VIRGINIA TECH

Effectiveness of stormwater management practices in protecting stream channel stability

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Acknowledgements

Maryland Department of Natural Resources

Maryland Department of Transportation State Highway Administration

United States Environmental Protection Agency

Chesapeake Bay Program – A Watershed Partnership

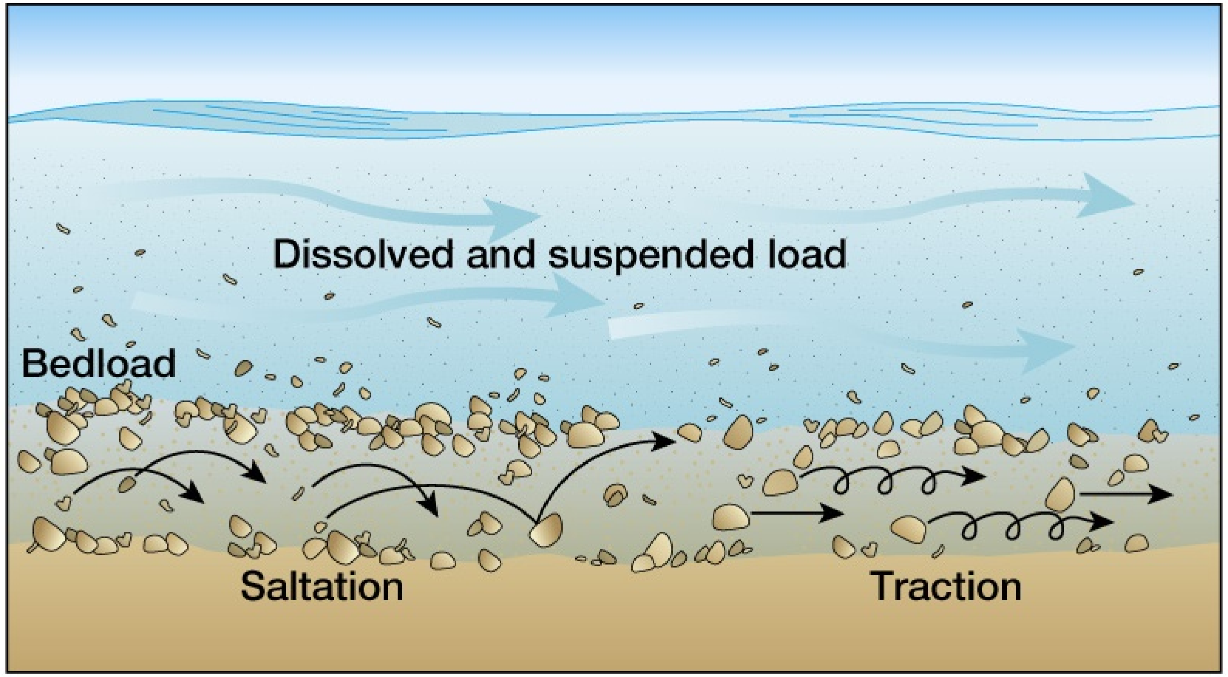
National Fish and Wildlife Foundation

Anne Arundel County Maryland

Montgomery County Maryland

Baltimore County Maryland

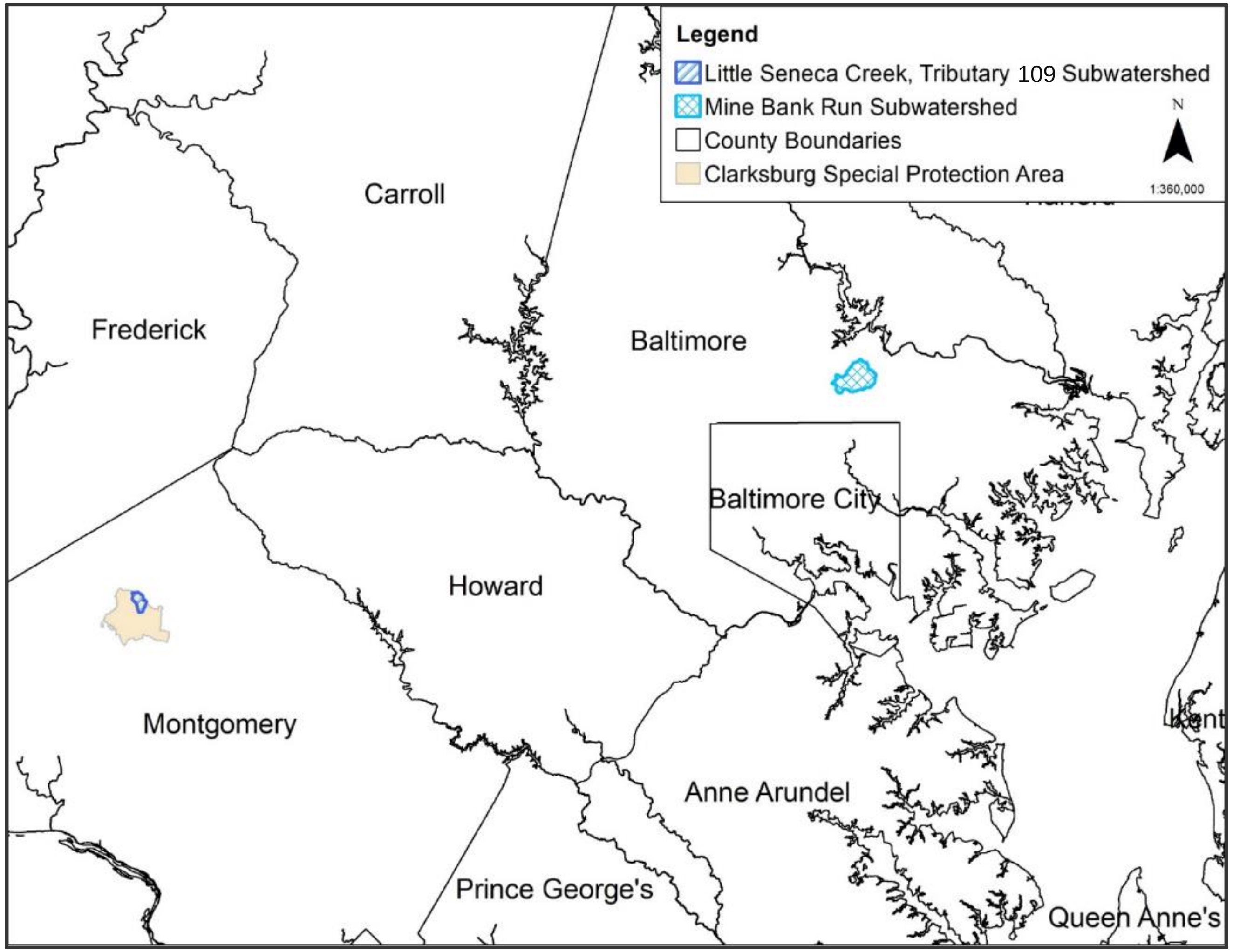
McCormick Taylor



In this talk "sediment" is not a four-lettered word.

- Coarse sediment is naturally transported in suspension and along the channel bed.
- Fine sediment does not play a major role in channel morphology.

