Developing the first Nutrient Bank through stream restoration in Virginia

Prepared For:
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ECOSYSTEM SERVICES

Thanks

Reeves Family

Claim

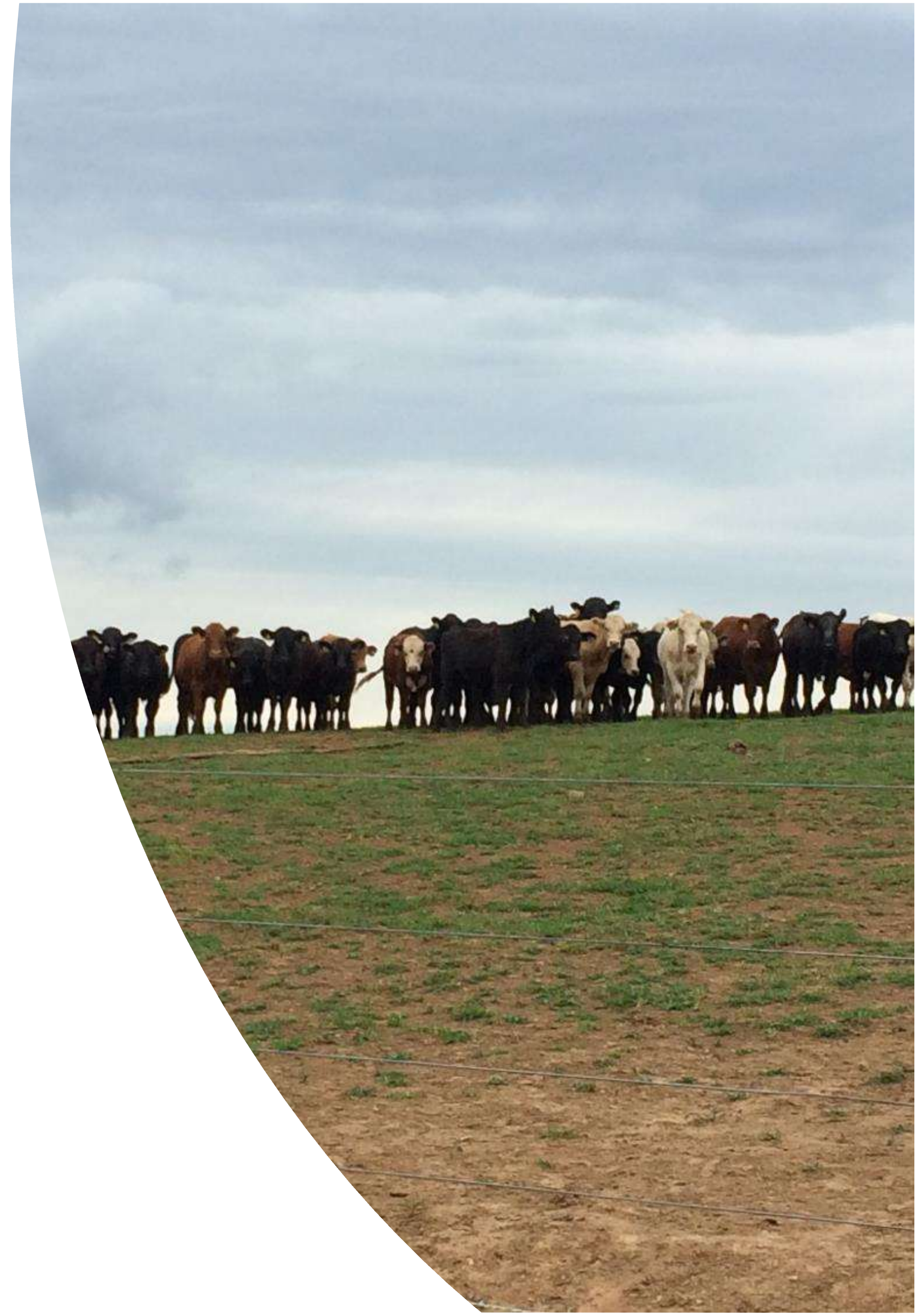
Stream restoration is now a nutrient and sediment credit generating practice in the Commonwealth of Virginia. The technical and regulatory requirements have many challenges and may shape the way restoration is conducted and where it occurs.

Talking points

- Regulatory Program
- Mossy Creek details
- The credit accounting process and attendant challenges

Regulatory Highlights

- Deed of restrictions or conservation easement
- Financial assurances
- Long-term protection
- 6% of sales to water quality improvement fund (5% retirement of credits)
- Baseline practices
- Release schedule

