SQT

- Spreadsheet based **calculator** and written guidance
- **Existing Condition Score (ECS)**
  - Option 1: Applicant completes ECS field assessment for all parameters
  - Option 2: Applicant completes ECS field assessment for some parameters
  - Option 3: Standard Existing Condition Score
    - Applicant uses standard ECS (1.0, 0.8, or 0.32)
- **Impact Severity Tier**
  - Applicant determines severity tier based on impact type and description
  - Tier 0 (no functional loss) to Tier 6 (100% functional loss)

Existing Condition Scores

- Option 1 and Option 2 require field visits and stream assessment
- Option 3 does not require field visits; standard ECS used
  - ECS = 1.0: ETW/ ONRWs
  - ECS = 0.8: intermittent/ perennial
  - ECS = 0.32 ephemeral

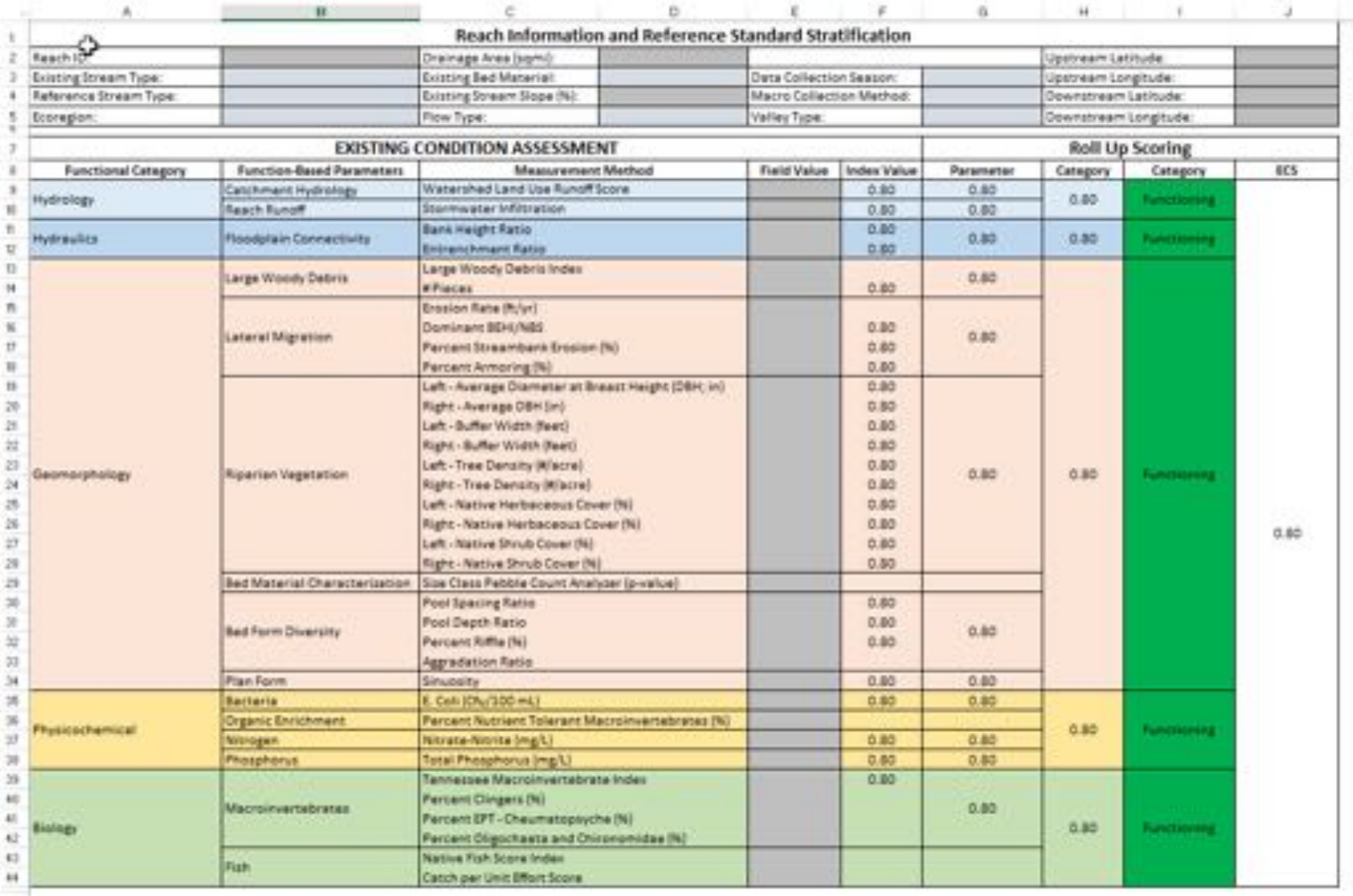
Minimum Existing Condition Score

- Minimum Mitigation Requirement : ***"Because all streams and wetlands serve important functions, the determination of existing conditions shall ensure at least minimal protection for all streams and wetlands not withstanding prior degradation"***

Even currently degraded streams (including many in urban areas) have resource values outside of those addressed in the functional quantification evaluation that must be offset if lost.

Therefore the *Guidelines* establish a **minimum Existing Condition Score** for all streams, to ensure overall net mitigation is sufficient to maintain classified uses and water quality standards.

ECS Field Scores – Data Input
(Options 1 & 2)



Reach Information and Reference Standard Stratification									
Reach ID:		Drainage Area (sqmi):				Upstream Latitude:			
Existing Stream Type:		Existing Bed Material:		Data Collection Season:		Upstream Longitude:			
Reference Stream Type:		Existing Stream Slope (%):		Macro Collection Method:		Downstream Latitude:			
Ecoregion:		Flow Type:		Valley Type:		Downstream Longitude:			

