



Gannett Fleming

*Excellence Delivered **As Promised***

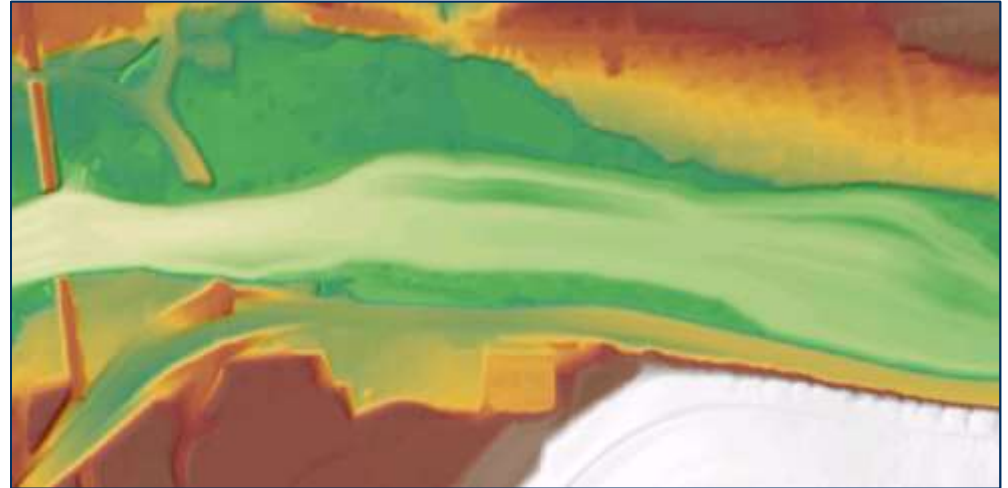
Hydraulic Modeling Methods of Densely Populated Areas and 3D Bathymetric Channel Solutions

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Gannett Fleming, Inc.



Outline

- **Introduction**
- **Terrain Data Development**
 - Bathymetric Channel Surface
- **Methods to Model Buildings**
 - Incorporate Buildings into DEM
 - Adjust Manning's n-Value
- **Comparing Results**



Terrain Development for Hydraulic Modeling

✓ Detailed terrain in overbank

Problem... No data acquired below top of water...



Terrain Development for Hydraulic Modeling (Cont'd)

Resulting impacts of not incorporating channel geometry

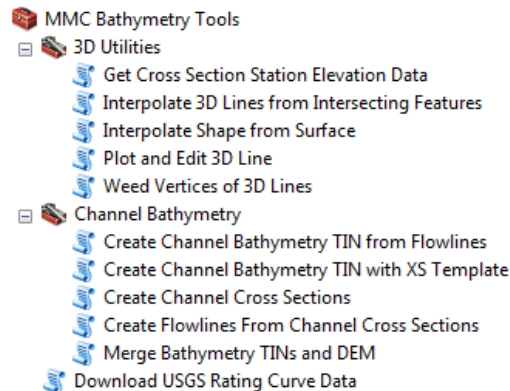


Terrain Development for Hydraulic Modeling (Cont'd)

Developing a bathymetric surface within GIS

Option 1: *Known* channel cross section geometry - when channel survey data or georeferenced HEC-RAS models are available

Option 2: *Estimating* channel cross section geometry – when channel cross section geometry is unknown. Geometry based off of stream invert, flow area, average flow depth, computing normal depth



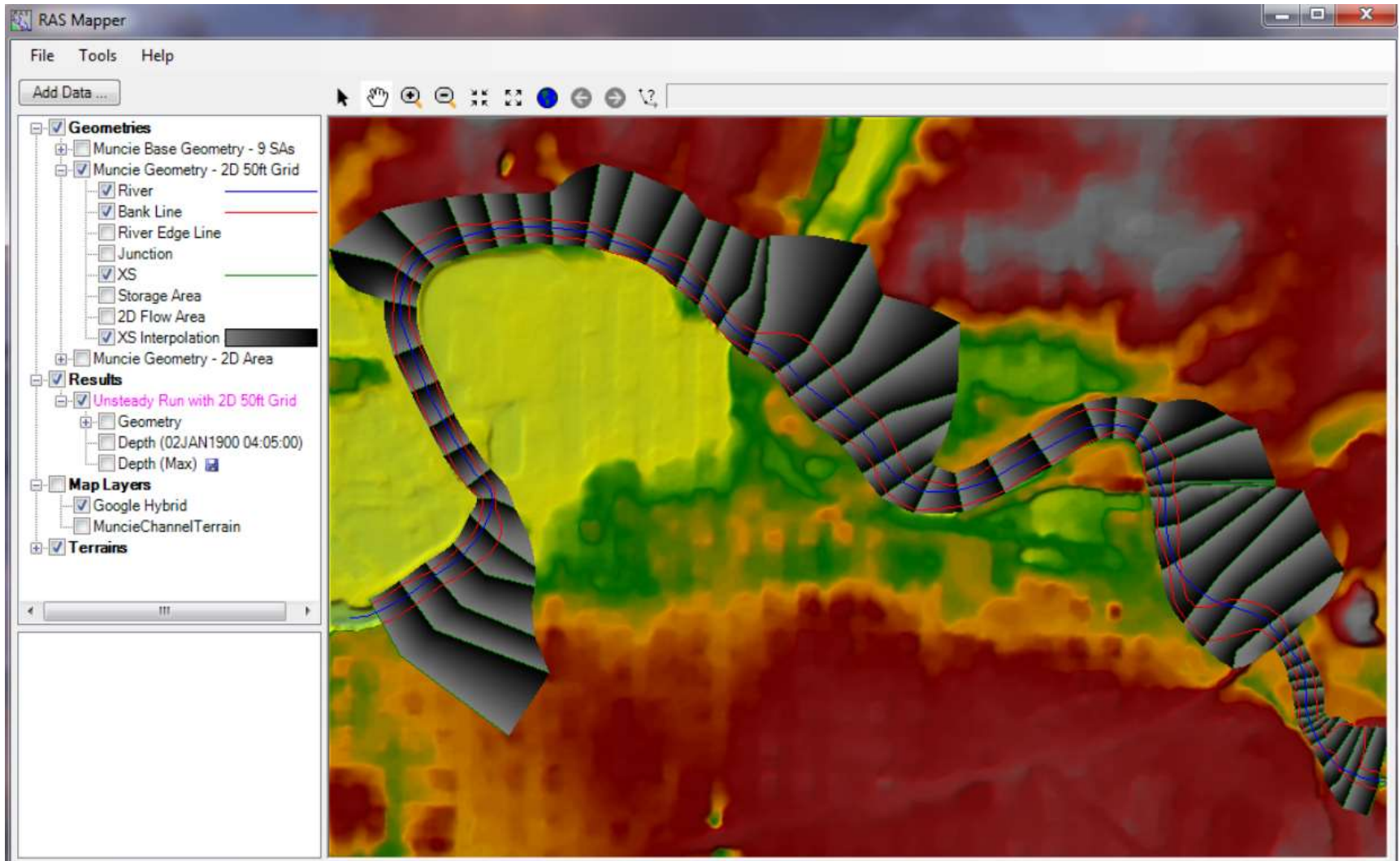
Terrain Development for Hydraulic Modeling (Cont'd)

Step 1. Develop an Edge of Water Polygon



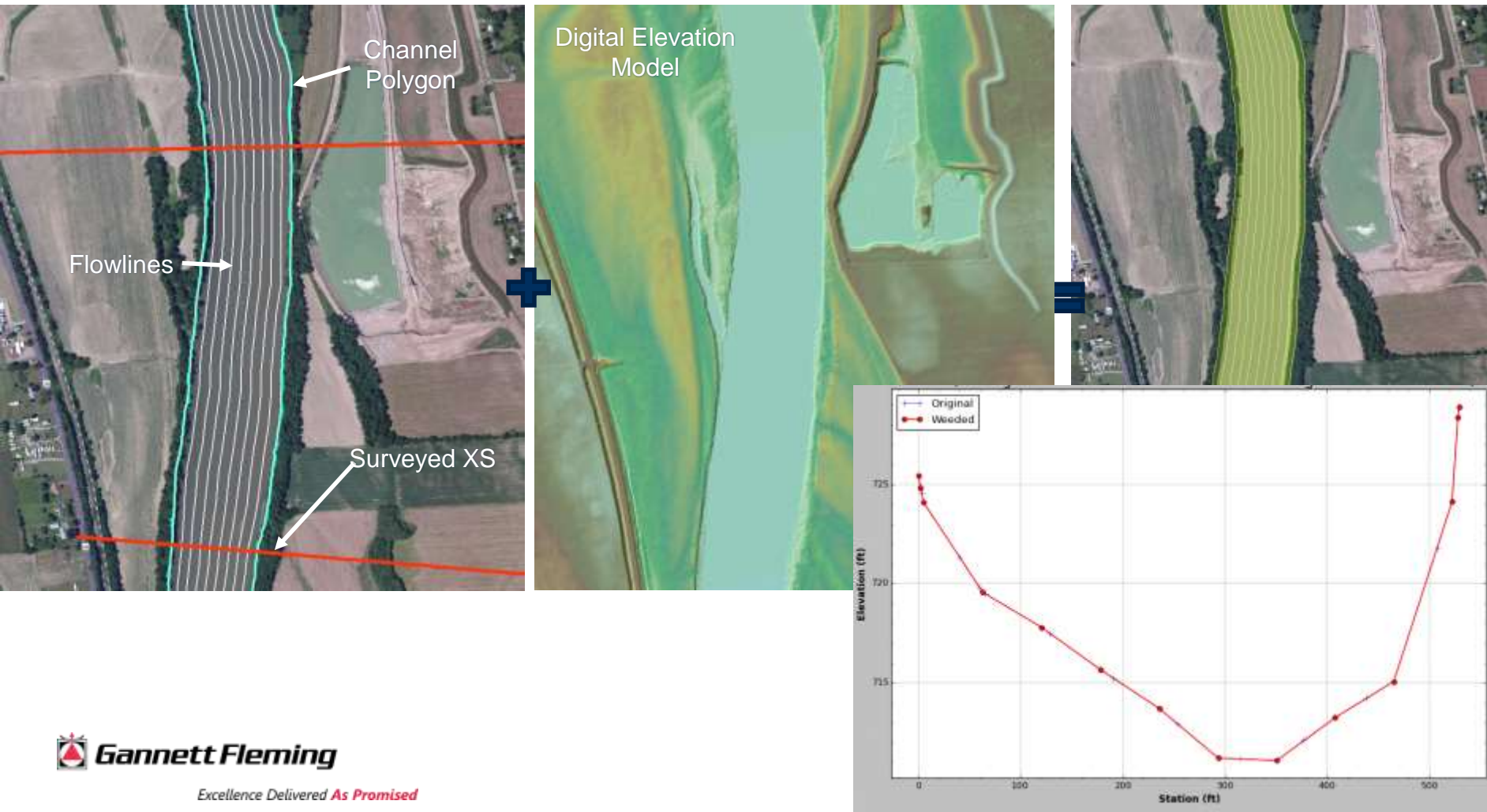
Terrain Development for Hydraulic Modeling (Cont'd)

Step 2. Create Line Features for Channel Surface Interpolation



Terrain Development for Hydraulic Modeling (Cont'd)

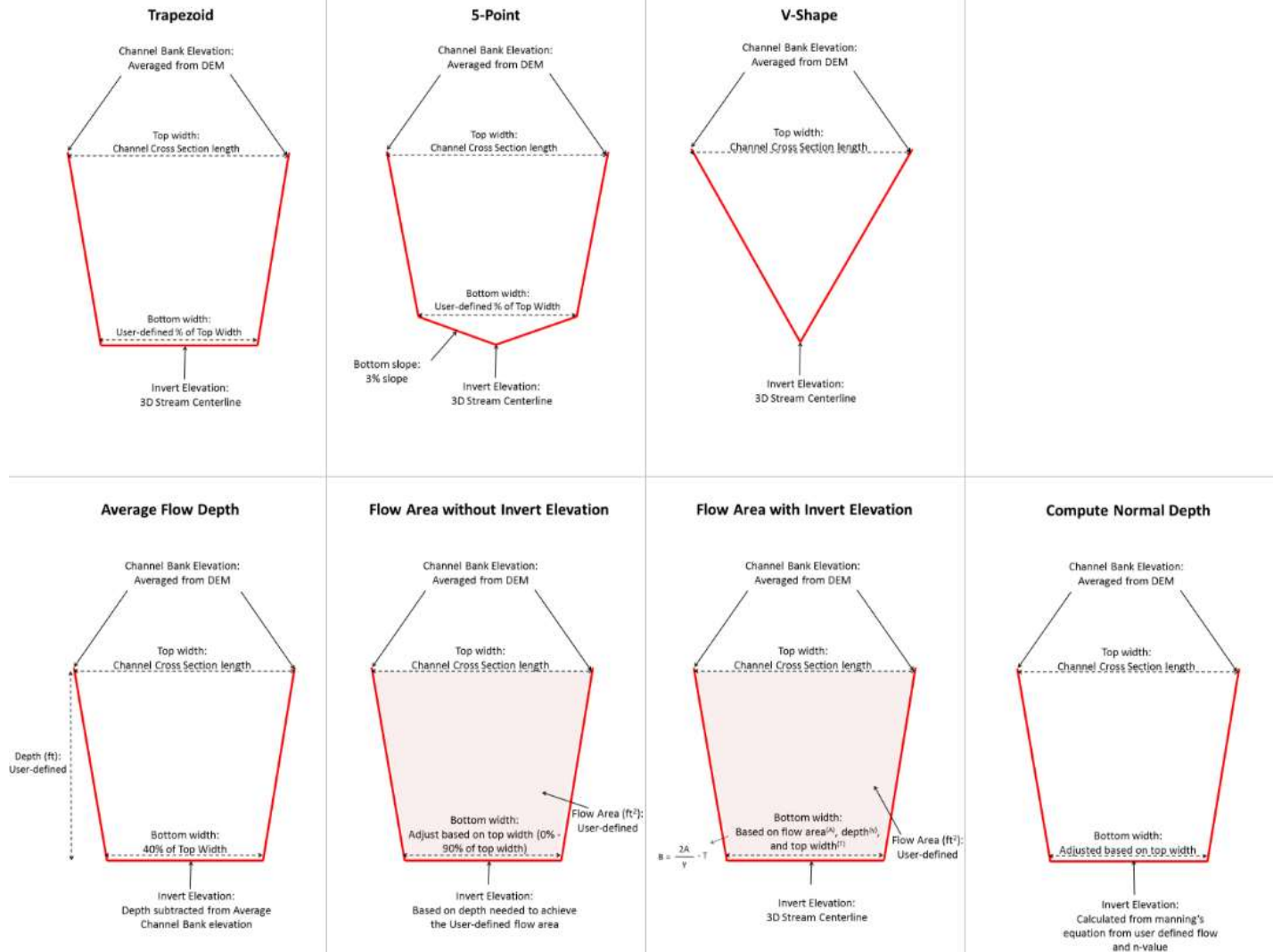
Step 3a. *KNOWN* Channel Geometry Method



Terrain Development for Hydraulic Modeling (Cont'd)