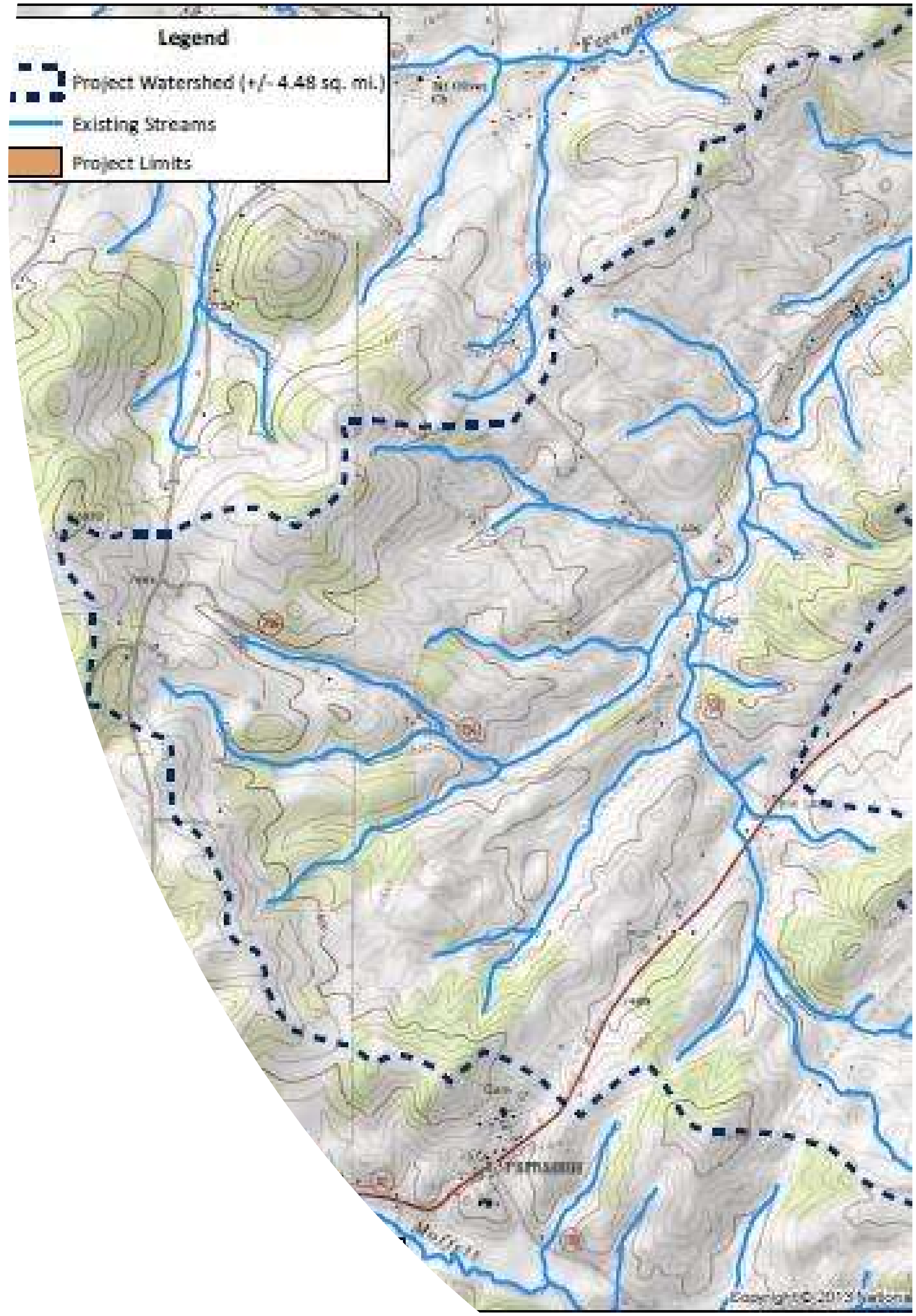


Qualifying Conditions

- > 100 linear feet
- Actively enlarging/degrading
- Not primarily undertaken for infrastructure protection
- Comprehensive approach/functional framework
- Must comply with State & Federal regulations
- 1st through 3rd order streams preferable

Baseline

- Soil Conservation Plan
- Nutrient Management Plan
- Livestock exclusion
- Accounting for reductions from upstream BMPs
- Accounting for assumed 100% compliance with approved TMDL Action Plans
- 35’ buffer on all perennial streams

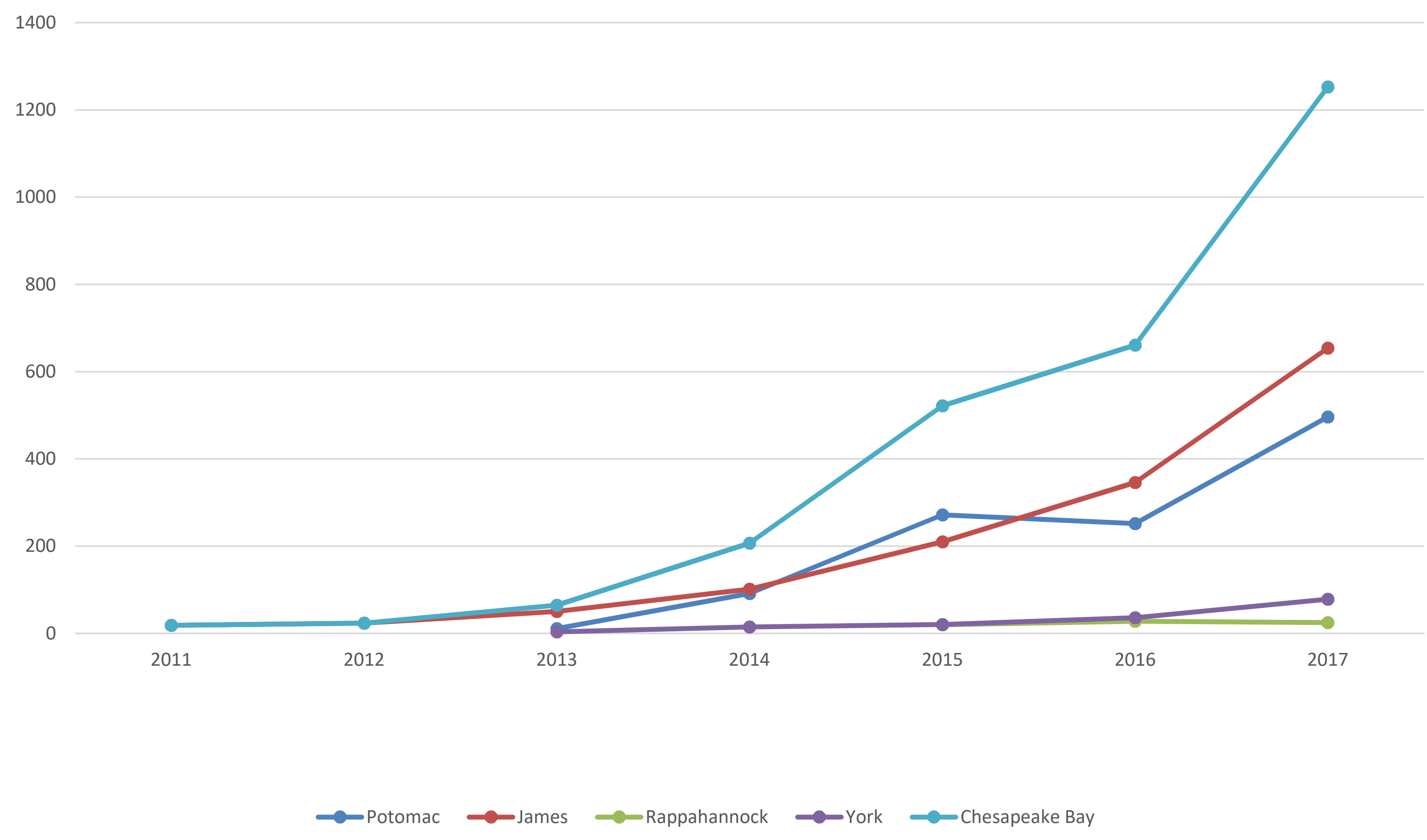


Regulatory Influences

- Preference for projects high in the watershed
- Preference for projects in watersheds with active development/markets
- Preference for projects in rural areas
- Preferences for wide floodplains
- Preference for highly eroded streams