EXISTING CONDITION ASSESSMENT					Roll Up Scoring			
Functional Category	Function-Based Parameters	Measurement Method	Field Value	Index Value	Parameter	Category	Category	ECS
Hydrology	Catchment Hydrology	Watershed Land Use Runoff Score		0.80	0.80	0.80	Functioning	0.80
	Reach Runoff	Stormwater Infiltration		0.80	0.80			
Hydraulics	Floodplain Connectivity	Bank Height Ratio		0.80	0.80	0.80	Functioning	
		Entrenchment Ratio		0.80				
Geomorphology	Large Woody Debris	Large Woody Debris Index			0.80	0.80	Functioning	
		# Flocas		0.80				
	Lateral Migration	Erosion Rate (ft/yr)			0.80			
		Dominant BEH/NBS		0.80				
		Percent Streambank Erosion (%)		0.80				
		Percent Armoring (%)		0.80				
	Riparian Vegetation	Left - Average Diameter at Breast Height (DBH; in)		0.80	0.80			
		Right - Average DBH (in)		0.80				
		Left - Buffer Width (feet)		0.80				
		Right - Buffer Width (feet)		0.80				
		Left - Tree Density (#/acre)		0.80				
		Right - Tree Density (#/acre)		0.80				
		Left - Native Herbaceous Cover (%)		0.80				
		Right - Native Herbaceous Cover (%)		0.80				
		Left - Native Shrub Cover (%)		0.80				
		Right - Native Shrub Cover (%)		0.80				
	Bed Material Characterization	Size Class Pebble Count Analyzer (p-value)						
	Bed Form Diversity	Pool Spacing Ratio		0.80	0.80			
		Pool Depth Ratio		0.80				
		Percent Riffle (%)		0.80				
		Aggradation Ratio						
	Plan Form	Sinuosity		0.80	0.80			
Physicochemical	Bacteria	E. Coli (CFU/100 mL)		0.80	0.80	0.80	Functioning	
	Organic Enrichment	Percent Nutrient Tolerant Macroinvertebrates (%)						
	Nitrogen	Nitrate-Nitrite (mg/L)		0.80	0.80			
	Phosphorus	Total Phosphorus (mg/L)		0.80	0.80			
Biology	Macroinvertebrates	Tennessee Macroinvertebrate Index		0.80	0.80	0.80	Functioning	
		Percent Clingers (%)						
		Percent EPT - Cheumatopsyche (%)						
		Percent Oligochaeta and Chironomidae (%)						
	Fish	Native Fish Score Index						
		Catch per Unit Effort Score						

