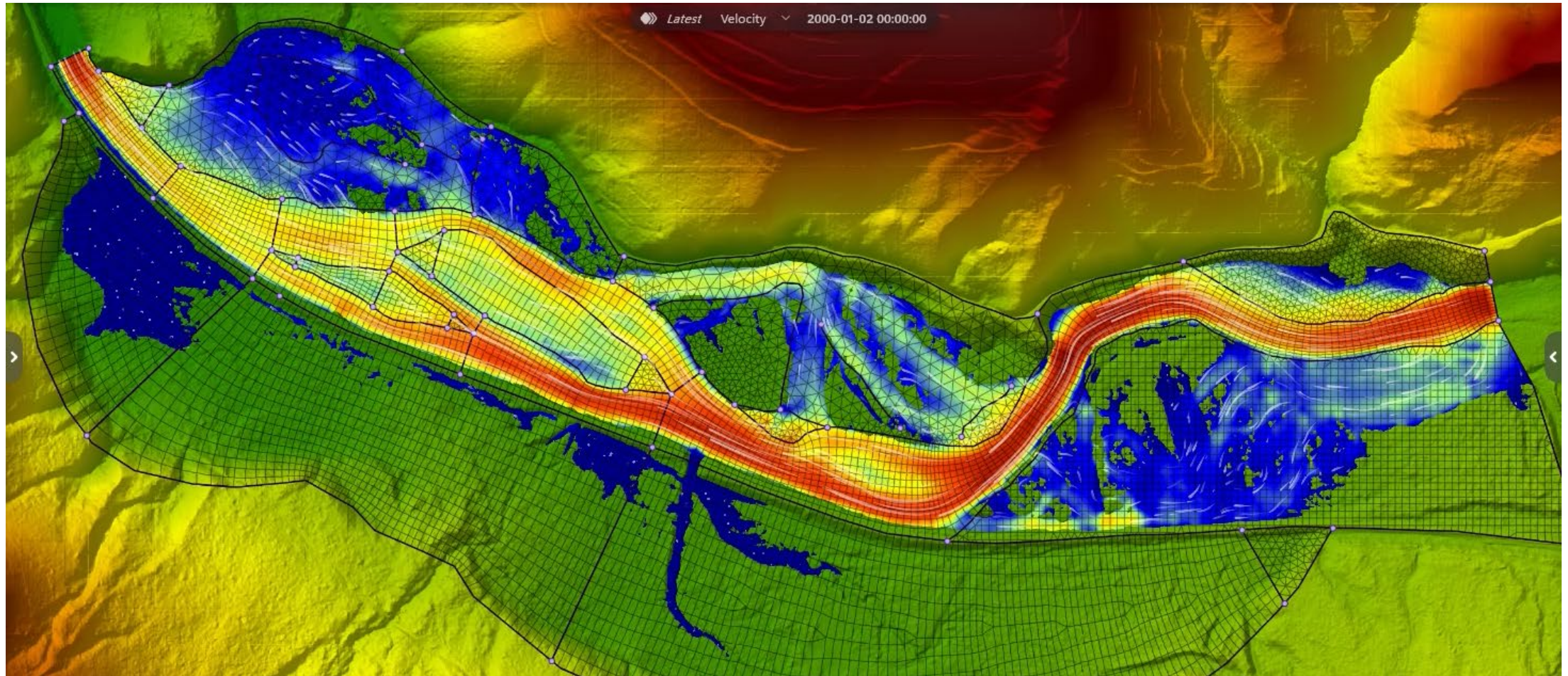


Mesh Development



RAS 2025 Class



Mesh Development

1. Mesh Development Approach

2. Overview of Mesh Types

1. Quads 3. Cartesian

2. Triangles 4. Blank

3. Application and Parameters Mesh Types

1. Quads 3. Cartesian

2. Triangles 4. Blank



Mesh Development Approach

Why develop a new meshing approach?

Why separate mesh workflow into editable conceptual mesh and an automated computational mesh?

