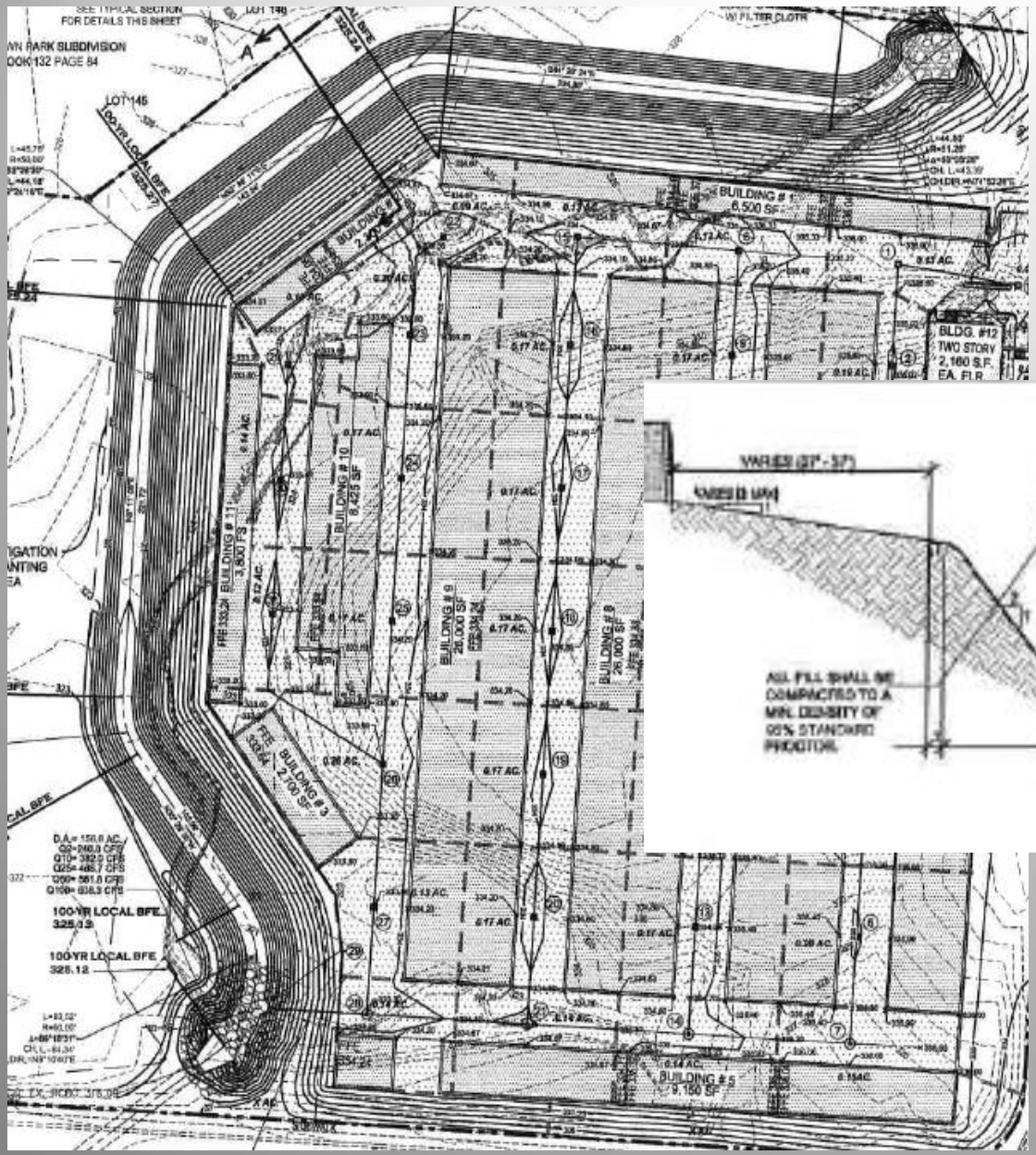
Regional Curves, Reference Streams, and Regionalization of the Stream Quantification Tool

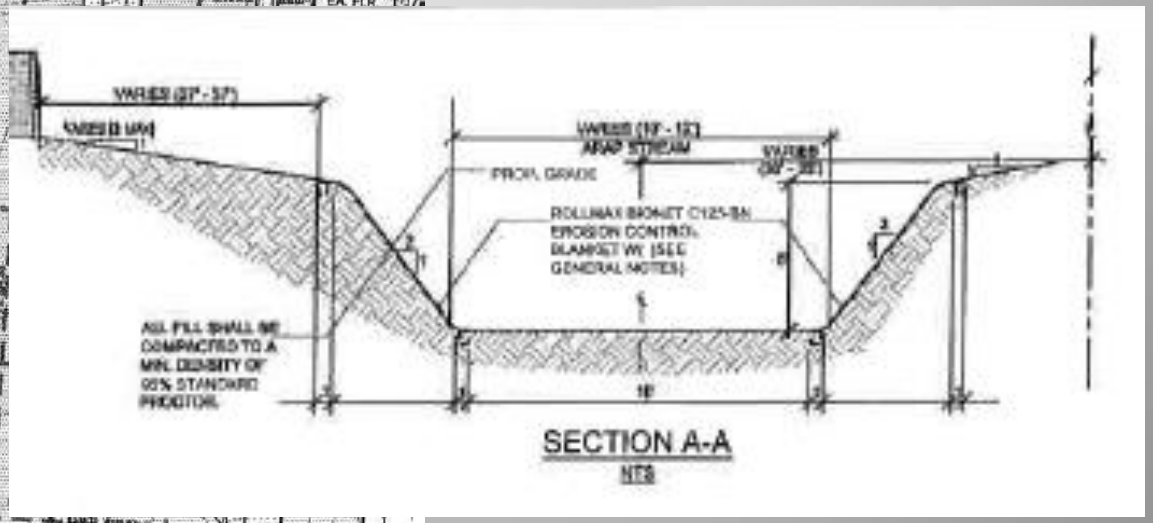
Vena Jones, TDEC

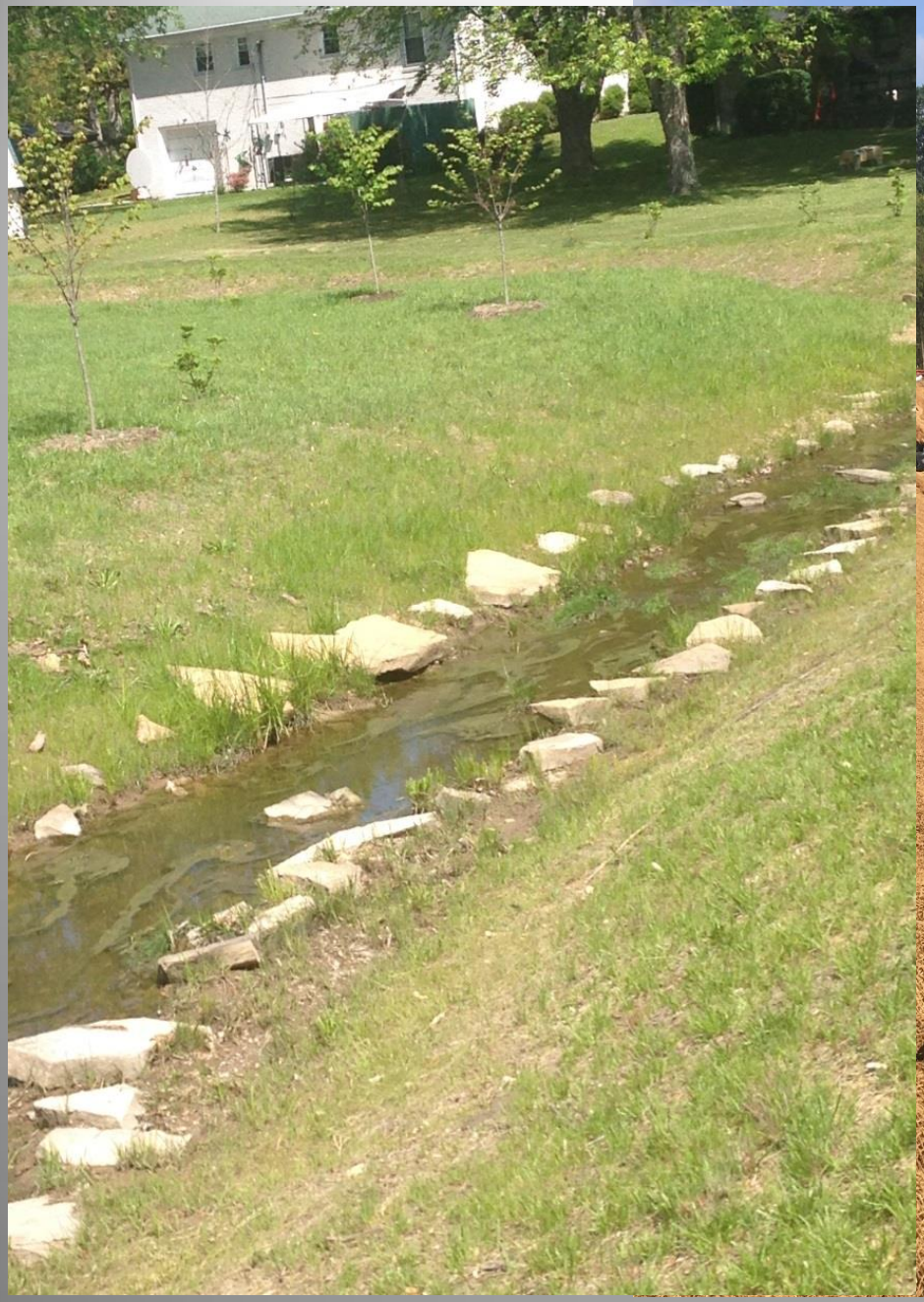
EPA Wetland Program Development Grant

- Tools – combine science with regulatory decision making
  - Practioners
  - Regulators
- Restoration- from compensatory mitigation to grant driven projects
- Relocations
- Flood control

Photo #6 – Looking upstream


LOT 146
100YR LOCAL BFE
325.13
100YR LOCAL BFE
325.12
BUILDING # 1
6,500 SF
BLDG. #12
TWO STORY
2,160 S.F.
EA. FLR
BUILDING # 10
8,625 SF
BUILDING # 11
3,600 FS
BUILDING # 9
26,000 SF
BUILDING # 8
26,000 SF
BUILDING # 3
2,100 SF
BUILDING # 5
9,150 SF


PROP. GRADE
ROLLMAX BIONET C125-BN
EROSION CONTROL
BLANKET W/ (SEE
GENERAL NOTES)
ALL FILL SHALL BE
COMPACTED TO A
MIN. DENSITY OF
95% STANDARD
PROCTOR
SECTION A-A
NTS



Dickson Brook Step Channel Project


Jul 15 2014

How to aid design and inform assessment

- Need a common vocabulary, easily transferrable process to individuals w/a variety of skillsets
- A natural stream system remains stable while transporting a wide range of flows and sediment produced in its watershed, maintaining a state of "dynamic equilibrium."

