Restoring the Choctawhatchee through targeted sediment reduction

Presented at the Florida Stormwater Association Conference

Sanibel, Florida

June 19, 2019

Photo: Florida Fish and Wildlife Conservation Commission (FWC)

Photo: JMT

Project Overview

This presentation is based on JMT's work for Florida DEP under Deepwater Horizon restoration funding in Florida's panhandle.

Project objectives: Reduce the sediment contribution to waterways from unpaved road-stream crossings to improve water quality and protected species habitat, especially Gulf Sturgeon

Project Impetus

Sediment load – Unpaved roads may contribute as much as 70% of total sediment load in the Choctawhatchee river (USDA-SCS, 1993)

Gulf sturgeon – Spawn in upper Choctawhatchee watershed in Alabama but not currently within Florida tributaries (second largest population of Gulf sturgeon in the Northeast Gulf of Mexico)

County maintenance – County staff and funds are tied-up with grading roads, hauling sand-clay aggregate, and cleaning ditches

U.S. Department of Agriculture, Soil Conservation Service (USDA-SCS). 1993. Choctawhatchee and Pea River basin study: Alabama and Florida reconnaissance report. Auburn, AL. 200 p.

Approach

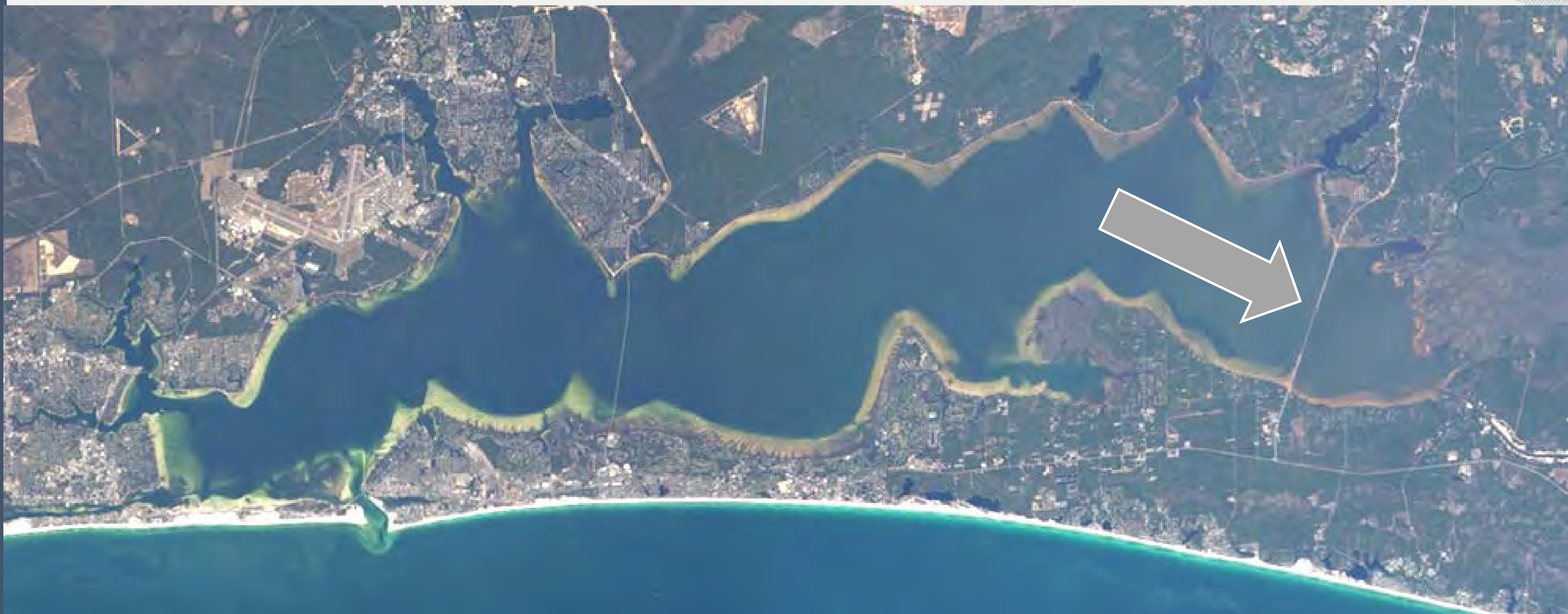
- Field assessment
- Prioritization of sites for BMP implementation because of limited funds
- BMP development for 15 sites

A. SEDIMENTATION IN THE CHOCTAWHATCHEE

Sedimentation Impacts

- Eroded sediment causes excess turbidity that harms aquatic life
- Sedimentation clogs drainage ditches, stream channels, water intakes, and reservoirs
- Sedimentation destroys aquatic habitats

Sedimentation and Aquatic Species



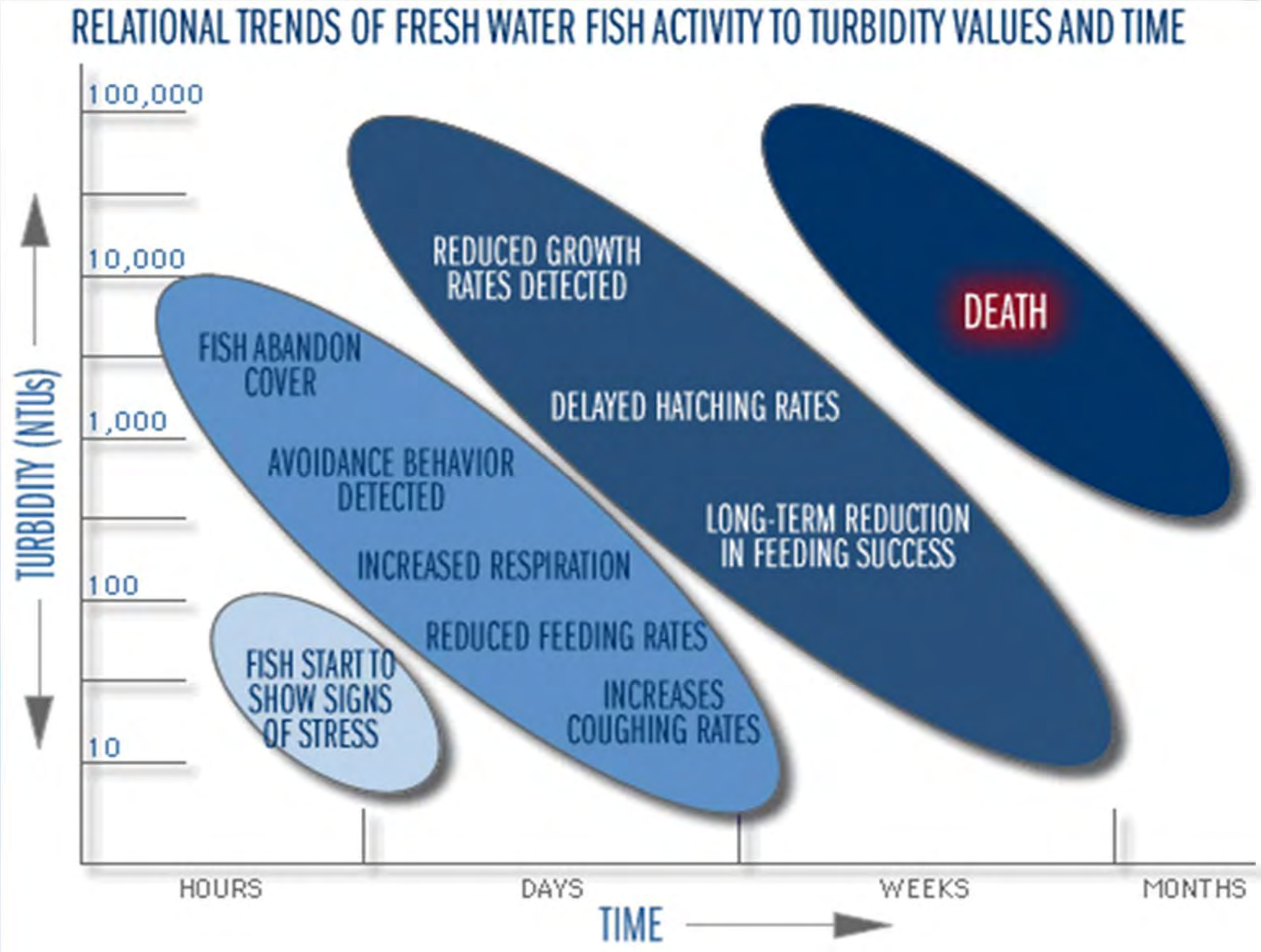
Sedimentation can adversely affect the behavior and physiology of aquatic species as far downstream as the Choctawhatchee Bay, Florida

Sedimentation and Fish

Suspended solids and sedimentation impact fish

- **Physiology**
- **Behavior**
- **Habitat**

Inhibits fish growth, reproduction, and survival



Schematic adapted from "Turbidity: A Water Quality Measure", Water Action Volunteers, Monitoring Fact sheet Series, UW-Extension, Environmental Resources Center, based on Newcombe, C. P., and J. O. T. Jensen. 1996. Channel suspended sediment and fisheries: a synthesis for quantitative assessment of risk and impact. *North American Journal of Fisheries Management.* 16: 693-727.

Material Loss and Sedimentation

- **Unpaved road beds erode directly into streams**
- **Roadside drainage ditches convey sediment into streams**

Steele Road over Penny Creek in Okaloosa County, Florida

Material Loss and Sedimentation

- Roadway maintenance involves constantly regrading roads and replacing lost aggregate

- Counties are opening new quarries to sustain the amount material needed for this maintenance

- Millions of cubic yards of material was pulled from one County's quarry over 57 years for road maintenance