Step 3b. ESTIMATED Channel Geometry Method

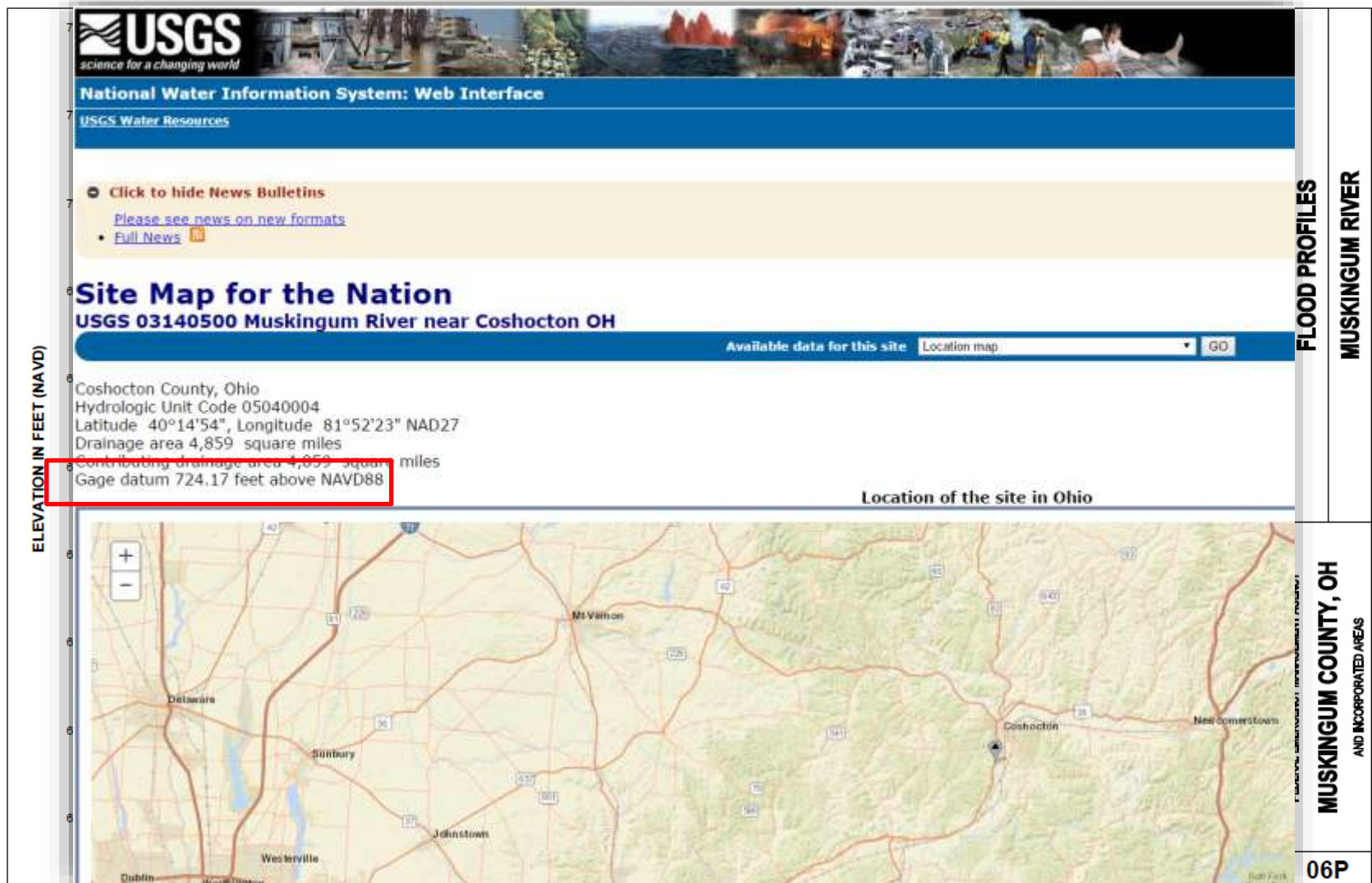
XS Template Types



Terrain Development for Hydraulic Modeling (Cont'd)

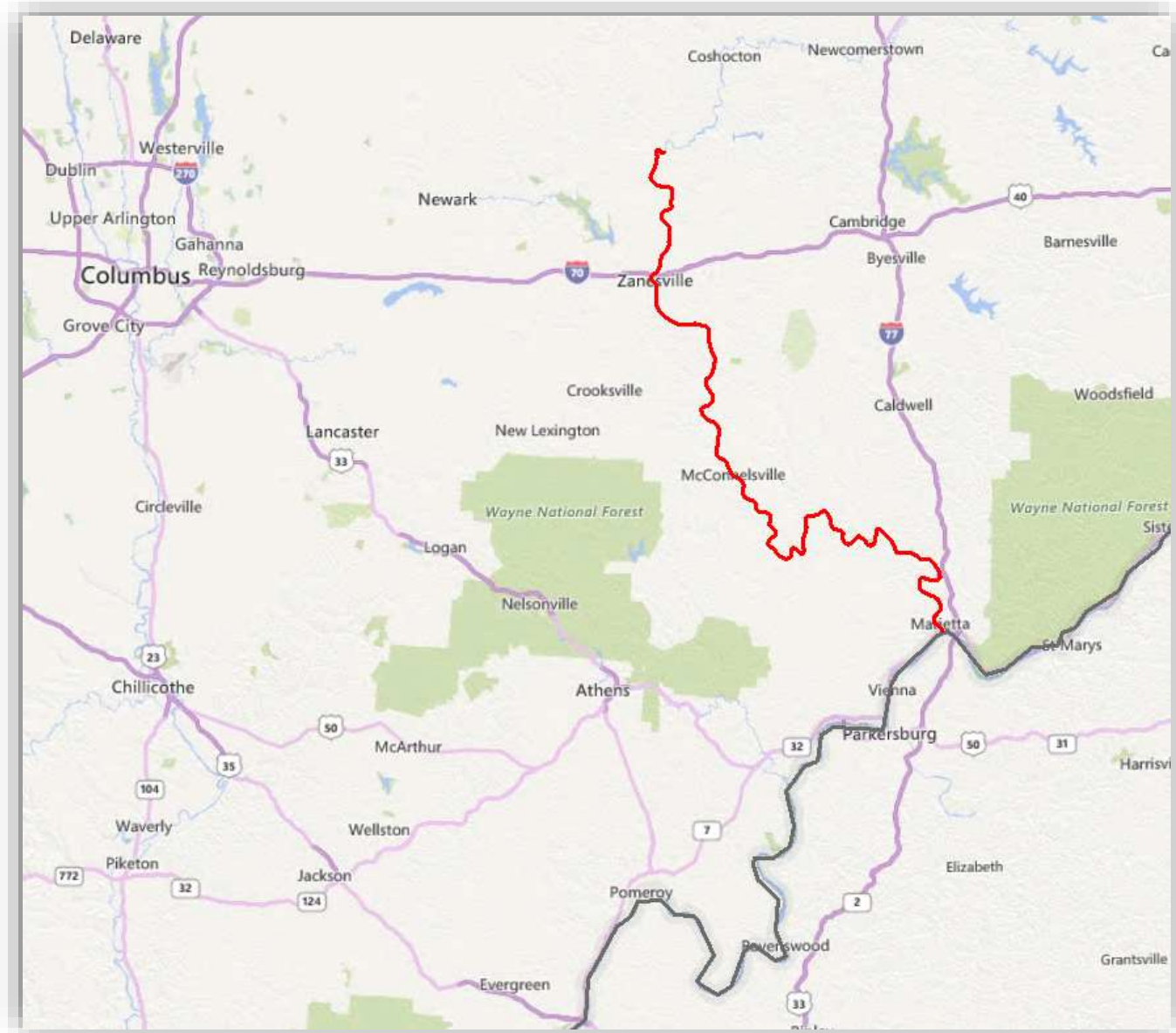
Step 3b. ESTIMATED Channel Geometry Method

Determining Stream Invert Elevations Example:

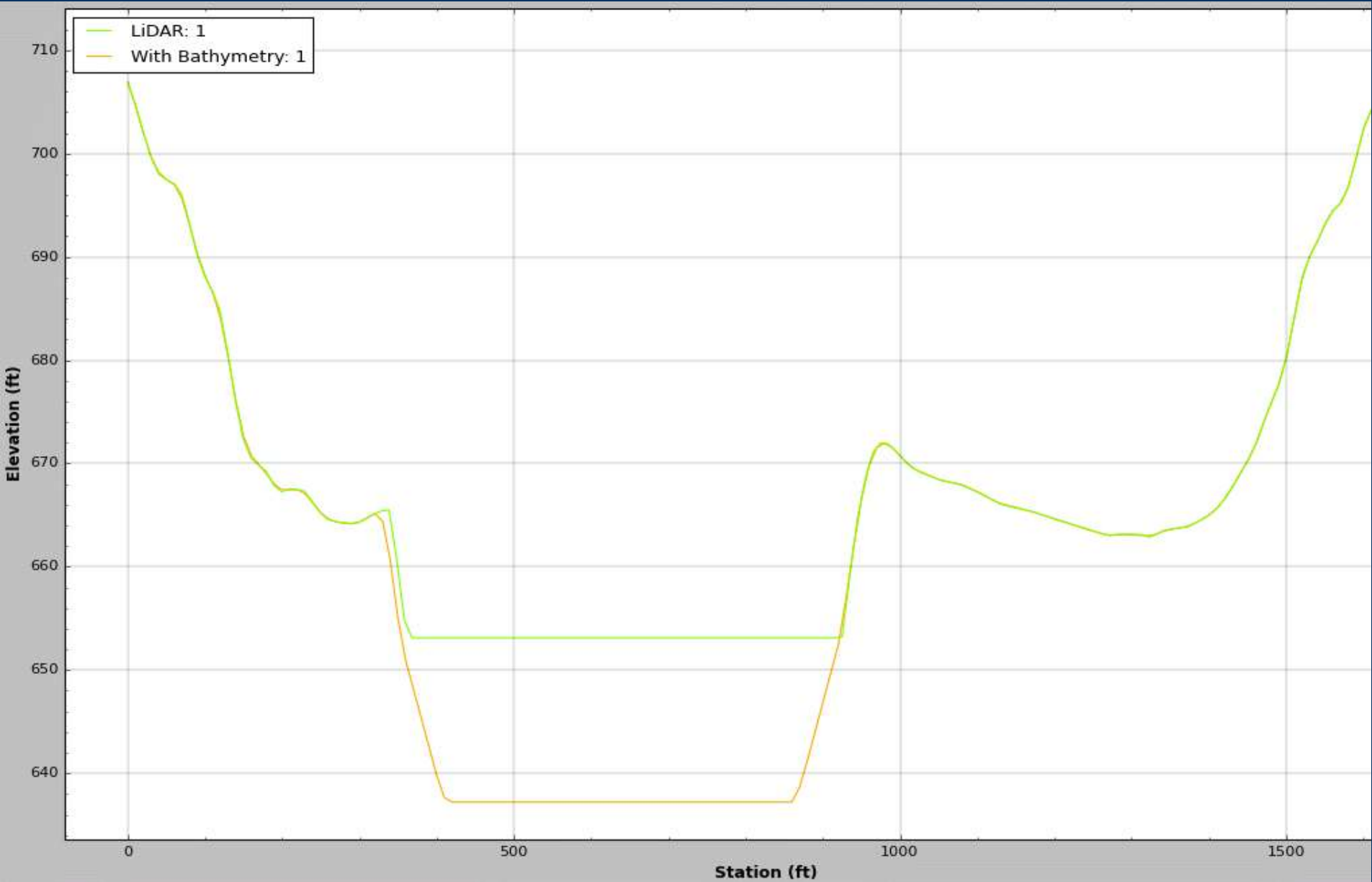


Terrain Development for Hydraulic Modeling (Cont'd)

*~100 stream miles along
Muskingum River*



Terrain Development for Hydraulic Modeling (Cont'd)

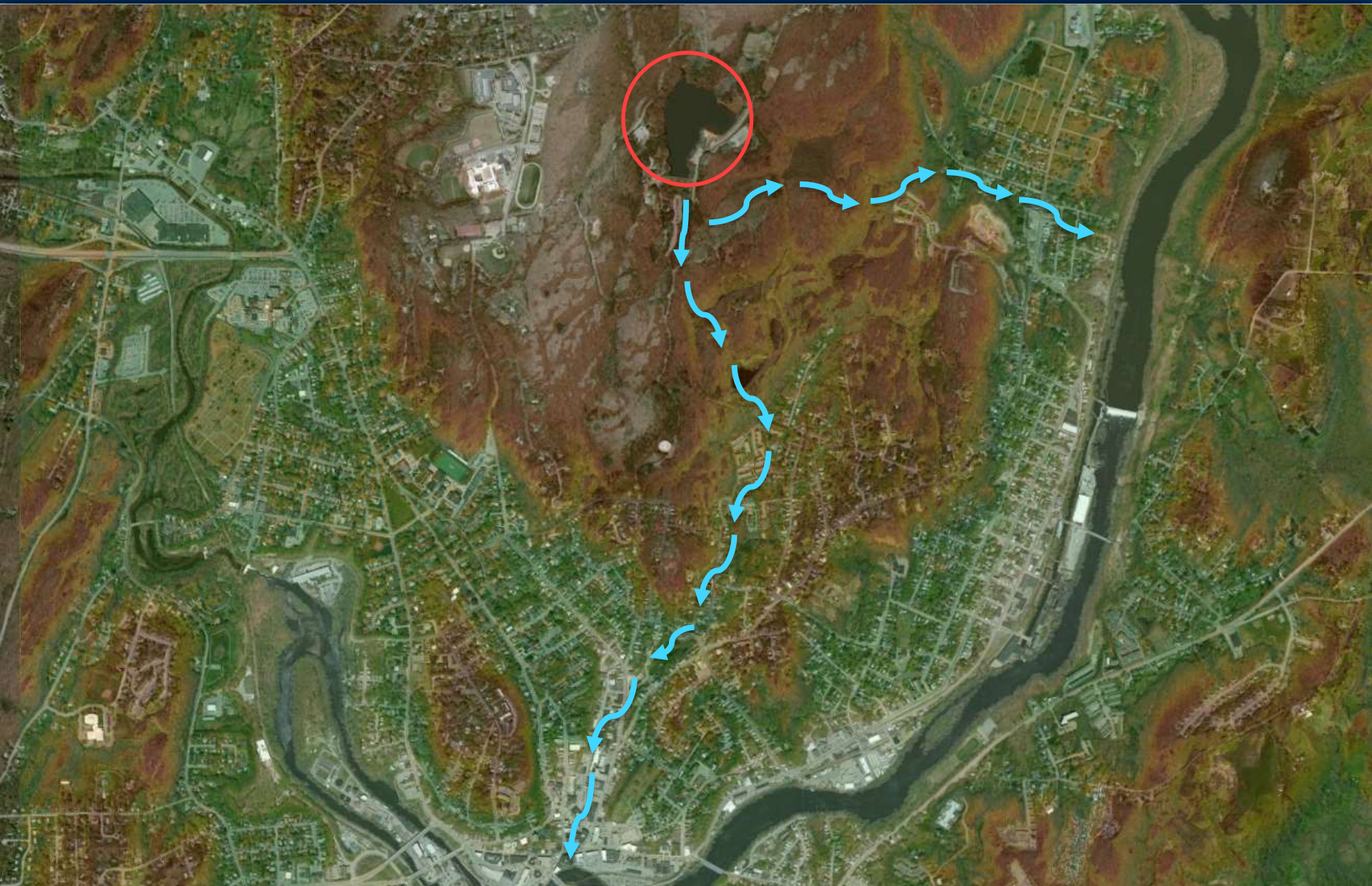


Methods to Model Buildings

Dam Breach Analysis of Spaulding Reservoir



Methods to Model Buildings (Cont'd)