Getting Back to Basics: Regional Curves
(Hydraulic Geometry Relationships)

- Relationships of measured stream morphology, discharge, and drainage area
- Valuable for geomorphic assessment to analyze departure from equilibrium conditions in disturbed ecosystems
- Valuable for restoration planning to determine approximate channel dimensions and discharge

Regional Curve Development: Site Selection

- USGS Gage Stations with long-term records in stable watersheds
- Reference streams (ungaged) representing the range of stream sizes to be assessed

Reference Streams:

- Channels well-connected to alluvial floodplains with little evidence of incision (bank height ratios less than 1.2)
- Freely-formed meanders with alternating riffles and pools
- Streambanks and floodplains well-vegetated with no erosion
- Upstream watersheds mostly forest and agriculture
- Stable and unconfined for a length 20 times bankfull width

8 Level III Ecoregions in Tennessee (East to West):

66: Blue Ridge

67: Ridge and Valley

69: Central Appalachians

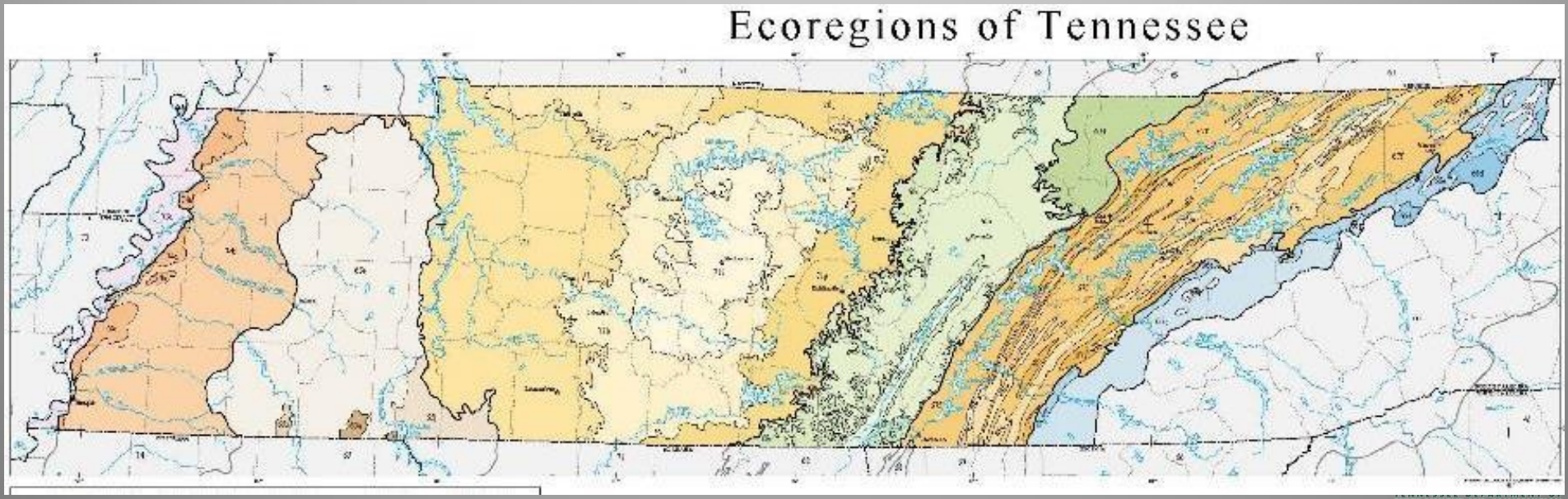
68: Southwestern Appalachians

71: Interior Plateau

65: Southeastern Plains

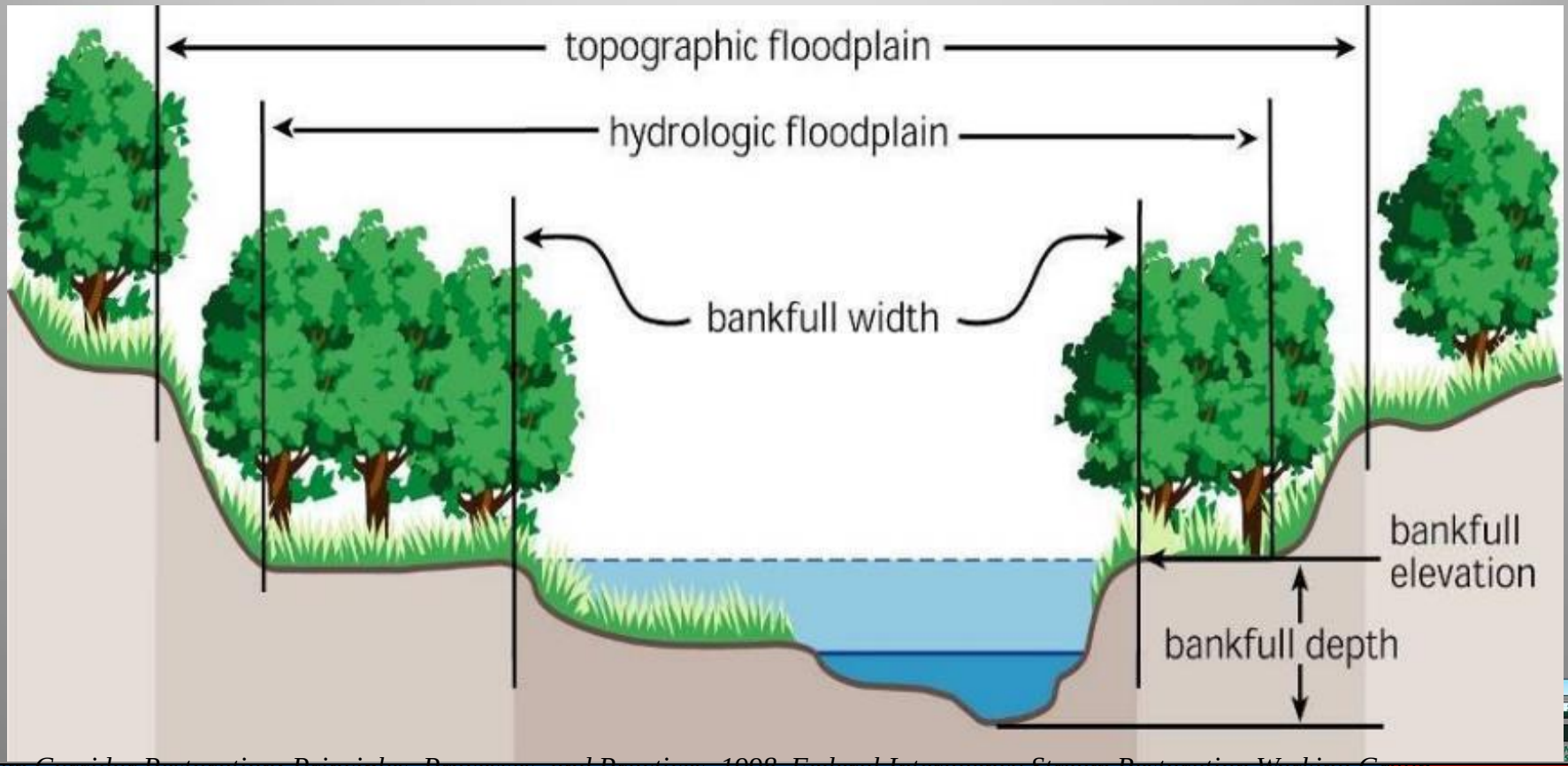
74: Mississippi Valley Loess Plains

73: Mississippi Alluvial Plain



Bankfull Stage: "incipient flooding"

"corresponds to the discharge at which channel maintenance is the most effective, that is, the discharge at which moving sediment, forming or removing bars, forming or changing bends and meanders, and generally doing work results in the average morphologic characteristics" *(Dunne & Leopold,1978)*



Stream Corridor Restoration: Principles, Processes, and Practices. 1998. Federal Interagency Stream Restoration Working Group.

The following five Level IV Ecoregions are found within the Interior Plateau of Tennessee (Figure 6):

71e: Western Pennyroyal Karst
71f: Western Highland Rim
71g: Eastern Highland Rim
71h: Outer Nashville Basin
71i: Inner Nashville Basin

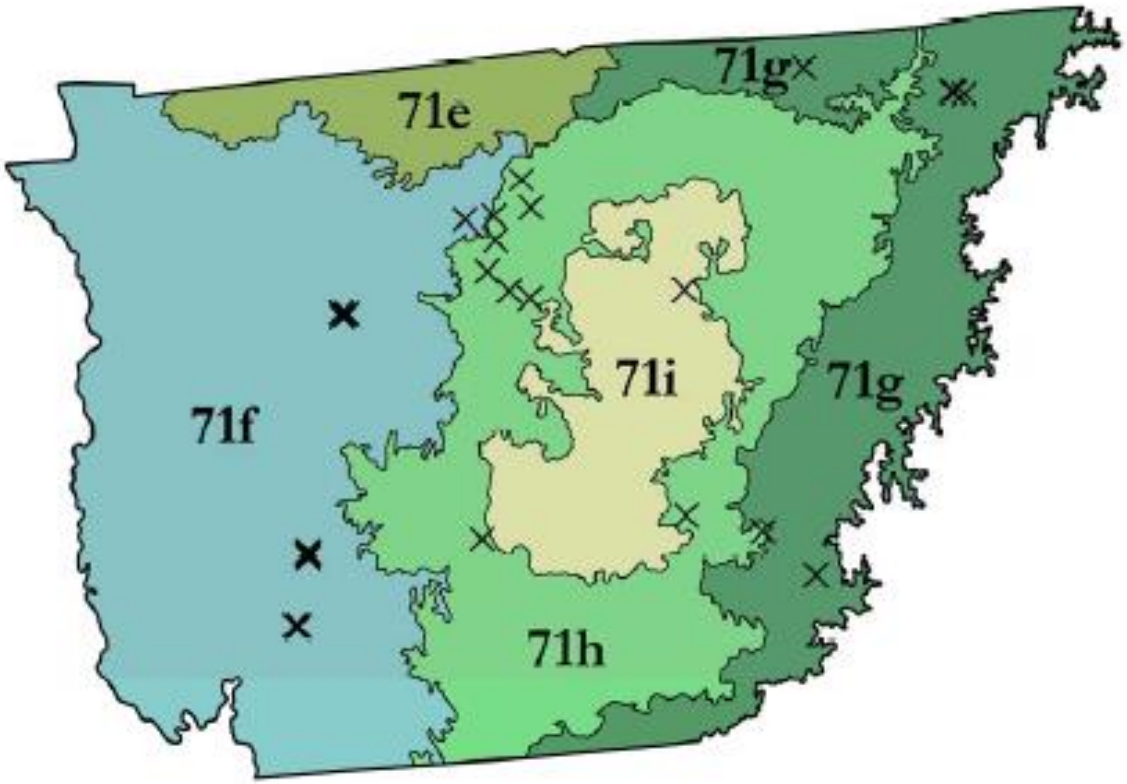


Figure 6. Level IV Ecoregions within the Interior Plateau of Tennessee (USEPA, 2013), with reference stream sites marked.