The overall study goal is to evaluate the impacts of different stormwater management practices on channel stability



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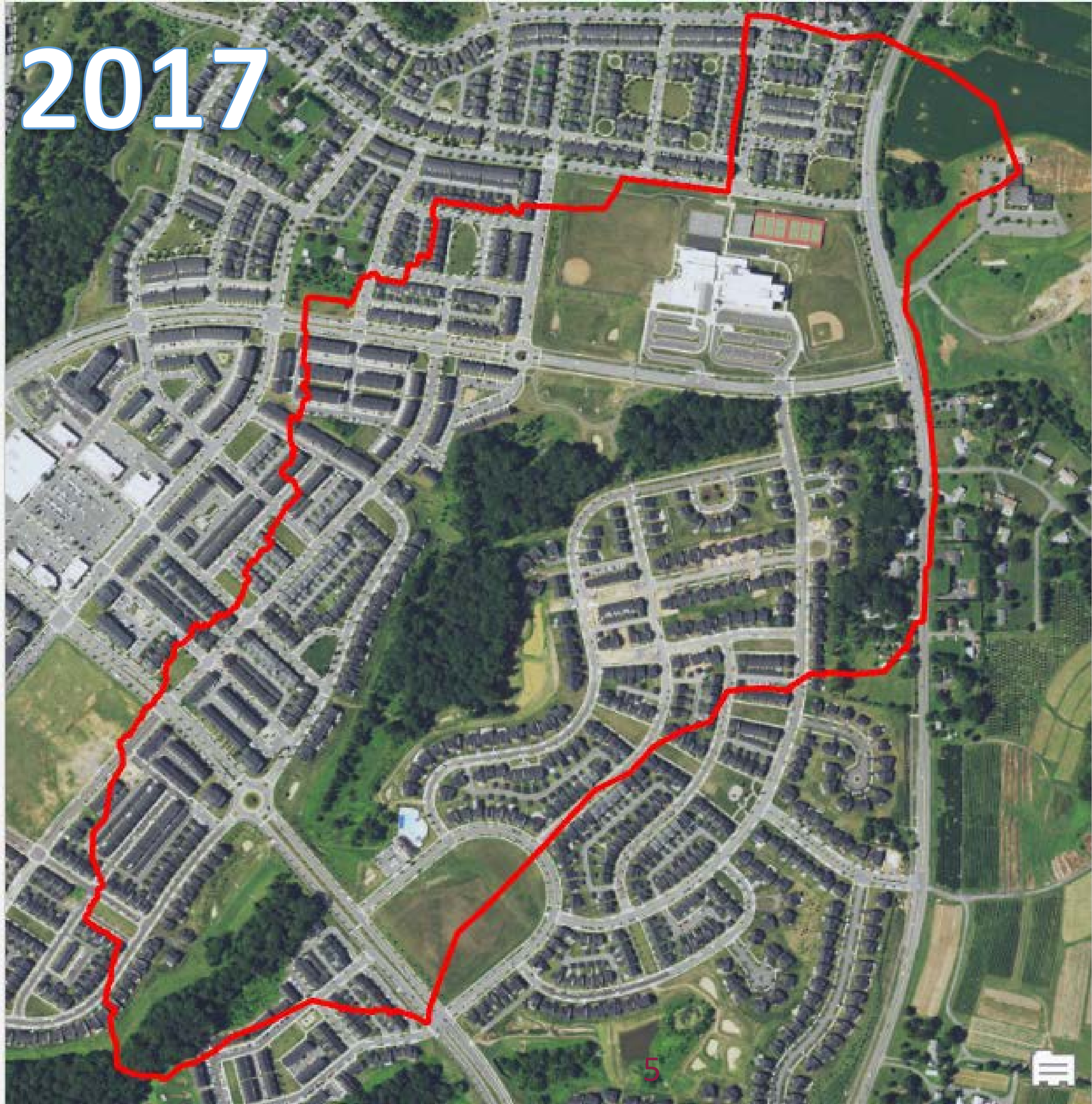
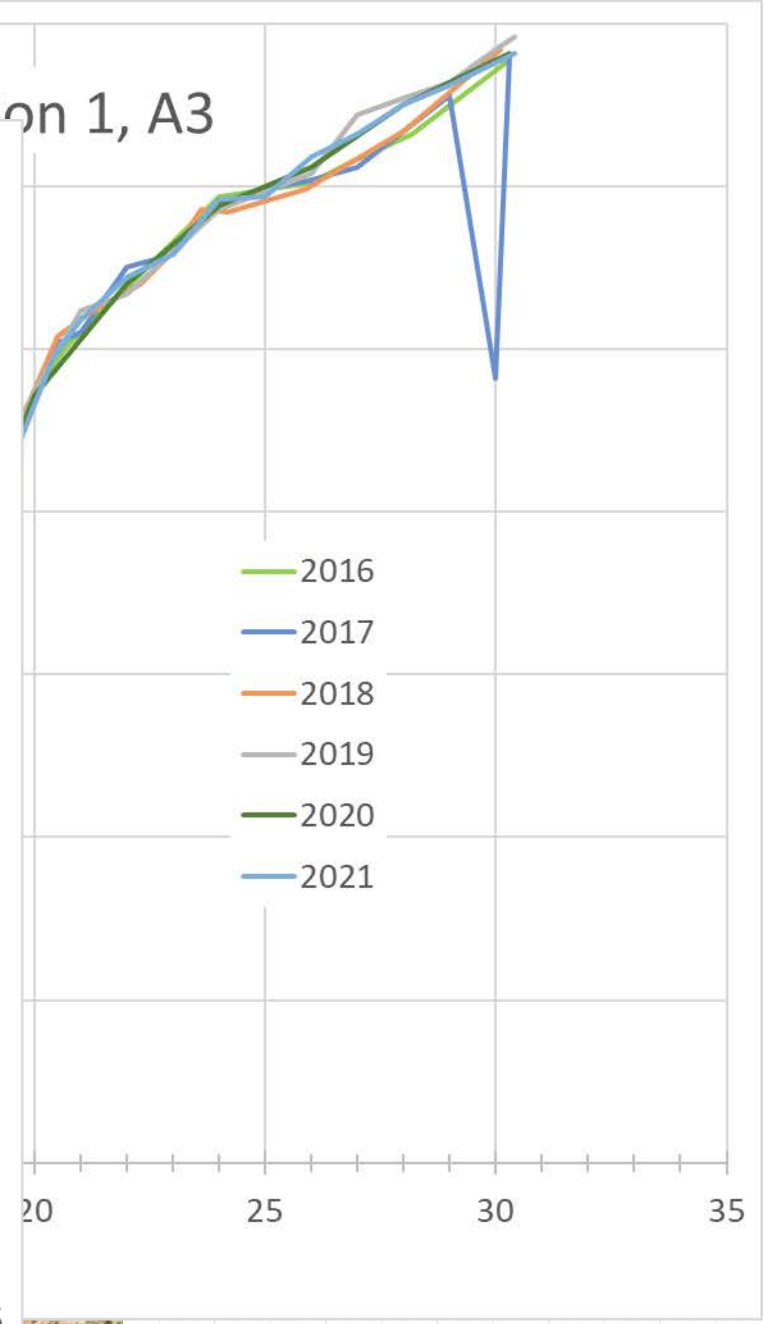
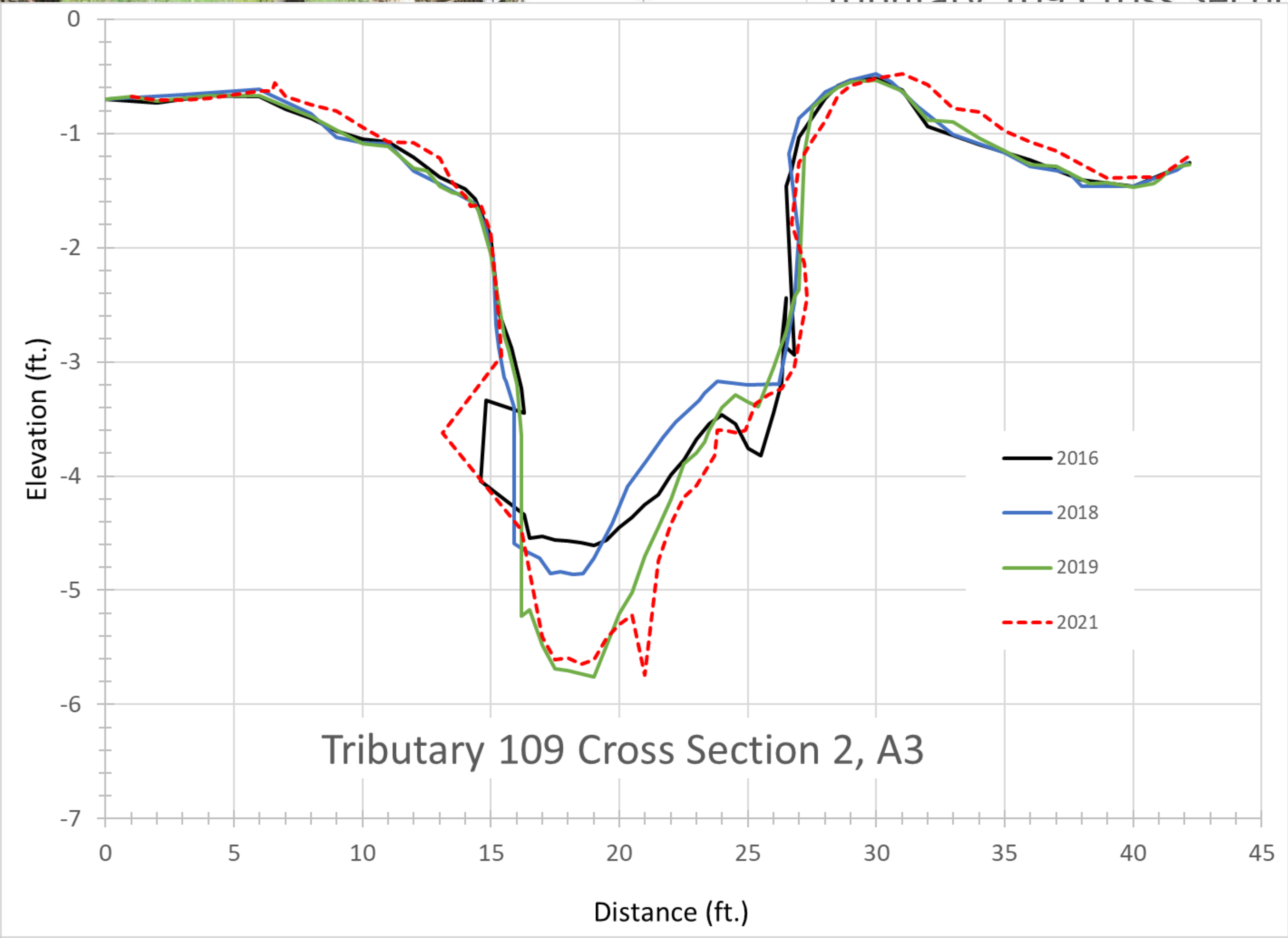
Watershed changes through time