Impact Severity Tiers

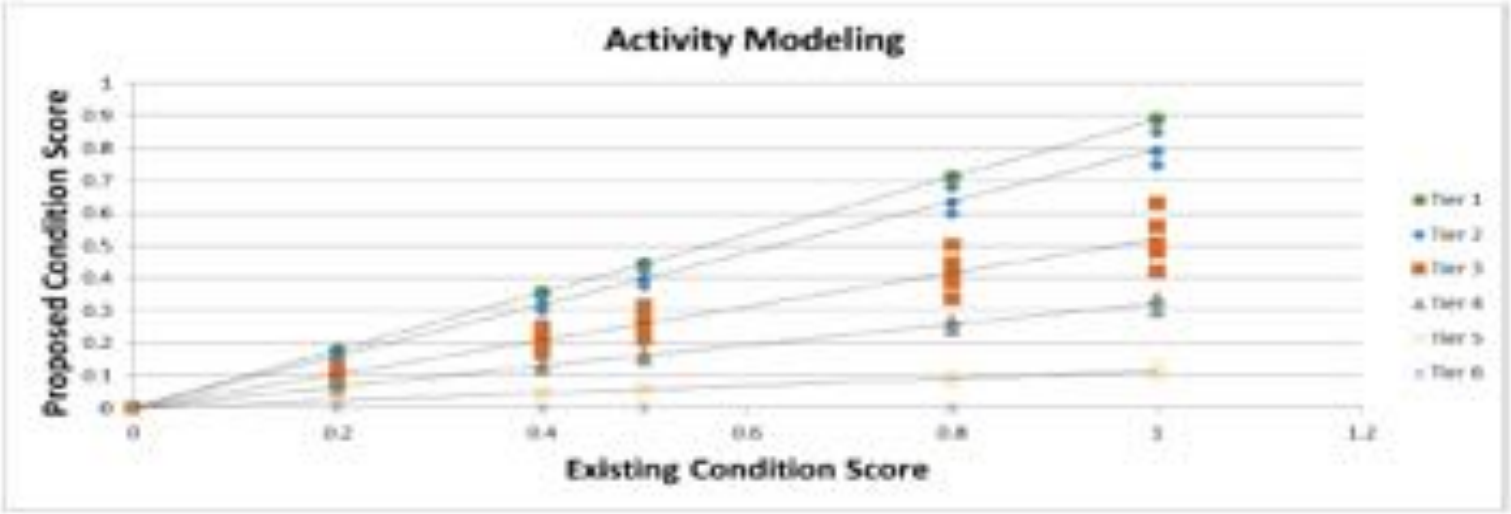
Name:
Date:

Impact Severity Tiers	Impact Factors	Percent Functional Loss
Tier 0	1.00	0%
Tier 1	0.89	11%
Tier 2	0.8	20%
Tier 3	0.52	48%
Tier 4	0.32	68%
Tier 5	0.12	88%
Tier 6	0.00	100%

TN SQT DEBIT TOOL v1.0

Proposed Impact Factors and Activity Modeling:

The graph below represents combined data from modeling individual activities and the impact these actions have on stream resources. The table has established tiers, percent functional loss and the impact factors used to determine debits. The Impact Factors were developed from linear regression equations of modeled impact scenarios using a simplified version of the SQT. Each impact type was described in detail and evaluated for stream functional loss by the proposed activities. Using a simplified SQT, an individual impact factor was developed for each impact type. These types were grouped based on % functional loss (in clusters) and graphed in "tiers". A trendline was drawn and the slope of that line became the combined impact factor representing all activities within a given tier.



Impact Severity Tier 0

- Vegetative bank stabilization

Impact Severity Tier 1

- Span bridge
- Half bank riprap

Impact Severity Tier 2

- Span bridge w/ pier in stream
- Single bank riprap, gabion baskets, Turf Reinforced Mat

Impact Severity Tier 3

- Bottomless culvert
- Double bank riprap
- Grade control

Impact Severity Tier 4

- Bed and bank armoring
- Bottomless culvert w/ impact to channel walls

Impact Severity Tier 5

- Box or pipe culvert
- Channelization

Debit Tool Testing the Tools

Using the 2004 Guidelines, "Project A" needed 2537 debits to offset impacts. Below is the same project using the TN Debit Tool