71 Interior Plateau Streams (36)

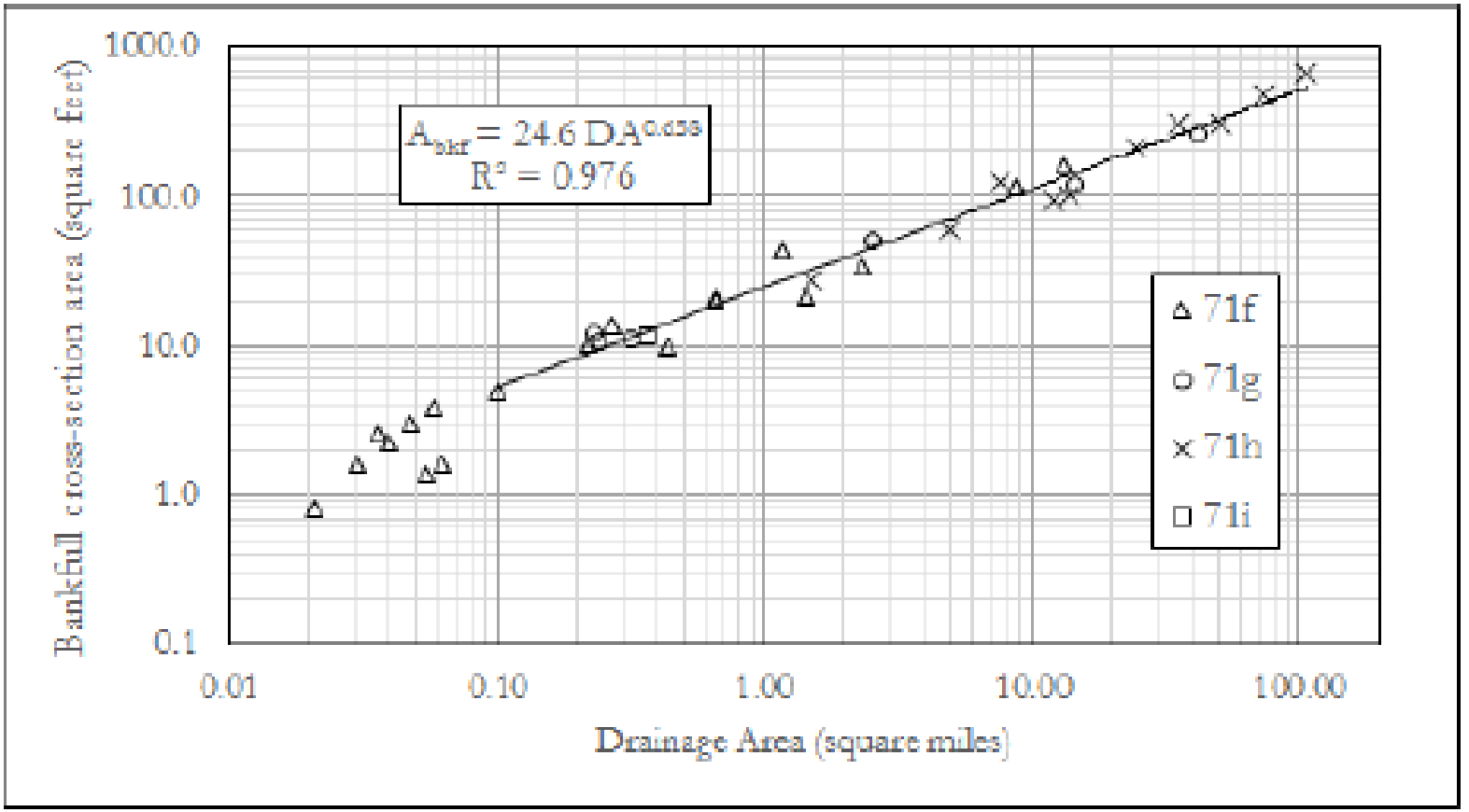


Figure 7. Bankfull riffle cross-section area related to drainage area for 36 Interior Plateau streams (TN), with different symbols for each Level IV Ecoregion.

71 Interior Plateau Streams (36)

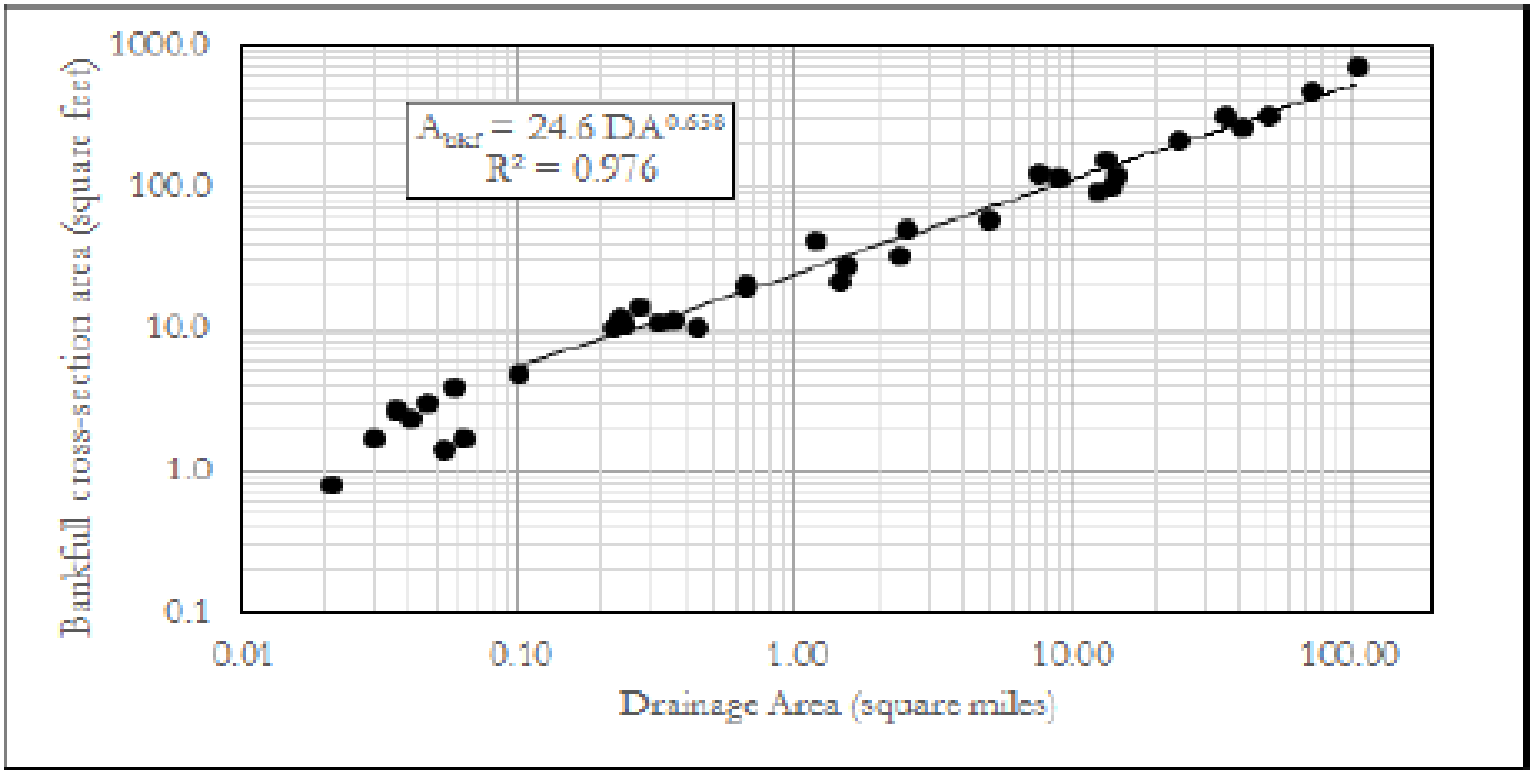


Figure 2. Bankfull riffle cross-section area related to drainage area for 36 Interior Plateau streams (TN).

68/69 Southwestern and Central Appalachian Streams (22)

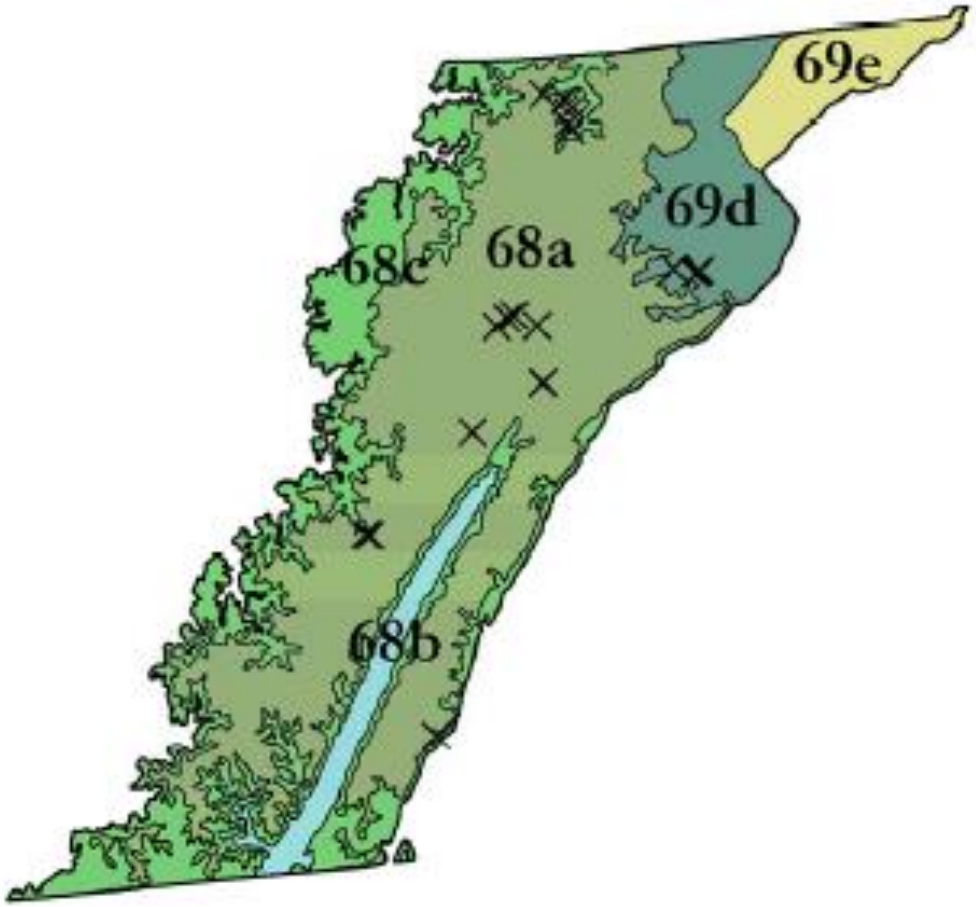


Figure 6. Level IV Ecoregions within the Southwestern and Central Appalachians of Tennessee (USEPA, 2013), with reference stream sites marked.