Tributary 109

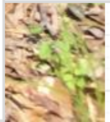




Tributary 109 Cross Section 1, A3
0
2016
2017
2018
2019
2020
2021
20
25
30
35

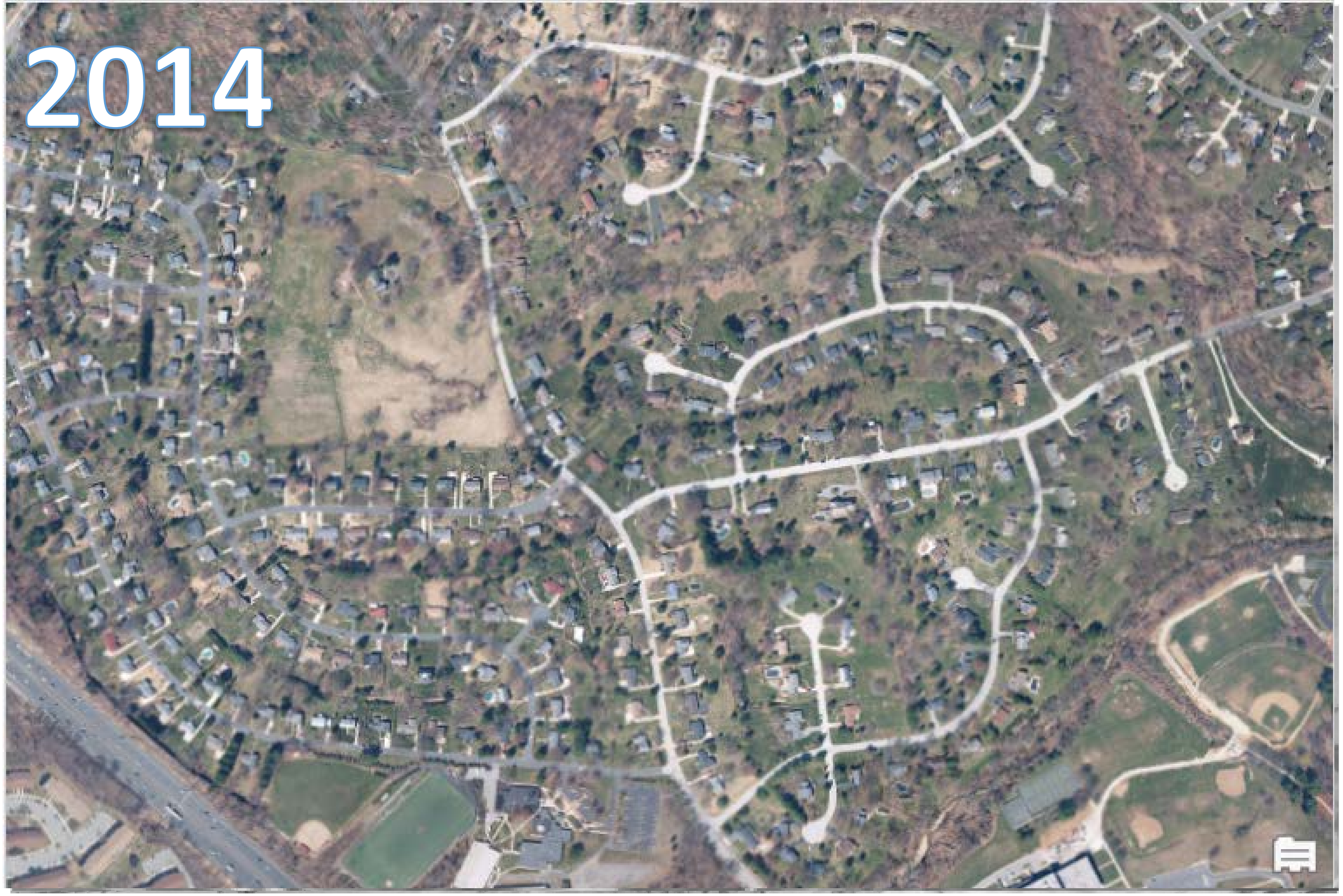


Tributary 109 Cross Section 2, A3
Elevation (ft.)
Distance (ft.)
0
-1
-2
-3
-4
-5
-6
-7
0
5
10
15
20
25
30
35
40
45
2016
2018
2019
2021