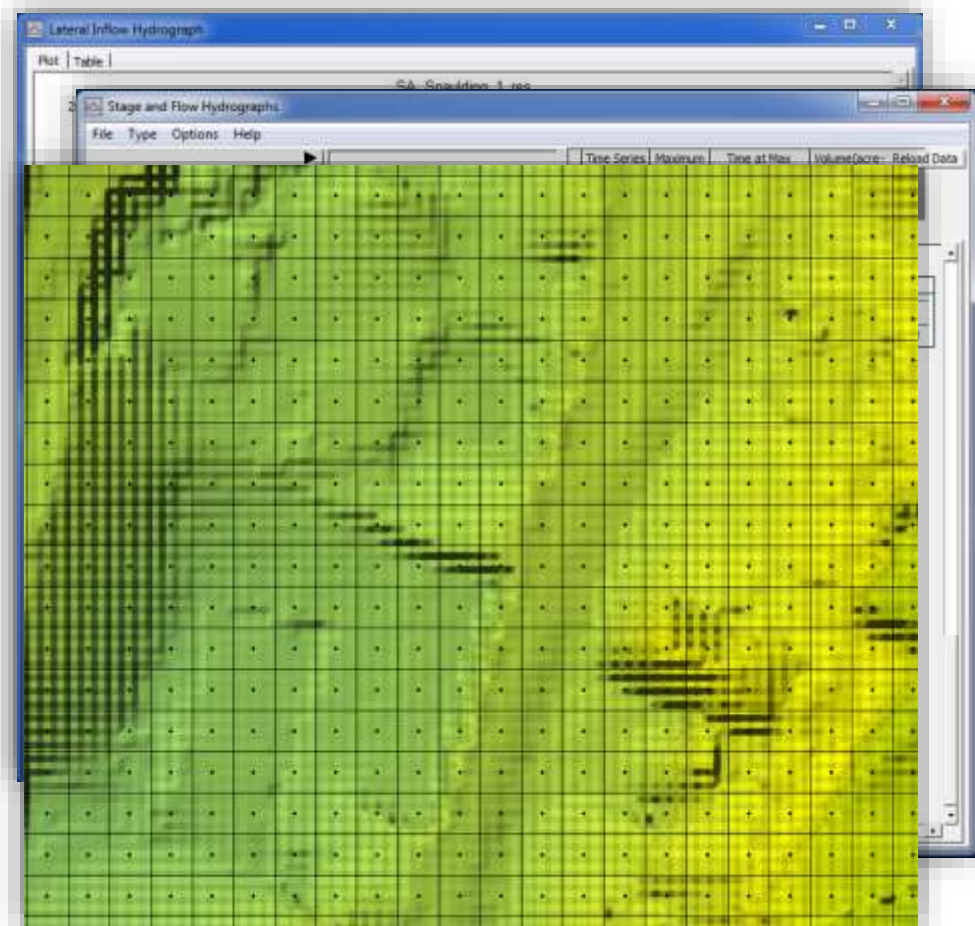


Methods to Model Buildings (Cont'd)

Dam Breach Analysis of Spaulding Reservoir

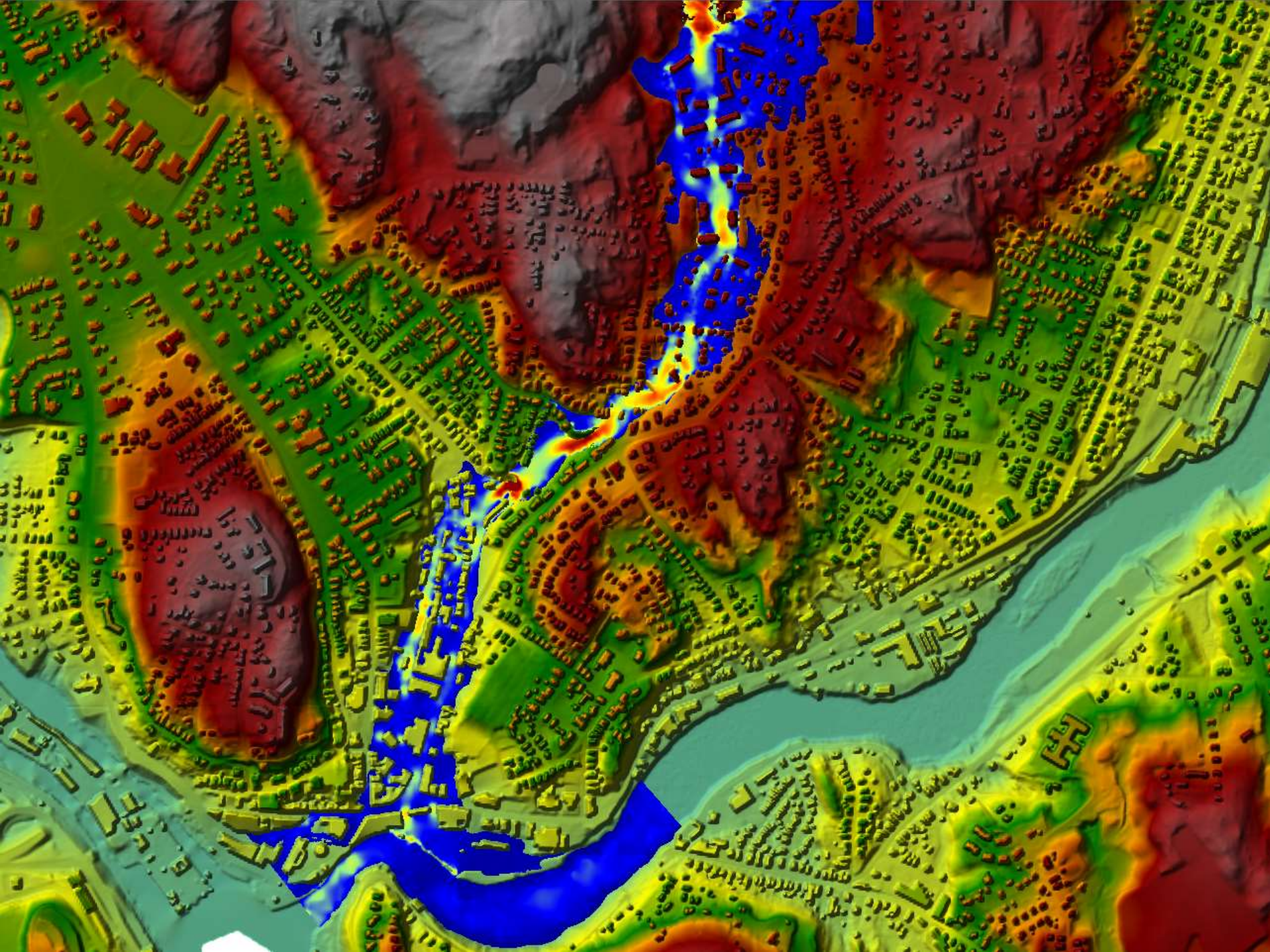
Model Characteristics

- ***HEC-RAS 2D Modeling***
- ***100-year 6-hour rainfall event***
- ***Peak Breach Discharge:
12,500 cfs***
- ***20-foot cell size***
- ***Full Momentum Equations***

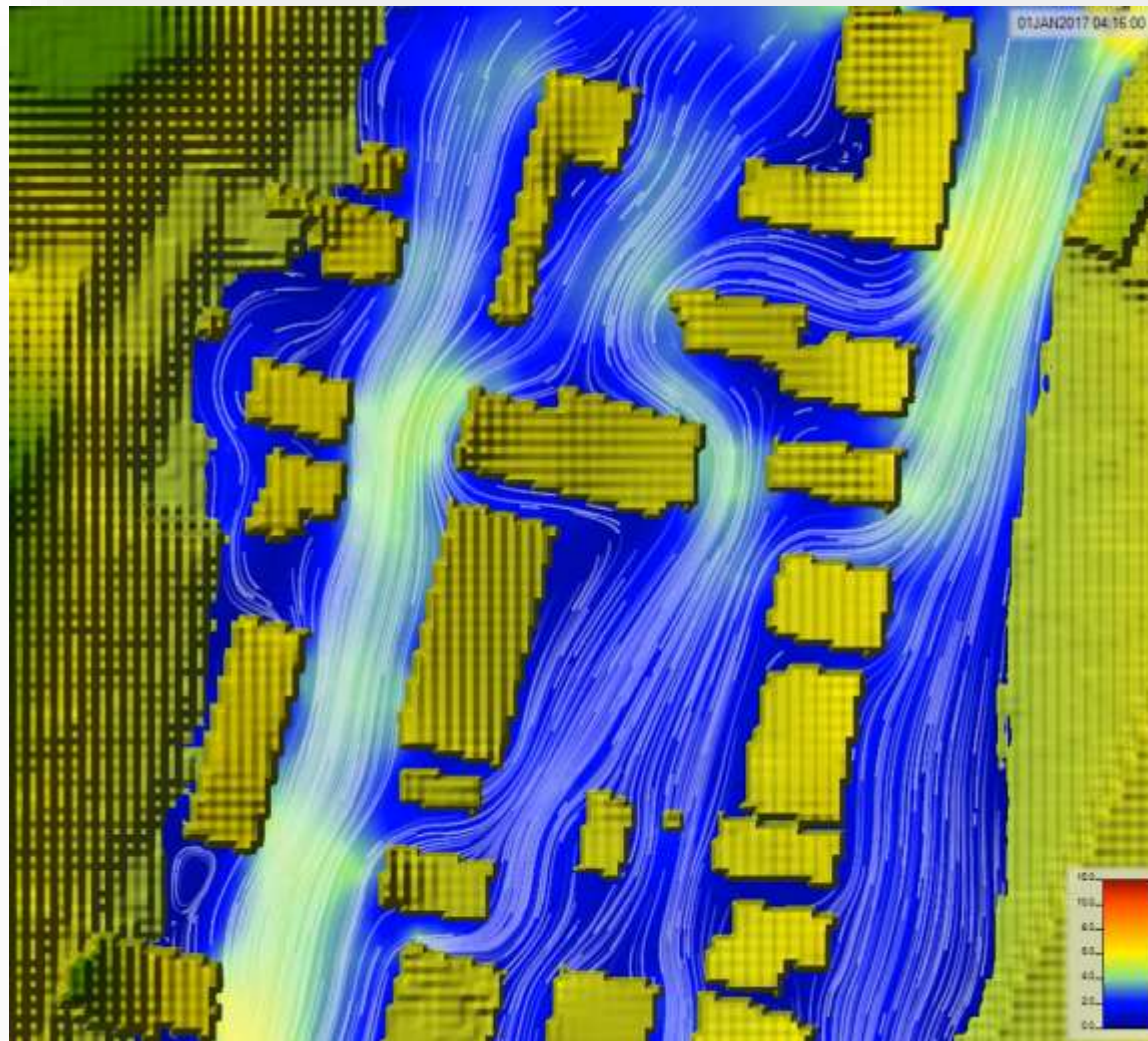


Methods to Model Buildings (Cont'd)

Method 1: Incorporate Buildings into DEM



Method 1 – Incorporate Buildings into DEM



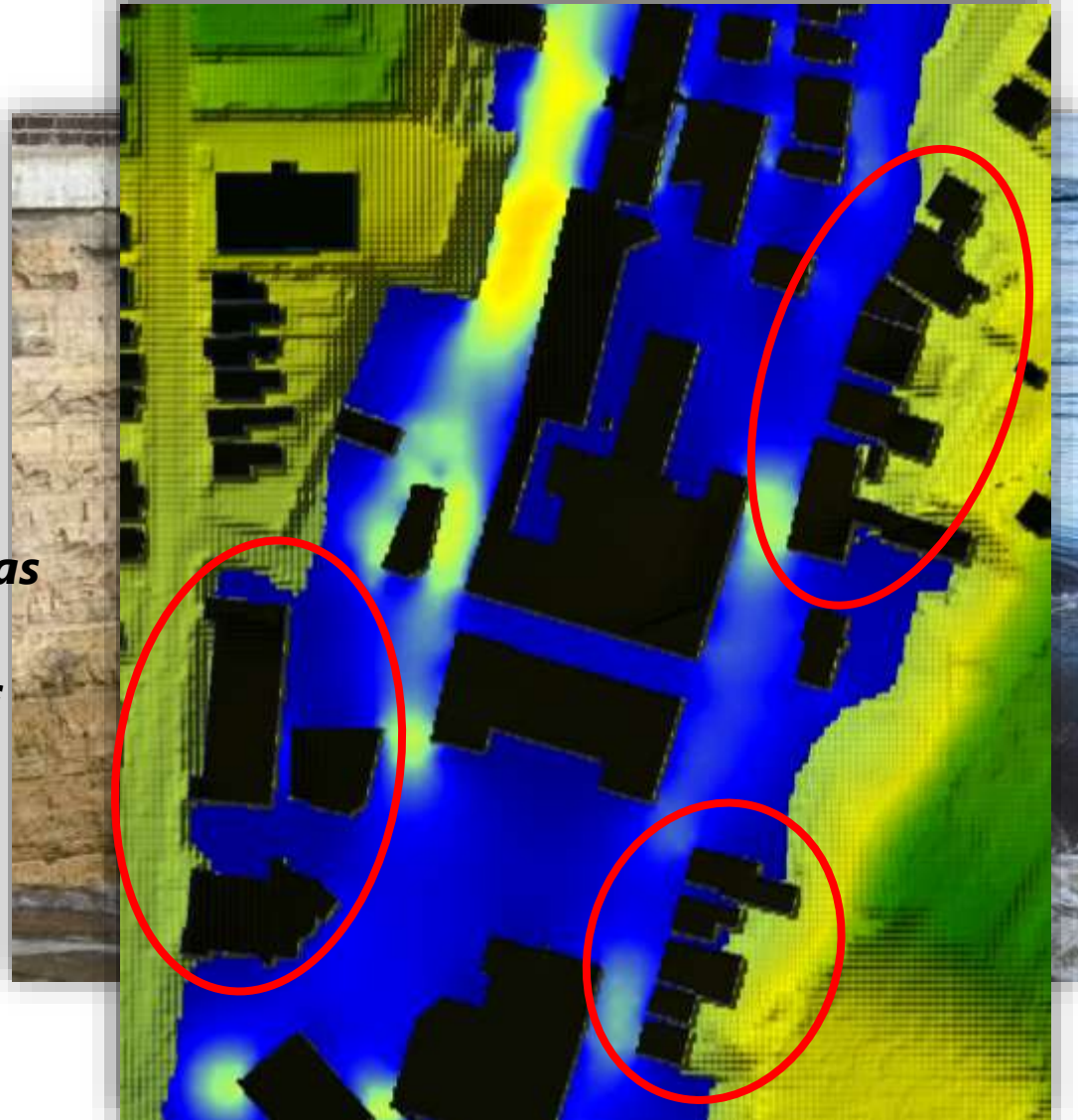
Method 1 – Incorporate Buildings into DEM (Cont'd)

Advantages

- *More conservative result*

Disadvantages

- *Assumes no water enters buildings*
- *“Holes” in the inundated areas*
- *Inaccuracies around edges of inundated areas*



Methods to Model Buildings (Cont'd)