68/69 Southwestern and Central Appalachian Streams (22)

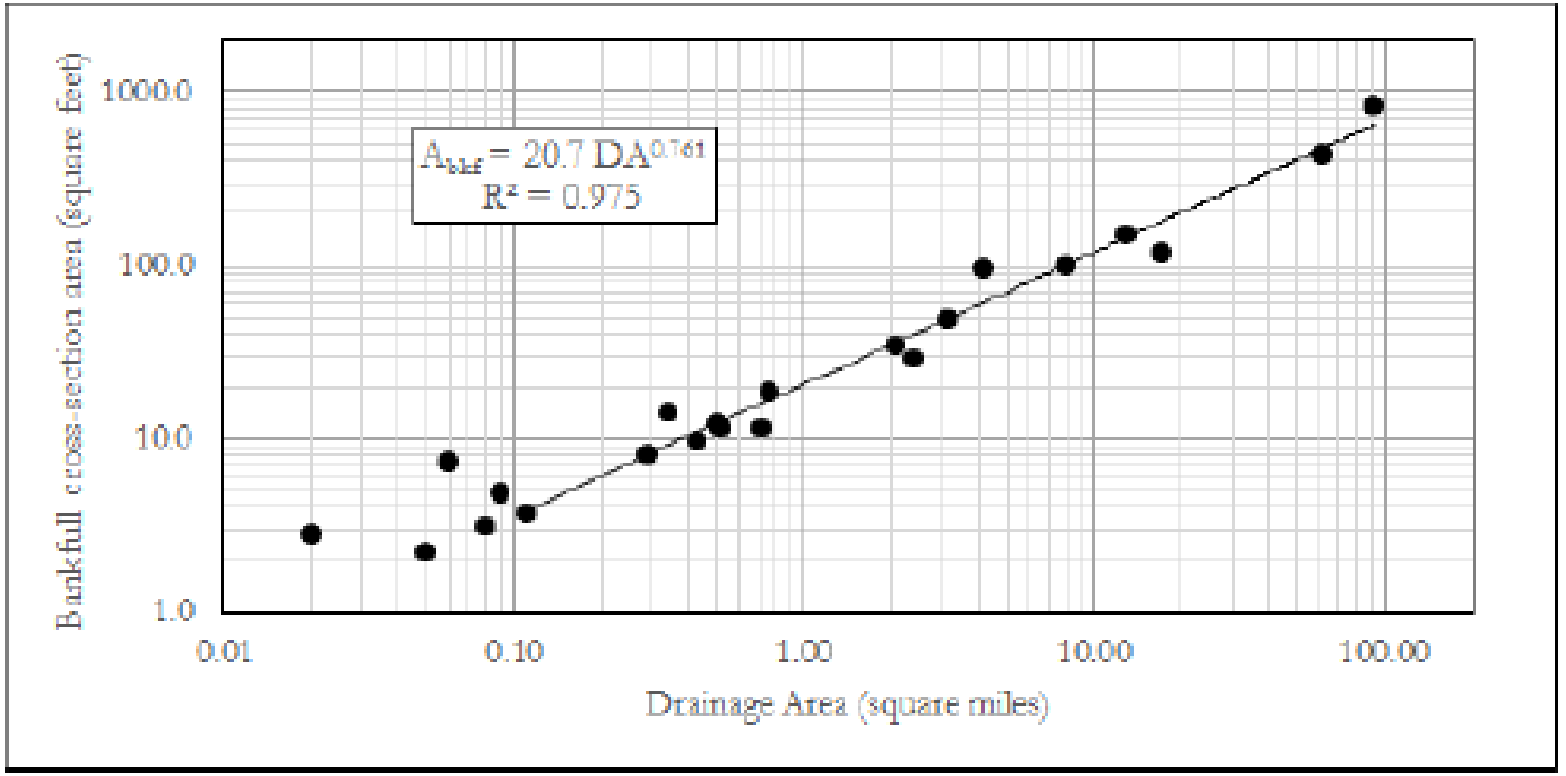


Figure 2. Bankfull riffle cross-section area related to drainage area for 22 Southwestern and Central Appalachians streams (TN).

67 Ridge and Valley Streams (18)

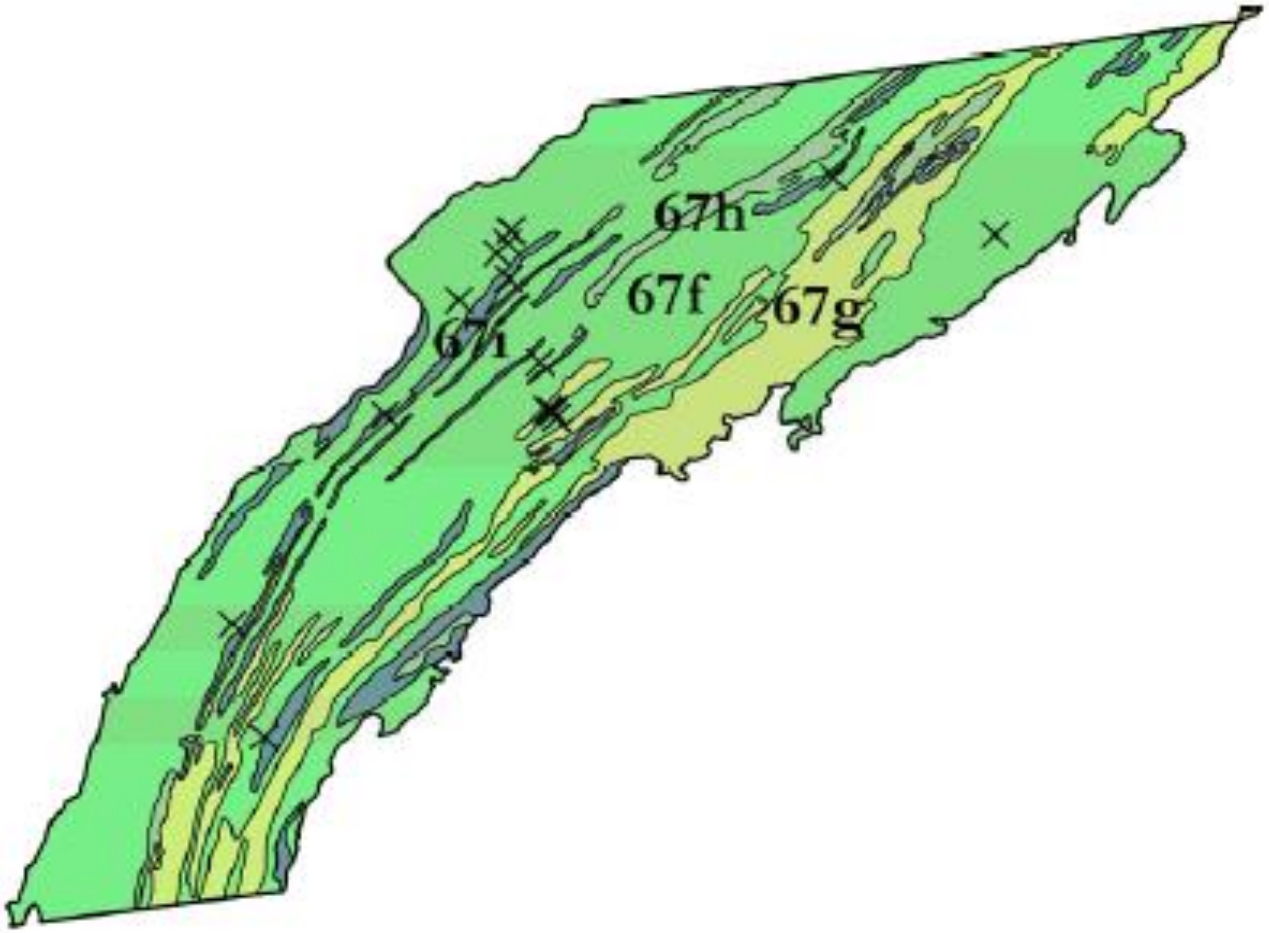


Figure 6. Level IV Ecoregions within the Ridge and Valley of Tennessee (USEPA, 2013), with reference stream sites marked.