Material Loss and Sedimentation

Windmill Branch, Otis Lane

Degraded Road Profile

Severely entrenched roadway approach to East Pittman Creek

Material Loss and Sedimentation

Unnamed Tributary, Roland Road

Unimpeded flow from road to stream

Graveyard Creek, Bell Road

Material Loss and Sedimentation


Unnamed Tributary, W V Armstrong Road

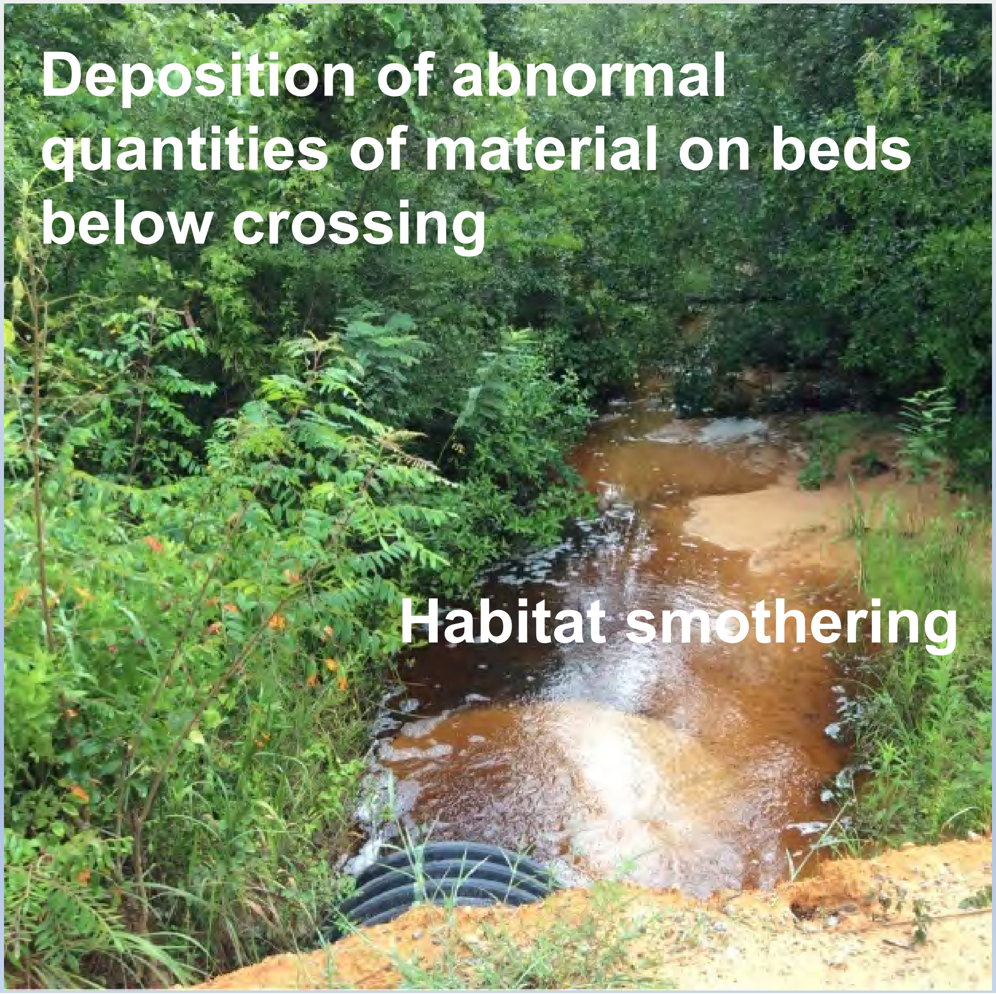

Turnpike Branch, Joe Dugger Road

Degraded roadside ditches

Culvert obstruction

Material Loss and Sedimentation

Sediment runoff at unpaved-road crossings: upstream and downstream views



B. BMPS – POTENTIAL SOLUTIONS

Sediment BMPs

Road Asphalt Paving / Paving Approaches

Paved, steep right approach of Firetower Road crossing of Reedy Creek, Washington County, FL (JMT Photo)

Clear water and stable crossing at Firetower Road and Reedy Creek, Washington County, FL (JMT Photo)

Sediment BMPs

Road Aggregate Surfacing

Roadway aggregate and riprap ditch in Walton County, FL

Sediment BMPs

Crowning and Grading

Photo from JMT 2018
FDEP Choctawhatchee Basin study

Sediment BMPs

Grade Breaks

Figure excerpted from
USDA (2012)

Figure 3.7—The two grade breaks pictured here prevent water from flowing down the road, even if the road's crown were to be lost.

Sediment BMPs

Rolling Dip / Broad-Based Dip

Figure excerpted from USDA (2012)

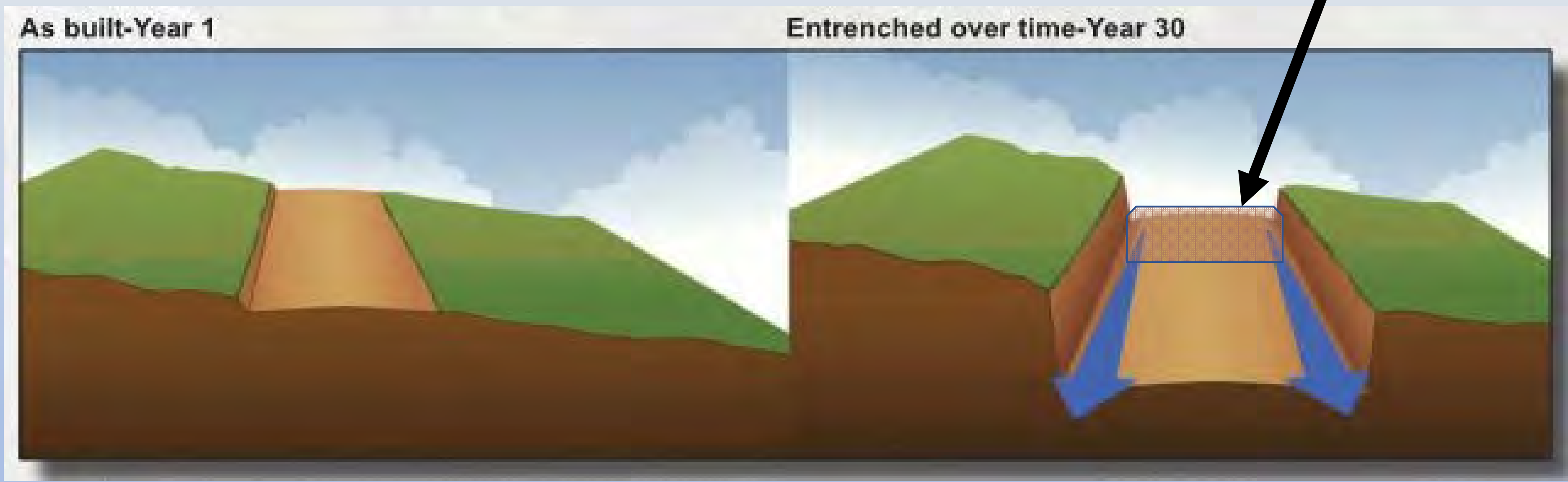
Figure 3.10—The broad-based dip pictured here conveys water from the road surface and upslope ditch into a vegetative filter area on the right.

Sediment BMPs

Raising the Road Profile

Figure excerpted from USDA (2012)

Fill road prism
and resurface



Over time, the elevation of many roads, especially unpaved roads, is lowered due to traffic, maintenance, and erosion. When roads become lower than the surrounding terrain, they are referred to as entrenched, and water often is trapped in the road travel-way.

Sediment BMPs

Berm Removal

Figure Excerpted from USDA (2012)

Figure 4.15—The berm was created by recent grading. Removing the berm and crowning the road allows sheet flow into the vegetation to the left.

Sediment BMPs

Roadside Slope Grading / Revegetation

Figure excerpted from USFWS (2005) *Northwest Florida Unpaved Road-Stream Crossing Manual*

Figure 2-1. Severely Eroded Unstable Roadside Slopes (Photos by Mike Rainer)

Sediment BMPs

Turnouts

Figure excerpted from USFWS (2005)

Turnouts are not always a panacea (JMT, 2018)

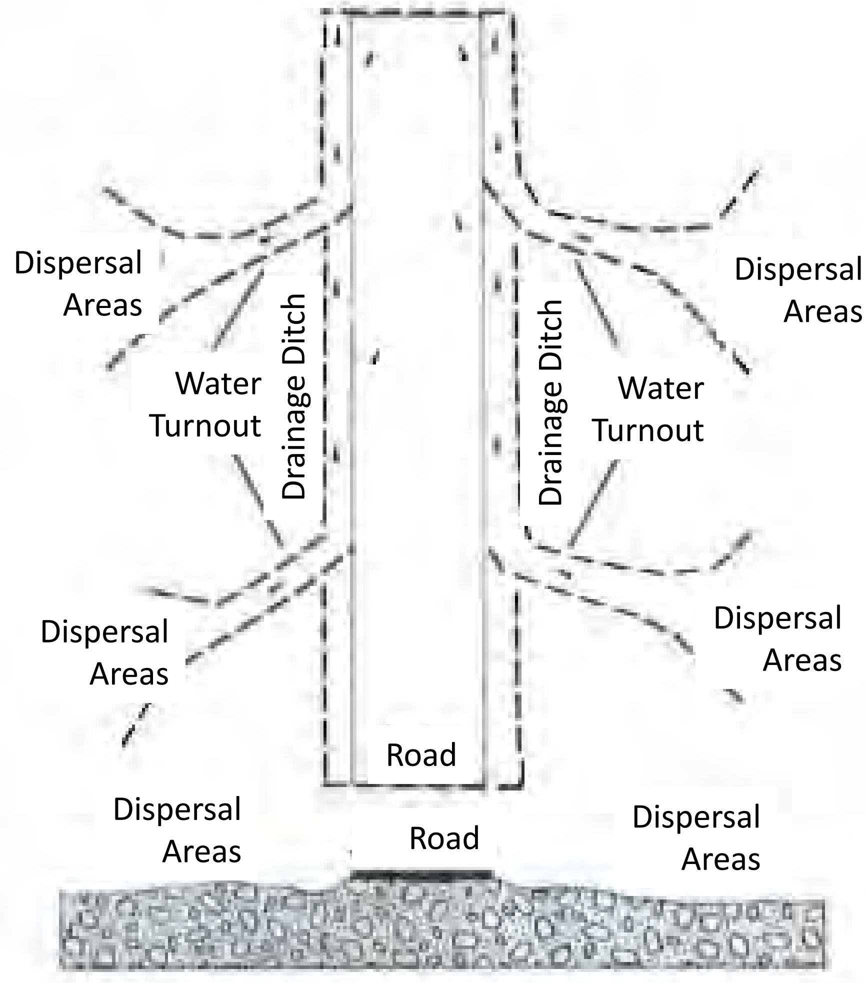


Figure 3-13. Roadside Turnout Configuration
(Florida Department of Agriculture and Consumer Services, 1993)

Sediment BMPs

Material addition

Figure excerpted from USFWS (2005)