Method 2: Adjust Manning's n Value

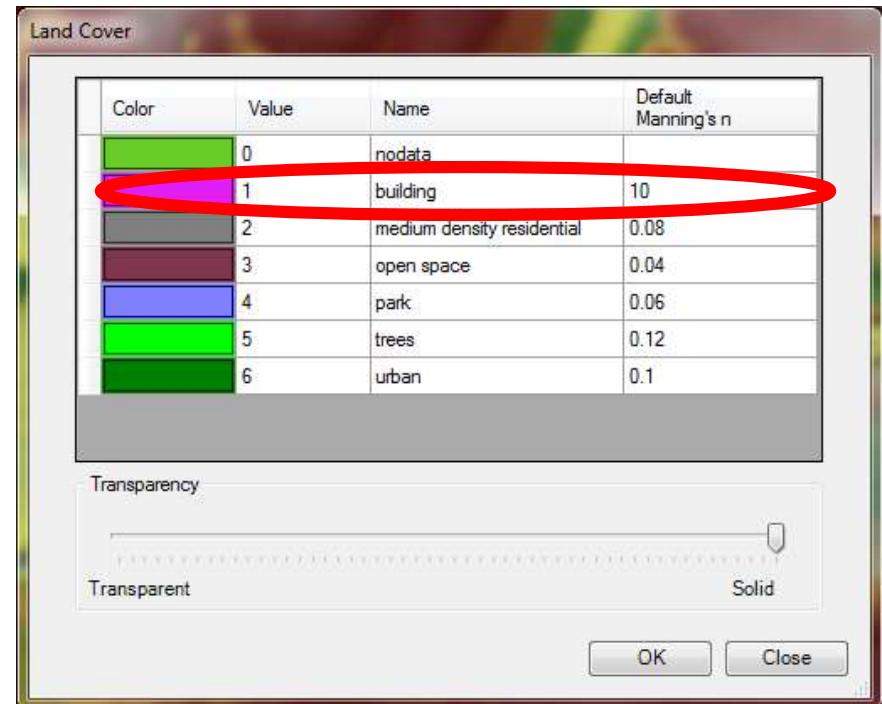


Method 2 – Adjust Manning's n Value

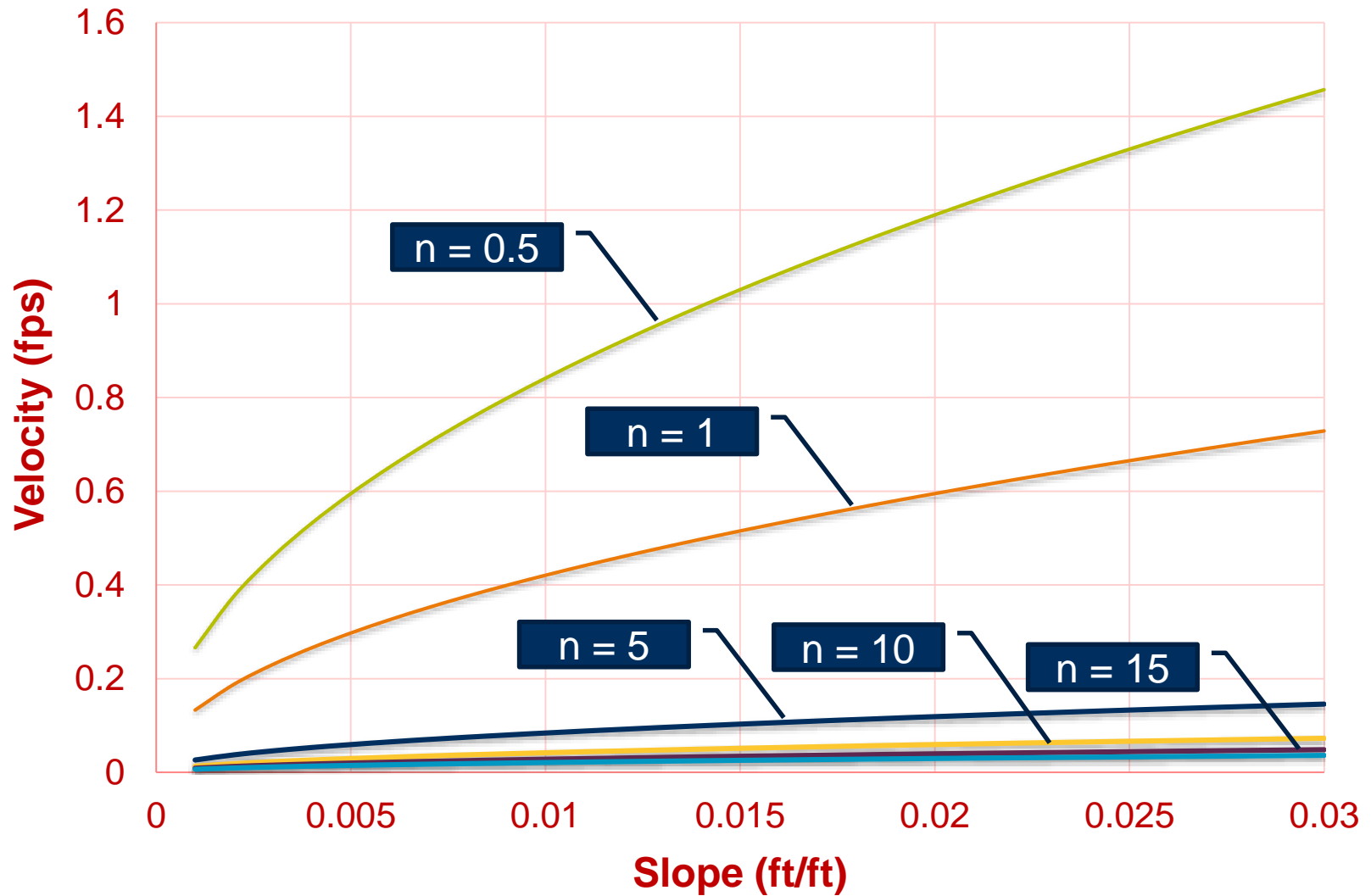
What Manning's n value to use?

To account for structures, observed Manning's n values ranged from 0.08 to 20.

-W.J. Syme



Method 2 – Adjust Manning's n Value (Cont'd)



Method 2 – Adjust Manning's n Value (Cont'd)