67 Ridge and Valley Streams (18)

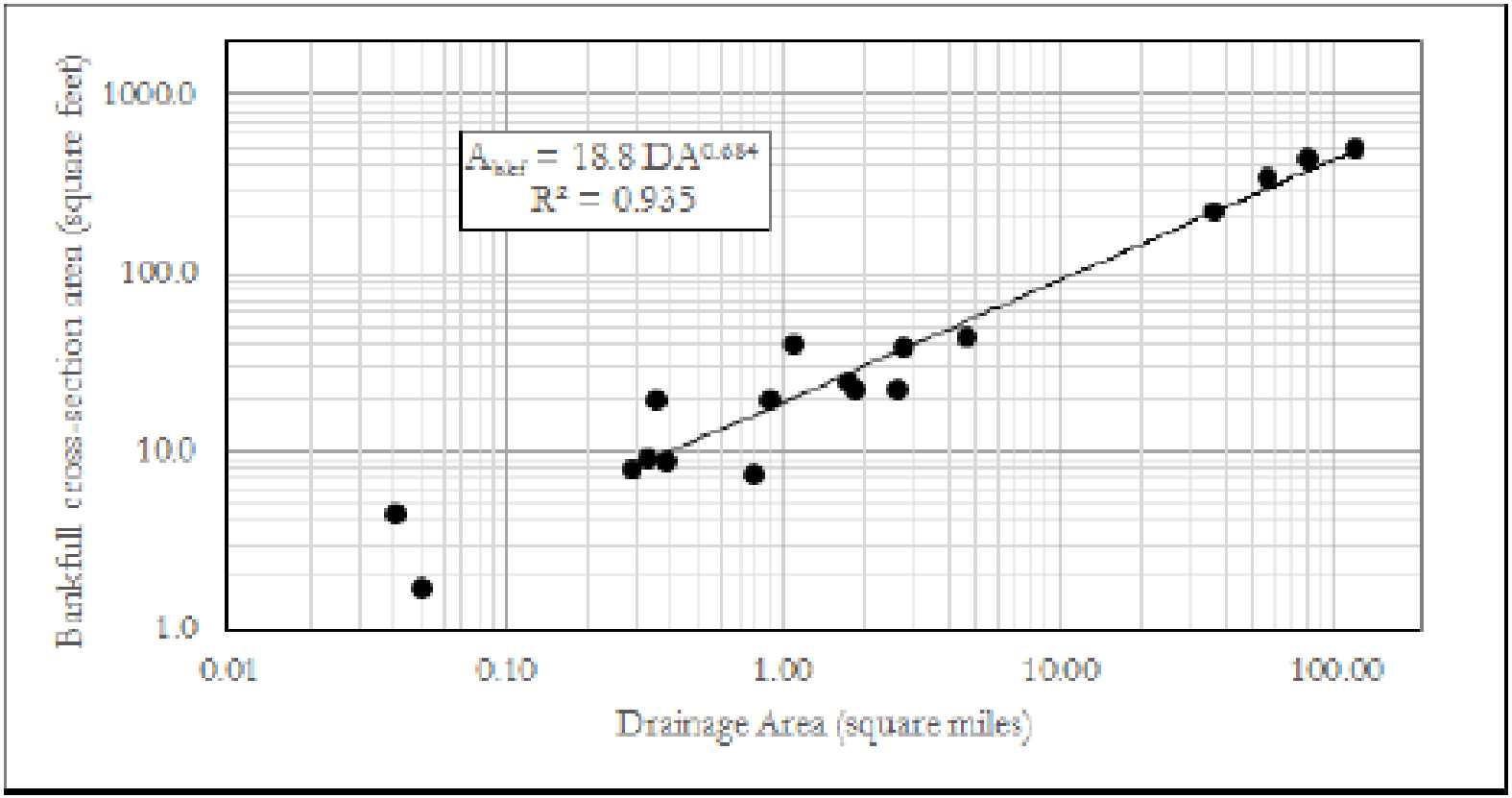
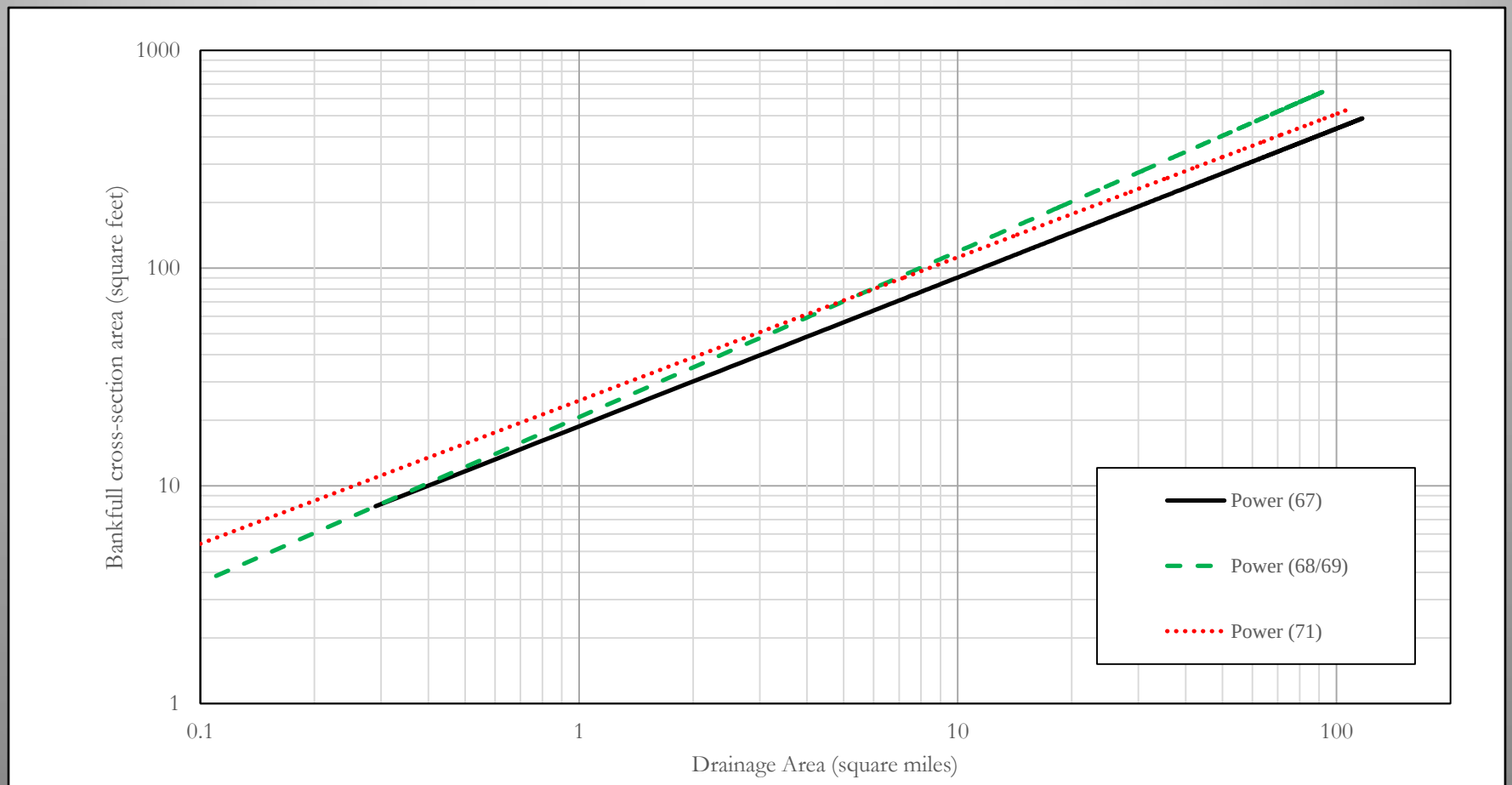
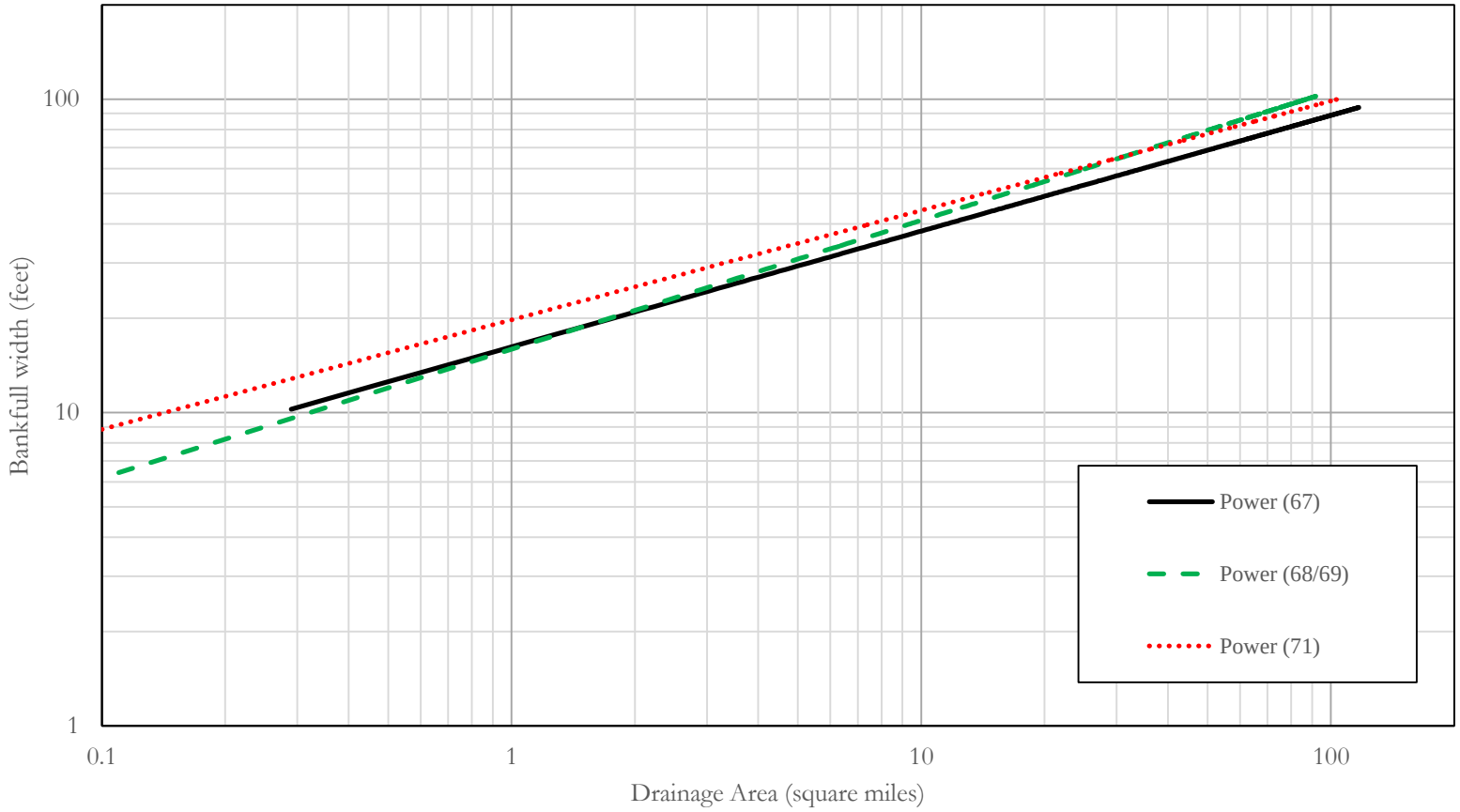


Figure 2. Bankfull riffle cross-section area related to drainage area for 18 Ridge and Valley streams (TN).

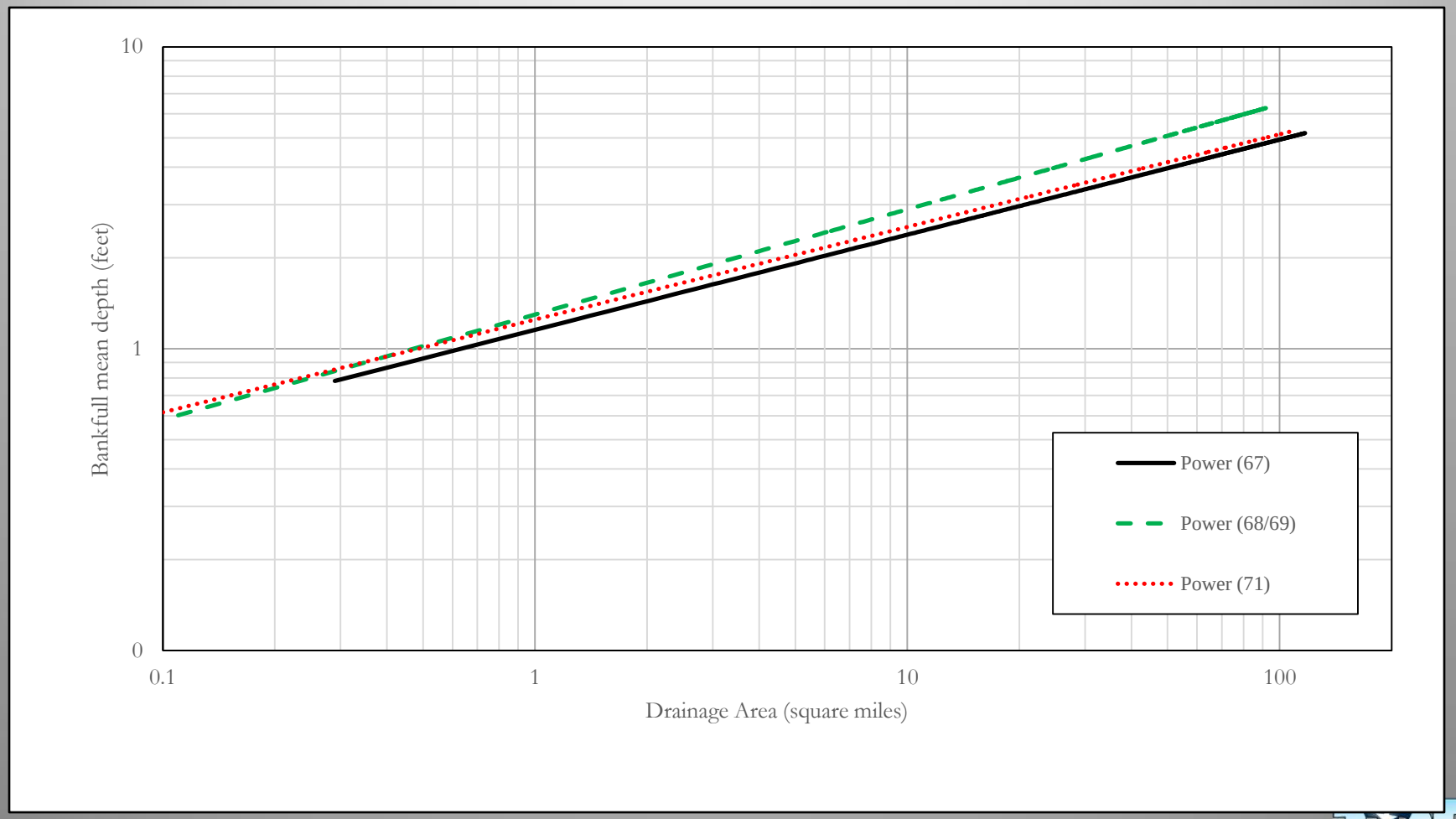
Ecoregion Results Cross sectional area vs DA