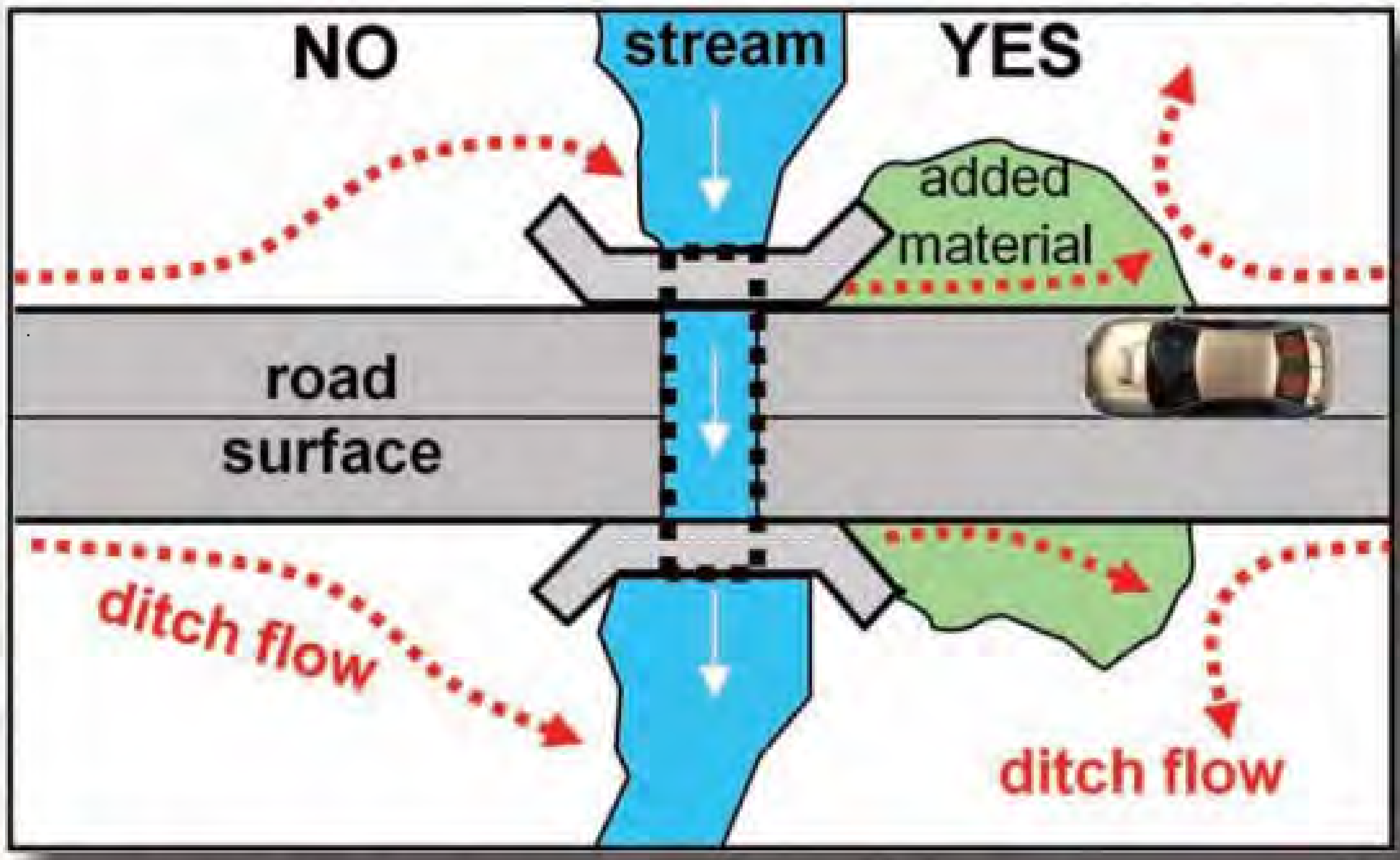


Figure 4.21—Aerial depiction of road-stream crossing. The left side of the diagram shows the traditional practice of discharging water to the stream. The right side of the diagram shows material added to redirect ditch flow and outlet water away from the stream.

Sediment BMPs

Soft-Armored Waterway

Photo: D2 Land and Water Resources; Figure excerpted from USFWS (2005)

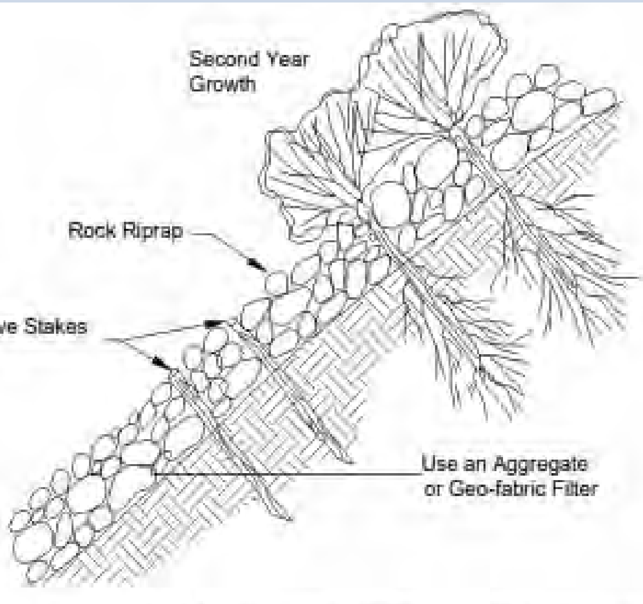
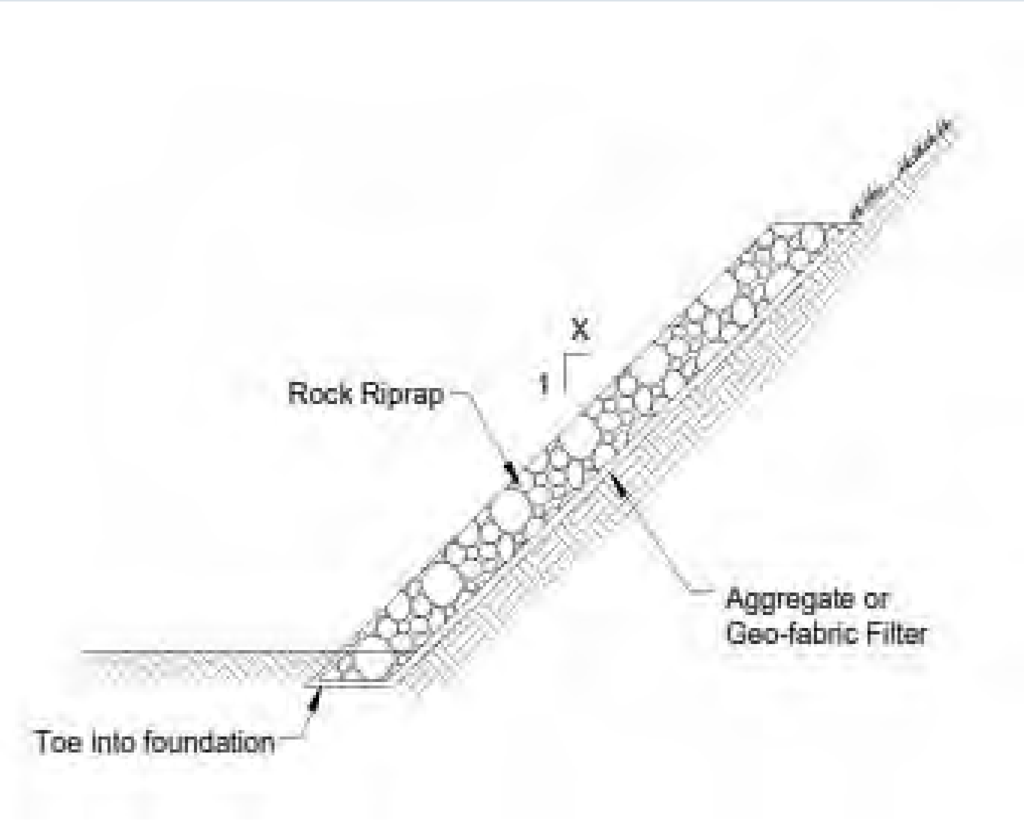


Figure 5-13. Vegetated Riprap Revetment

Sediment BMPs

Hard-Armored Waterway

Photo excerpted from USFWS (2005);
Figure excerpted from epa.gov



Drainage discharge

Sediment BMPs

Stream Culvert

Figure excerpted from USFWS (2005)

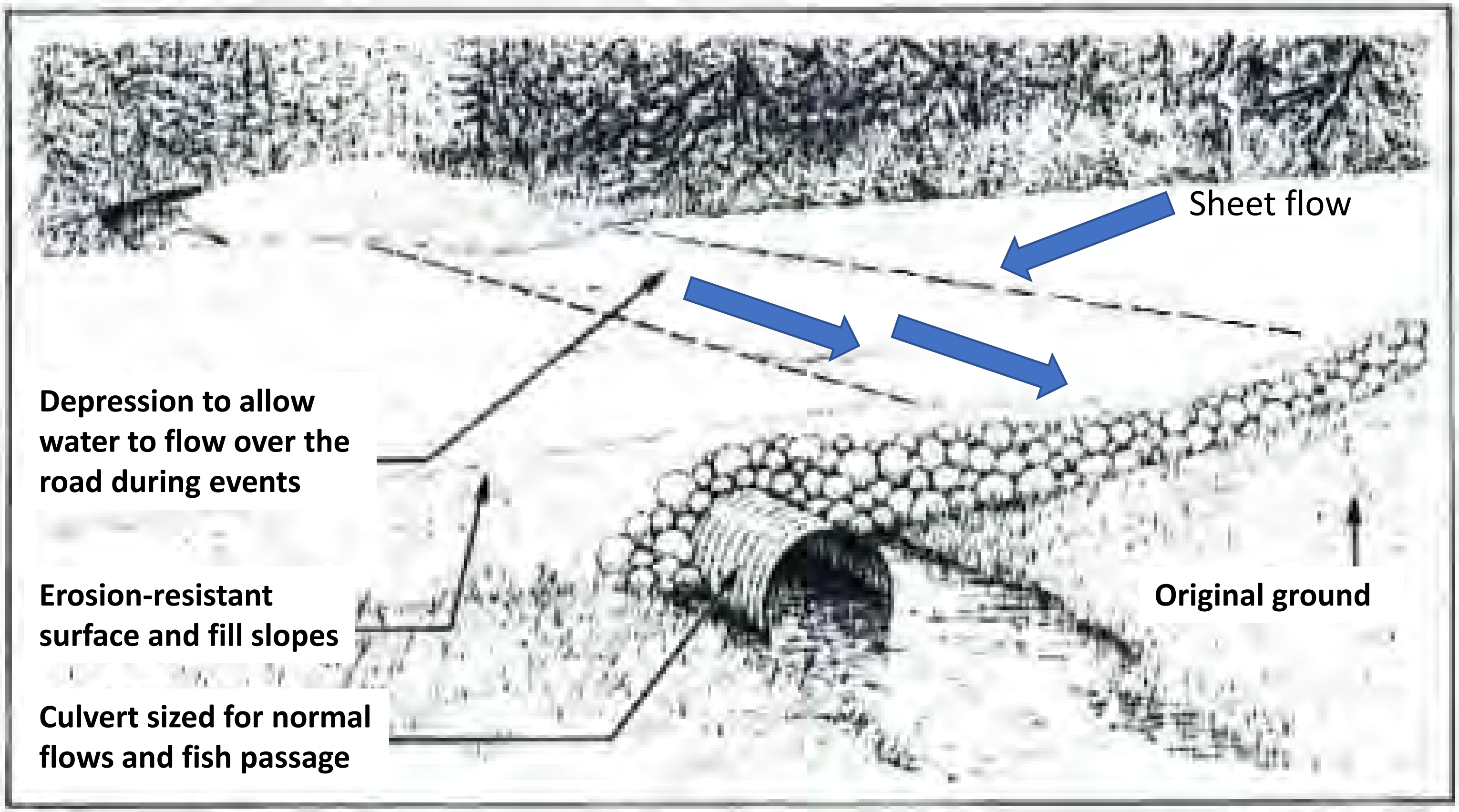


Figure 5-2. Culvert Water Crossing with an Overflow Depression

Sediment BMPs

Riprap Installation

Figure excerpted from USFWS (2005)