Stream	Reach ID	Option	Existing Length	ECS	Proposed Length	Impact Severity Tier	PCS	Change in FF
STR-6		3	106	0.8	0	Tier 6	0.00	-84.8
STR-5		2	118	0.8	118	Tier 5	0.10	-82.6
STR-7	1	3	378	0.8	378	Tier 5	0.10	-264.6
STR-7	2		51	0.8	0	Tier 6	0.00	-40.8
STR-8			80	0.8	0	Tier 6	0.00	-64.0
STR-9			54	0.8	0	Tier 6	0.00	-43.2
STR-10	1a	2	253	0.8	253	Tier 5	0.10	-177.1
STR-10	1b		5	0.8	0	Tier 6	0.00	-4.0
STR-10	2		157	0.8	157	Tier 5	0.10	-109.9
STR-13	1		593	0.8	593	Tier 5	0.10	-415.1
STR-13	2		30	0.8	0	Tier 6	0.00	-24.0
STR-14	1		459	0.8	459	Tier 5	0.10	-321.3
STR-14	2		12	0.8	0	Tier 6	0.00	-9.6
STR-15			136	0.8	0	Tier 6	0.00	-108.8
STR-16			49	0.8	0	Tier 6	0.00	-39.2
				0.8		Tier 4	0.26	0.0
				0.8		Tier 5	0.10	0.0
				0.8		Tier 6	0.00	0.0
				0.3		Tier 5	0.04	0.0
				0.3		Tier 4	0.10	0.0
				0.3		Tier 3	0.16	0.0
				0.3		Tier 2	0.24	0.0
				0.3		Tier 1	0.27	0.0
				0.3		Tier 0	0.30	0.0
				0.3		Tier 1	0.27	0.0
				0.3		Tier 2	0.24	0.0
							Total Functional Loss:	-1749.8 FF

Debit Tool- Estimating ECS

Streams	Reach ID	Option	Existing Length	ECS	Proposed Length	Impact Severity Tier	PCS	Change in FF
STR-5		3	118	0.54	118	Tier 5	0.06	-56.6
STR-6		3	106	0.54	0	Tier 6	0.00	-57.2
STR-7		3	378	0.58	378	Tier 5	0.07	-192.8
STR-7		3	51	0.58	0	Tier 6	0.00	-29.6
STR-8		3	80	0.57	0	Tier 6	0.00	-45.6
STR-9		3	54	0.55	0	Tier 6	0.00	-29.7
STR-10		3	5	0.53	0	Tier 6	0.00	-2.7
STR-10		3	253	0.53	255	Tier 5	0.06	-118.9
STR-13		3	593	0.63	593	Tier 5	0.08	-326.2
STR-13		3	30	0.63	0	Tier 6	0.00	-18.9
STR-14		3	12	0.59	0	Tier 6	0.00	-7.1
STR-14		3	459	0.59	459	Tier 5	0.07	-258.7
STR-15		3	136	0.58	0	Tier 6	0.00	-78.9
STR-16		3	49	0.62	0	Tier 6	0.00	-30.4
STR-10		3	157	0.53	157	Tier 5	0.06	-73.8
						Total Functional Loss (Debits):		-1307.0 FF

Permittee elected to **estimate the ECS** by measuring some parameters while others remained unmeasured.