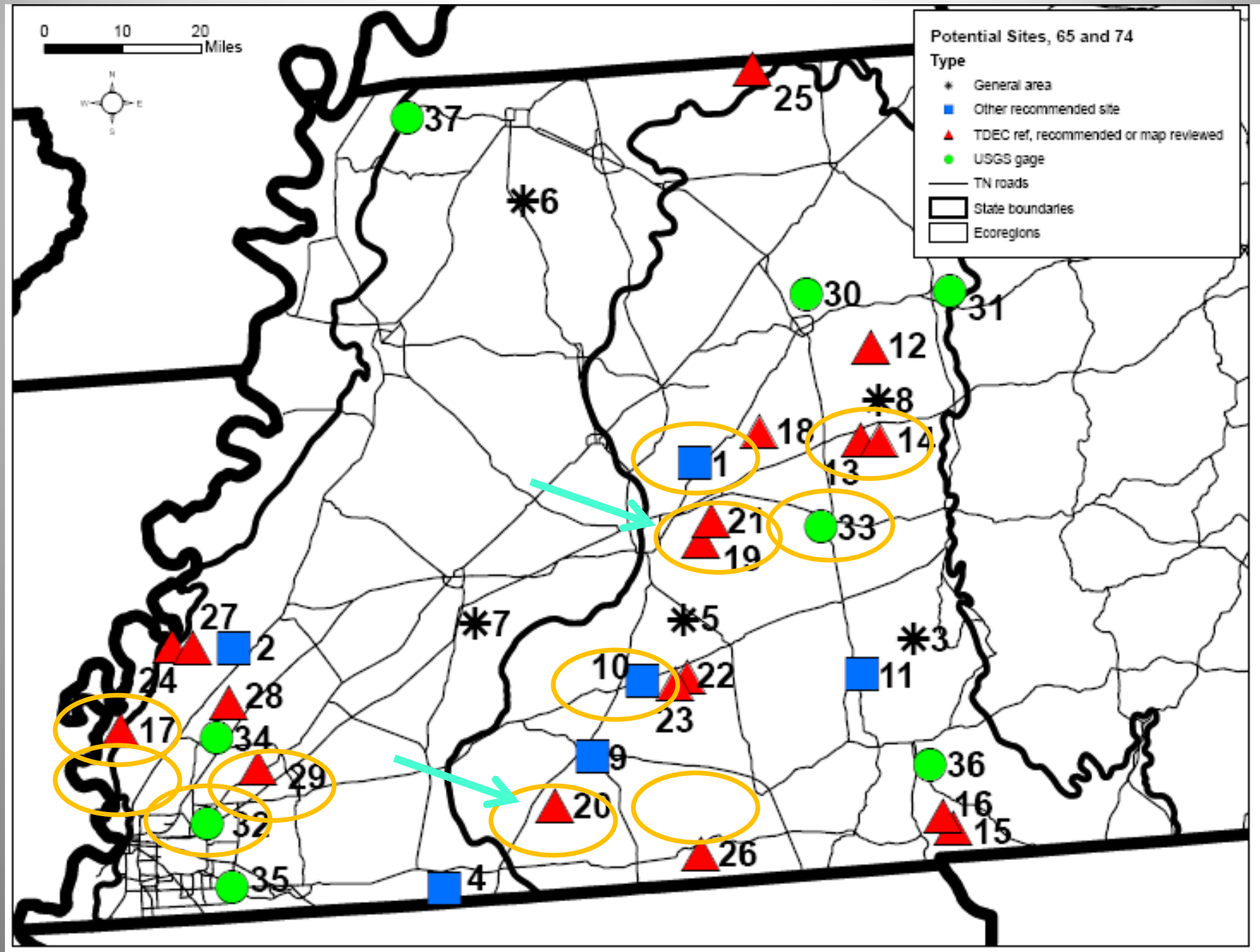


Bankfull width vs DA



Bankfull mean depth vs DA




0
10
20
Miles
Potential Sites, 65 and 74
Type
General area
Other recommended site
TDEC ref, recommended or map reviewed
USGS gage
TN roads
State boundaries
Ecoregions
25
37
6
30
31
12
8
18
14
1
13
21
19
33
27
2
7
5
3
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28
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23
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36
29
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16
15
32
26
35
4

West Tennessee

TENNESSEE DEPARTMENT OF ENVIRONMENT AND CONSERVATION

Temp. ID	Type	Other ID	Name	Lat	Long
1	Other reference		Spring Creek	35.770129	-88.691930
10	Other reference		Cypress Creek	35.376401	-88.852283
10a	Other reference		UT Piney Creek	35.389989	-88.789536
14	TDEC reference	FECO65E04	UT North Fork Cub Creek	35.785215	-88.264681
17	TDEC reference	FECO74A04	Barnishee Bayou	35.352193	-90.046340
17a	Other reference		UT1 Barnishee Bayou	35.351310	-90.046340
19	TDEC reference	ECO65E08	Harris Creek	35.626065	-88.694443
20	TDEC reference	ECO65E10	Marshall Creek	35.160921	-89.067608
21	TDEC reference	ECO65E19	Trace Creek	35.662943	-88.668672
29	TDEC reference	SCOTT001.7SH	Scotts Creek	35.267750	-89.740489
32	USGS gage	07031692	Fletcher Creek	35.169307	-89.866455
33	USGS gage	03594421	Beech River	35.634167	-88.414722
35	USGS gage	7032200	Nonconnah Creek	35.049389	-89.818276
72	Other reference		UT Poplar Tree Lake	35.314997	-90.058076
73	Other reference		UT2 Barnishee Bayou	35.365364	-90.033687
74	Other reference		UT3 Barnsihee Bayou	35.371643	-90.026829
75	Other reference		UT1 Tuscumbia River	35.051156	-88.750444
76	TDEC reference	FECO65E95	UT2 Tuscumbia River	35.050330	-88.748937

The Future of TN Mitigation: Tool Development

- EPA Wetland Program Development Grant

- **IRT Goals**
- Finalize regional curves 2016-2017
- Gather LWD data 2016-2017
- Gather ecological success criteria 2017
- Build regionalized quantification tool 2017-2018

Regionalization

- Regional curves
  - Provide channel geometry relationship based on DA and estimates bankfull discharge
- Bedforms
  - Riffles, pools
- Sinuosity
- Complexity of flood prone zone
- Large woody debris
- Biology
- Physicochemical

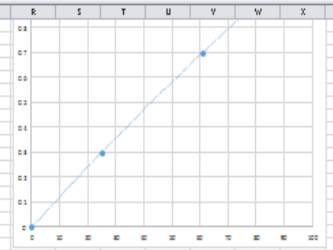
Functional Category	Function Based Parameter	Measurement Method
Hydrology	Catchment Hydrology	Catchment Assessment Form
	Reach Runoff	Stormwater Infiltration
		Concentrated Flow Points
		Soil Compaction
Hydraulics	Floodplain Connectivity	Bank Height Ratio
		Entrenchment Ratio
Geomorphology	Large Woody Debris	LWD Index
	Lateral Stability	Erosion Rate
		Dominant BEHI/NBS
		Percent Streambank Erosion
	Riparian Vegetation	
	Bedform Diversity	Pool Spacing Ratio
		Pool Depth Ratio
		Percent Riffle
		Bankfull WDR
	Sinuosity	Plan Form
Physicochemical	Organic Carbon	Leaf-Litter Processing Rate
		Percent Shredders
	Bacteria	
	Nitrate-Nitrite	Monitoring
	Phosphorus	Monitoring
Biology	Macroinvertebrates	TMI
		% EPT – Cheumatopsyche
		% Clingers
		% Oligochaetes & Chironomids
	Fish	Total # Native Fish Taxa
		Fish Catch/Unit Effort

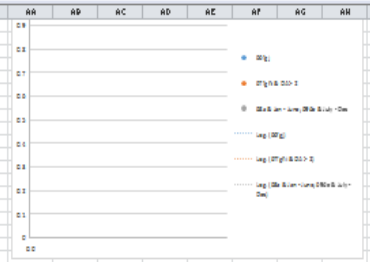
TN Quantification Tool v0.02 (3) [Protected View] - Microsoft Excel

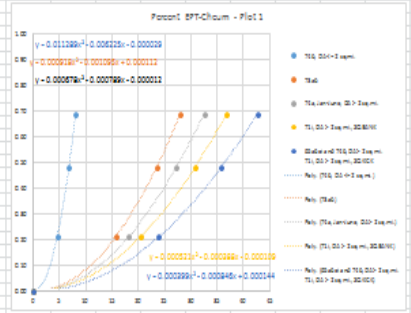
File Home Insert Page Layout Formulas Data Review View

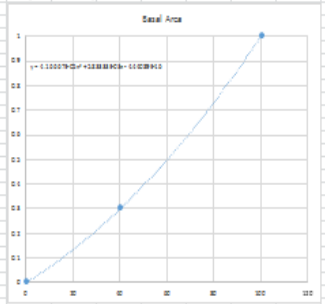
Protected View This file originated as an e-mail attachment and might be unsafe. Click for more details. Enable Editing