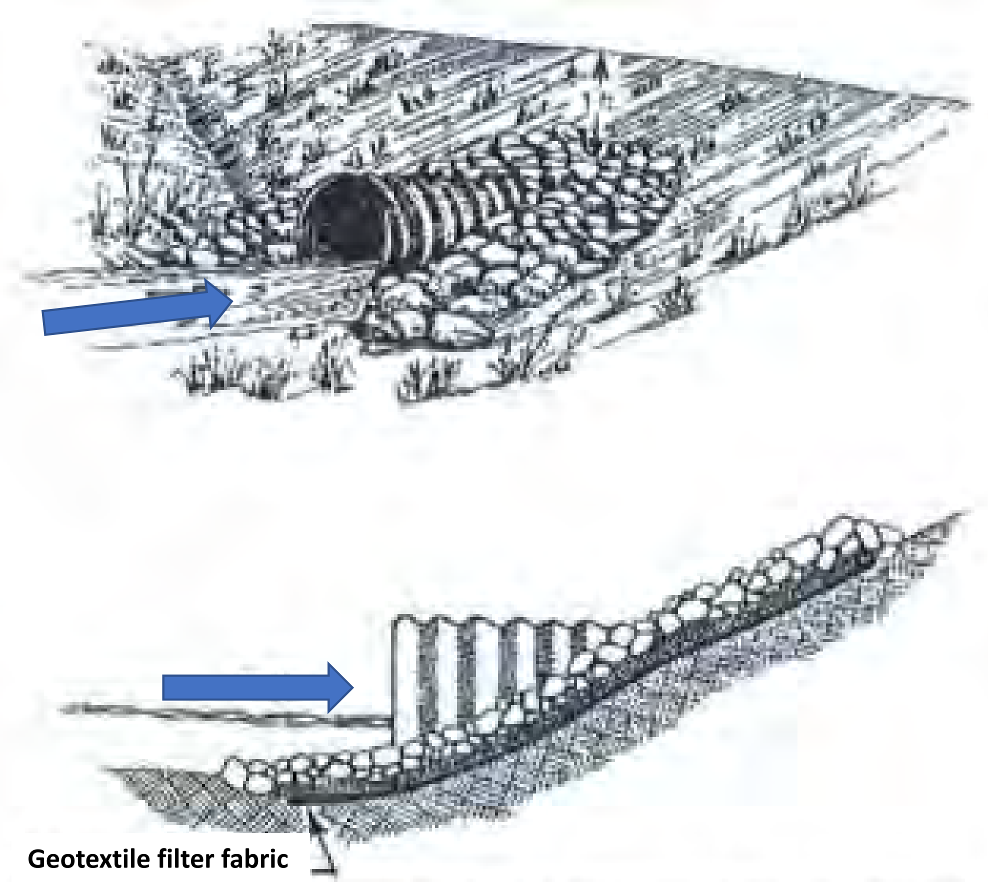


Figure 5-4. Riprap Installed on a Crossing Fill Culvert Inlet

B. FIELD DATA COLLECTION

Sediment Risk Index (SRI)

SRI is based on a method developed and applied in the Choctawhatchee Watershed in southeastern Alabama.

JMT visited unpaved road-stream crossings identified by FDEP

12 qualitative and quantitative factors related to:

- **Soil erodibility**
- **Road sedimentation abatement features**
- **Stream morphology**

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DEVELOPMENT AND USE OF A SEDIMENTATION RISK INDEX FOR UNPAVED ROAD-STREAM CROSSINGS IN THE CHOCTAWHATCHEE WATERSHED[1]

Patrick L. Witmer, Paul M. Stewart, and Christopher K. Metcalf[2]

Field Data Collection

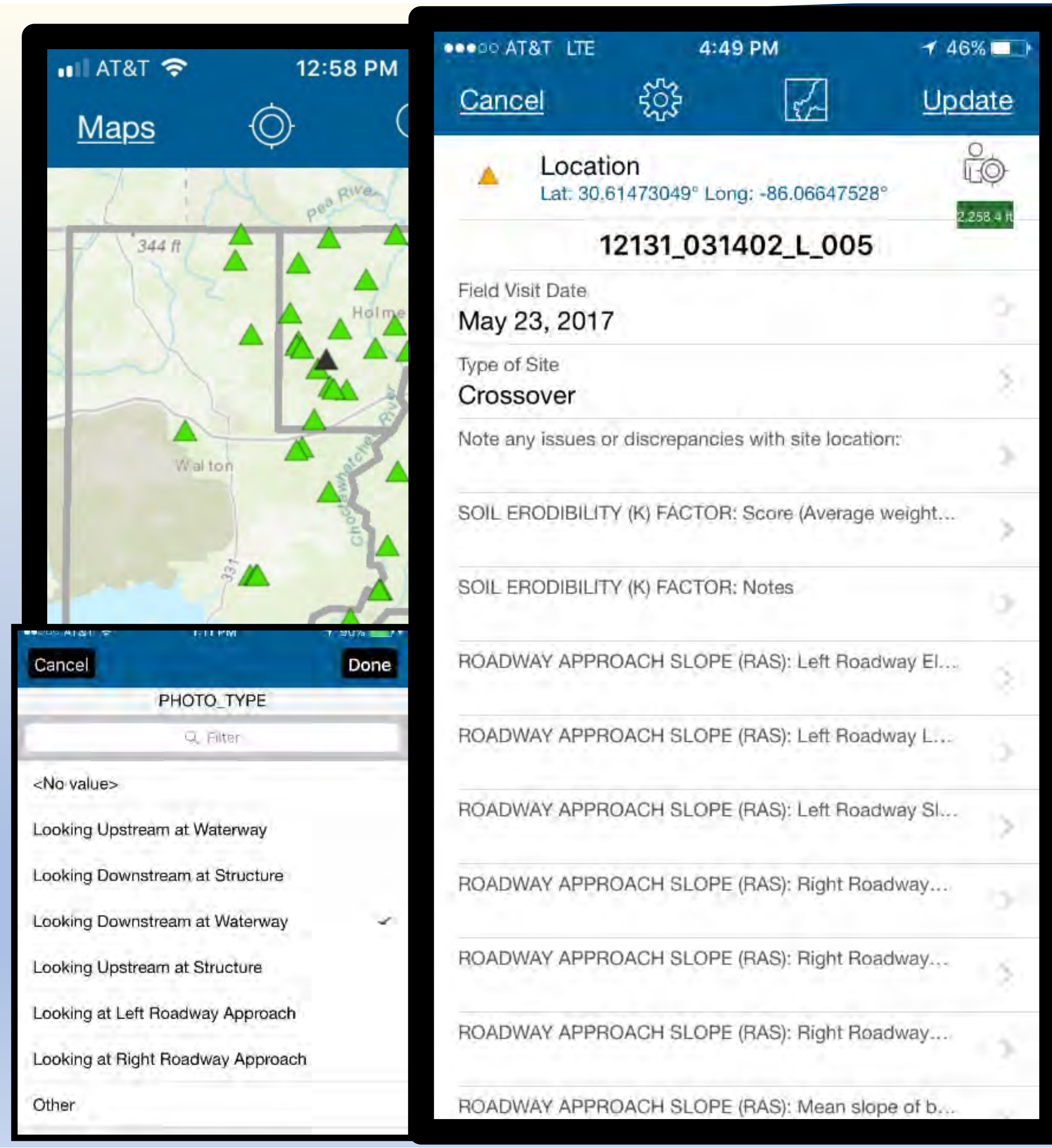
Needed SRI data and geo-located photos for each road-stream crossing site

Developed a geodatabase schema to capture the SRI data

Configured Collector for ArcGIS to use on iPhones and iPads

Online and Offline collection

Replaced paper forms and photo logs = time savings, standardized and legible outputs



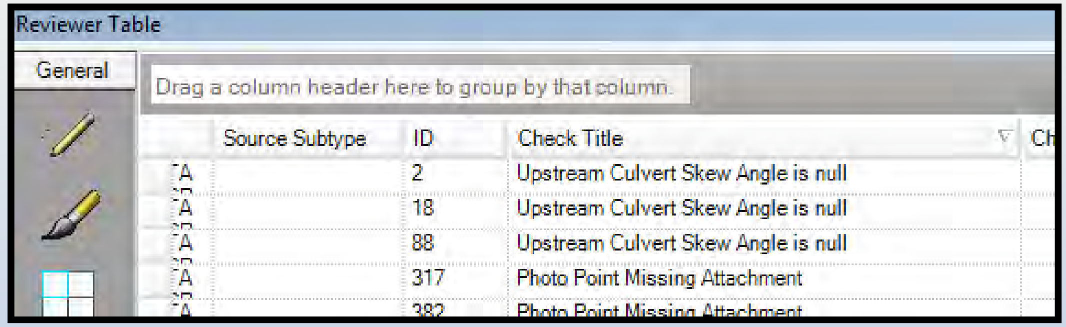
Field Data Quality Control

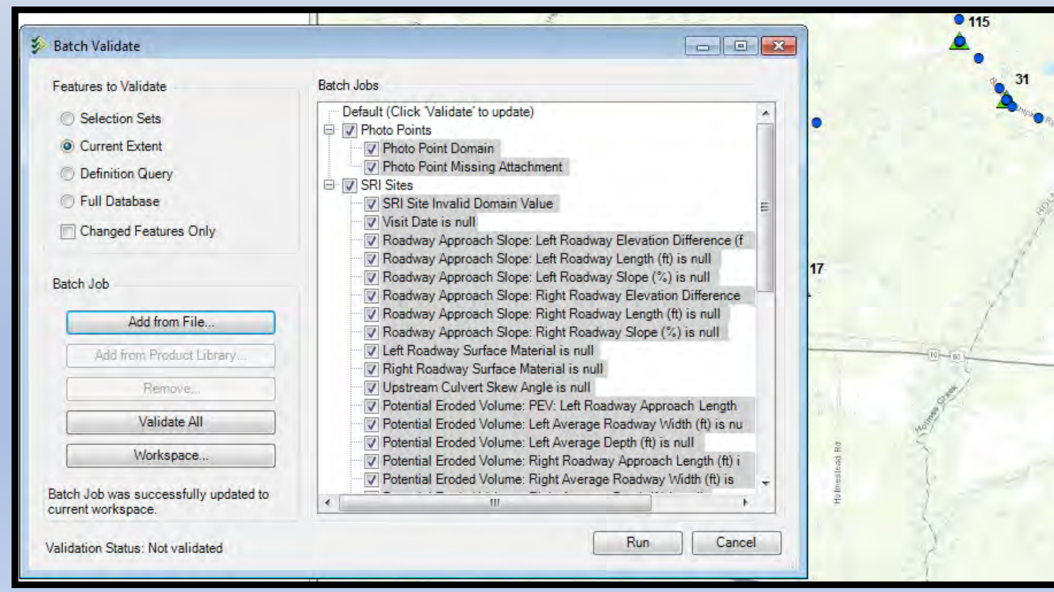
Office staff able to review field data in real time or as synced

Used Data Reviewer (ArcGIS Desktop extension) to automate checks

Configured batch file of checks to run daily

Quickly run checks to validate attributes and photos while field staff were still in the vicinity of the sites visited that day