Watershed changes through time

Minebank Run




Channel stability is a two-part problem

Water

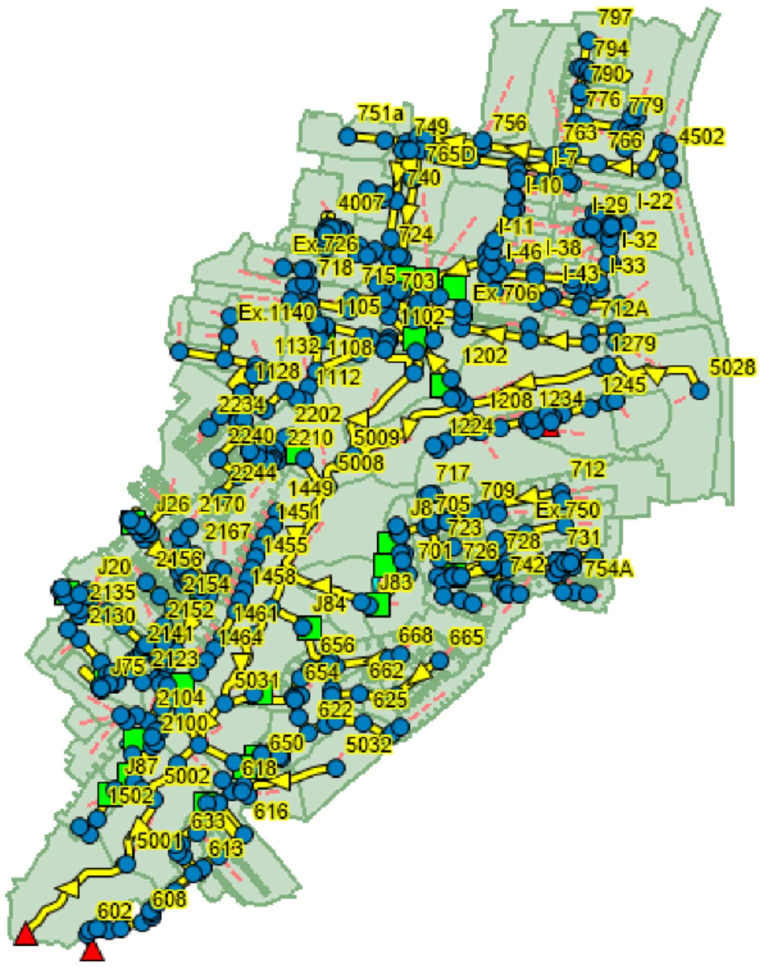
SWMM
Storm Water Management Model

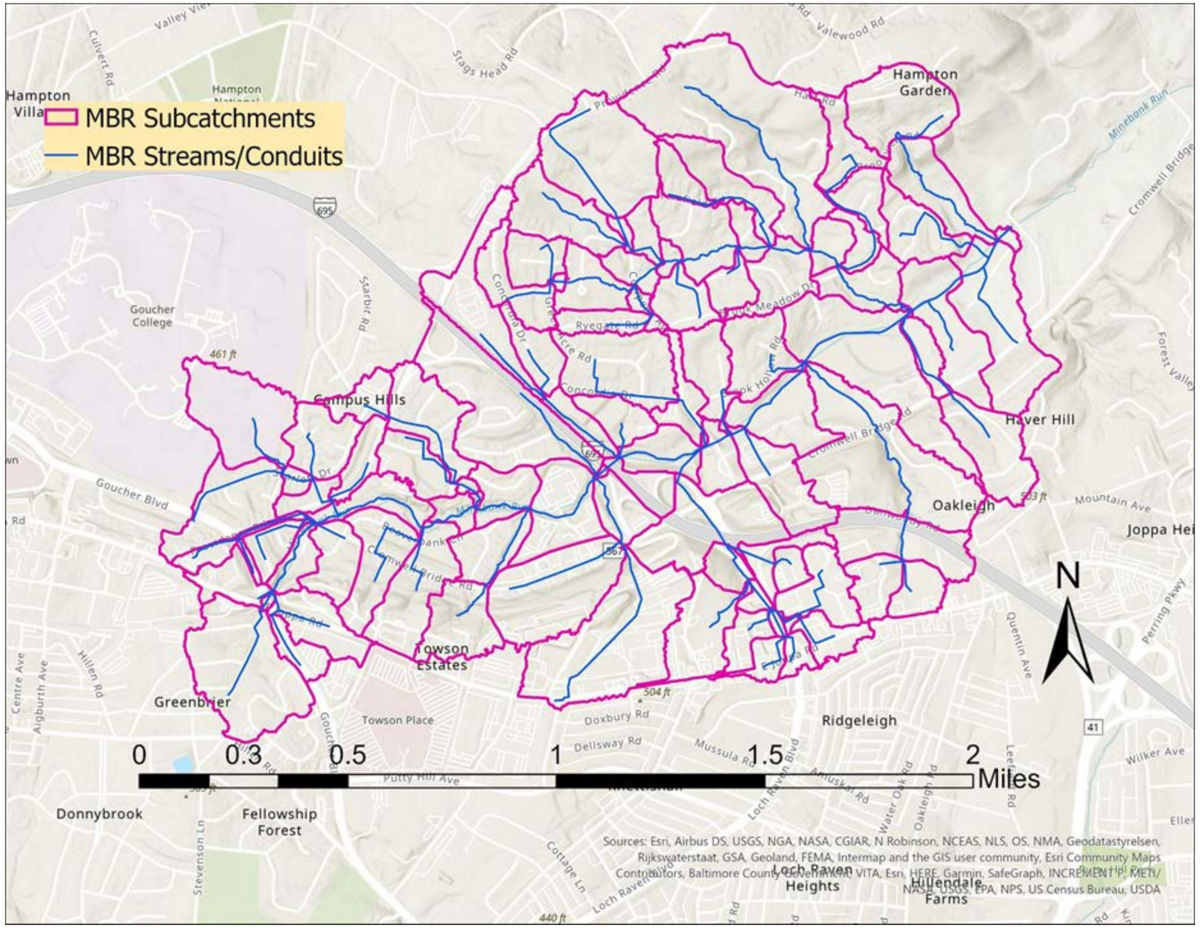
Sediment

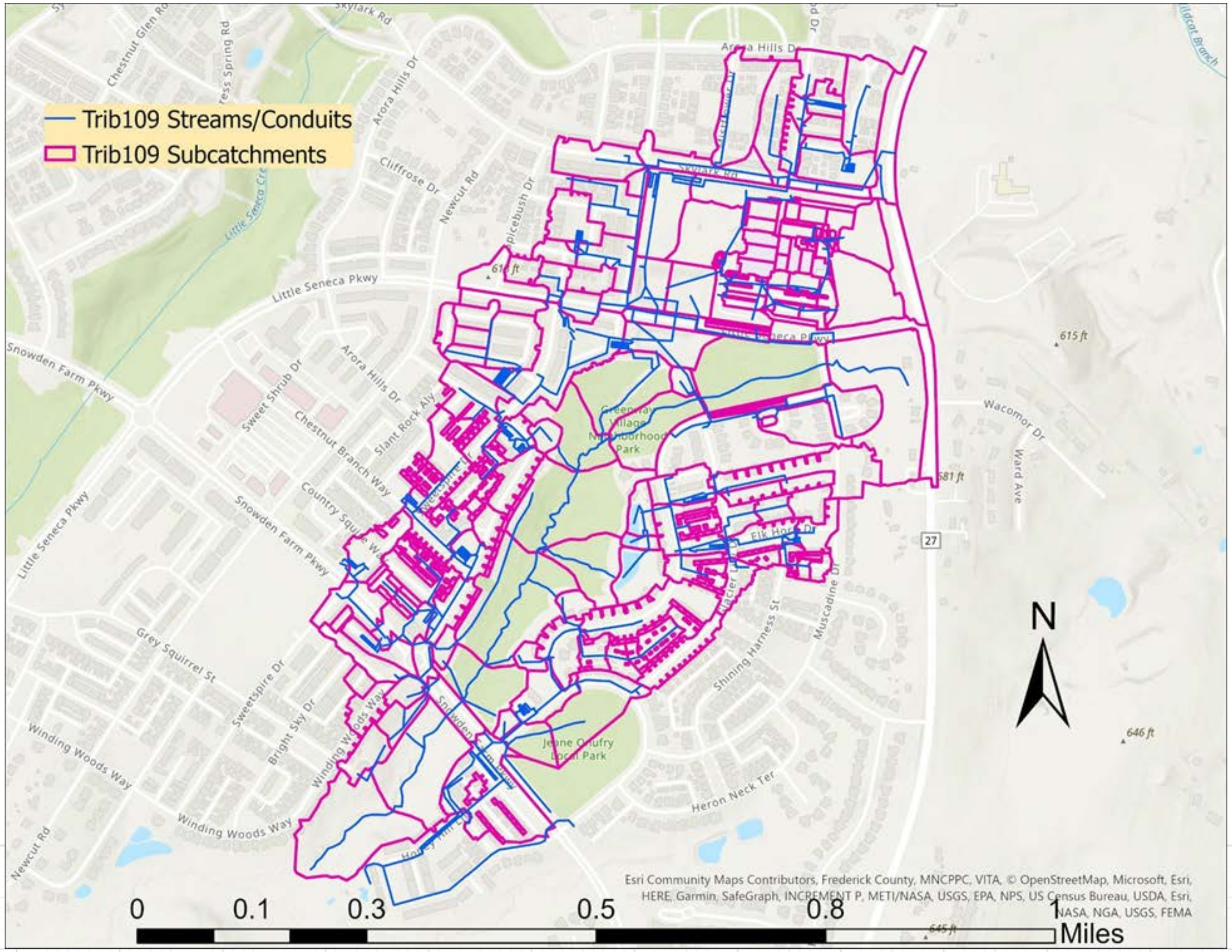
HEC-RAS 6.2

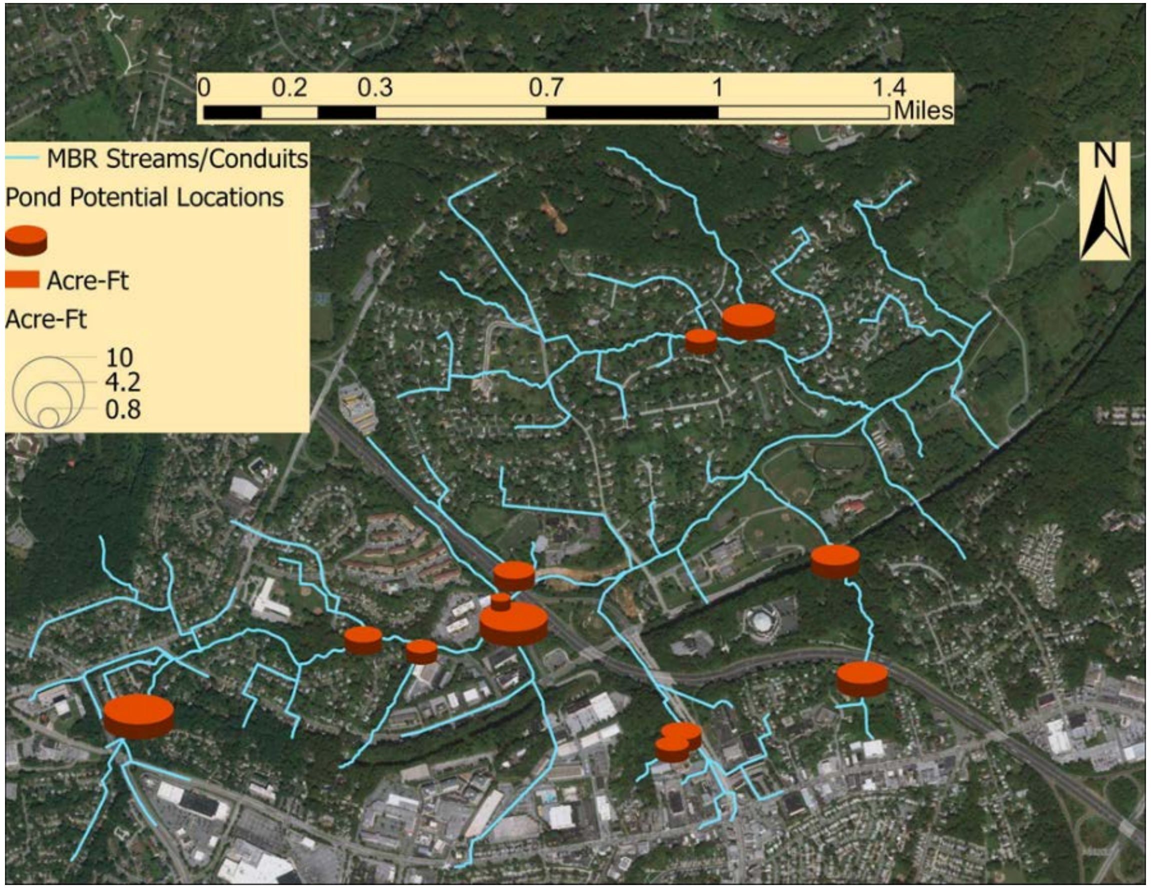
SWMM model development

1. Watershed characteristics and stormwater infrastructure attributes entered into models
2. Models calibrated based on observed USGS flow data
3. Calibrated models used to explore multiple scenarios
4. Modeled stream discharge used in HEC-RAS model