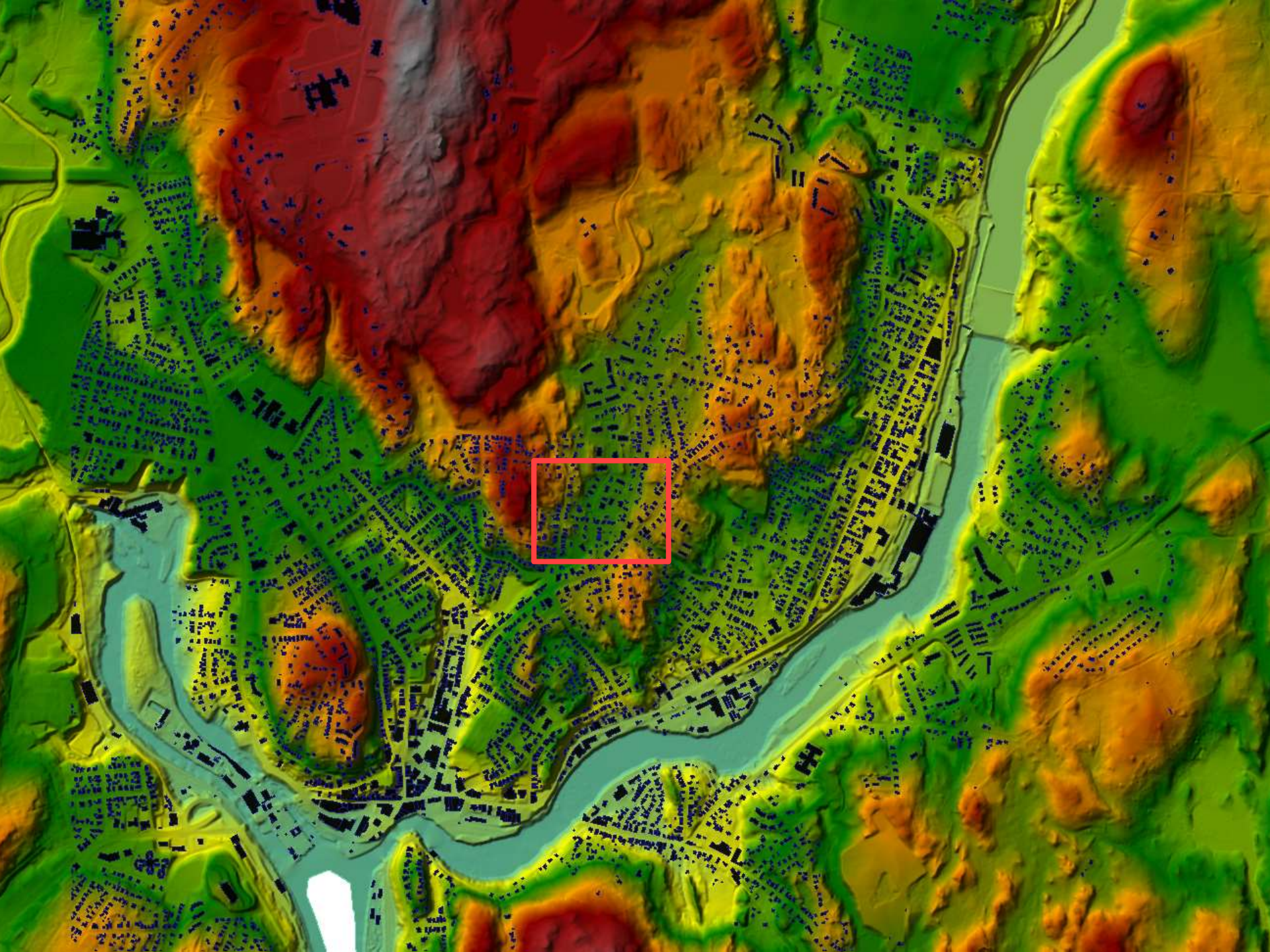


Building Manning's $n = 1$

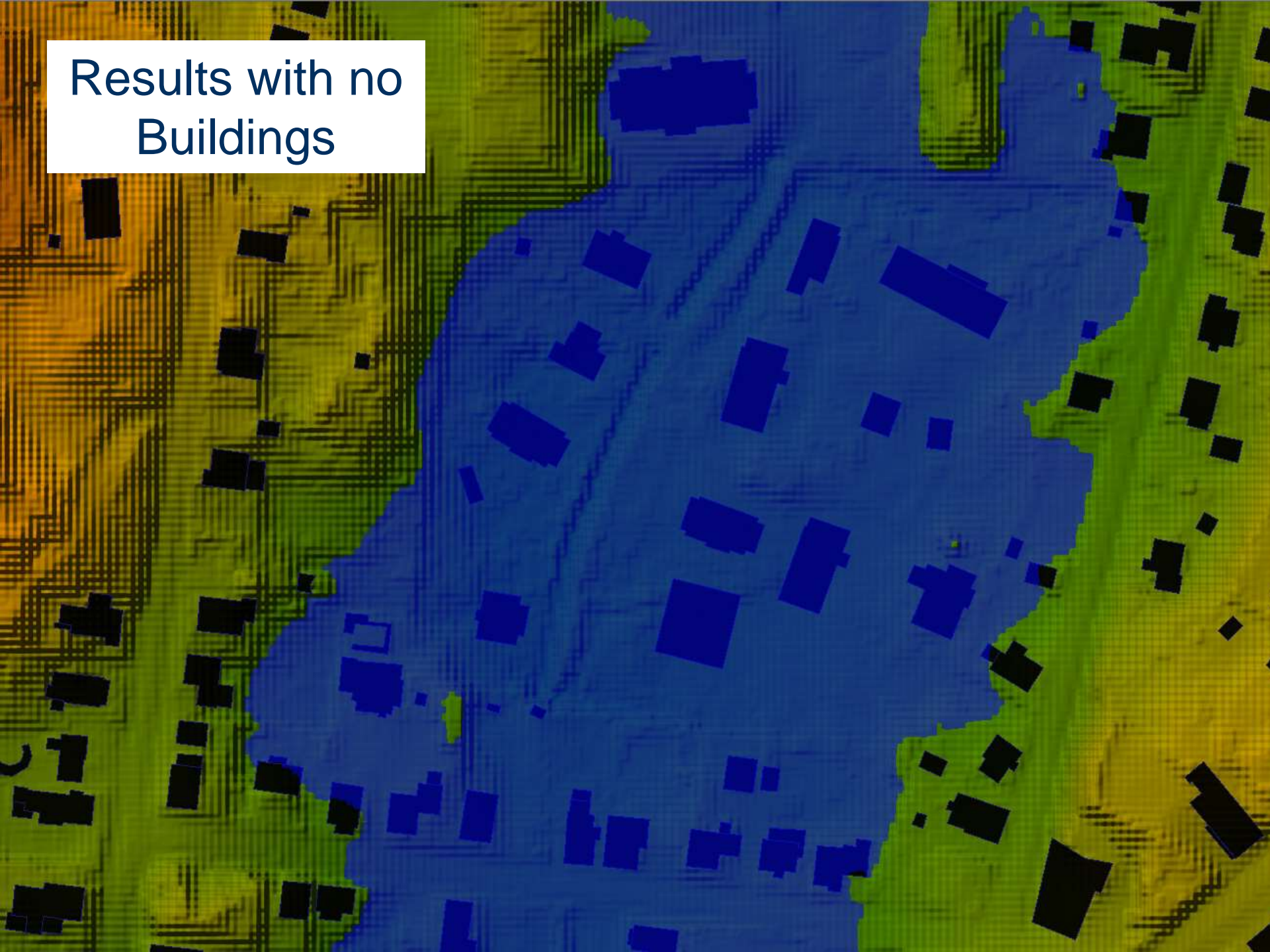


Building Manning's $n = 20$

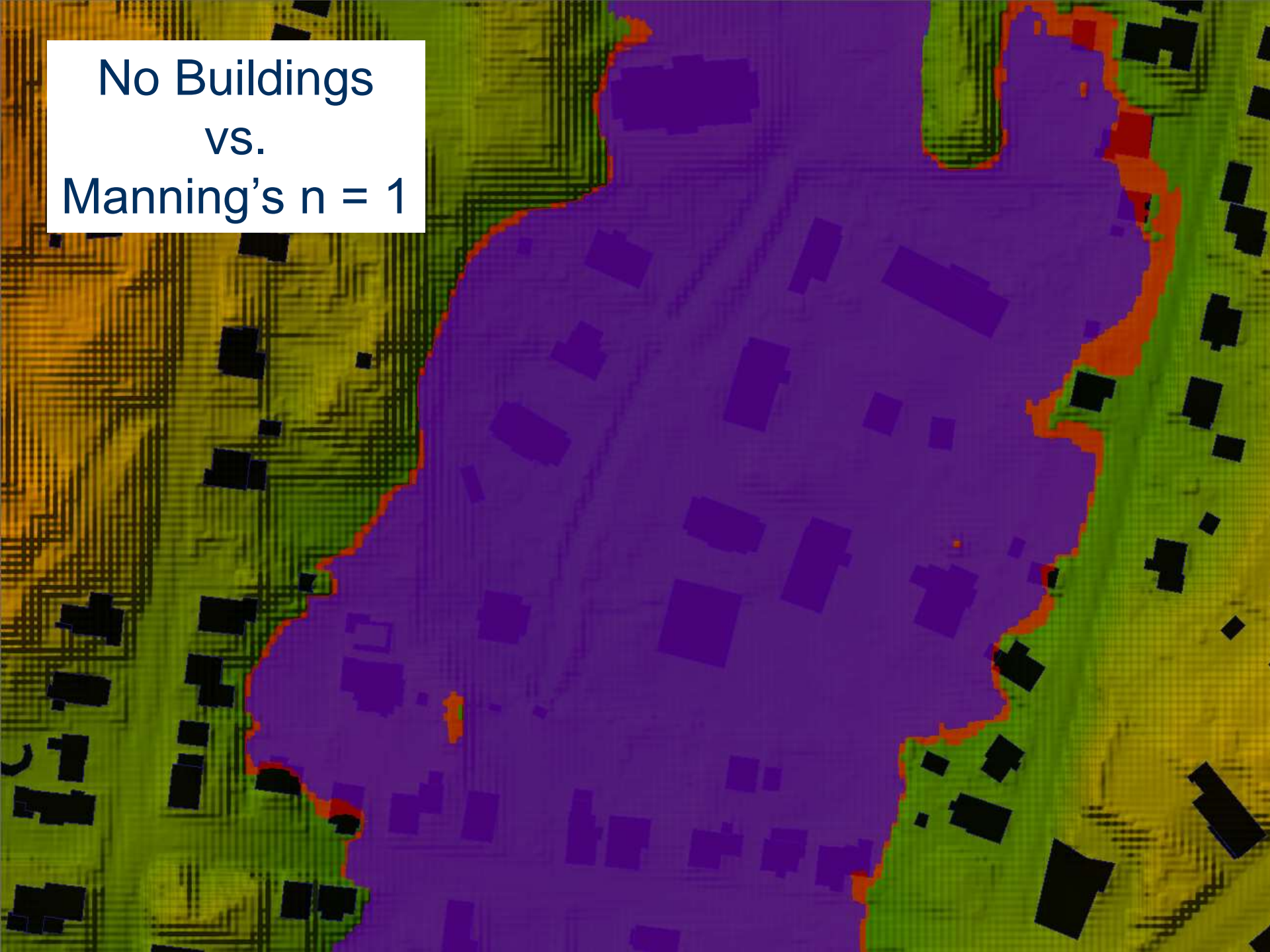
COMPARING RESULTS



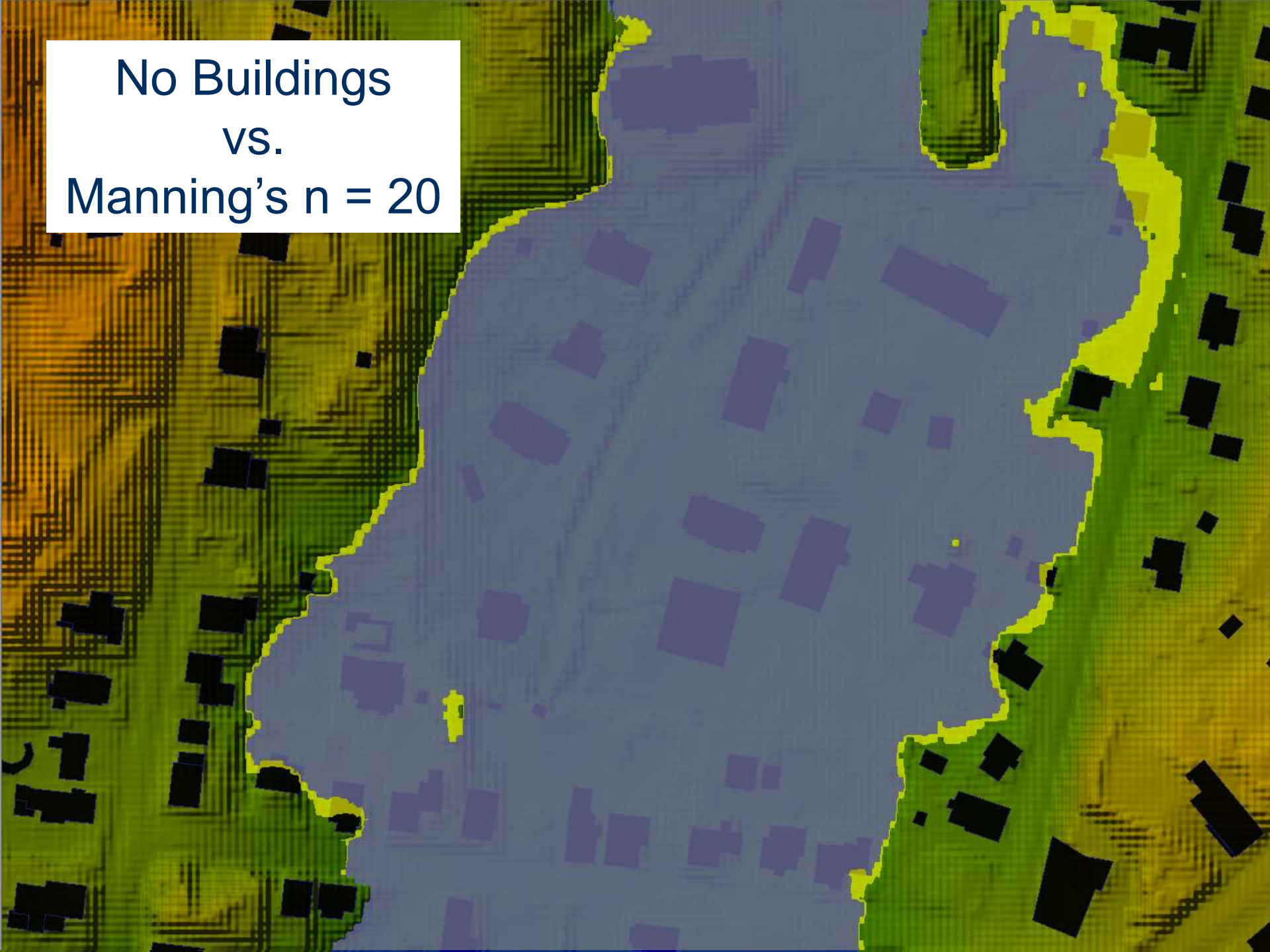
Results with no
Buildings



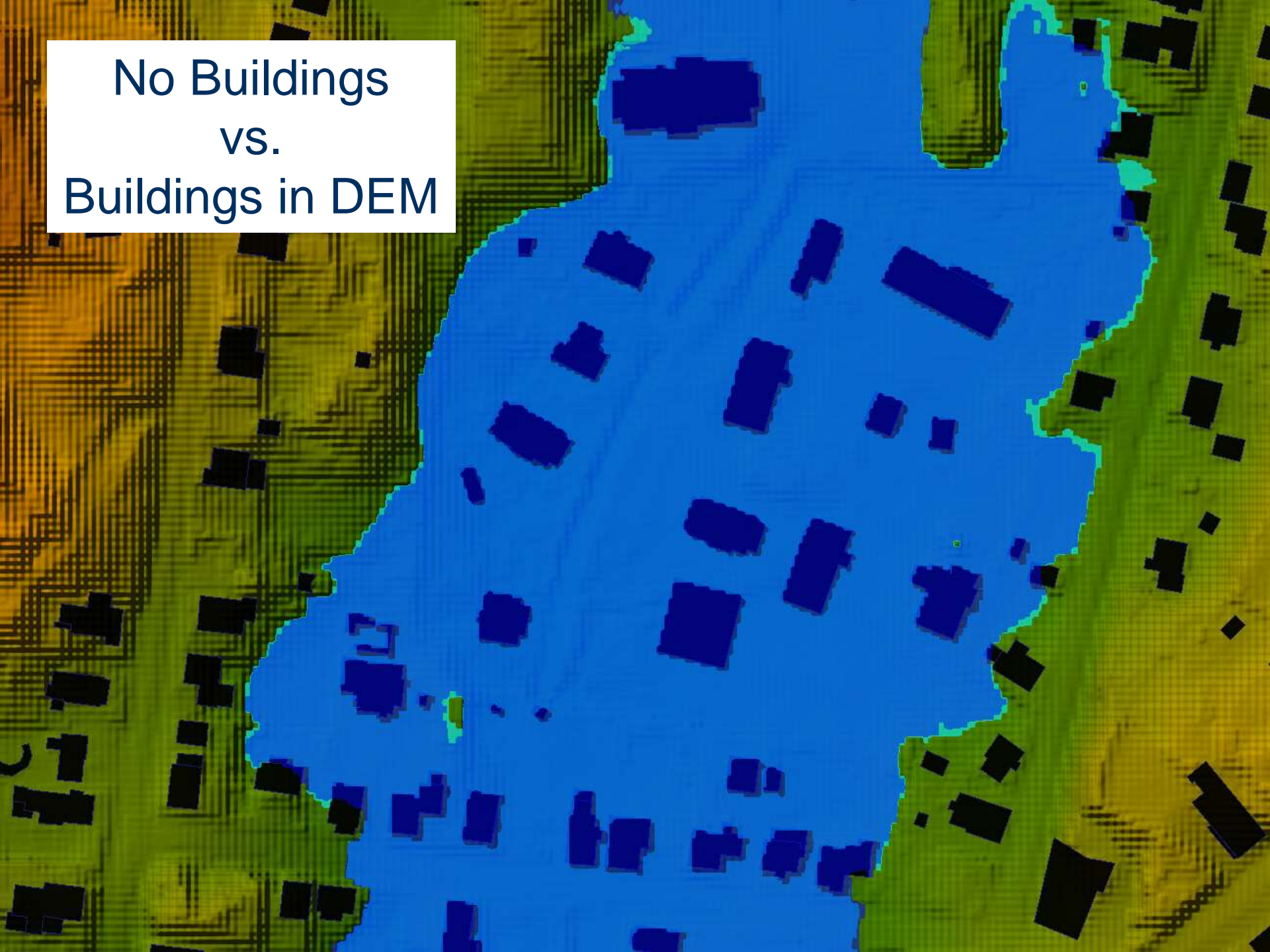
No Buildings
vs.
Manning's $n = 1$

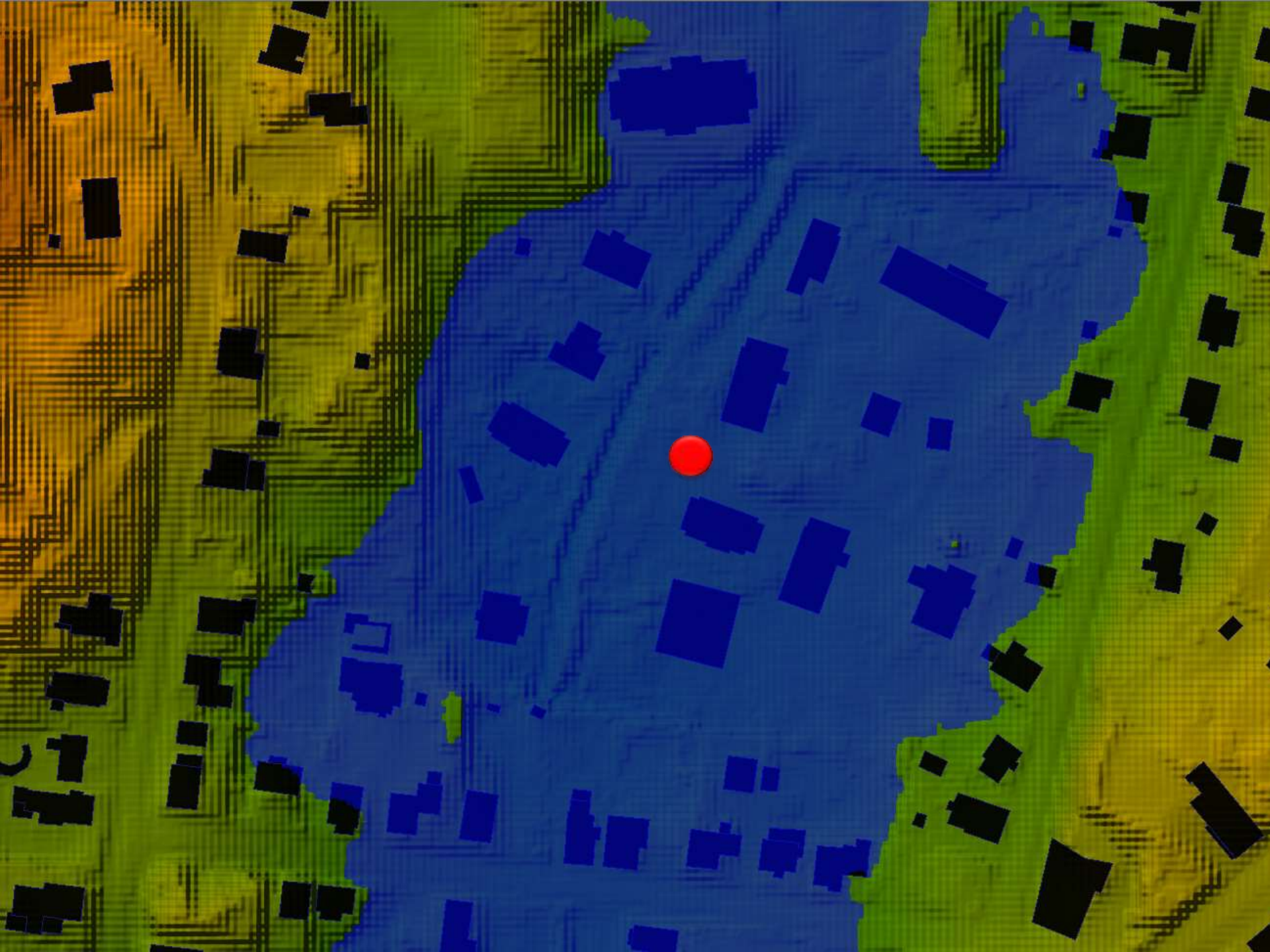


No Buildings