Field Data Post-Processing

Developed custom Python Toolbox for ArcGIS

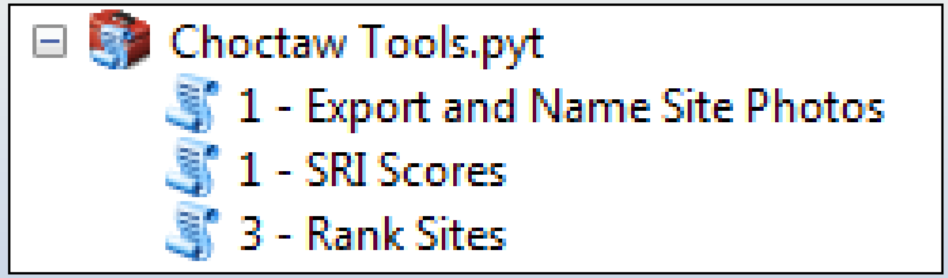
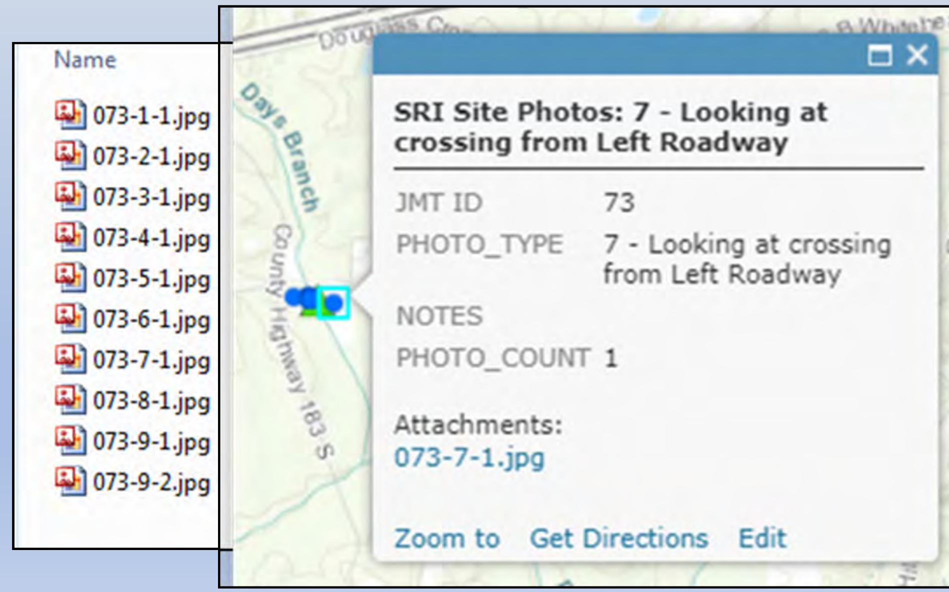


Photo Export Tool

- **Exports photo attachment**
- **Names photo based on site ID and photo type**
- **Re-attaches photo**



Field Data Post-Processing

Tool calculated subscores and final SRI score from attributes collected

Data then ready for use in calculation of watershed sediment load

Unpaved Road-Stream Crossing Site SRI - 37: 30.6698, -85.7731

PEV: Total Volume (cf)	116460
PEV: Score of Total Volume	1 - V >= 1,080
IMPROVED OUTLET SYSTEM: Abatement features may include vegetation, riprap, armoring, energy dissipation by sheet flow	3 - 1- 3 abatement features
Identify Outlet Abatement Features	3 turnouts
IMPROVED DRAINAGE SYSTEM: Abatement features may include vegetation, riprap, armoring, energy dissipation by sheet flow	1 - 0 abatement features
Identify Drainage Abatement Features	None clean sand ditches
Upstream Channel Morphology (CM): Note general conditions of streambanks	<Null>
Upstream Channel Morphology (CM): Score	5 - B, C, D, E stream Types or naturally ponded
Downstream Channel Morphology (CM): Note general conditions of streambanks	No waterway downstream
Downstream Channel Morphology (CM): Score	5 - B, C, D, E stream Types or naturally ponded
Downstream Bank Alteration: Note dredging, straightening, channelization, cutting, riprap, dam structure, human alteration	<Null>
Downstream Bank Alteration: Score	5 - Natural channel
Upstream Culvert Skew Angle (CSA): Angle	0
Upstream Culvert Skew Angle (CSA): Score	5 - CSA <= 5
CROSSING INLET/OUTLET CONDITION: Score	3 - Scour / Sediment Islands
CROSSING INLET/OUTLET CONDITION: Notes	Right downstream ditch delivers sand/ sediment directly into floodplain and pipe exit
CROSSING FILL CONDITION: Score	3 - Fair - Up to 50% erosion, surface poorly maintained
CROSSING FILL CONDITION: Notes	Recently graded Grading creating artificial curb
Overall Site Comments	<Null>
SRI Score	44
Sedimentation Risk	Moderate

1 of 1

C. SEDIMENT QUANTIFICATION AND WATERSHED MODELING

Watershed Sediment Load Calculation

Combined field data with spatial data to quantify sediment sources

- **Annual soil loss from each road-stream crossing**
- **Measurements of turbidity & TSS at river gages**
- **Modeling of hydrology and sediment at the watershed and subwatershed levels**

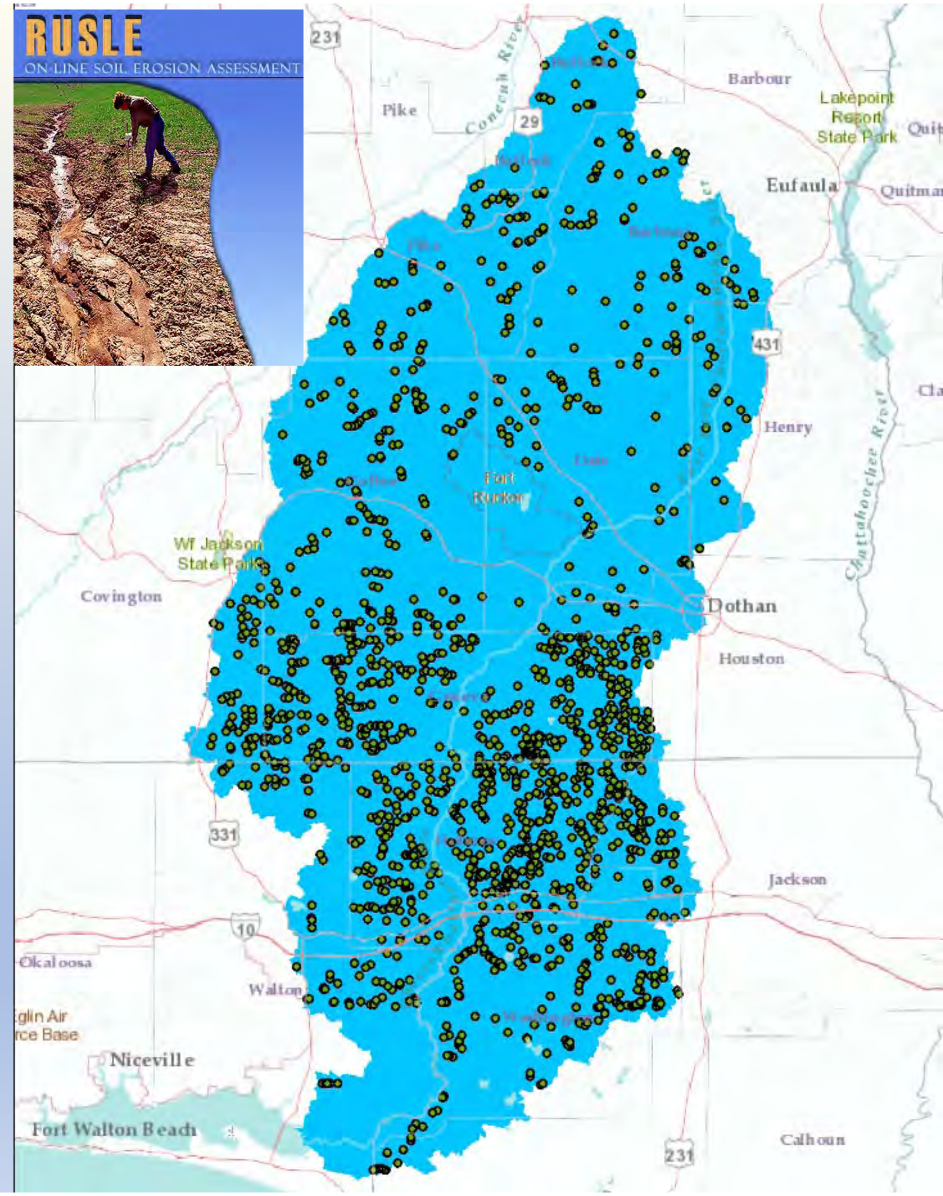
RUSLE

Revised Universal Soil Loss Equation (RUSLE) was applied at each unpaved road approach to quantify sediment load
Field data were collected at 99 sites

Median annual soil loss =
13.8 tons/year per crossing
(range 0.4 to 194 tons/year)

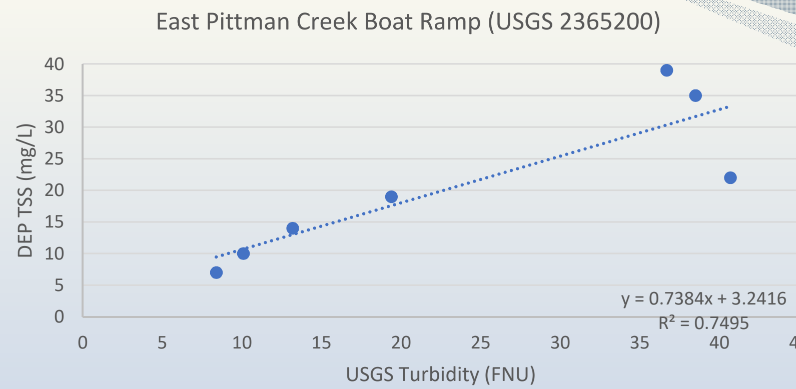
Approximately 723 unpaved road-stream crossings in Florida and 881 in Alabama within the watershed