Nutrient Credit Market

Ches. Bay Sales History



Mossy Creek Details

South Fork Shenandoah - Potomac Watershed

Watershed = 4.48 mi^2

Impervious Cover = 0.55%

Spring-fed 3^{rd} order stream

Restored length = 1,500 lf

Slope = 0.5%

Pre-restoration depth = +/- 4’

Pre-restoration width = 15’-20’

Average restored depth = 1’

Restored width = 9’

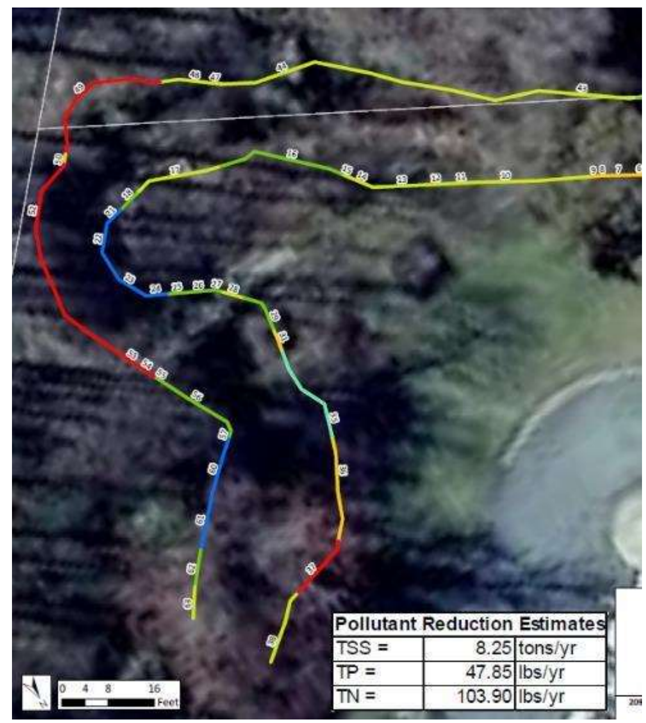
Sediment reduction = 13.75 tons

Total Phosphorus reduction = 70.17 lbs

Total Nitrogen reduction = 239.79 lbs

Protocol 1: Sediment Prevented

- Erosion Estimate
  - BANCS: BEHI, NBS, Bankfull
  - **Bed pins (calibration), aerial imagery, BSTEM**
- Bulk Density
- Pollutant Concentrations
- Restoration Efficiency - 50%



BANCS Results

Average Weighted Erosion Rate = 0.56 ft/yr

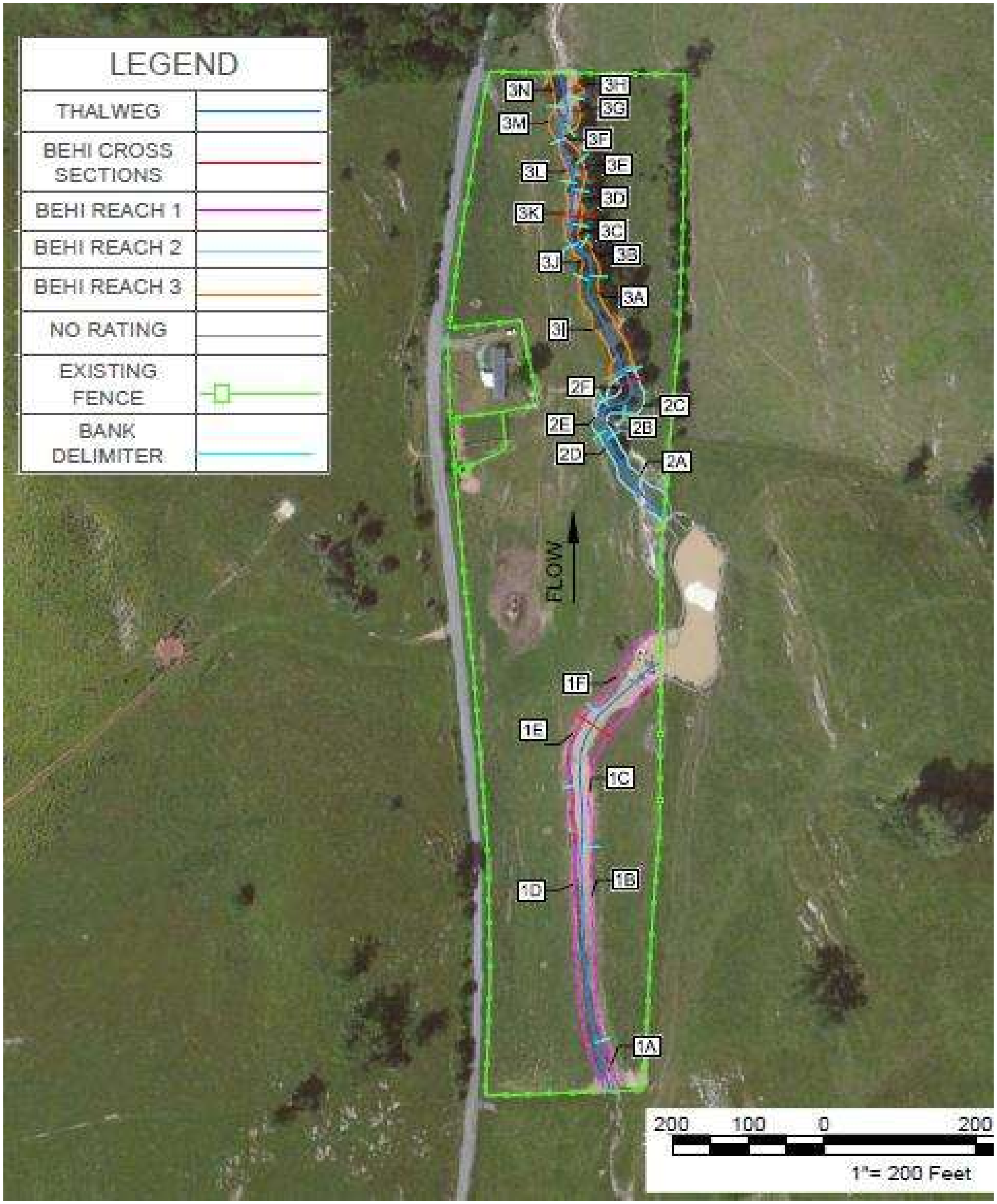
Average height of bank = 3.60’