vs.
Manning's $n = 20$

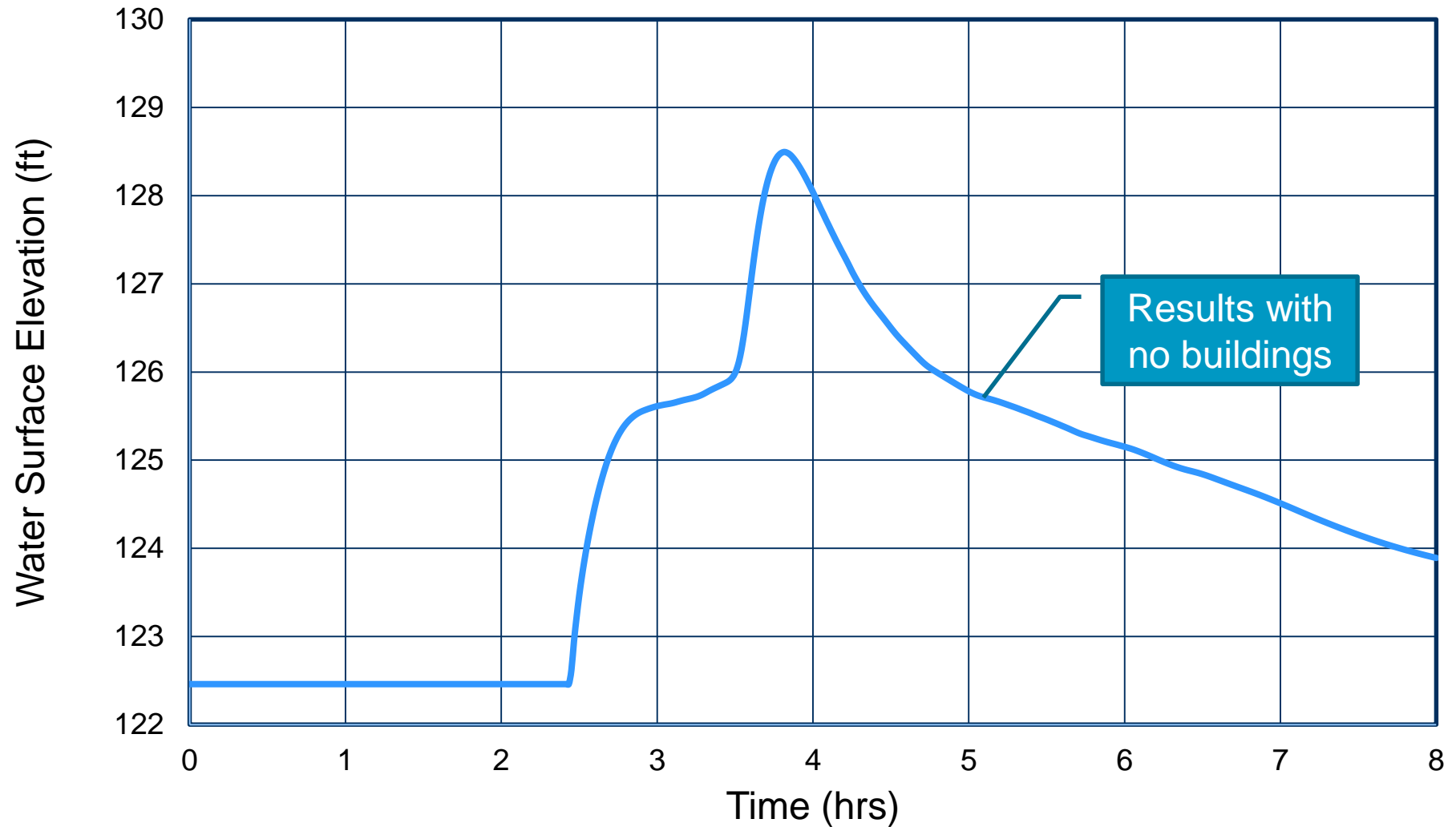


No Buildings
vs.
Buildings in DEM

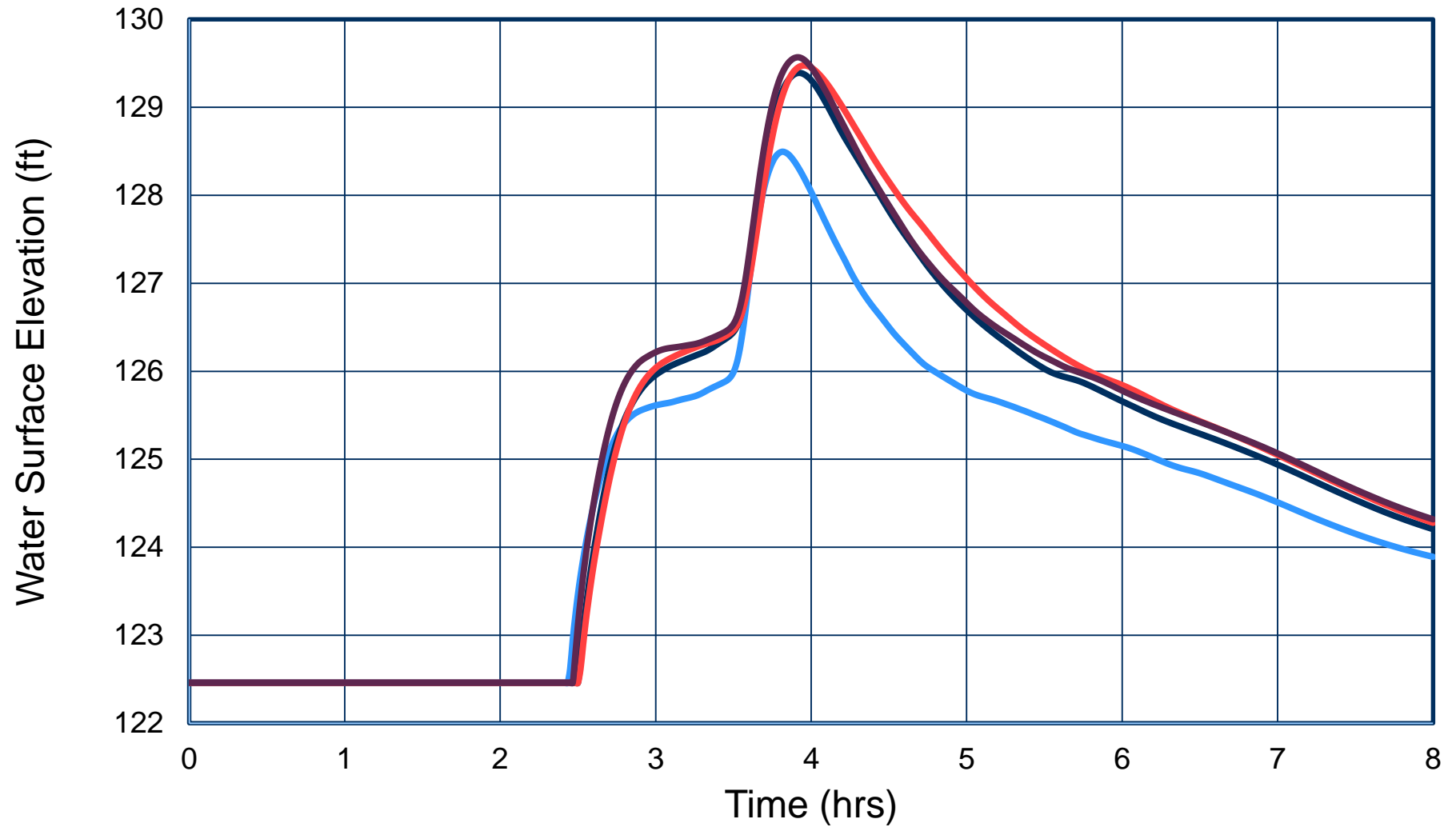


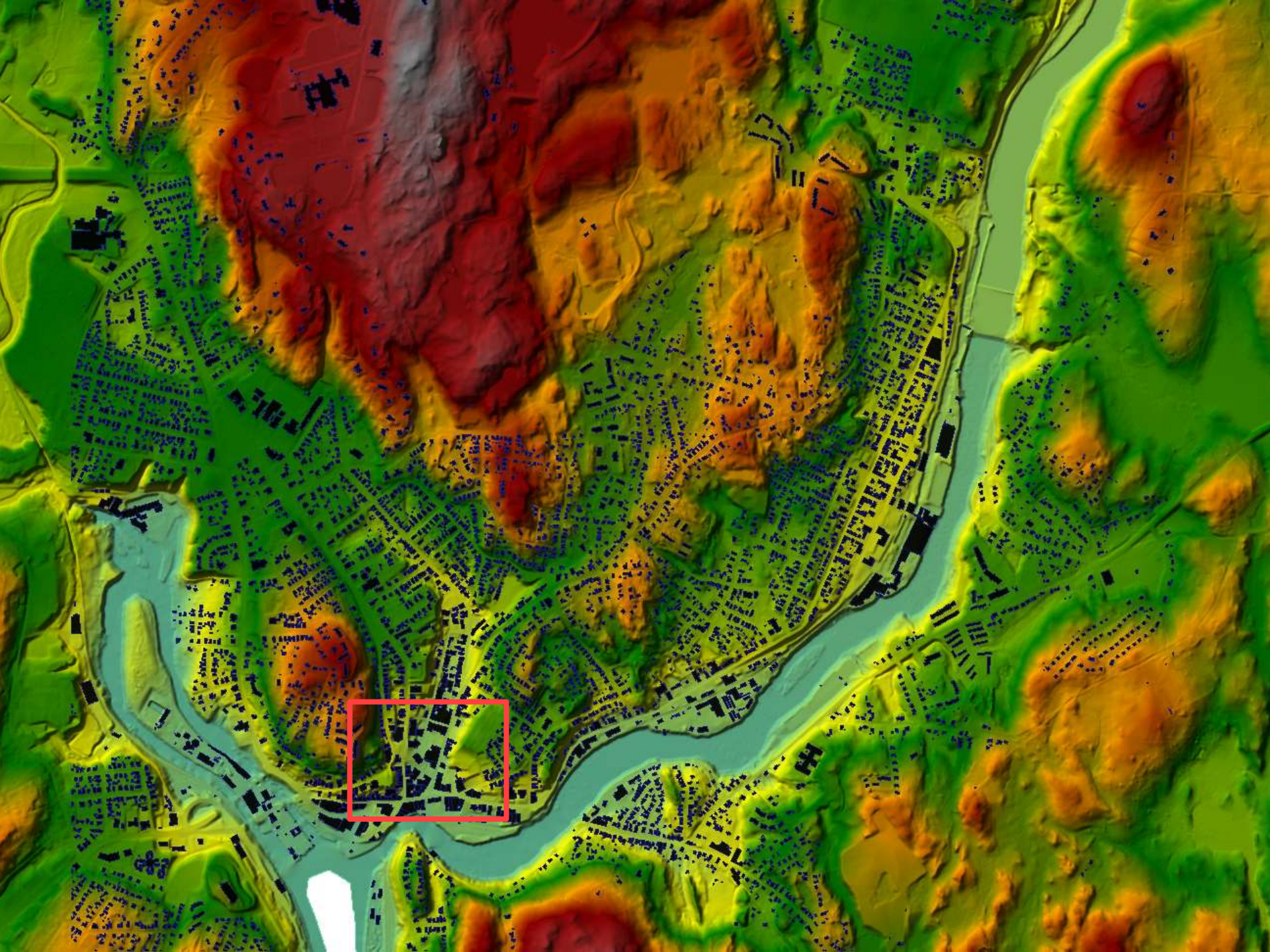


Comparing Results (Cont'd)



Comparing Results (Cont'd)





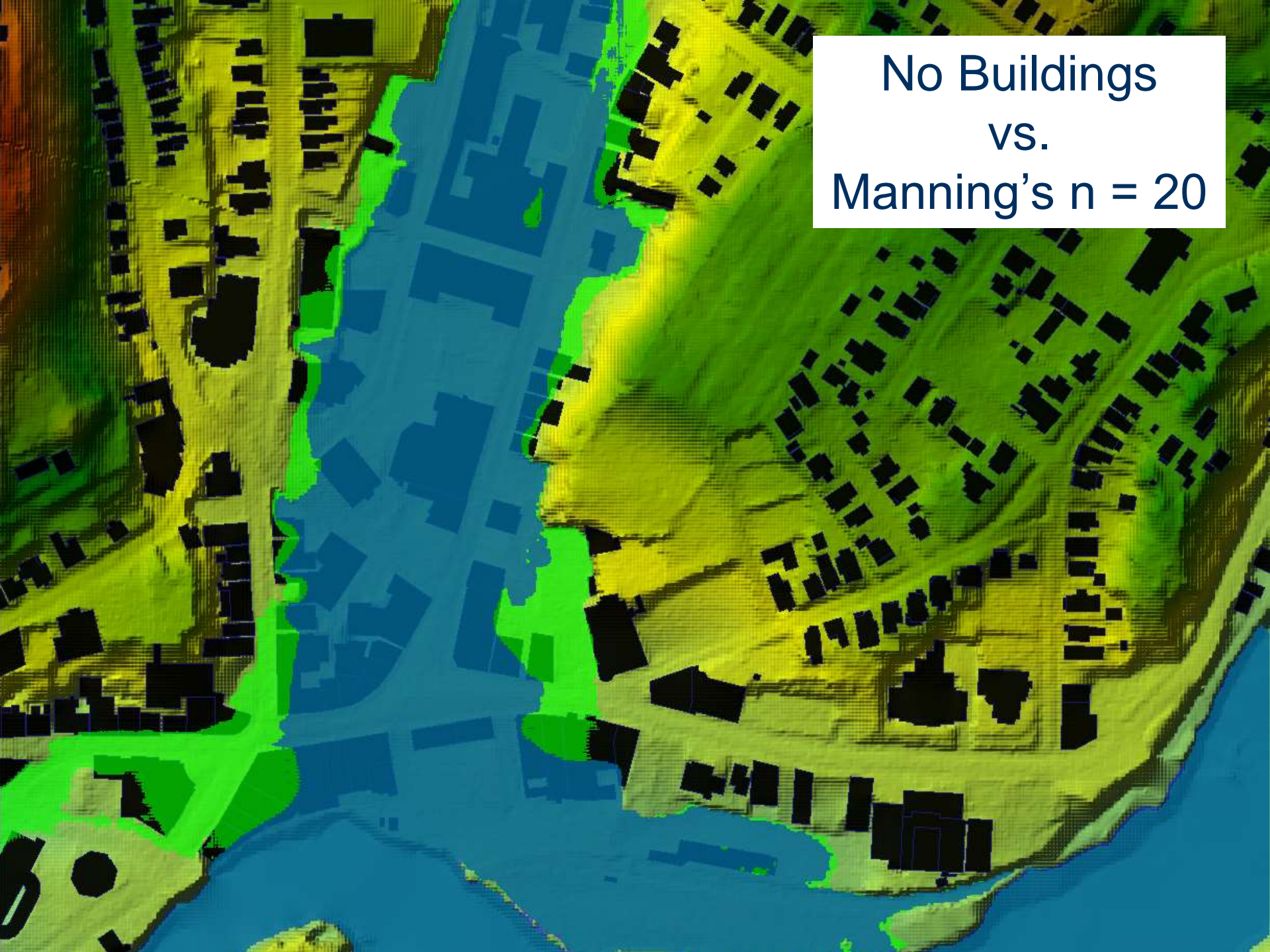
Results with no
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No Buildings
vs.
Manning's $n = 1$