MBR Subcatchments
MBR Streams/Conduits
N
0 0.3 0.5 1 1.5 2
Miles
Sources: Esri, Airbus DS, USGS, NGA, NASA, CGIAR, N Robinson, NCEAS, NLS, OS, NMA, Geodatastyrelsen, Rijkswaterstaat, GSA, Geoland, FEMA, Intermap and the GIS user community, Esri Community Maps Contributors, Baltimore County Government, VITA, Esri, HERE, Garmin, SafeGraph, INCREMENT P, METI/NASA, USGS, EPA, NPS, US Census Bureau, USDA
Hampton Garden
Goucher College
Campus Hills
Haver Hill
Oakleigh
Towson Estates
Greenbrier
Ridgeleigh
Donnybrook
Fellowship Forest
Loch Raven Heights
Hillendale Farms


Trib109 Streams/Conduits
Trib109 Subcatchments
N
0 0.1 0.3 0.5 0.8 1
Miles
Esri Community Maps Contributors, Frederick County, MNCPPC, VITA, © OpenStreetMap, Microsoft, Esri, HERE, Garmin, SafeGraph, INCREMENT P, METI/NASA, USGS, EPA, NPS, US Census Bureau, USDA, Esri, NASA, NGA, USGS, FEMA
Little Seneca Pkwy
Snowden Farm Pkwy
Greenway Village Neighborhood Park
Jeane Onufry Local Park
Winding Woods Way



The effect of different stormwater management strategies were modeled for Minebank Run

1. Imperviousness reduced by 50%
2. Depression storage doubled
3. Soil hydraulic conductivity doubled
4. Route all impervious to pervious
5. 12 ponds with a total storage volume of 54 acre-ft
6. Combinations of scenarios of 2-5