<u>Annual estimated reduction:</u>

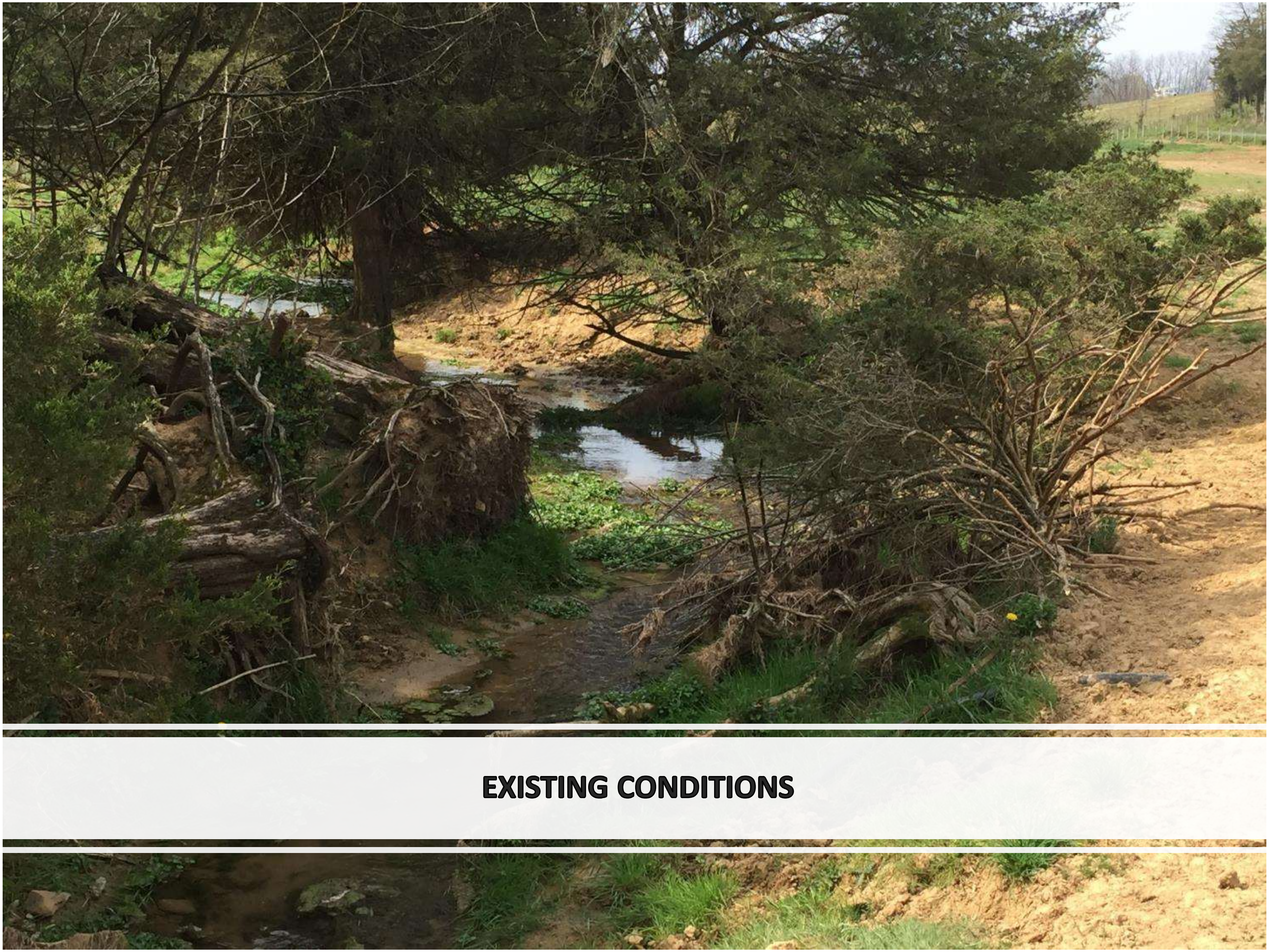
Sediment = 18.96 tons

Phosphorus = 109.97 lbs

Nitrogen = 238.79 lbs



EXISTING CONDITIONS

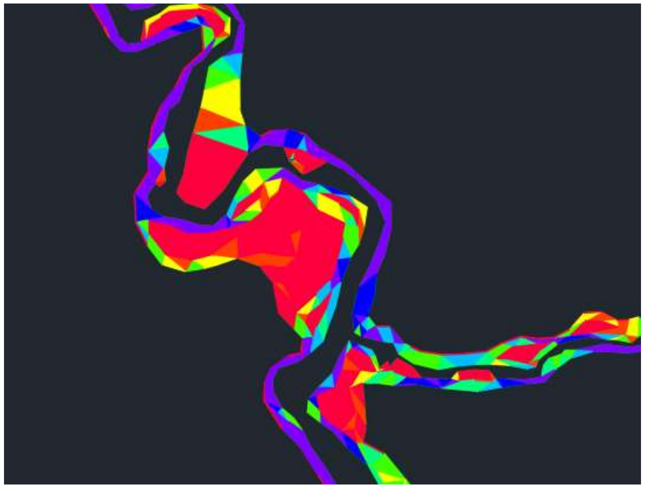


EXISTING CONDITIONS

EXISTING CONDITIONS

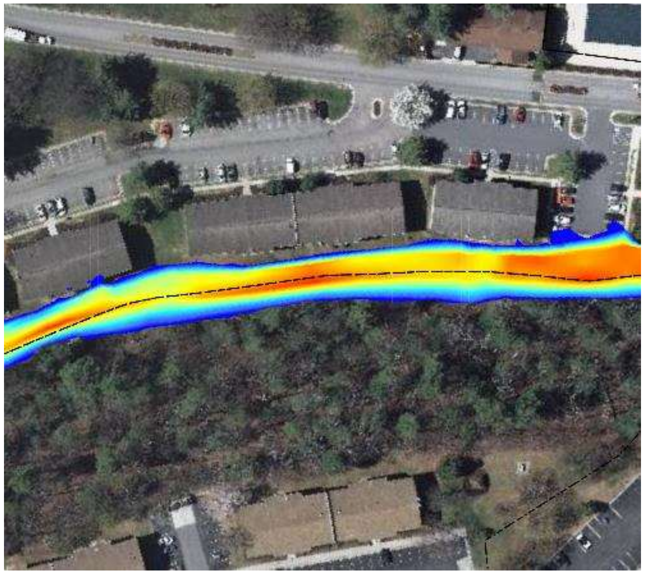
BEHI
Best Practices

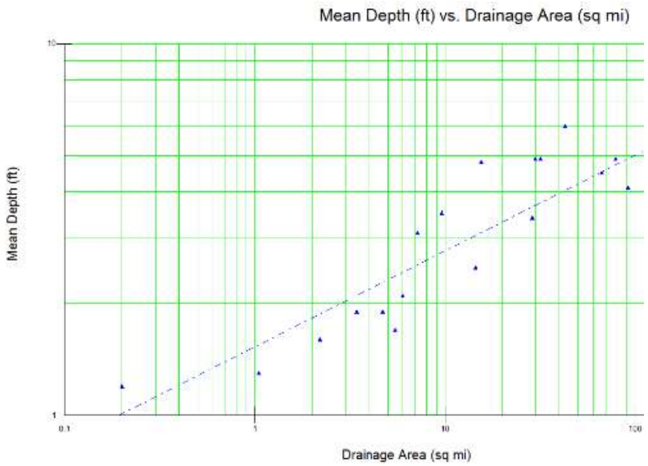
- Based on Bankfull discharge
  - Use multiple methods and look for converging evidence. At least 2!
- Confirmation bias & parameter assessment consistency
  - Field calibration
  - Assess parameters not banks (GPS Methodology)
  - Use survey data & processing techniques
  - Don't assess depositional areas



NBS
Best Practices

- What Level of investigation is appropriate?
  - All of them!
  - Look for converging evidence to support your decision. Beware of Bankfull observations in dynamic systems
  - Stream hydraulics is complicated…
  - Model it!





Bulk Density Best Practices

- Measure bulk density in the field
  - Account for all soil types and stratification