Potentially 23,588 tons/year from unpaved road-stream crossings within watershed

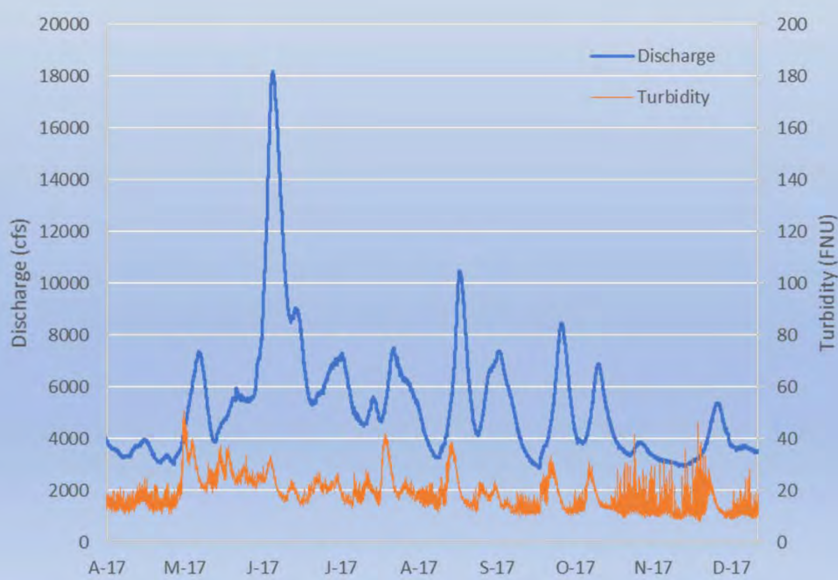


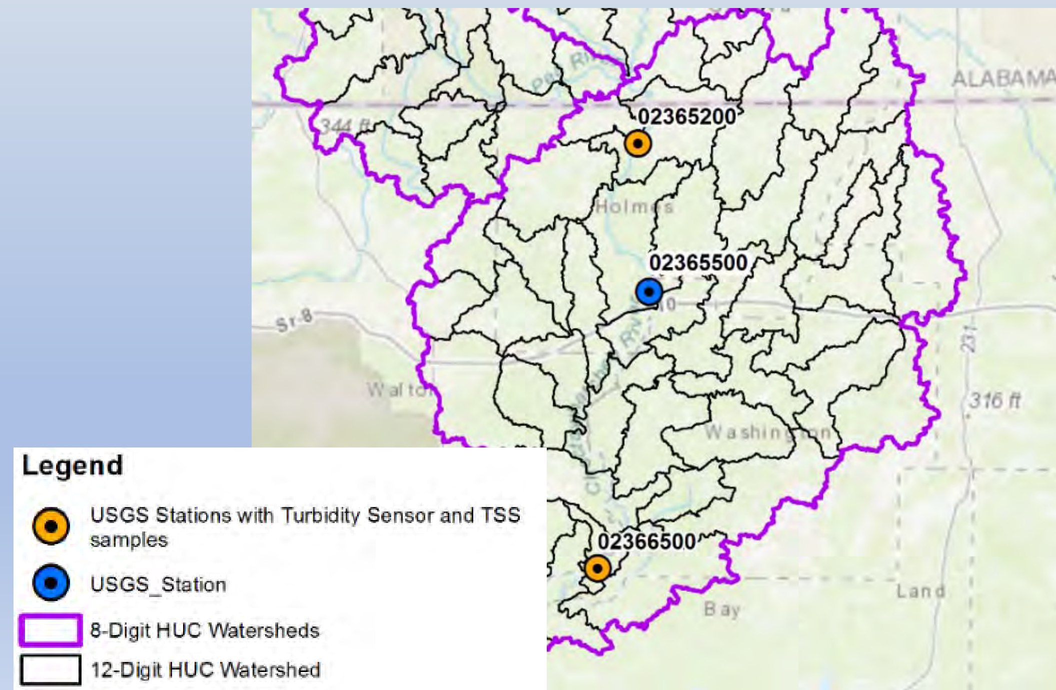
Monitoring Estimate

Estimate load directly from TSS/turbidity relation, then integrate with hydrology record at downstream-most gage



Approx. 67,990 tons TSS/year (wash-load)





HSPF Model

HSPF (Hydrological Simulation Program) is a spatial hydrological & sediment model

Goal was to identify sediment hotspots and quantify total sediment load

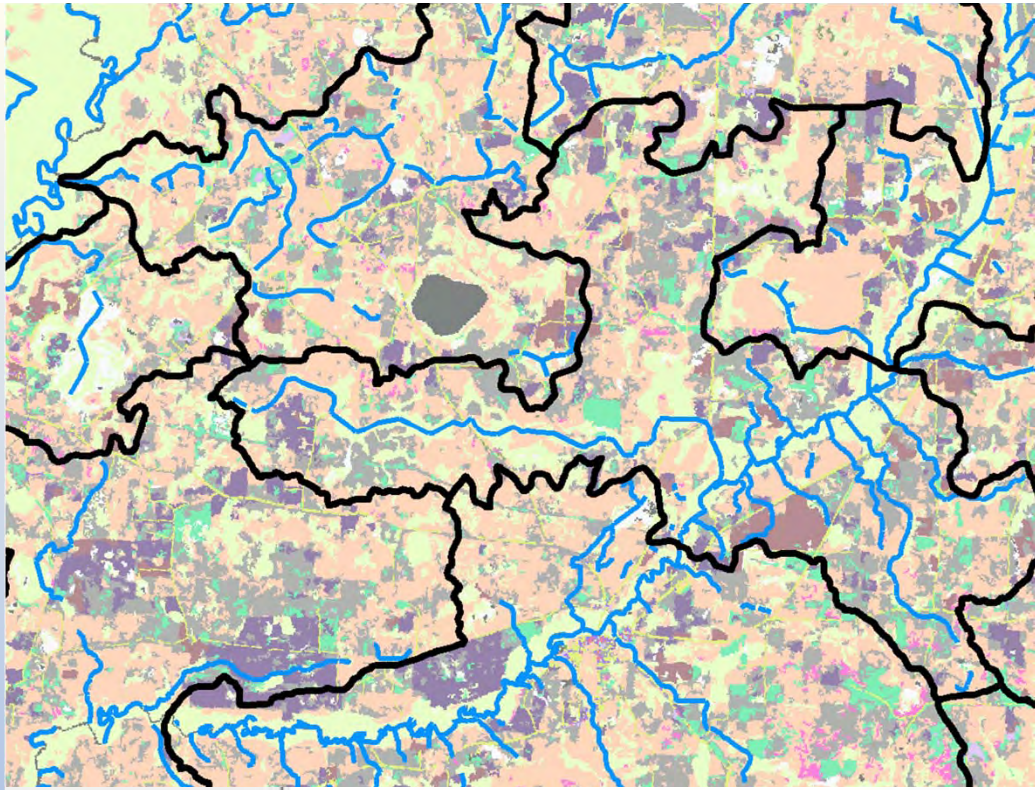
Sediment runoff from

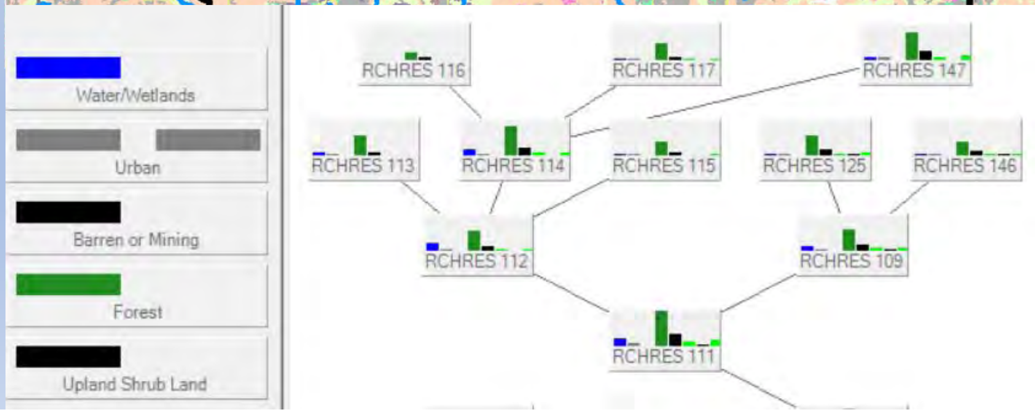
- **point sources (road-stream crossings, NPDES permitted discharges)**
- **non-point sources (overland runoff)**

Model inputs derived from GIS

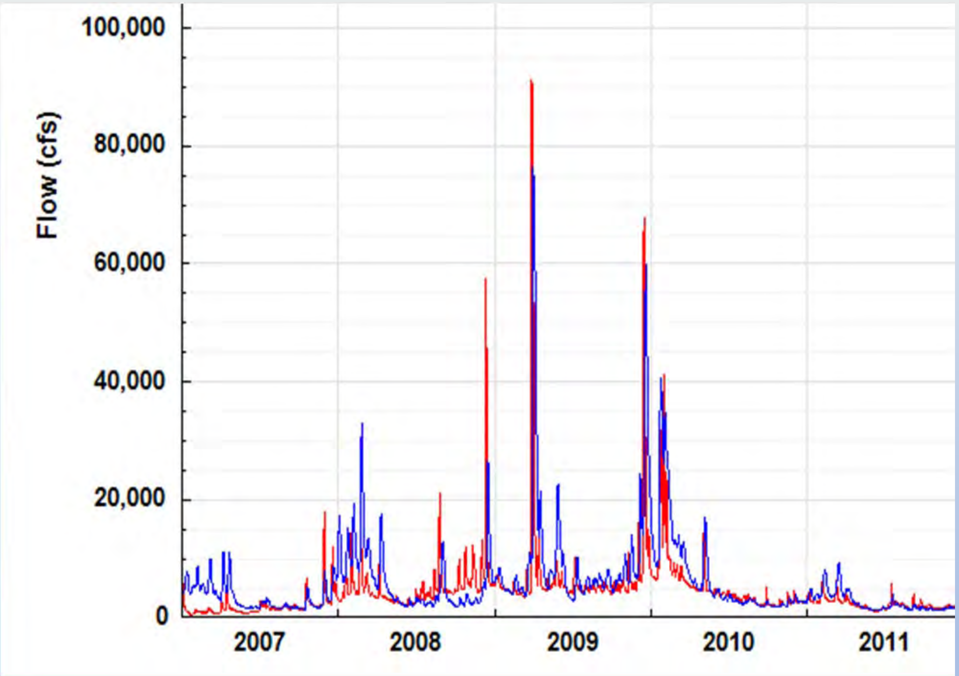
- **National Land-cover Dataset (NLCD)**
- **National Hydrography Dataset (NHD)**

Simulated hydrology & sediment runoff for each of the 147 HUC12s in the watershed