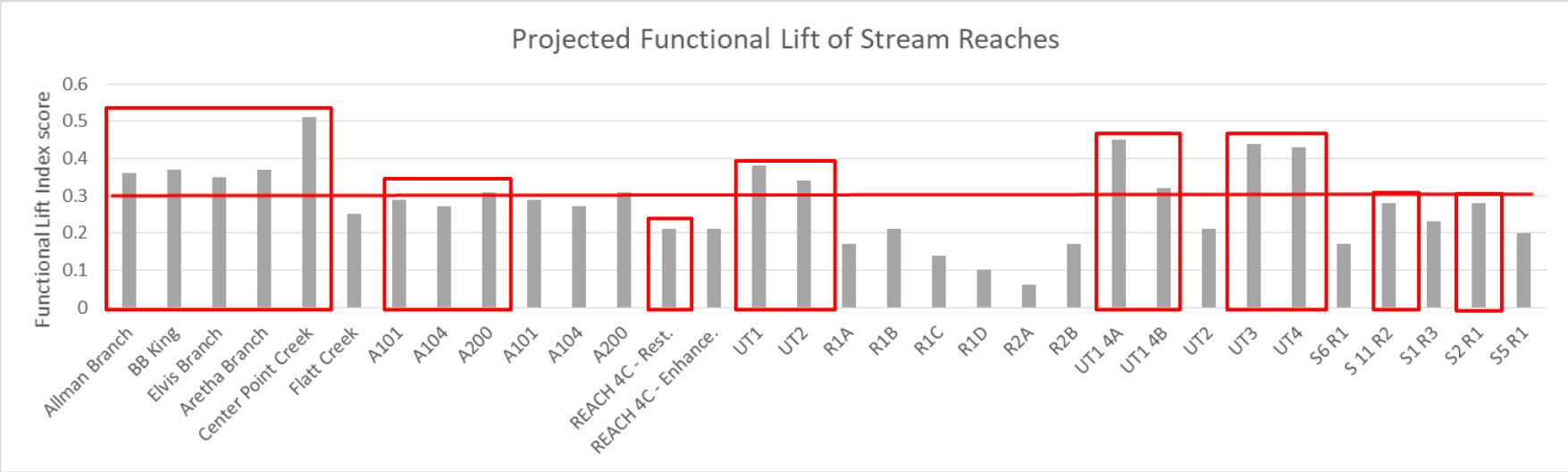
2004 Mitigation Guidelines		TN Debit Tool Functional Feet		
Impact Feature	Ratio Based Debits	ECS 0.80	ECS 0.50	ECS 0.40
STR-10	415	292	183	146
STR-11	0	0	0	0
STR-12	36	25	16	13
STR-12	323	227	143	114
STR-13	116	81	51	41
STR-14	235	165	103	82
STR-15	233	163	103	82
STR-17	229	161	101	80
STR-19	698	530	332	265
TOTALS	2285	1643	1032	822

Comparison of Debits in Authorized Permits

2004 Mitigation Guidelines	TN Debit Tool Functional Feet		
No Existing Condition Score (ECS)	ECS 0.80	ECS 0.50	ECS 0.40
1140	589	370	293
461	326	204	163
2285	1643	1032	822
310	240	150	120
496	295	185	147

Testing the TN SQT for compensatory mitigation

Projects the IRT determined qualify for a restoration ratio (1.5:1)

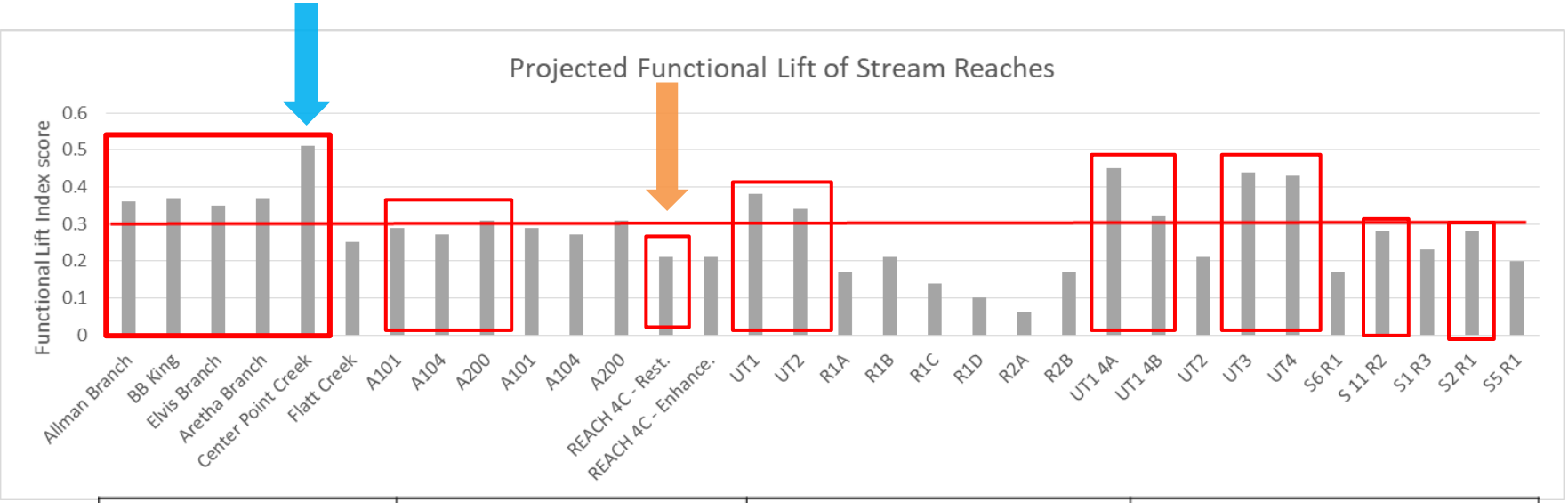


Ratio	Average Functional Lift	Max	Min
Restoration 1.5:1	0.35	0.51	0.21
Enhancement 3:1	0.20	0.31	0.06