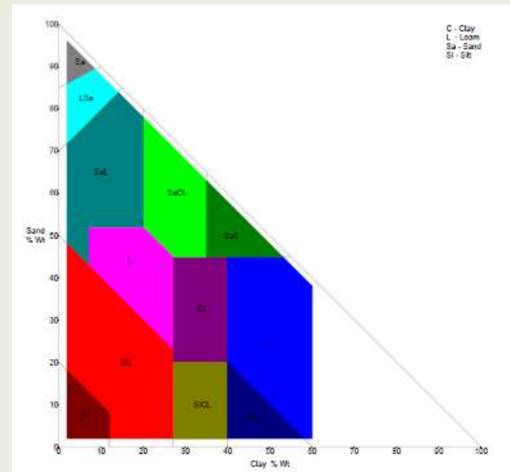
Clay: 85 lb/ft^3

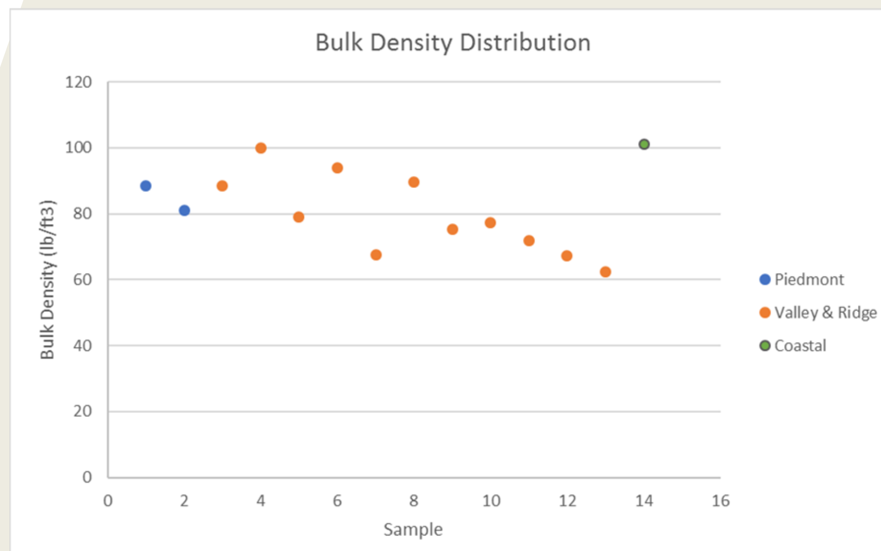
Sand: 89 lb/ft^3

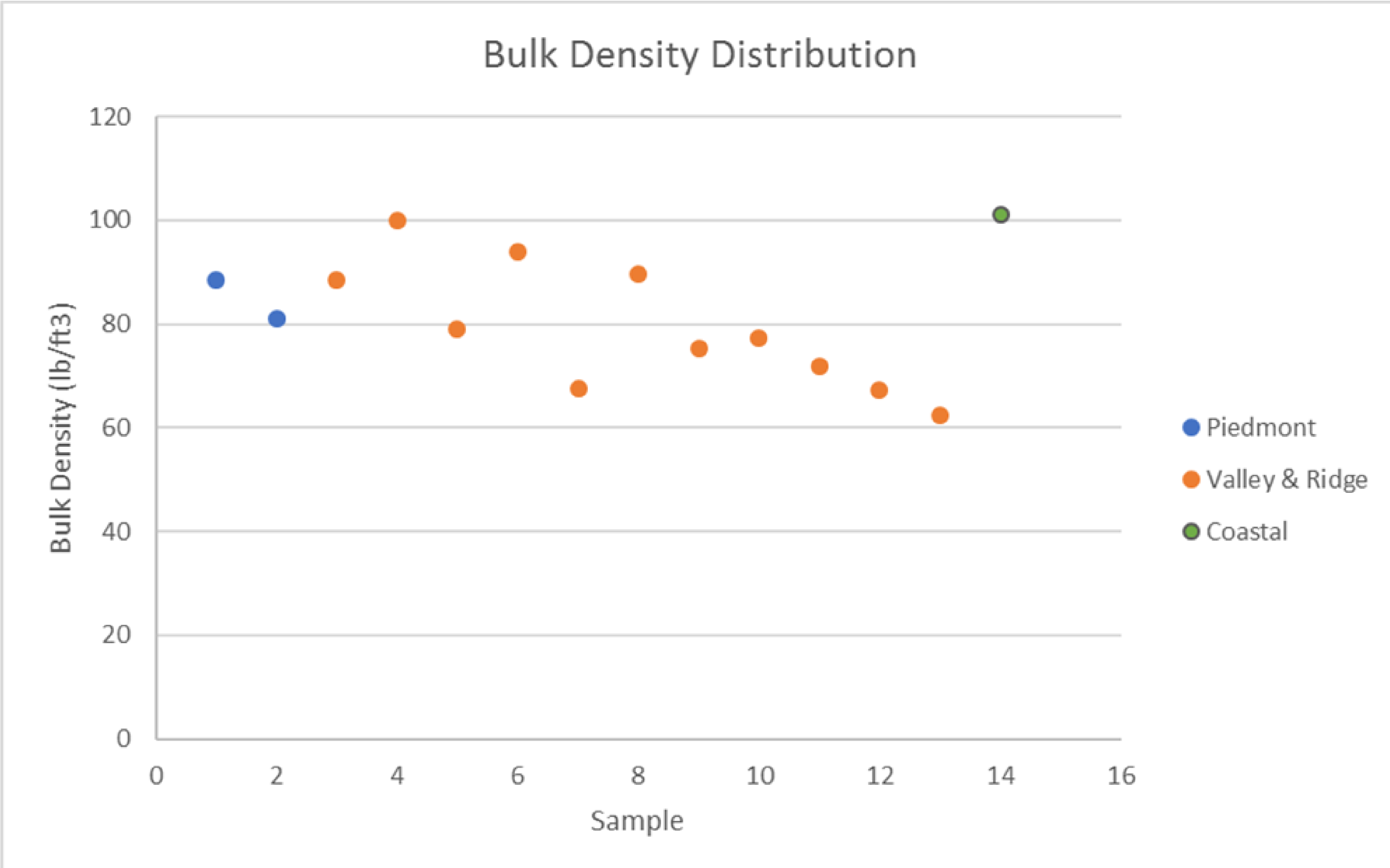
Sandy Clay Loam: 94 lb/ft^3

Silt: 86 lb/ft^3

Silty Clay: 77 lb/ft^3



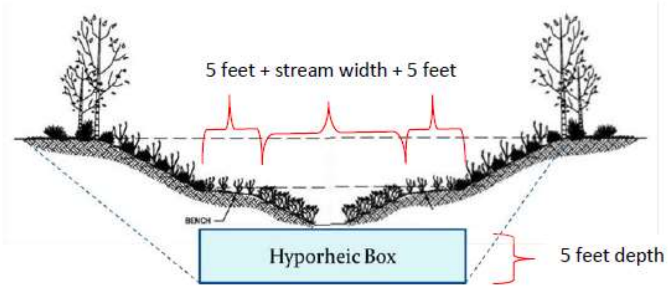




Bulk density varied from 67.50 - 93.97 lbs/ft^3 over the site

Protocol 2: Nutrient Processing during Base Flow

- Length of stream with Bank Height Ratio of one or less
- Determine median base flow depth
- Calculate hyporheic box(es)
- Calculate denitrification
- Check to make sure you're under the cap!



$$BF = a\ ln\ (Q) + b\ Q + c$$

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$$Q = monthly\ average\ stream\ discharge$$

$$BF = base\ flow\ fraction$$

$$Q_s = monthly\ average\ surface\ runoff$$

$$Q_g = monthly\ average\ groundwater\ discharge$$

$$Q = Q_g + Q_s$$

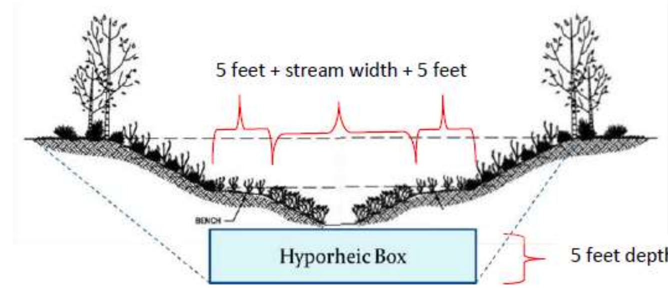
$$BF = \frac{Q_g}{Q_g + Q_s}$$

$$\frac{Q_g}{Q_g + Q_s} = a\ln(Q_g + Q_s) + b(Q_g + Q_s) + c$$

$$Q_s = \frac{1}{[a\ln(Q_g + Q_s) + b(Q_g + Q_s) + c]}Q_g - Q_g$$

Protocol 2
Best Practices

- Median Base Flow Width
  - USGS regression
  - Monitoring data
  - Field measurements
  - Geomorphic observations w/ modeling
- Reduce hyporheic box if bedrock is encountered