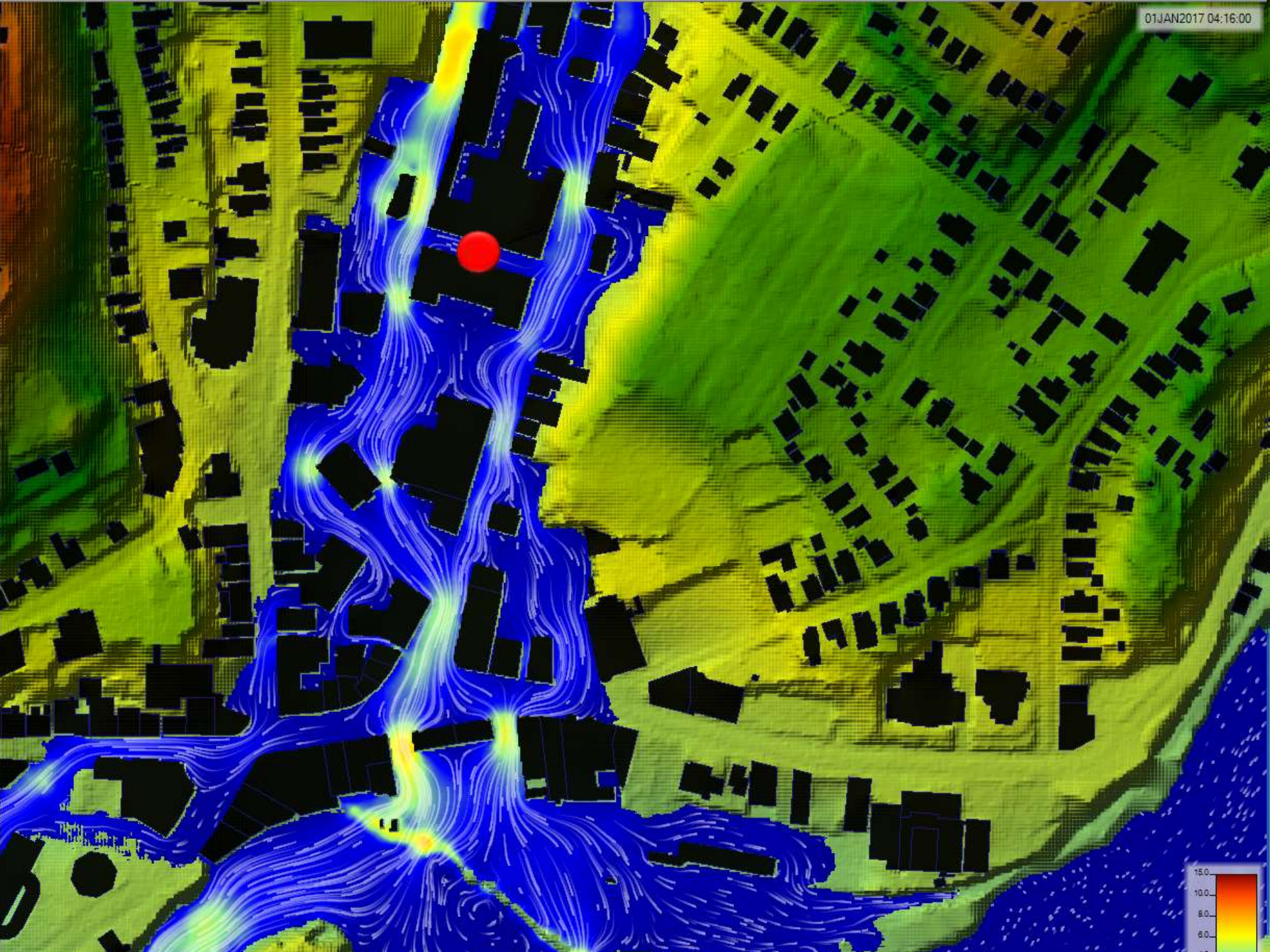


No Buildings
vs.
Manning's $n = 20$

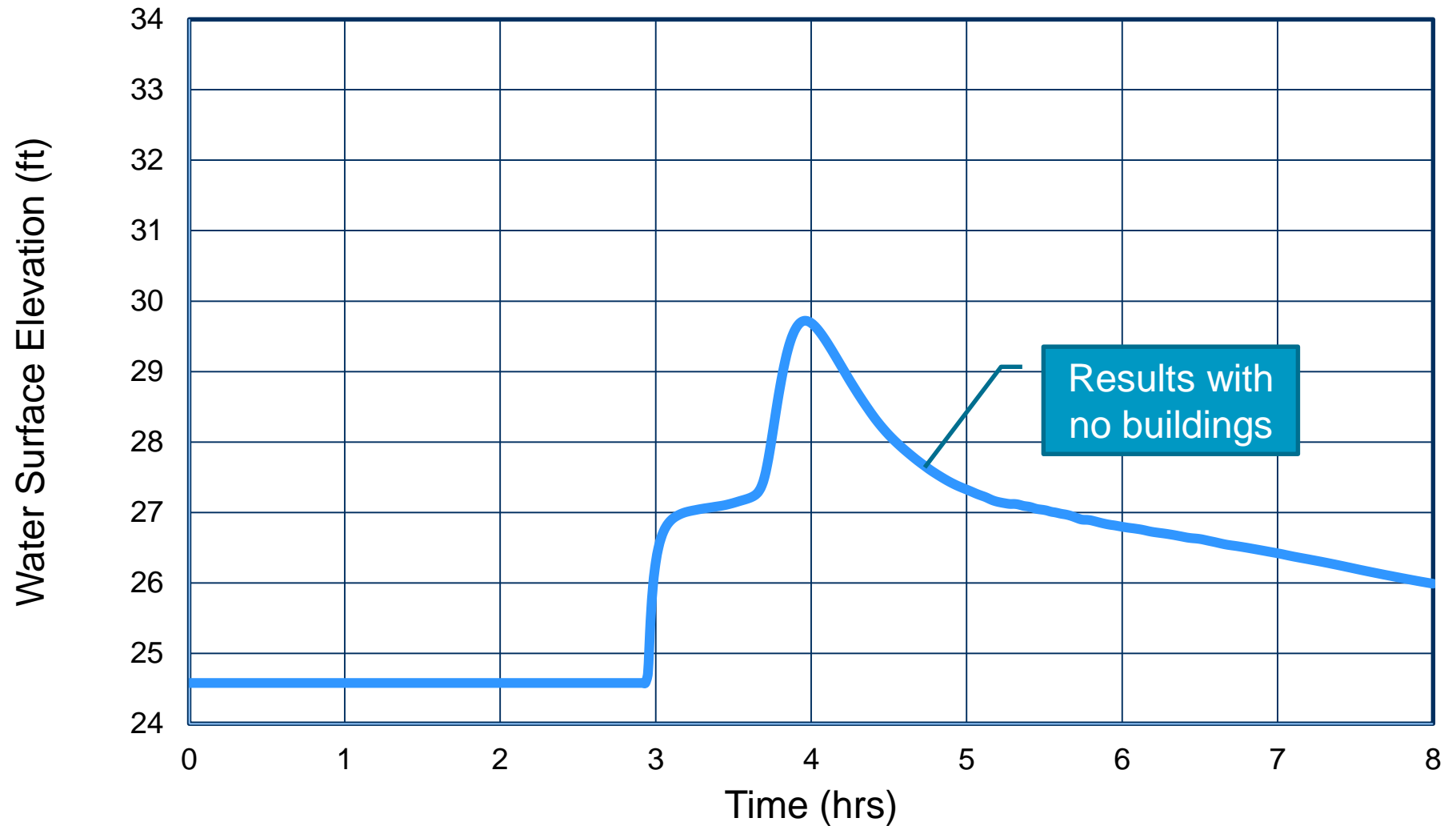


No Buildings
vs.
Buildings in DEM

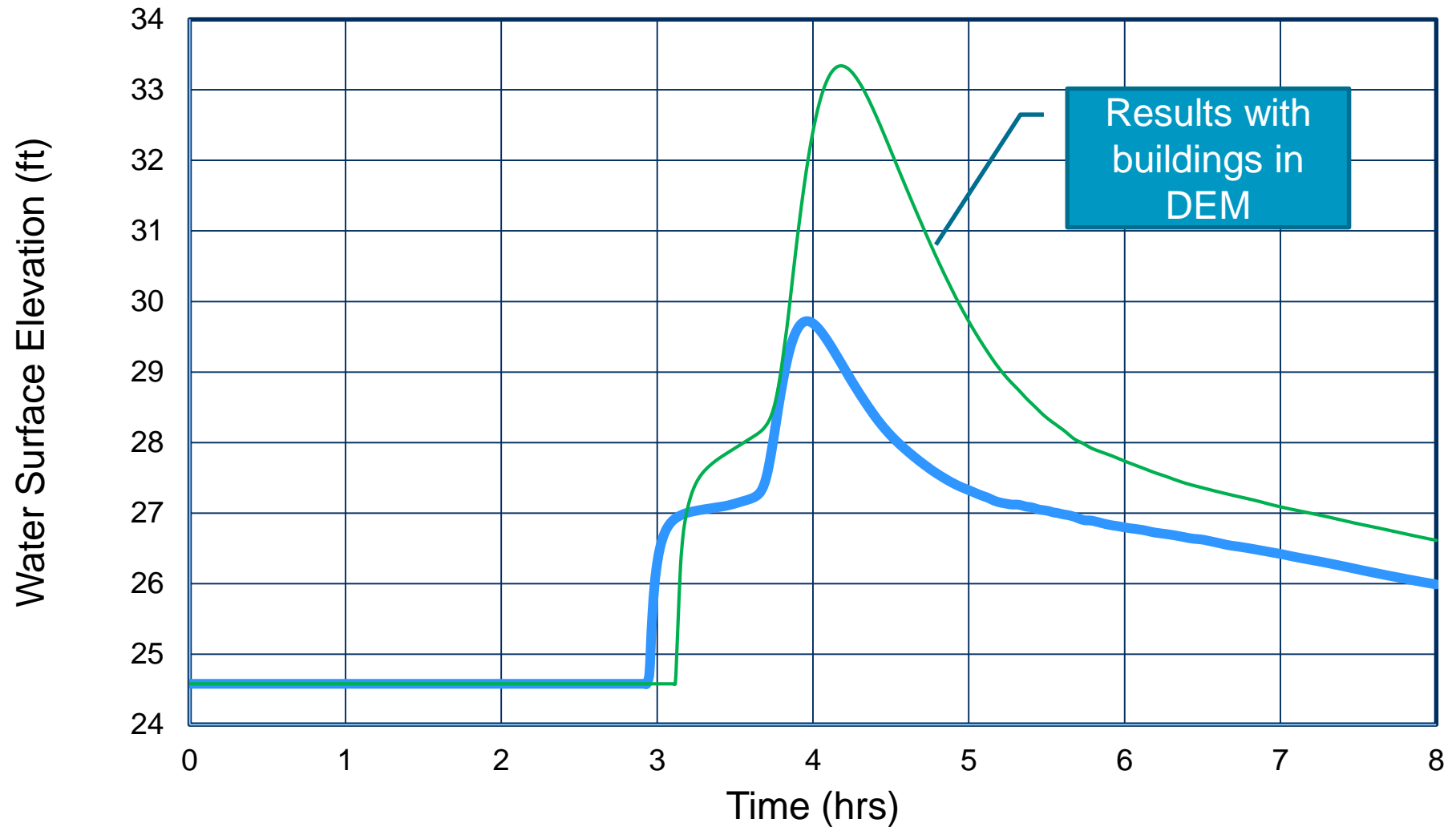




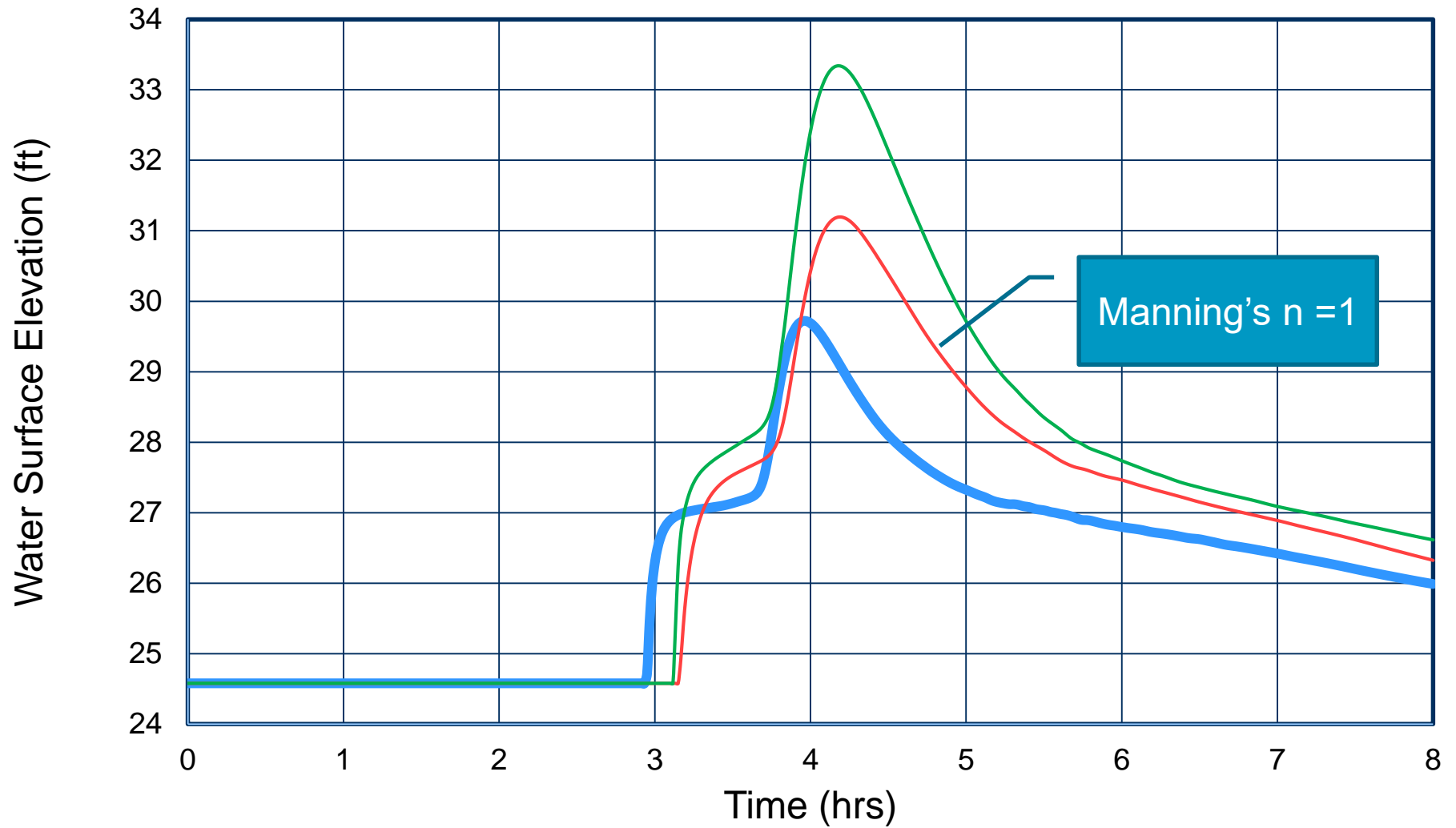
Comparing Results (Cont'd)



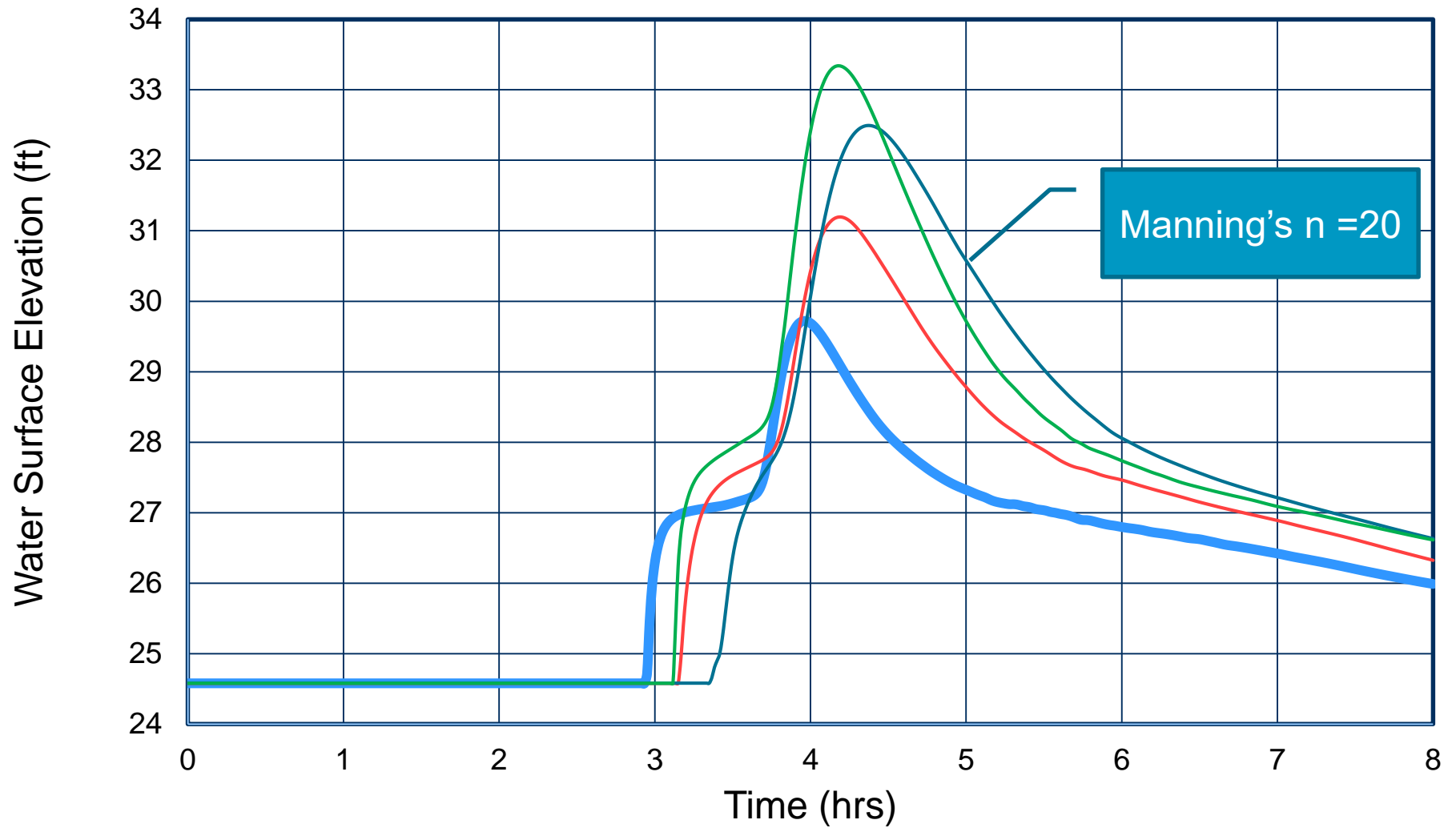
Comparing Results (Cont'd)

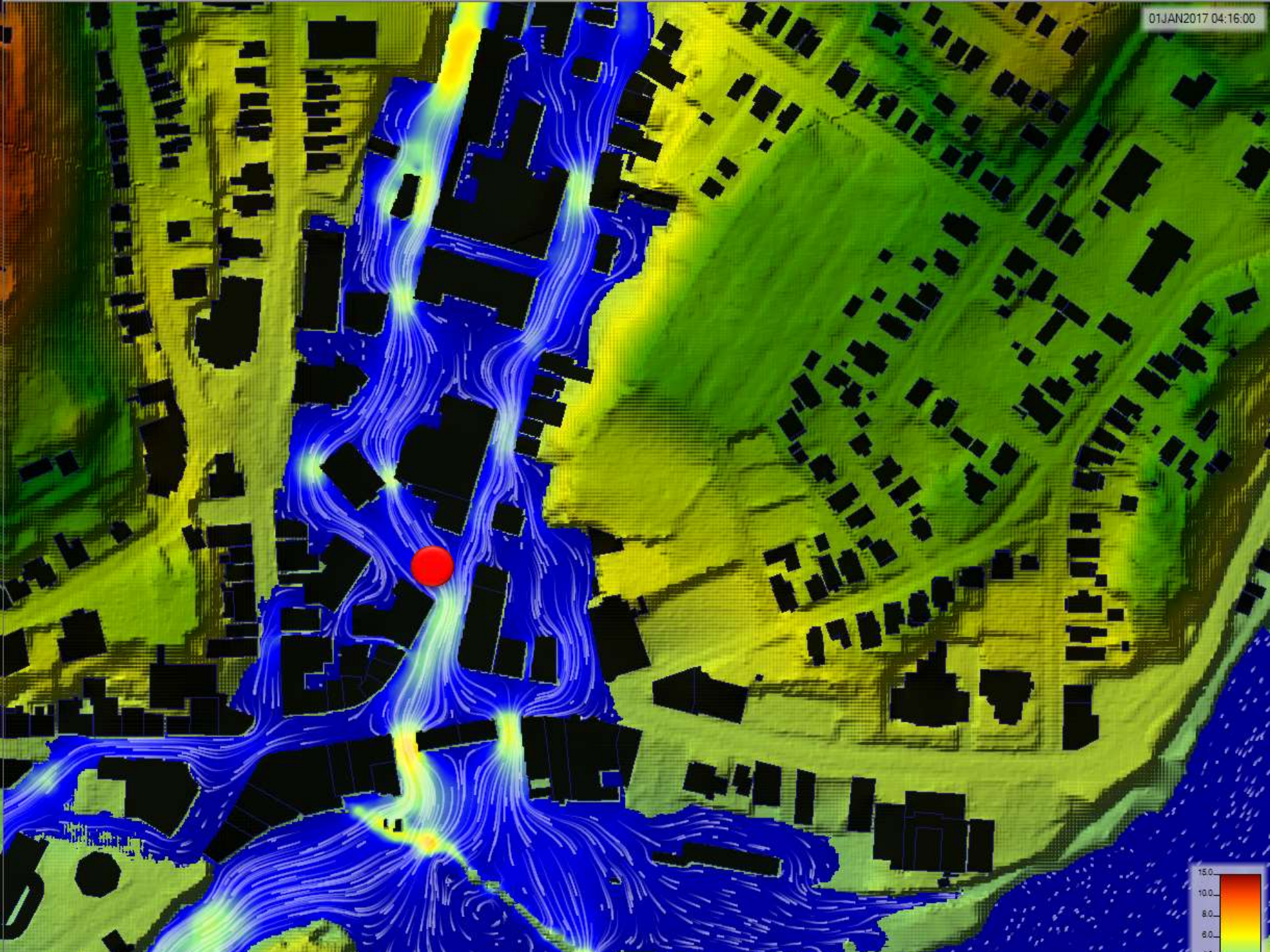


Comparing Results (Cont'd)