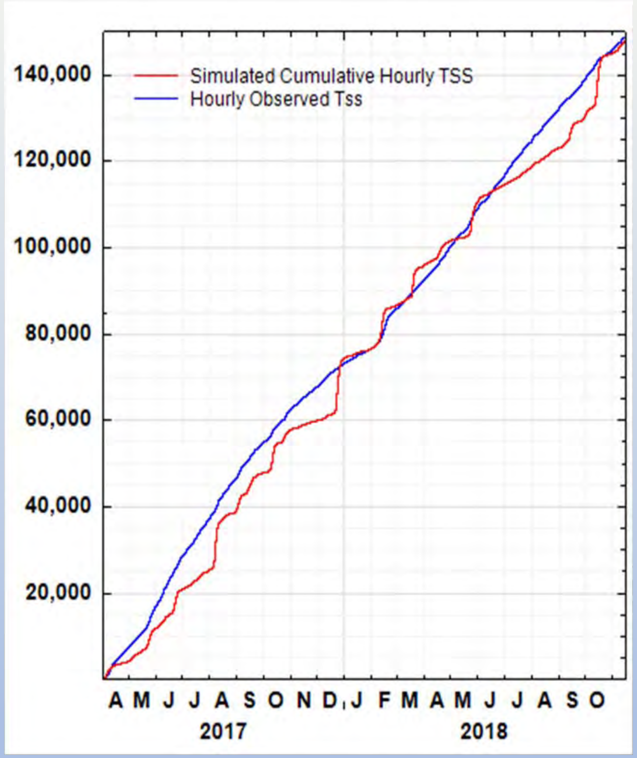




HSPF Model Calibration



Hydrology was calibrated to USGS gages

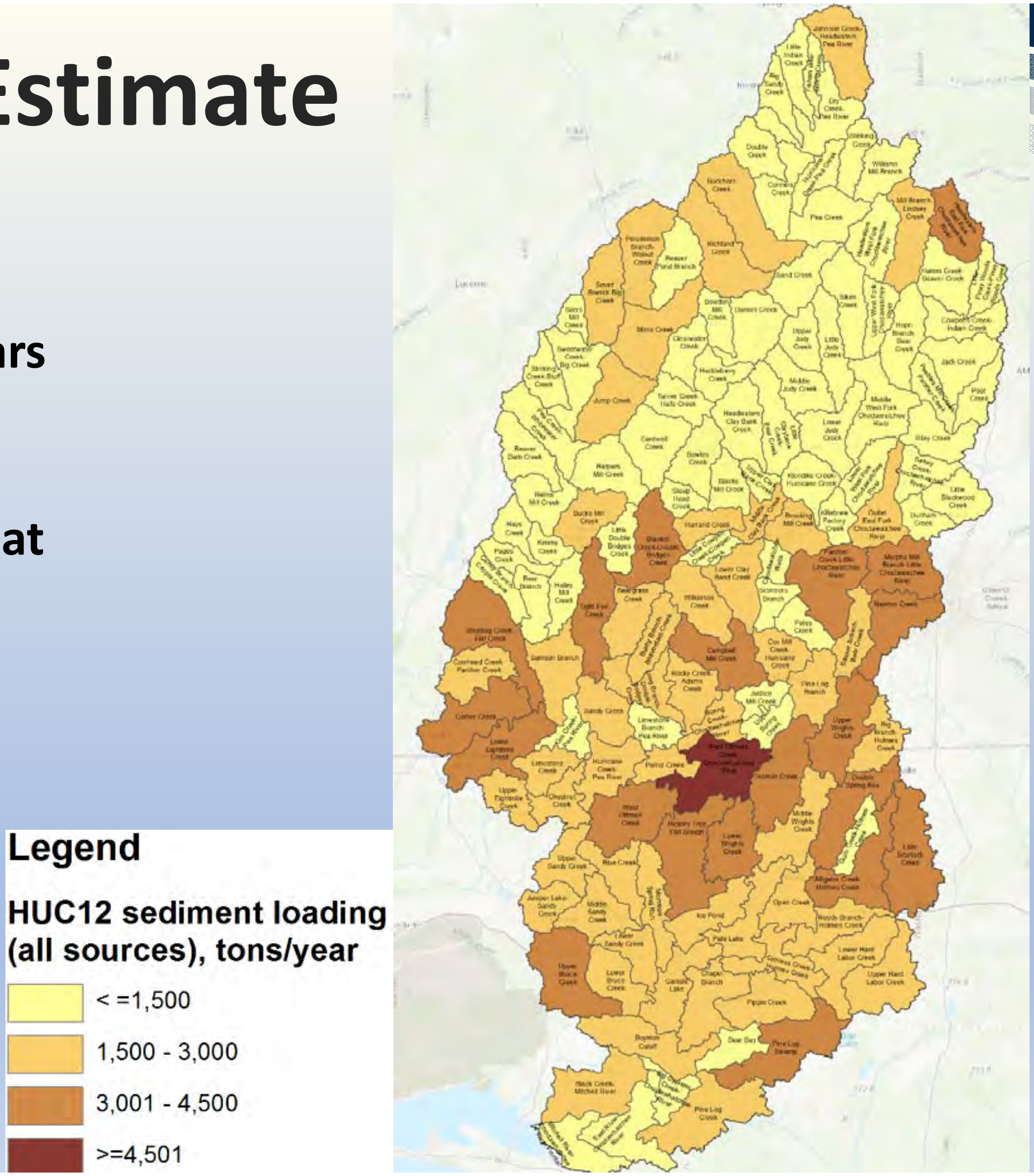


Sediment concentrations were calibrated to TSS and turbidity measurements

* Bedload is unknown. The values of "cumulative hourly TSS concentration" are not meaningful, but they are a useful metric for model calibration

Modeled Sediment Estimate

- We performed a simulation on 10 years of precipitation, PET, and other data from 10 climate stations
- Sediment “hotspots” were identified at the HUC-12 scale



Modeled Sediment Estimate

Total Sediment Load	257,729 tons/year
Nonpoint Sources	229,444 tons/year
Road-stream Crossings	23,588 tons/year
NPDES Permitted Discharges	4,697 tons/year

Modeled Sediment Estimate

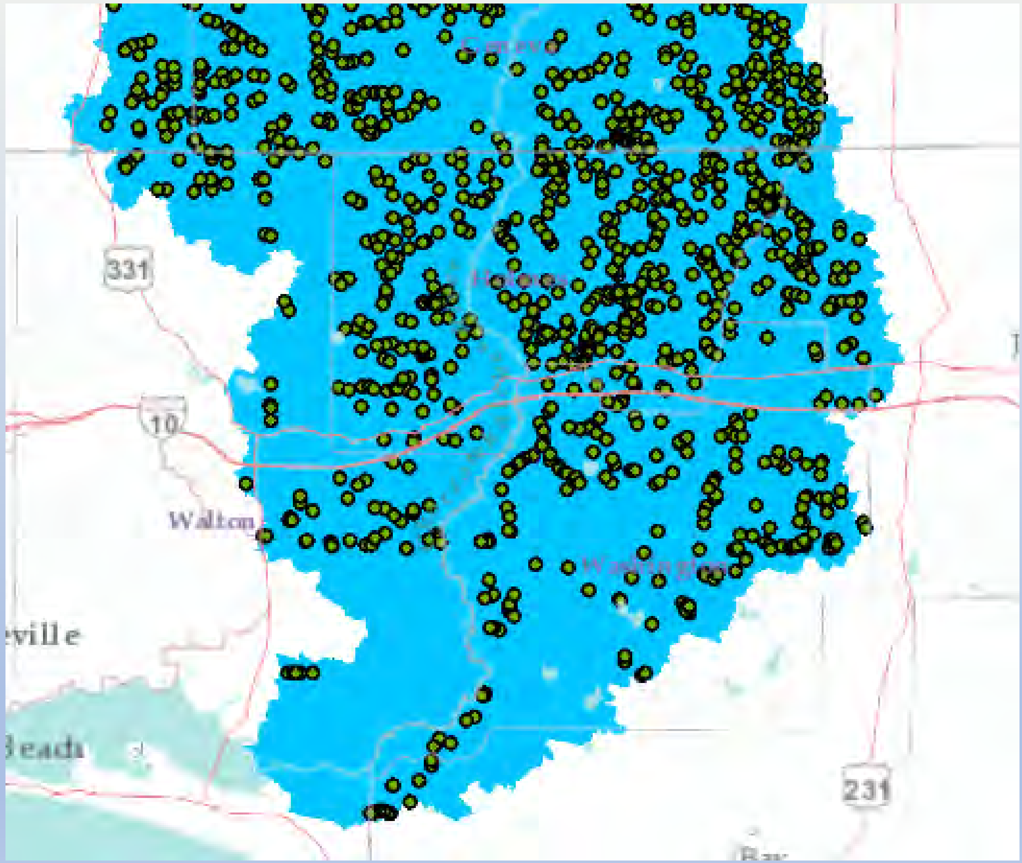
Total Sediment Load	257,729 tons/year
Nonpoint Sources	229,444 tons/year
“Predevelopment” Nonpoint Sources	183,906 tons/year
Road-stream Crossings	23,588 tons/year
NPDES Permitted Discharges	4,697 tons/year

* 32% of this difference can be achieved with BMPs at road-stream crossings

D. PRIORITIZATION

Prioritization – How to choose?

- **Funds are available to develop designs for 15 road-stream crossings**
- **Where will we have the greatest impact?**



Prioritization

Which unpaved road crossing sites . . .

- **contribute the most sediment**
- **provide greatest environmental benefit**
- **have physical crossing characteristics conducive to BMPs**

Prioritization: Assess Biology and Ecology

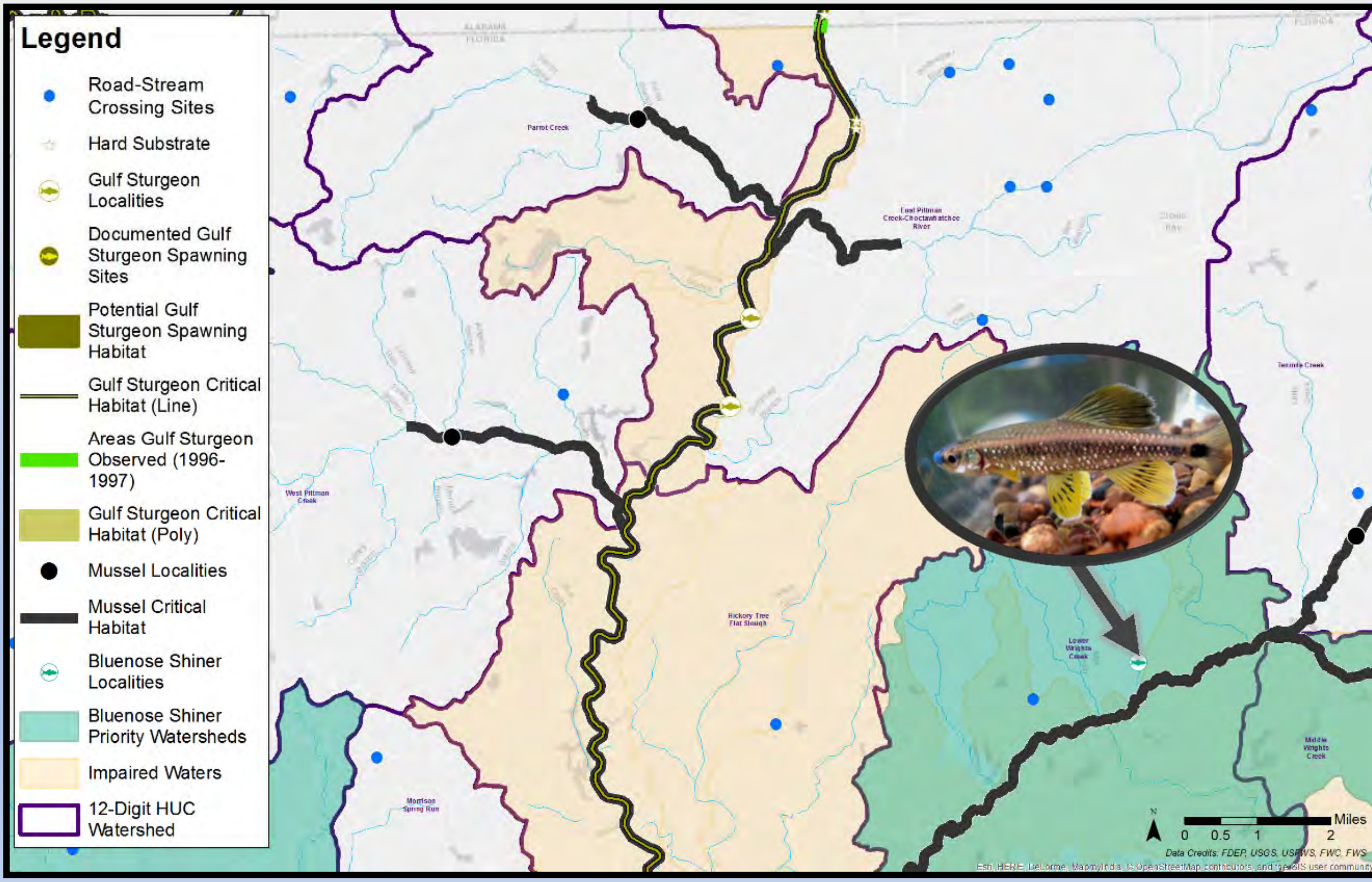
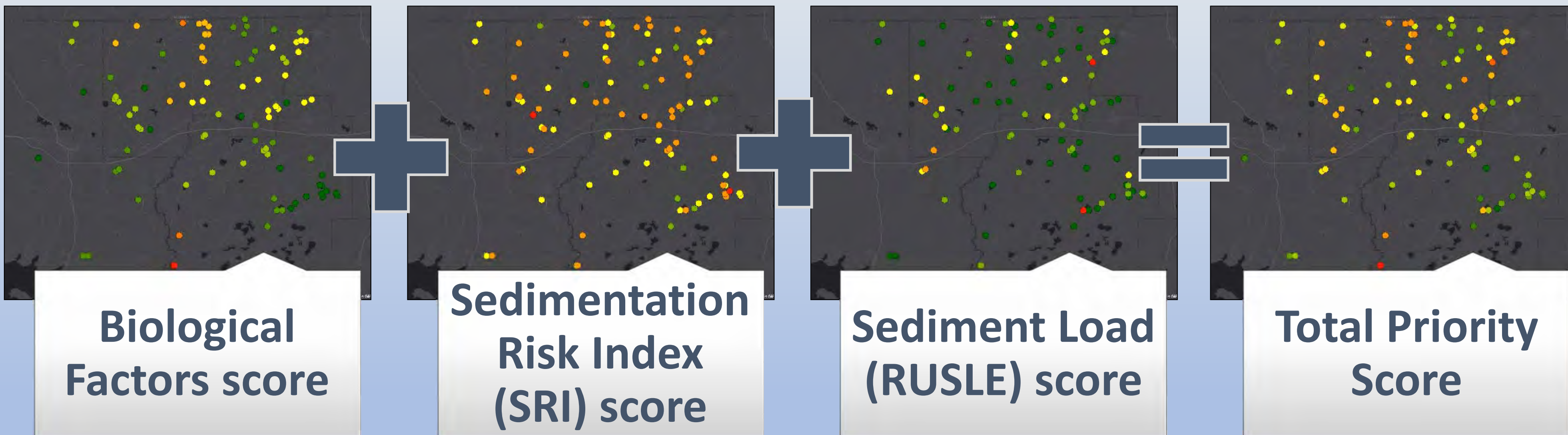