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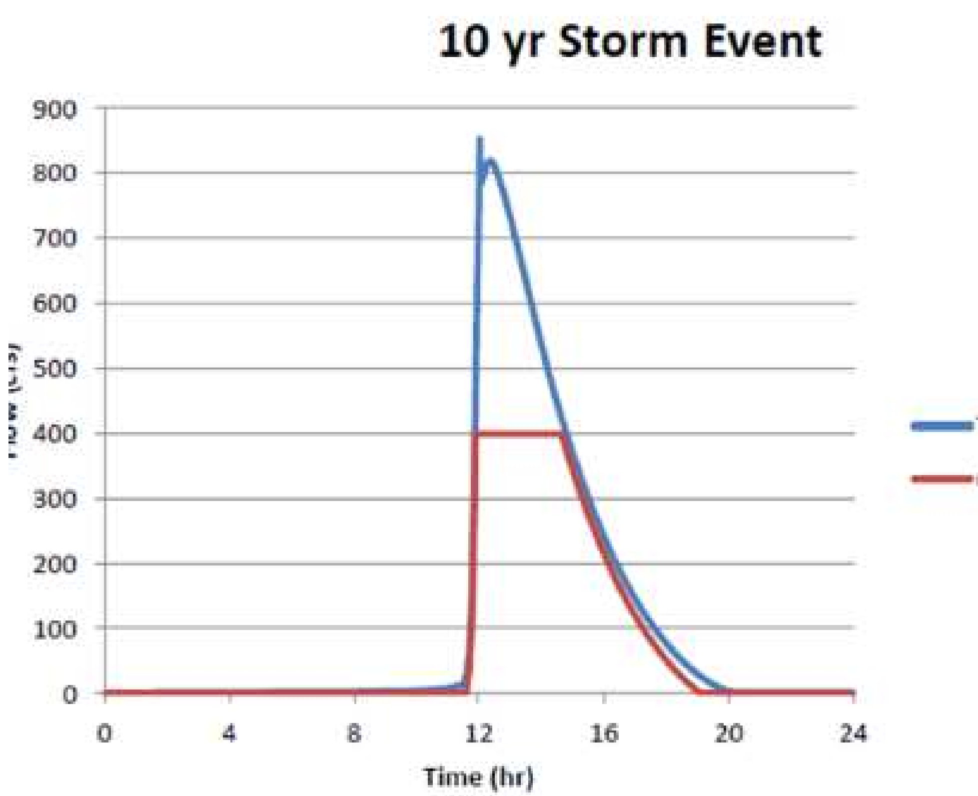
Protocol 3: Floodplain Reconnection

- Develop hydrologic and hydraulic model to estimate volume of runoff & area of floodplain accessed
- Determine treatment efficiency
  - Ratio of watershed to floodplain
  - Ratio of total runoff volume to volume accessed by floodplain wetlands
  - Wetland removal efficiency
- Determine pollutant loading
  - Remove baselines and loading removed by upstream practices



e 5: Hydrograph comparing total outflow to treated overbank flow during the 10 y

Protocol 3
Best Practices

- Model calibration
- Determine what probability storm event has access to the floodplain
- Use hydraulic model to determine storm probability that equals 1’ depth over floodplain wetlands