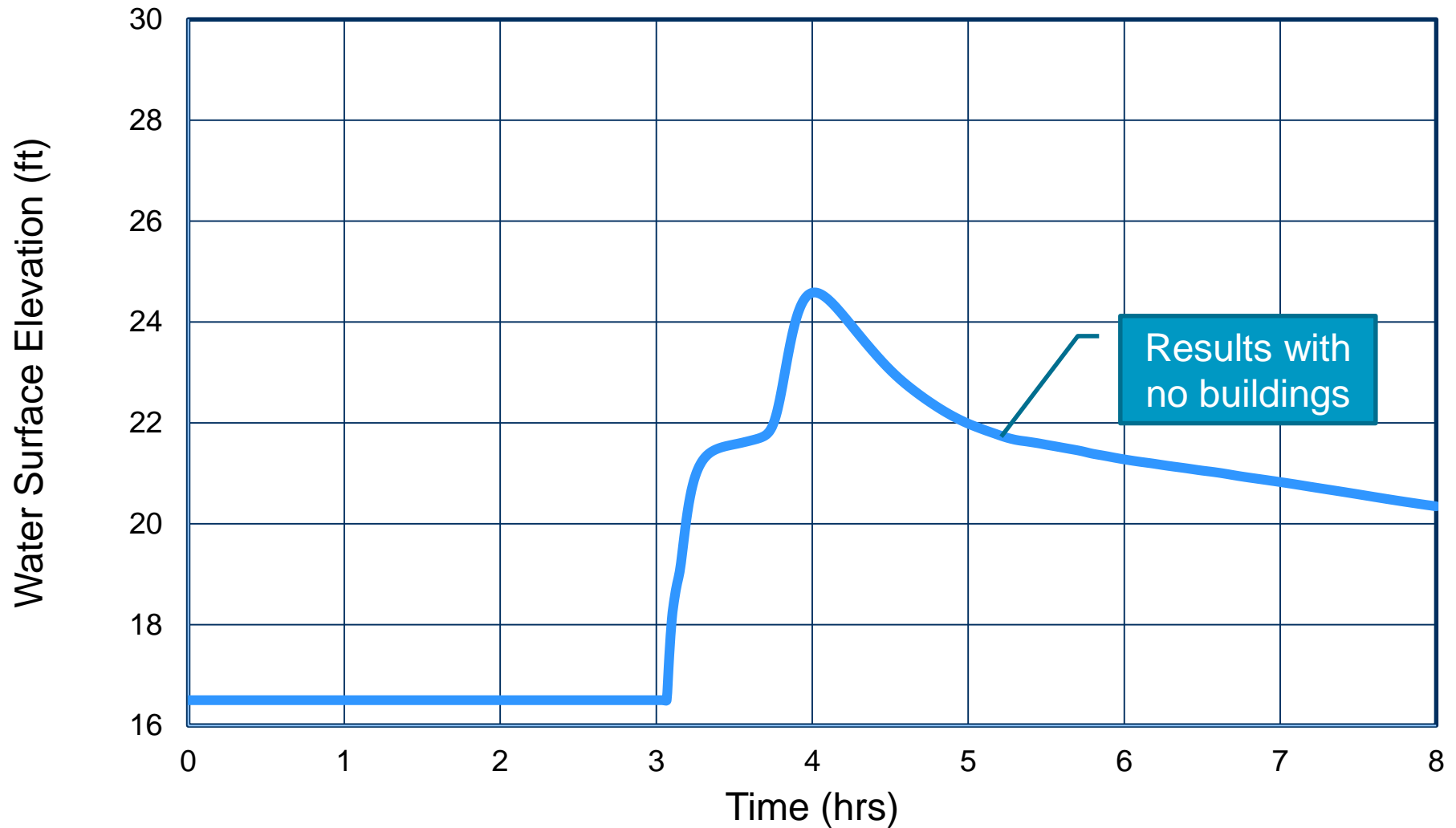


Comparing Results (Cont'd)

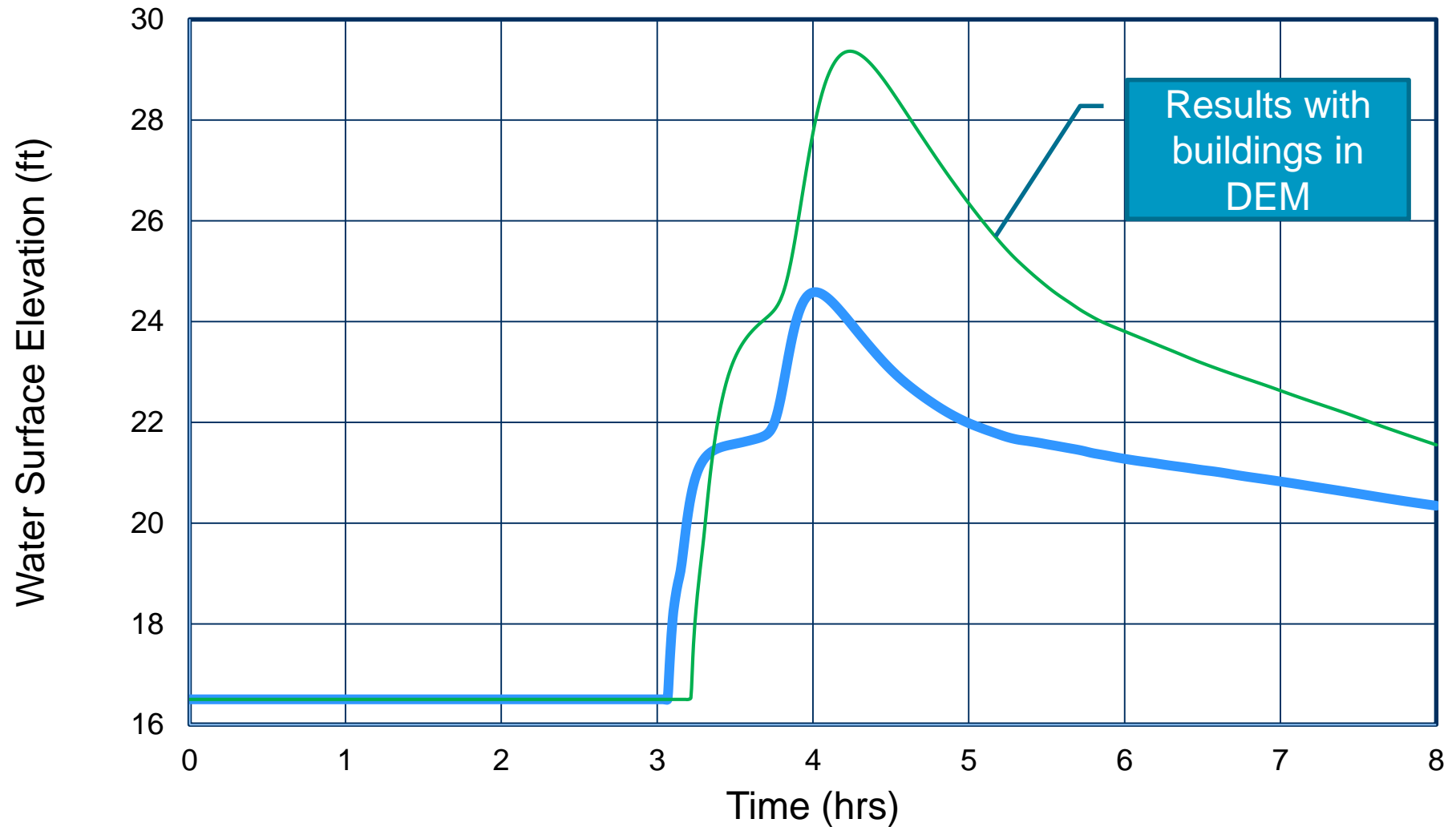




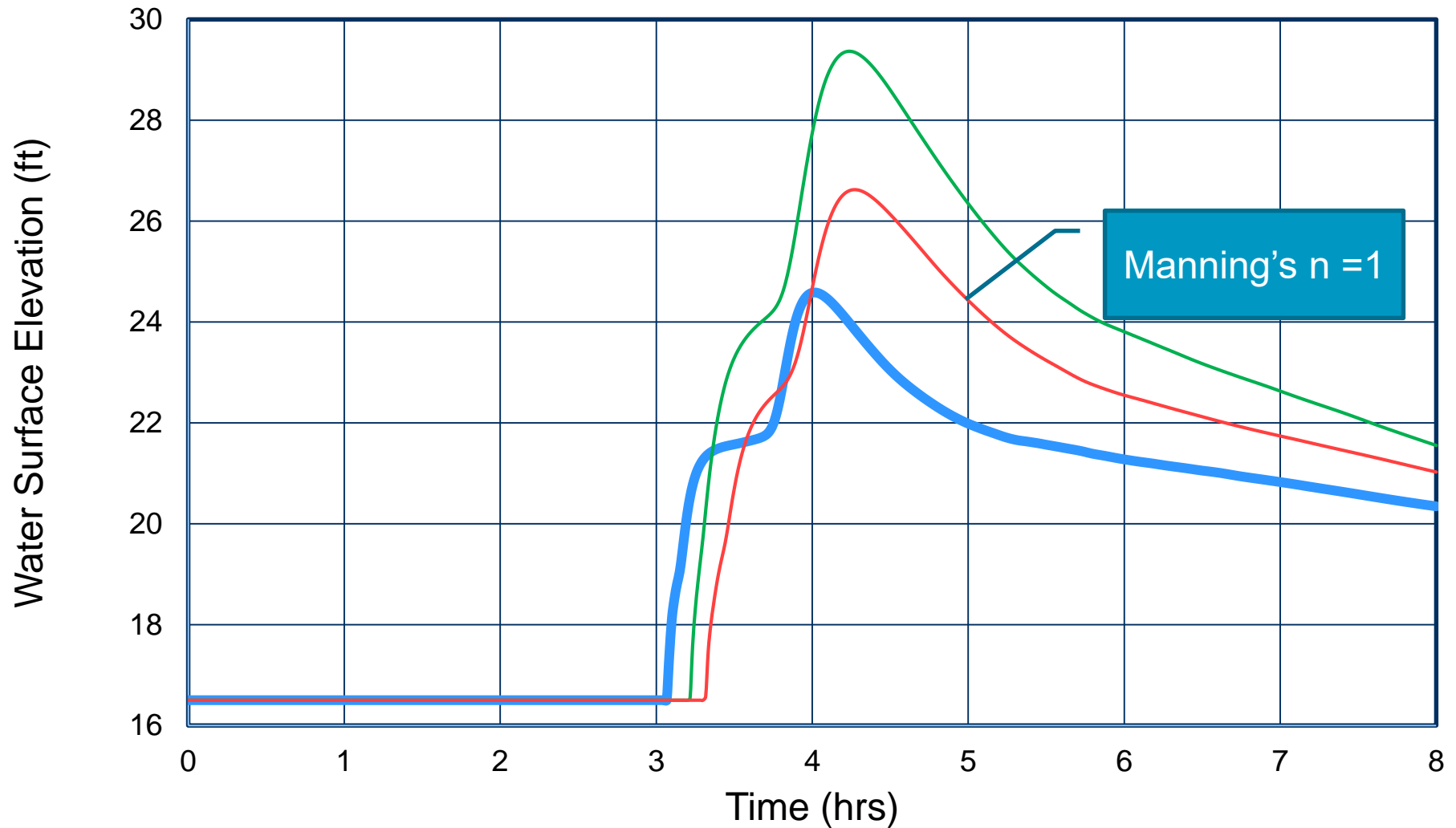
Comparing Results (Cont'd)



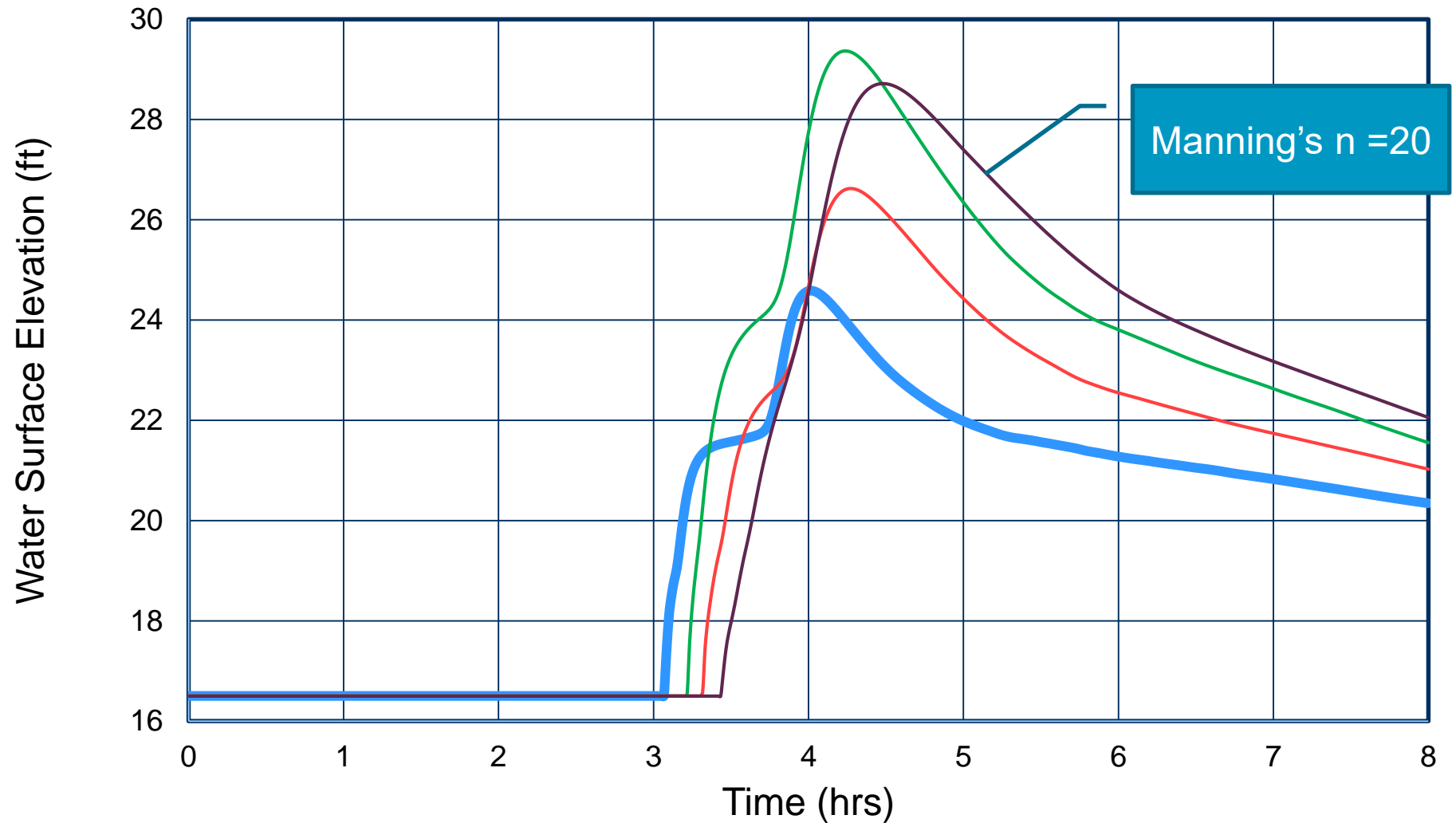
Comparing Results (Cont'd)



Comparing Results (Cont'd)



Comparing Results (Cont'd)





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Thank You!

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