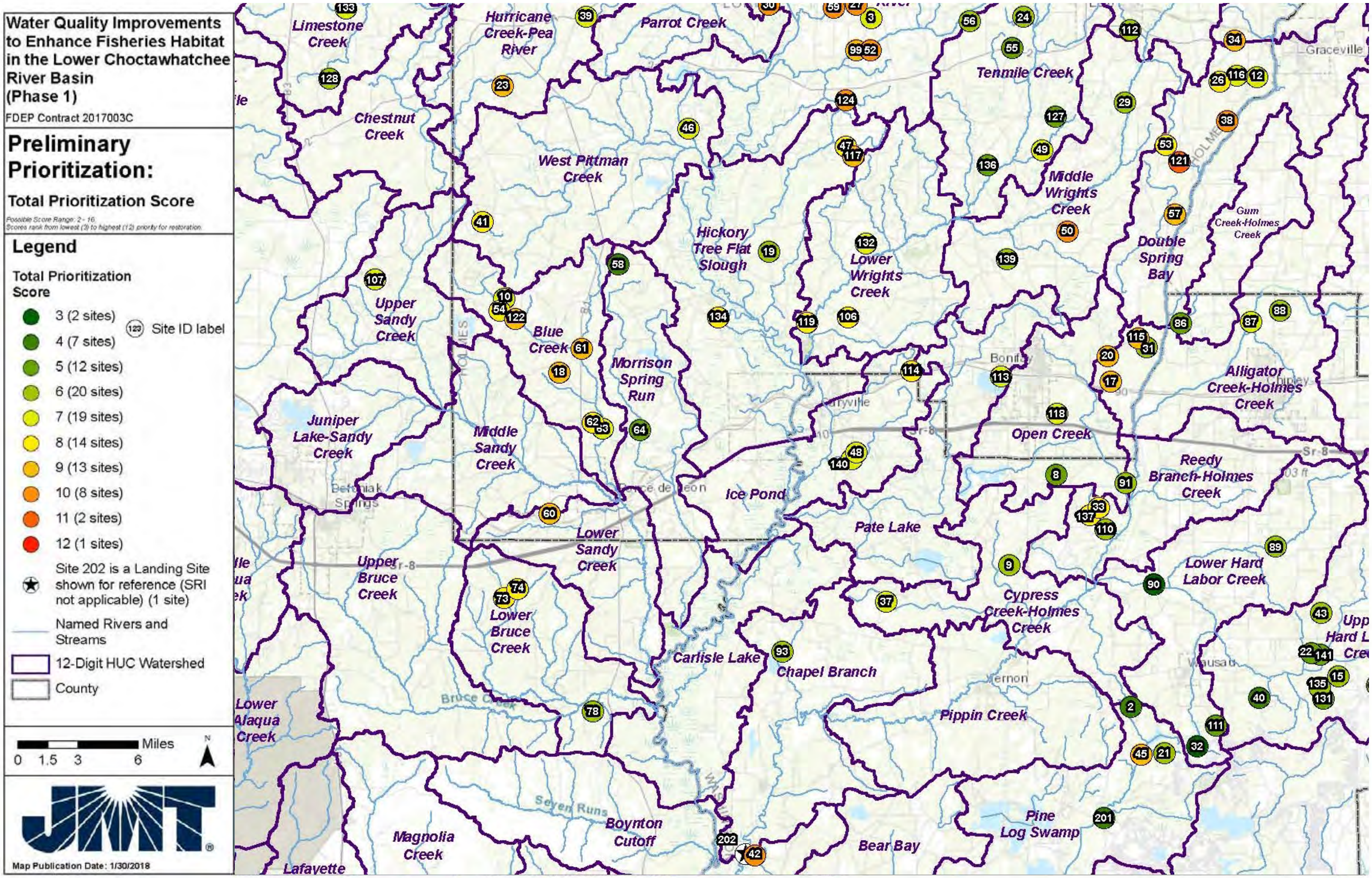
Photo: FWC Bluenose Shiner Species Action Plan

Prioritization

Ranking scheme



Prioritization



E. BMP DESIGNS

Conceptual Suite of BMPs

JMT SITE ID: 124

County: Holmes

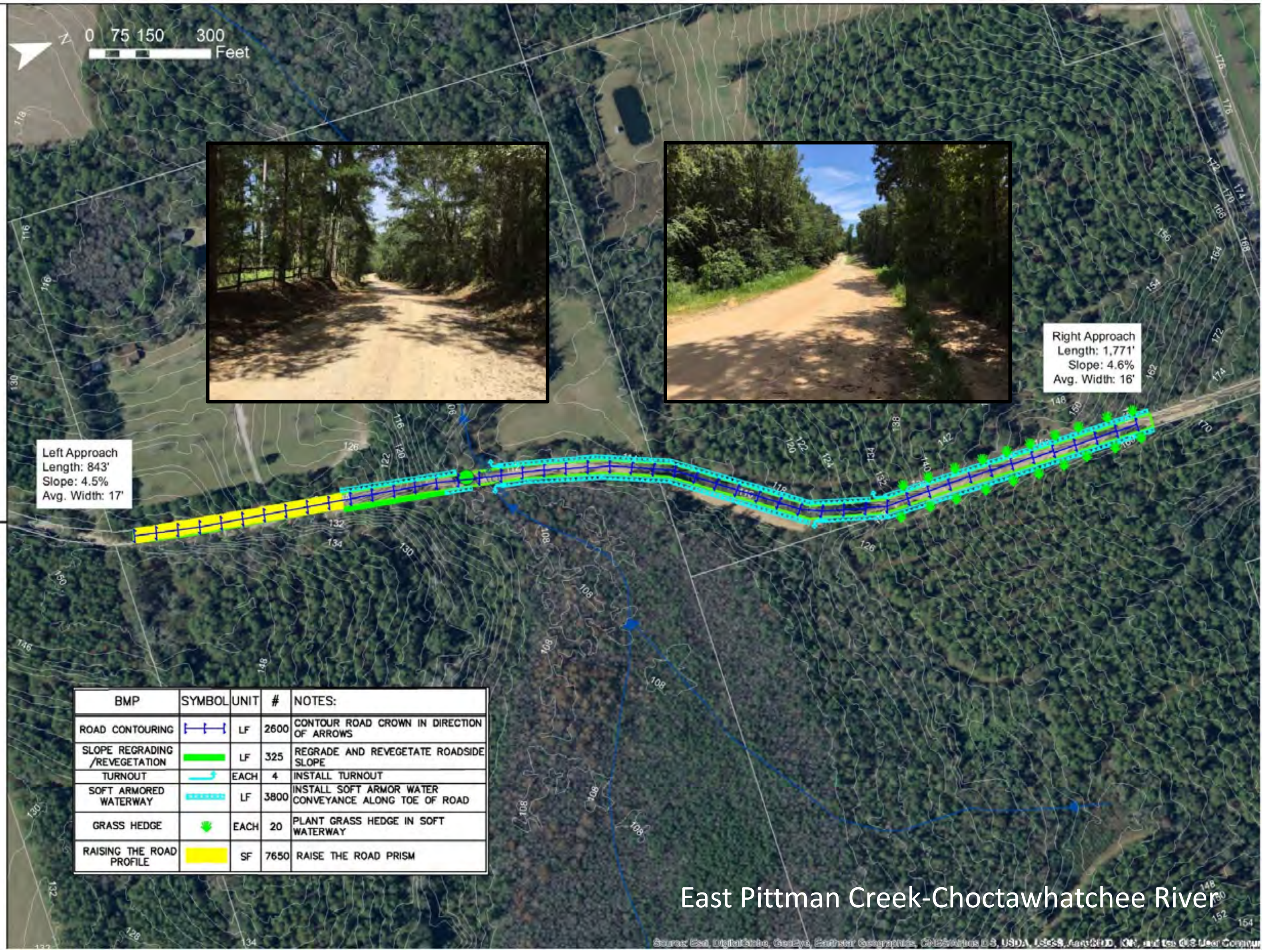
Approx. Address:
1300-1448 CR-65 Bonifay, FL 32425

Legend

- Approx. Site Location
- NHD Flowlines
- 2 Foot Contours (NWFWMD)
- Parcels (2015 Florida Department of Revenue's tax database)
- Approximate Right of Way (ROW)

ROW Boundary
Source: Parcel Boundary

County ROW Width:
30-35



BMP	SYMBOL	UNIT	#	NOTES:
ROAD CONTOURING		LF	2600	CONTOUR ROAD CROWN IN DIRECTION OF ARROWS
SLOPE REGRADING /REVEGETATION		LF	325	REGRADE AND REVEGETATE ROADSIDE SLOPE
TURNOUT		EACH	4	INSTALL TURNOUT
SOFT ARMORED WATERWAY		LF	3800	INSTALL SOFT ARMOR WATER CONVEYANCE ALONG TOE OF ROAD
GRASS HEDGE		EACH	20	PLANT GRASS HEDGE IN SOFT WATERWAY
RAISING THE ROAD PROFILE		SF	7650	RAISE THE ROAD PRISM

Bang for Your Buck

- We considered both unpaved road BMPs and paving alternatives
- BMPs to stabilize the swales are included in both alternatives

Paving approaches must also consider drainage or risk failure (SAIC, 2013)

Bang for Your Buck

Unpaved roadway BMPs

- $1,930 to $120,366 per ton of reduced sediment runoff
- Median: $7,800/ton (**$3.90/lb**)

Paving

- $5,269 to $179,478 per ton of reduced sediment runoff
- Median: $18,676/ton (**$9.40/lb**)

2019 SWFWMD Metric for Ranking Cost Effectiveness of Cooperative Funding Projects cost/lb of pollutant removed			
Project Type	High	Medium	Low
Total Suspended Solids (cost/lb)	<$5	≥ $5 ≤ $13	>$13

Q&A

Feedback

Thank you!

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