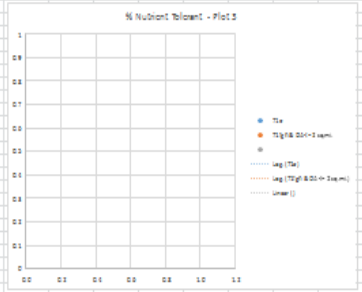
Chart 32

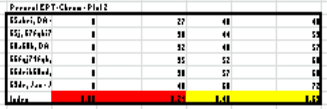


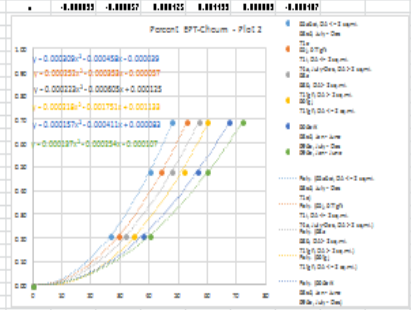


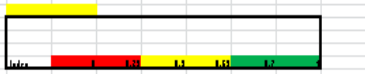










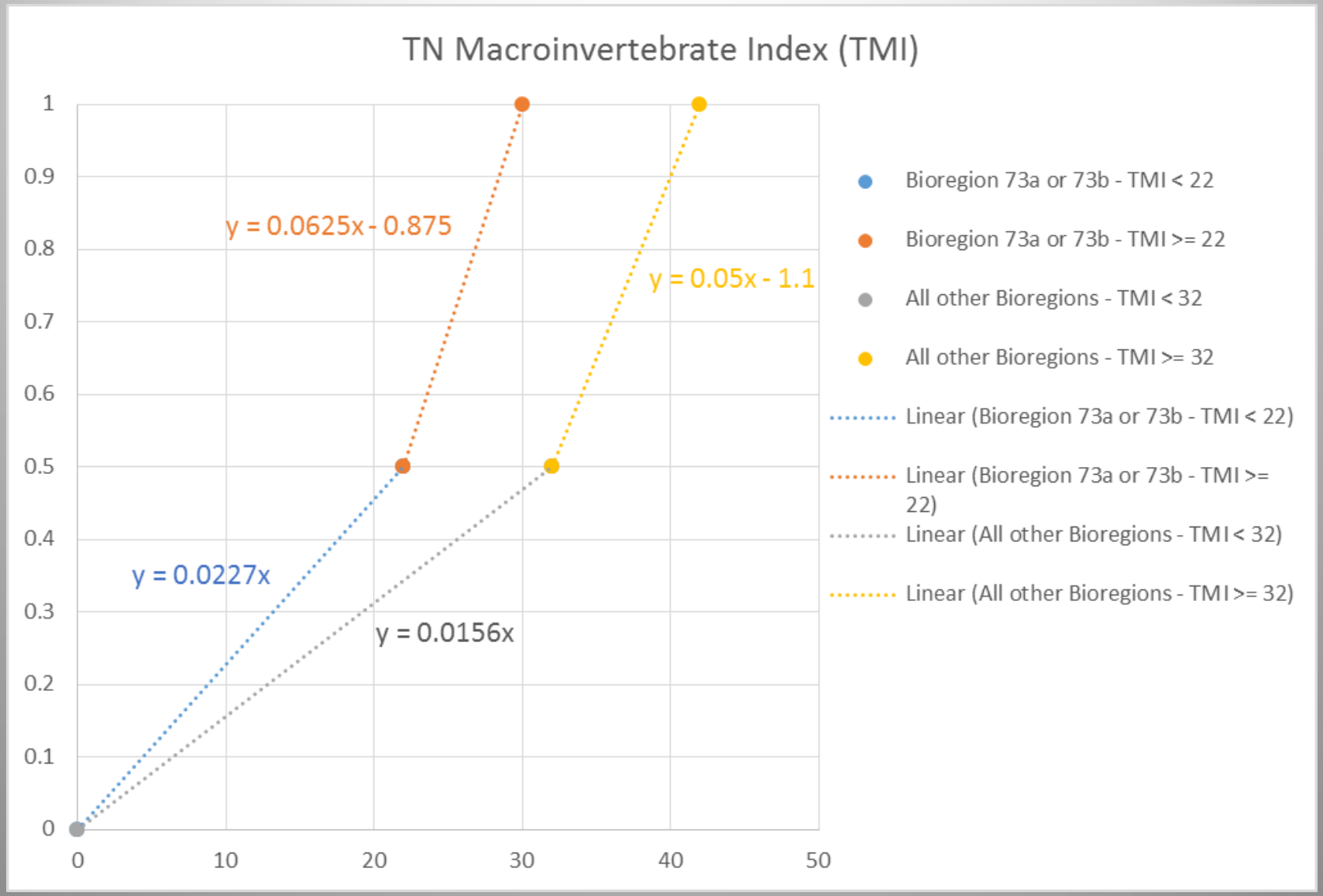


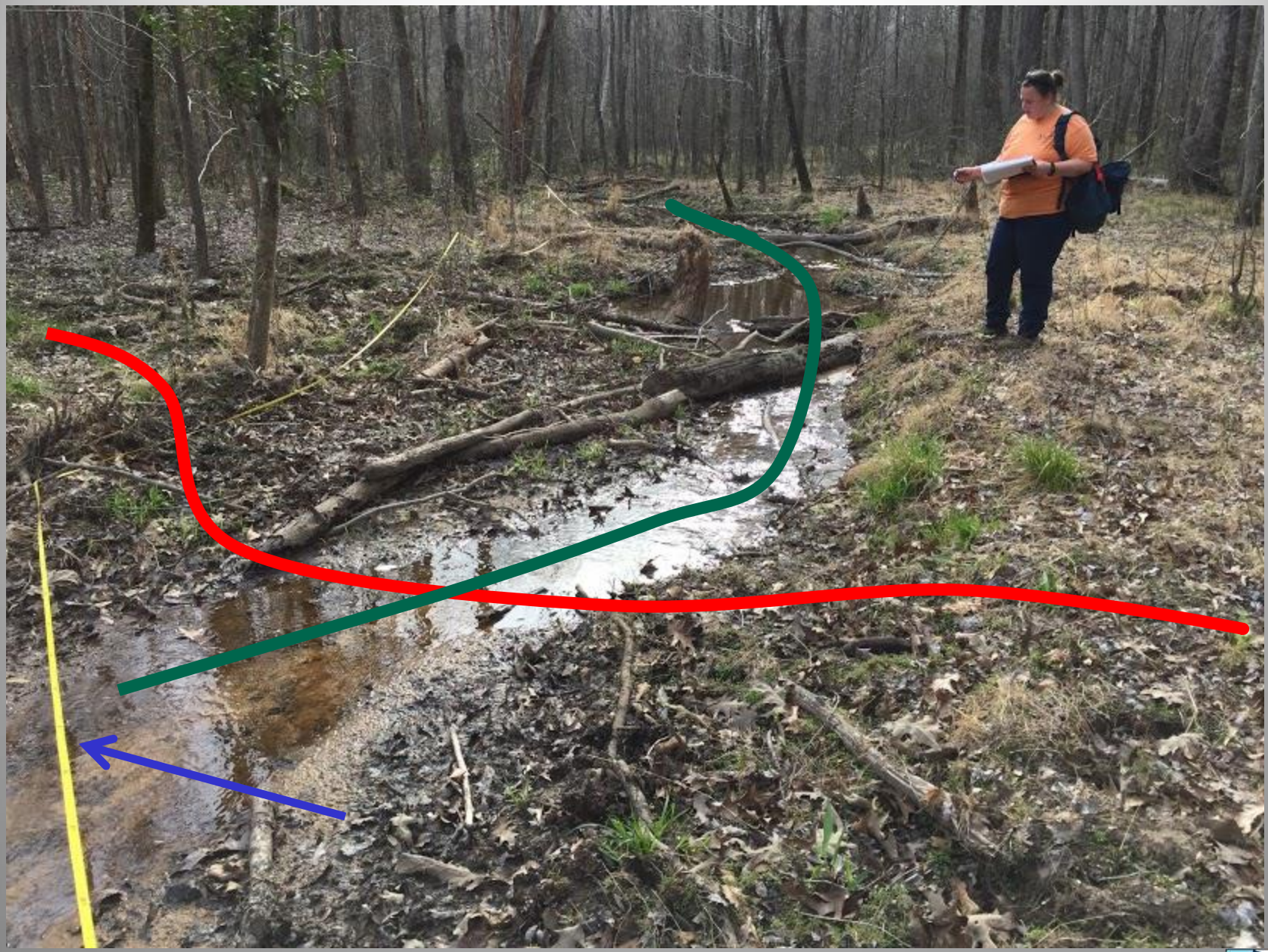
Project Assessment | Catchment Assessment | Parameter Selection Guide | Quantification Tool | **Performance Standards** | Pull Down Notes

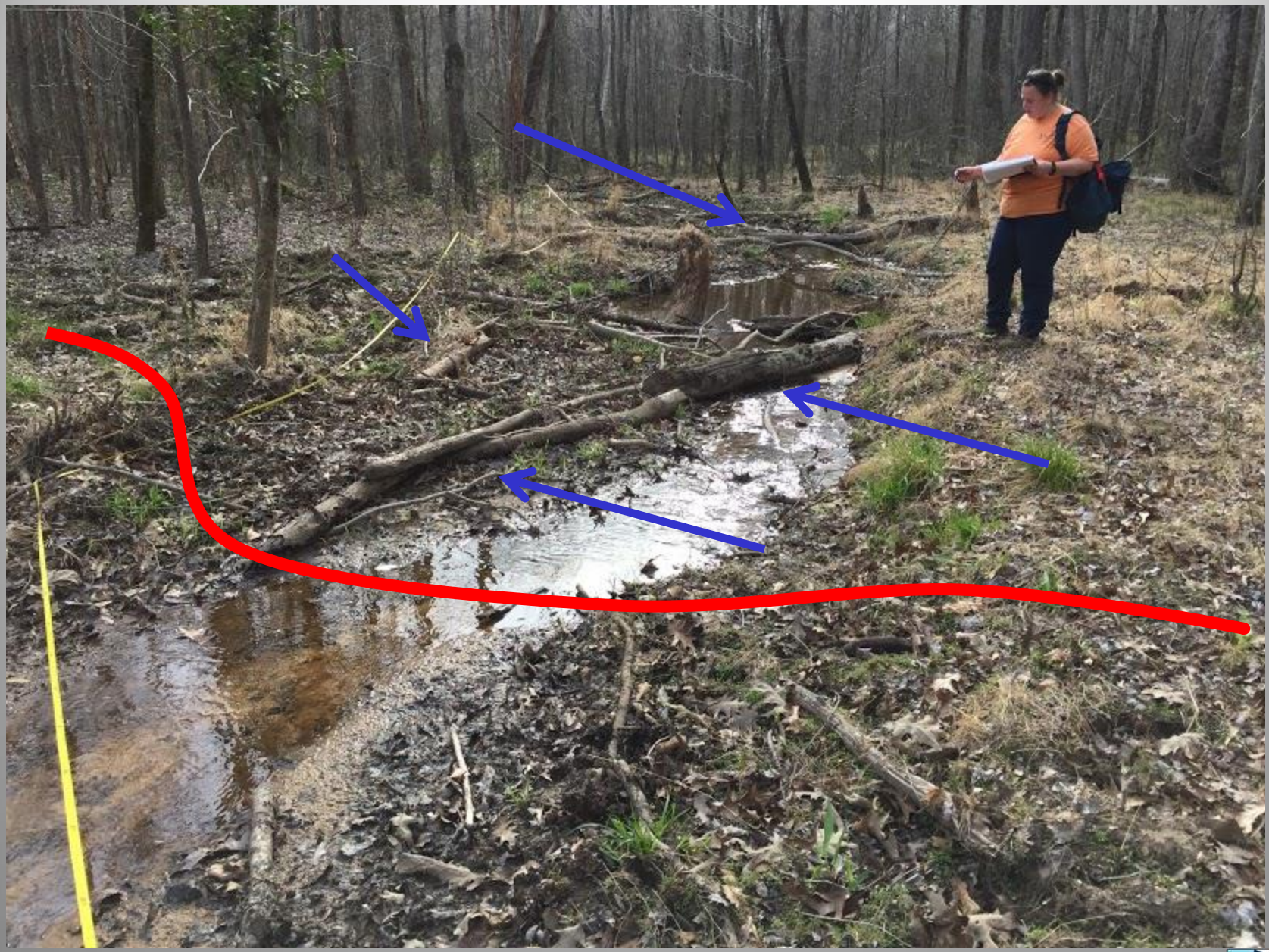
Ready 40%

11:32 AM 4/19/2017

TENNESSEE DEPARTMENT OF ENVIRONMENT AND CONSERVATION


TN Macroinvertebrate Index (TMI)
1
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0
0
10
20
30
40
50
y = 0.0625x - 0.875
y = 0.05x - 1.1
y = 0.0227x
y = 0.0156x
Bioregion 73a or 73b - TMI < 22
Bioregion 73a or 73b - TMI >= 22
All other Bioregions - TMI < 32
All other Bioregions - TMI >= 32
Linear (Bioregion 73a or 73b - TMI < 22)
Linear (Bioregion 73a or 73b - TMI >= 22)
Linear (All other Bioregions - TMI < 32)
Linear (All other Bioregions - TMI >= 32)





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Hydrology	Catchment Hydrology	Catchment Assessment Form
	Reach Runoff	Stormwater Infiltration
		Concentrated Flow Points
		Soil Compaction
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		Entrenchment Ratio
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	Lateral Stability	Erosion Rate
		Dominant BEHI/NBS
		Percent Streambank Erosion
	Riparian Vegetation	
	Bedform Diversity	Pool Spacing Ratio
		Pool Depth Ratio
		Percent Riffle
		Bankfull WDR
	Sinuosity	Plan Form
Physicochemical	Organic Carbon	Leaf-Litter Processing Rate
		Percent Shredders
	Bacteria	
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	Phosphorus	Monitoring
Biology	Macroinvertebrates	TMI
		% EPT – Cheumatopsyche
		% Clingers
		% Oligochaetes & Chironomids
	Fish	Total # Native Fish Taxa
		Fish Catch/Unit Effort