Channel stability is a two-part problem

Water

Sediment

SWMM
Storm Water Management Model

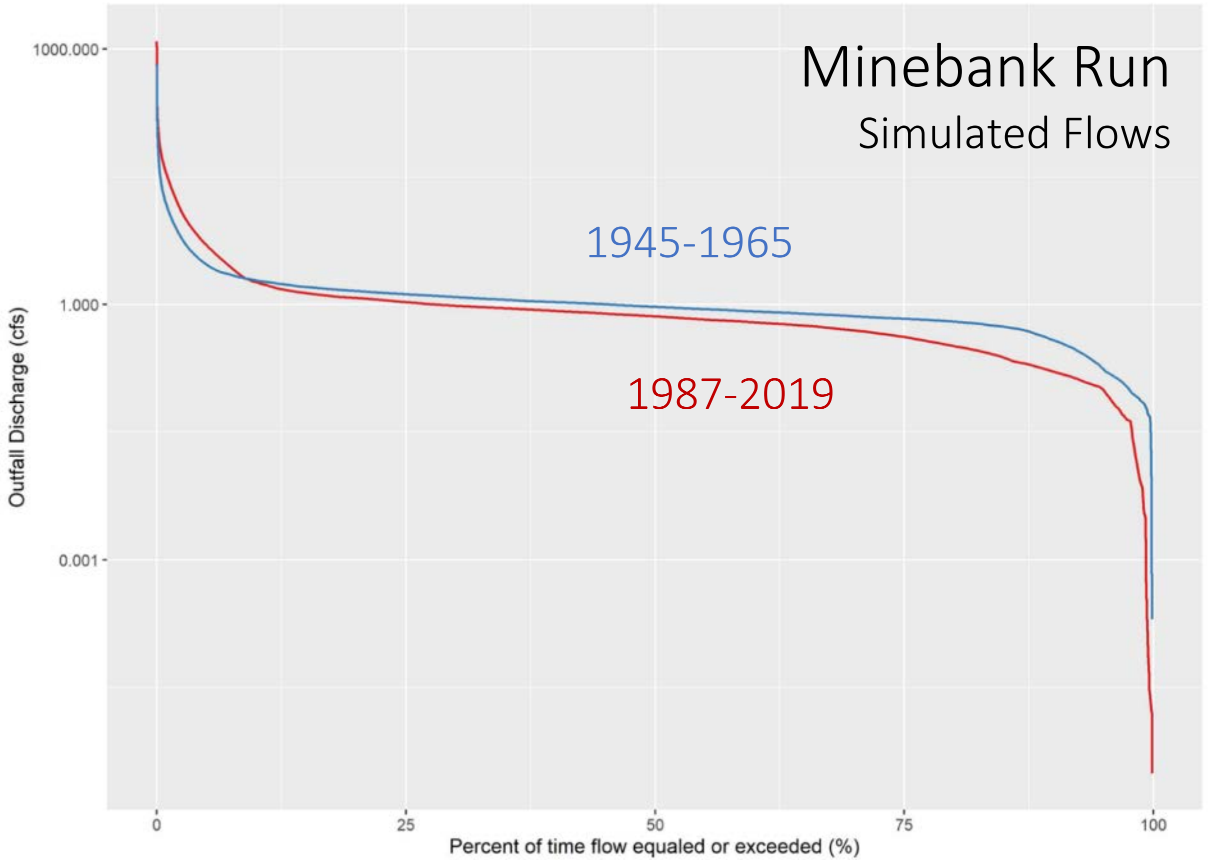
HEC-RAS 6.2

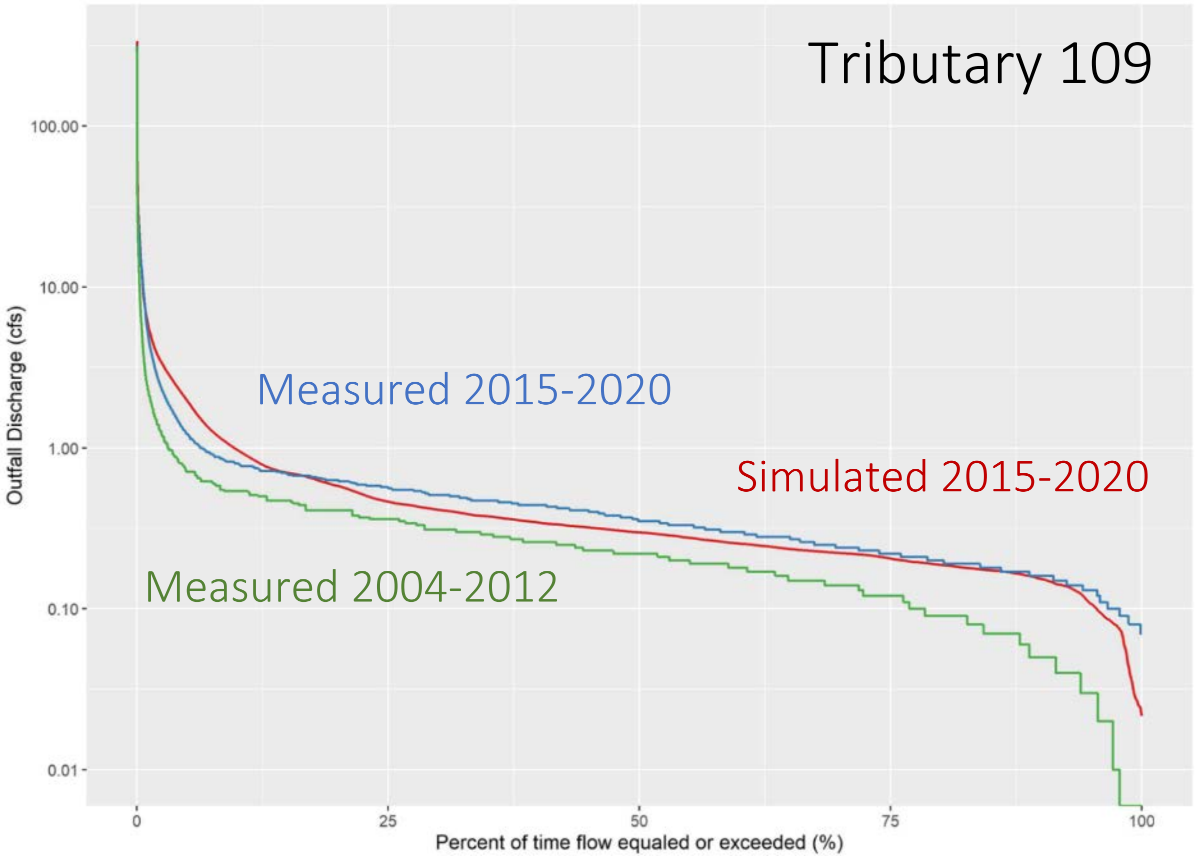
HEC-RAS 1-D model development

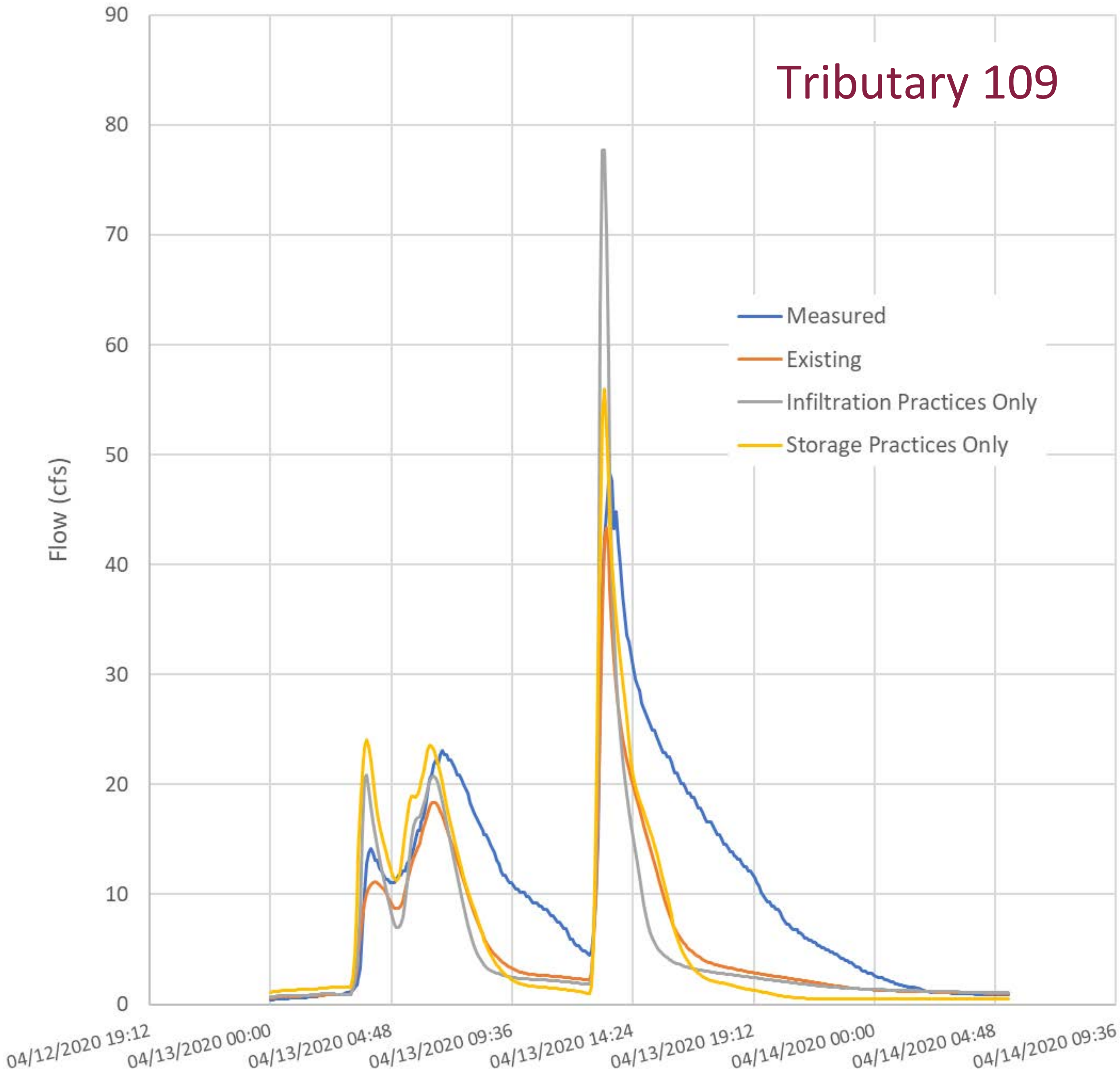
1. Lidar data and measured cross sections used to create channel geometry