- Based on the testing, functional lift indexes around 0.3 or greater typically correlated with projects that the IRT supported for restoration credit.

Application of the TN SQT on stream mitigation projects in Tennessee

Projects the IRT determined to qualify for a restoration ratio (1.5:1)



Ratio	Average Functional Lift	Max	Min
Restoration 1.5:1	0.35	0.51	0.21
Enhancement 3:1	0.20	0.31	0.06

- Moving away from categorical based mitigation ratios will help ensure mitigation crediting is better linked to functional lift provided by a mitigation project

Update: Tools into Policy

- **Stream Mitigation Guidelines**-interprets rules, establishes performance standards, align with USACE
- **Aquatic Resource Alteration Rules-** defines mitigation requirements
- **Water Quality Standards-** ensures all features maintain classified uses, flow, and use quantitative methods

Mitigation Guidelines

- ✓ **Improved** explanation of **what** activities **constitute a loss of resource value** and when is mitigation required.
- ✓ Provides a **quantitative and scientifically defensible** framework for how the amount of mitigation required to ensure no net loss will be evaluated.
- ✓ **Modernizes** what type of activities are eligible for offsetting lost resource value.
- ✓ Provides mitigation **site selection** evaluation guidance.
- ✓ Improves **performance standards and monitoring**.
- ✓ **Changes the currency** to Functional Feet with the use of the TN Debit Tool and the TN SQT
- ✓ This allows Credits and Debits to be evaluated using the same scientifically defensible methodology (functional-feet), as required to defend no net loss.

Updates to Rules Regarding Mitigation

- *"The Division will evaluate resource value compensation through the use of an appropriate **quantitative** assessment or other defensible scientific method approved by the Division that demonstrates a sufficient increase in resource values to compensate for permitted impacts"*

- *"At a minimum, all **new and relocated streams** must include a vegetated riparian zone, demonstrate lateral and vertical channel stability, and have a natural channel bottom. All mitigation watercourses must **maintain or improve classified uses and flow** after mitigation is complete."*

Long Term Goals

- ✓ **Develop Tools**
  - ✓ Stream functional assessment to capture function lift of compensatory mitigation
  - ✓ Companion debit calculator
- **Update**
  - Stream Mitigation Guidelines
  - *TDEC rules* on mitigation

Short Term Goals

- ✓ **Streamline Process**
  - ✓ Bring consistency
    - ✓ Banking templates
    - ✓ Land Use Protection documents
    - ✓ Checklists
    - ✓ Mitigation crosswalk
- ✓ **Communicate changes**
  - ✓ Series of joint education and outreach events over several years
  - ✓ Training, webinars and workshops

Improved Market and Coverage Across State

Long Term Goals (6 Years Later)

ARAP Rules

- adopted by the Water, Oil, and Gas Board on Oct 16, 2018
- Rules to be approved (by the legislature) in late **SUMMER 2019**

Stream Mitigation Guidelines

- TDEC public notice issued November 9, 2018.
- Public meeting December 11, 2018 @ 1pm
- Release of Stream Mitigation Guidelines (includes Debit Tool), **SPRING 2019**
- USACE 30 day public notice issued December, 2018. Soliciting comments on debit tool, temporal loss, and proximity factor.

TN SQT

- Complete; USACE (LRN and MVM) and TDEC solicited comments through PN, received input from practitioners, staff, IRT, and academia.

Questions?

Strategic Planning for the Future:

- Build a process for:
  - Version control of tools
  - Version updates
  - Parameter or measurement method substitutions specific to a project
  - MOU with USACE on process
- MORE TRAINING

Vena.L.Jones@tn.gov
615-253-5320