StreamMechanics

Functional Lift Summary

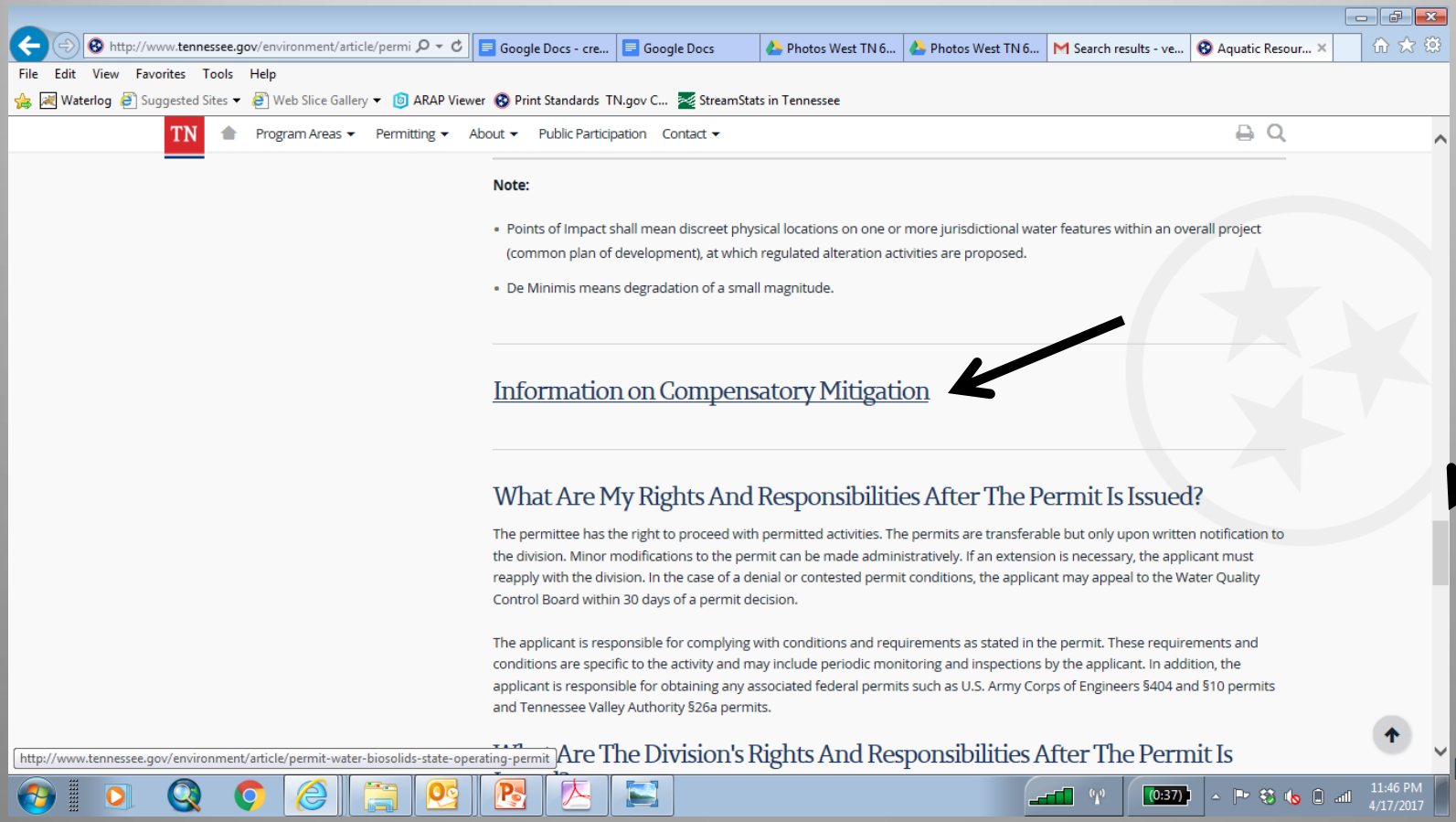
Functional Category	Function-Based Parameters	Existing Parameter	Proposed Parameter
Hydrology	Catchment Hydrology	0.4	0.4
Hydrology	Runoff		
Hydrology	Flow Duration		
Hydraulics	Floodplain Connectivity	0.5	1.0
Geomorphology	Large Woody Debris	0.1	0.58
Geomorphology	Lateral Stability	0.42	1
Geomorphology	Riparian Vegetation	0.53	0.76
Geomorphology	Bed Material Composition		
Geomorphology	Bed Form Diversity	0.59	1.0
Geomorphology	Sinuosity	0.70	0.93
Physicochemical	Temperature		
Physicochemical	Salinity		
Physicochemical	Bacteria	0.0	0.79
Physicochemical	Stream Metabolism		
Physicochemical	Organic Matter	0.50	0.90
Physicochemical	Nitrogen		
Physicochemical	Phosphorus		
Biology	Macros	0.36	0.60
Biology	Fish	0.0	0.61

Figure 16: Overall function-based existing condition and restoration potential of Little Tuscarora project. Taken from Hutzell & Starr (2015).

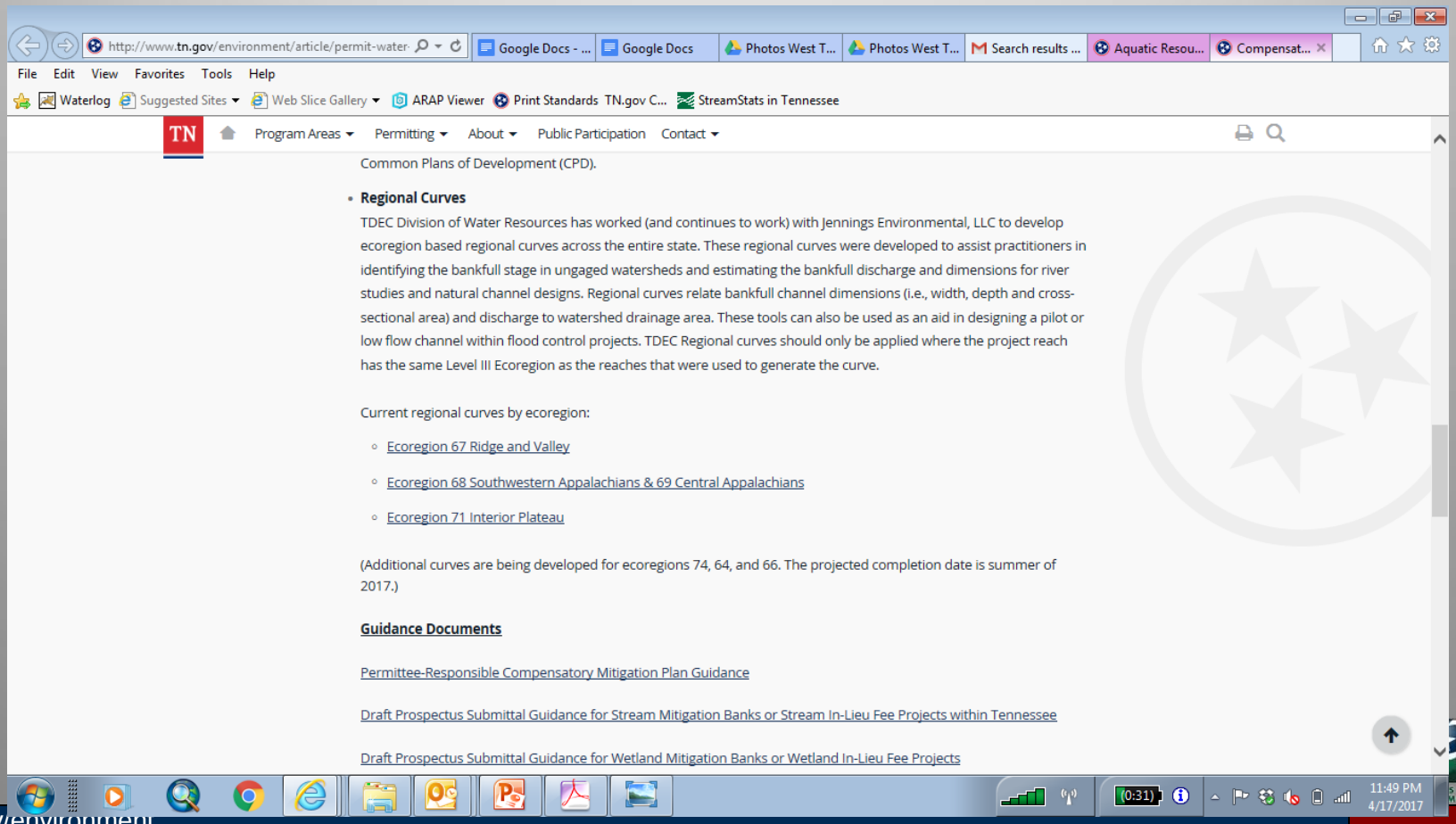
Level and Category	Parameter	Pre-Restoration Rating	Restoration Potential
1 - Hydrology	Channel-Forming Discharge	N/A	N/A
2 - Hydraulics	Floodplain Connectivity	Functioning-at-Risk	Functioning
3 - Geomorphology	Bed Form Diversity	Functioning-at-Risk	Functioning
	Channel Evolution	Not Functioning	Functioning
	Riparian Vegetation	Not Functioning	Functioning
	Lateral Stability	Functioning-at-Risk	Functioning
4 - Physicochemical	Water Quality	Not Functioning	Functioning-at-Risk
5 - Biology	Macroinvertebrate Communities	Functioning-at-Risk	Functioning-at-Risk
	Fish Communities	Functioning-at-Risk	Functioning-at-Risk

TDEC Mitigation Website

- Google TDEC ARAP Mitigation



http://www.tn.gov/environment/article/permit-water-arap-compensatory-mitigation



Common Plans of Development (CPD).

- **Regional Curves**

TDEC Division of Water Resources has worked (and continues to work) with Jennings Environmental, LLC to develop ecoregion based regional curves across the entire state. These regional curves were developed to assist practitioners in identifying the bankfull stage in ungaged watersheds and estimating the bankfull discharge and dimensions for river studies and natural channel designs. Regional curves relate bankfull channel dimensions (i.e., width, depth and cross-sectional area) and discharge to watershed drainage area. These tools can also be used as an aid in designing a pilot or low flow channel within flood control projects. TDEC Regional curves should only be applied where the project reach has the same Level III Ecoregion as the reaches that were used to generate the curve.

Current regional curves by ecoregion:

- Ecoregion 67 Ridge and Valley
- Ecoregion 68 Southwestern Appalachians & 69 Central Appalachians
- Ecoregion 71 Interior Plateau

(Additional curves are being developed for ecoregions 74, 64, and 66. The projected completion date is summer of 2017.)

Guidance Documents

Permittee-Responsible Compensatory Mitigation Plan Guidance

Draft Prospectus Submittal Guidance for Stream Mitigation Banks or Stream In-Lieu Fee Projects within Tennessee

Draft Prospectus Submittal Guidance for Wetland Mitigation Banks or Wetland In-Lieu Fee Projects

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DWR-Natural Resources Unit
Vena.l.jones@tn.gov
615-253-5320

TN Department of Environment & Conservation