2. Bed particle counts, bulk sediment samples, and USGS suspended sediment data used to parameterize sediment transport routines
3. Bank soil samples and jet tests used to parameterize bank erosion routines
4. Calibrate HEC-RAS to USGS stage data and measured cross section change
5. Modeling channel response to stormwater scenarios modeled using SWMM

Results to date…

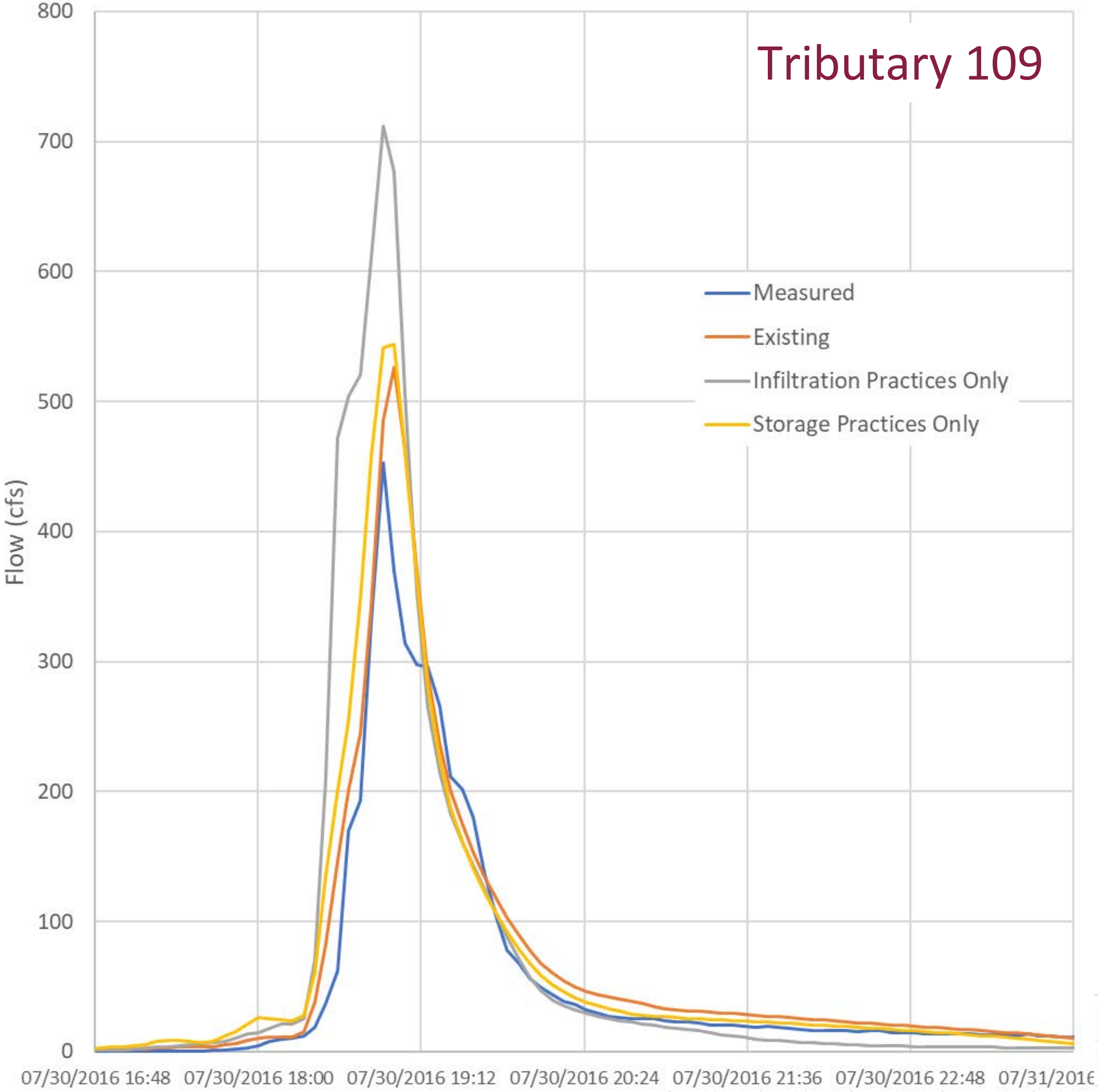
With ESD all flows increased.