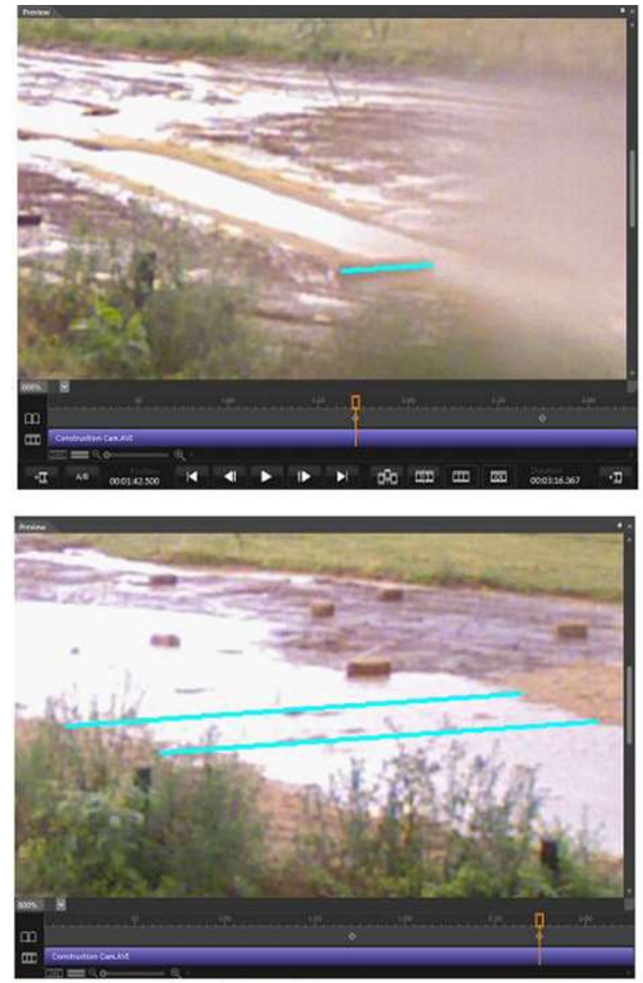
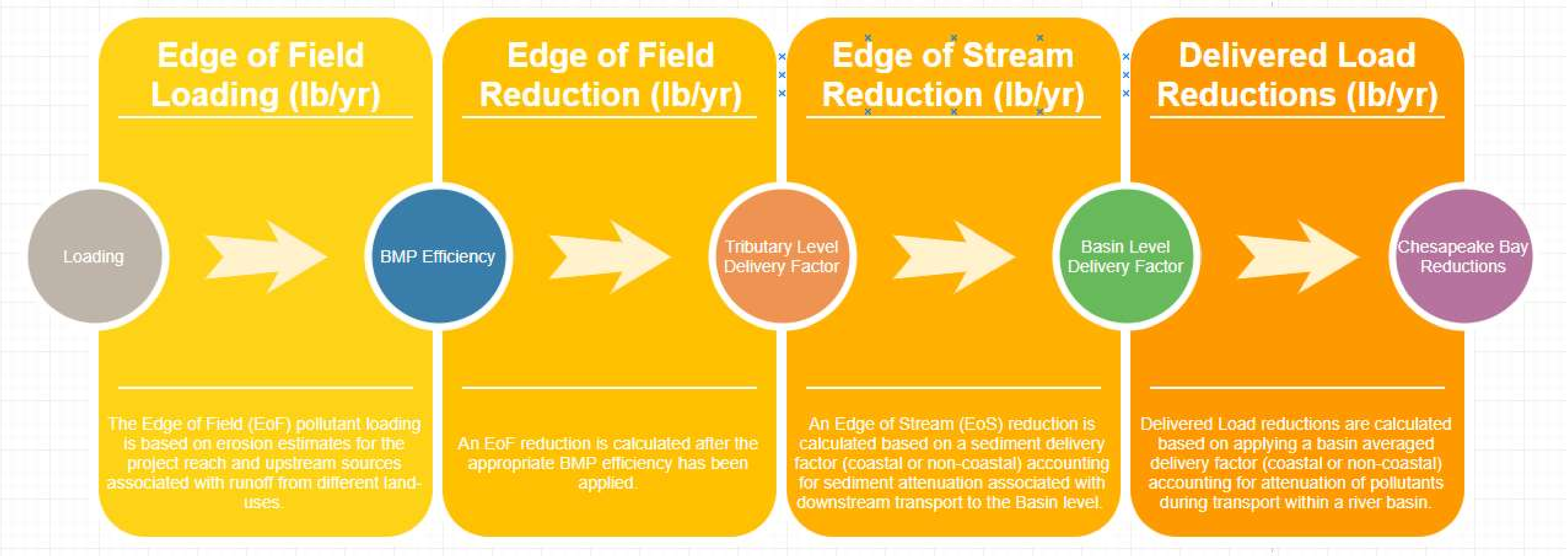
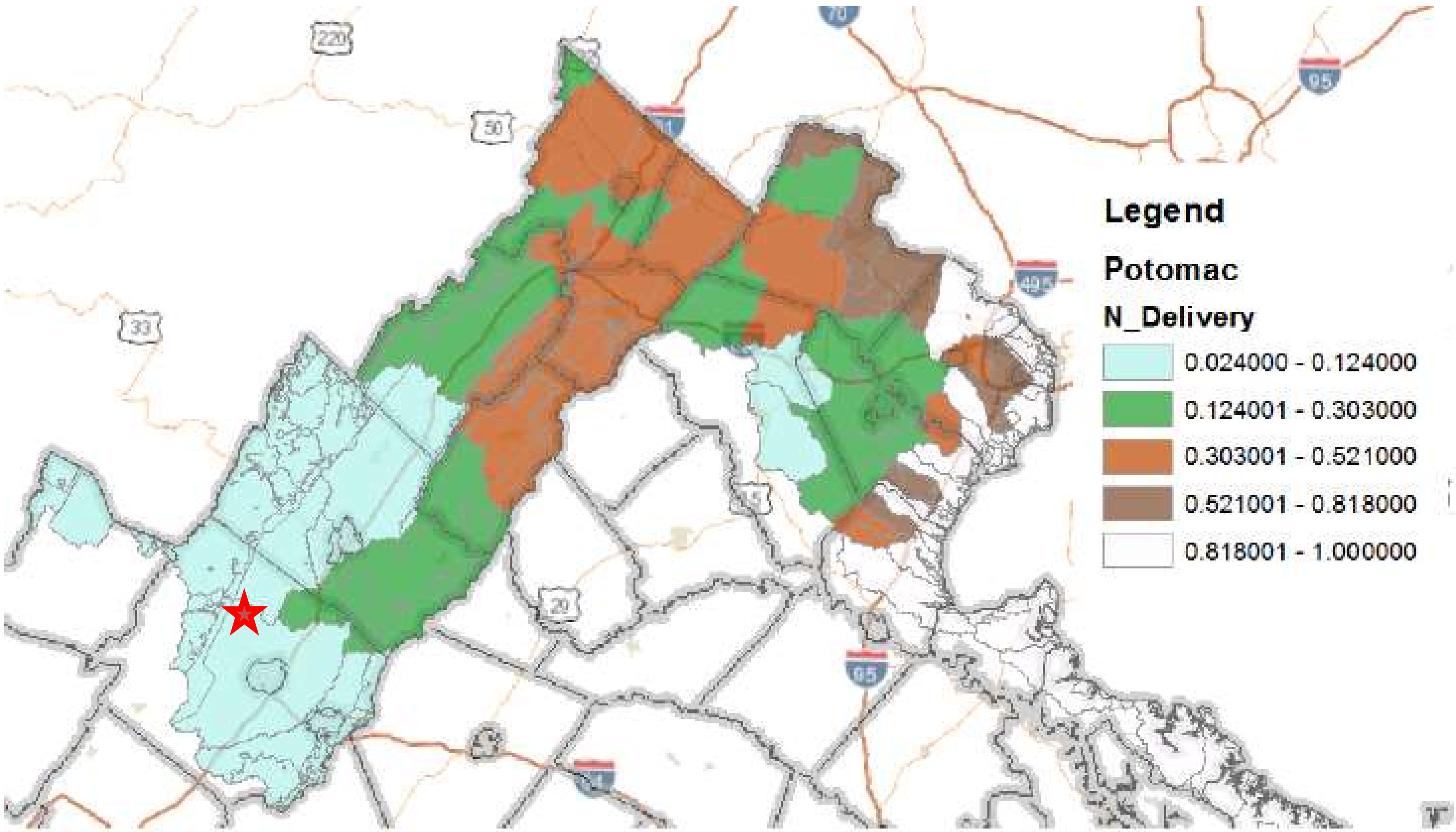


Figure 3: This pair of pictures was used to estimate the width of flow during a storm that occurred on July 7th, 2016

Delivery Factors



Delivery Factors



Total Nitrogen	Total Phosphorus	Sediment
0.357	0.493	0.664

DURING CONSTRUCTION

DURING CONSTRUCTION

1 MONTH AFTER CONSTRUCTION


1 YEAR AFTER CONSTRUCTION

1.5 YEAR AFTER CONSTRUCTION

1.5 YEAR AFTER CONSTRUCTION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