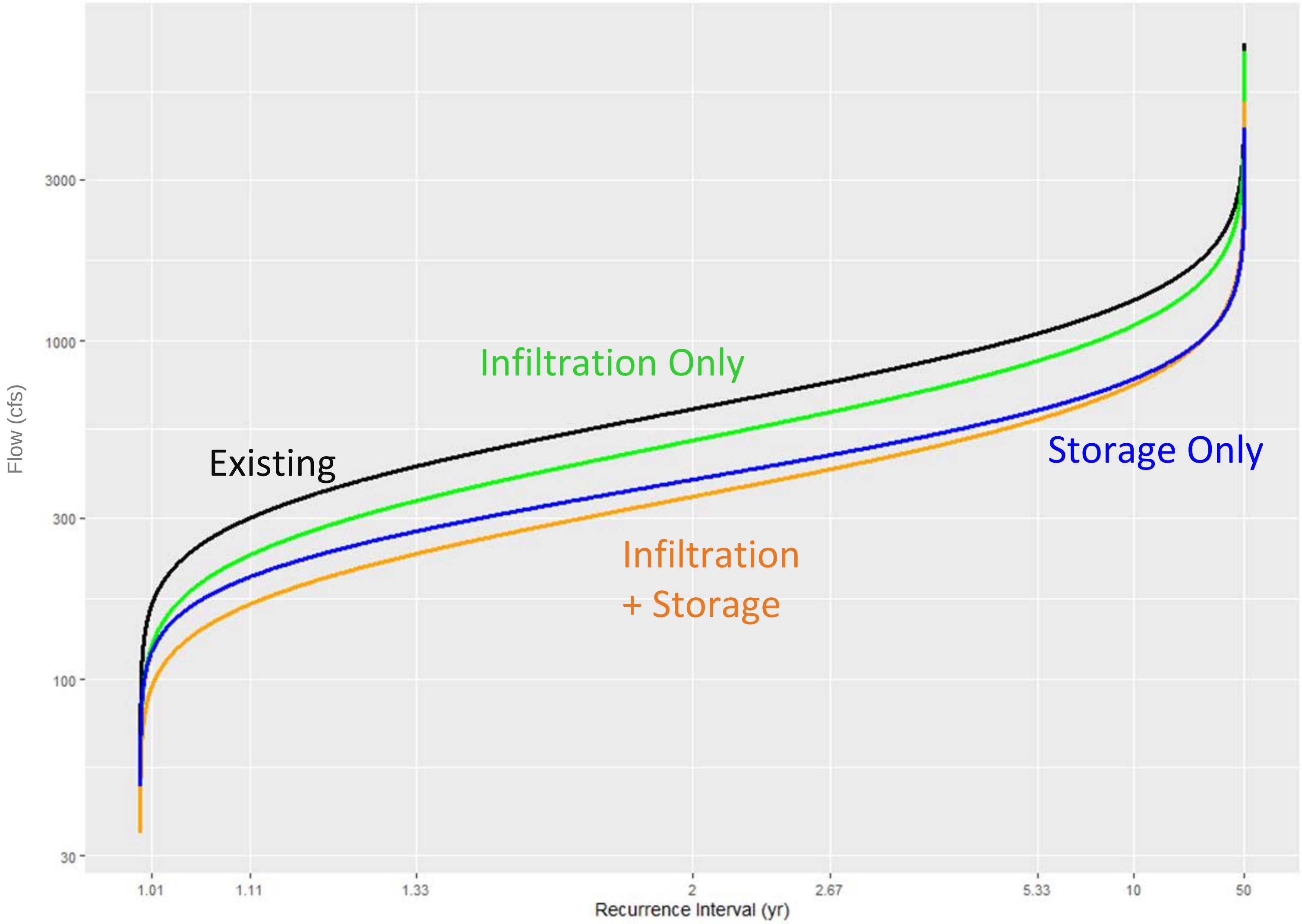


For small storm events, infiltration practices reduce runoff more than storage practices.



Storage practices are necessary to reduce peak flows from large storm events.

Flood frequency analysis   Minebank Run



Infiltration practices effectively reduce peak flows from small storm events, but storage practices are necessary to reduce peak flows from large storm events.

Channel stability results coming…

Summary

1. SWMM and HEC-RAS models developed for two watersheds to investigate how much ESD protects channel stability following development.
2. Flow reduction is greatest when using a combination of ESD controlling small storms and SCMs controlling larger events.
3. ESD is more effective for small magnitude, high frequency storms, whereas storage BMPs (ponds) are more helpful in controlling flows from large events.
4. Channel stability findings…

Translation Slides

What are the take home points?
What does this mean for me?

Translation Slides by Sara Weglein

What does this mean for me?

- ESD/infiltration BMPs are more effective in reducing the impacts of smaller, more frequent storms.
- SCMs/storage BMPs are more effective in reducing the impacts of large storm events.
- These BMPs in combination had the greatest impact in reducing the impacts of stormflow overall.

- ESD/infiltration BMPs were also effective in increasing baseflow.
  - This could be an area of additional study; what effect does ESD and increased baseflow have on stream temperature?

What does this mean for me?

What do I take from this if I am a practitioner:

- Need to apply a combination of infiltration and storage BMPs for the greatest chance of success in reducing stormflow.

What do I take from this if I am a regulator:

- Same as above.
- ESD could be utilized to increase the magnitude of baseflows (where a concern), reduce the frequency of dry conditions, and thereby protect biota.