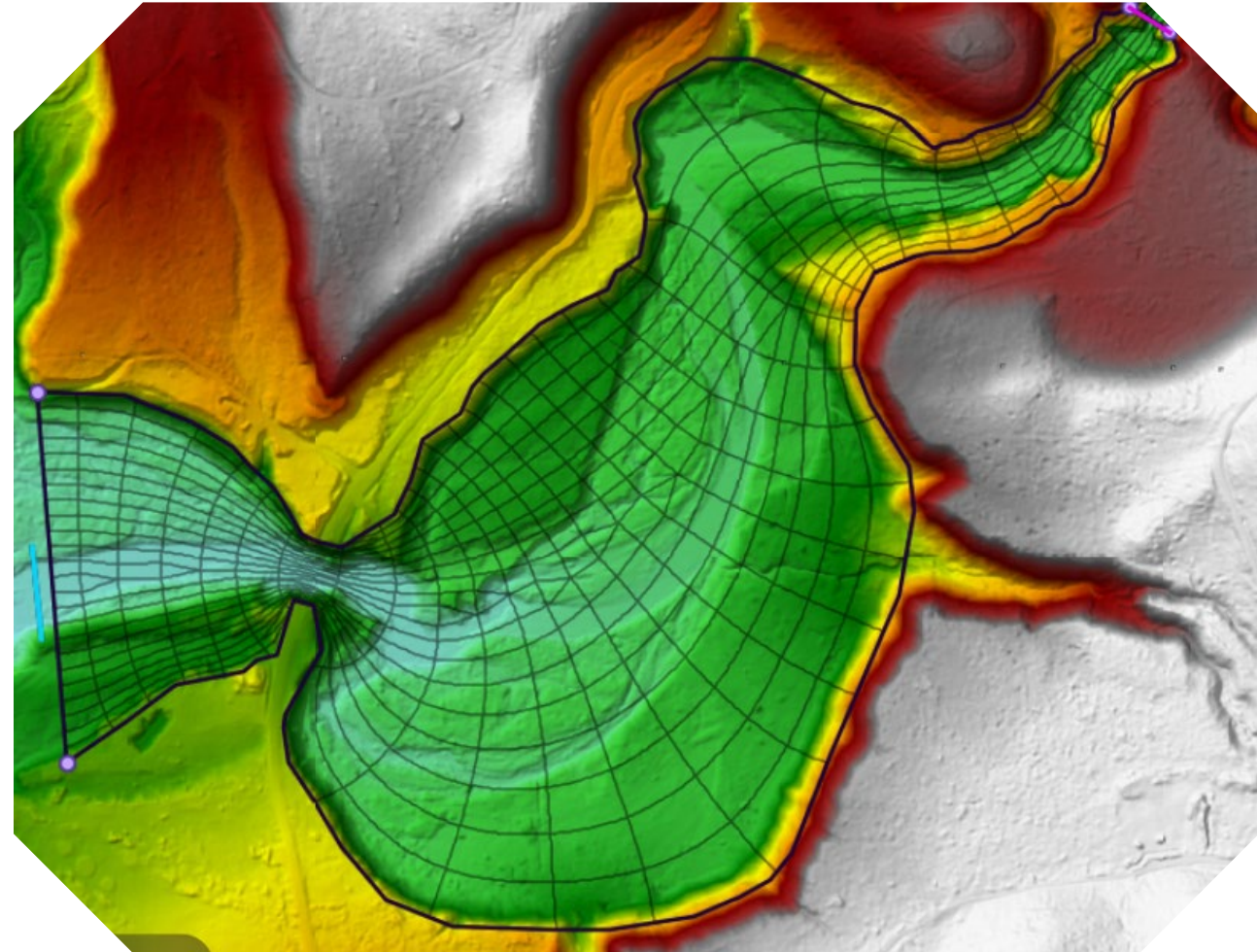
The New Mesh Approach is:

- Reproducible
- Flexible
- Light
- Obedient (Breaklines)



Why develop a new meshing approach?

- **Reproducible**
 - Meshes are 100 % reproducible from conceptual mesh
 - No hand edits
 - ‘Recompute mesh’ is no longer dangerous
- **Flexible**
 - Standard toolset useful diverse meshing situations
 - Mesh resolution scalable from some conceptual mesh





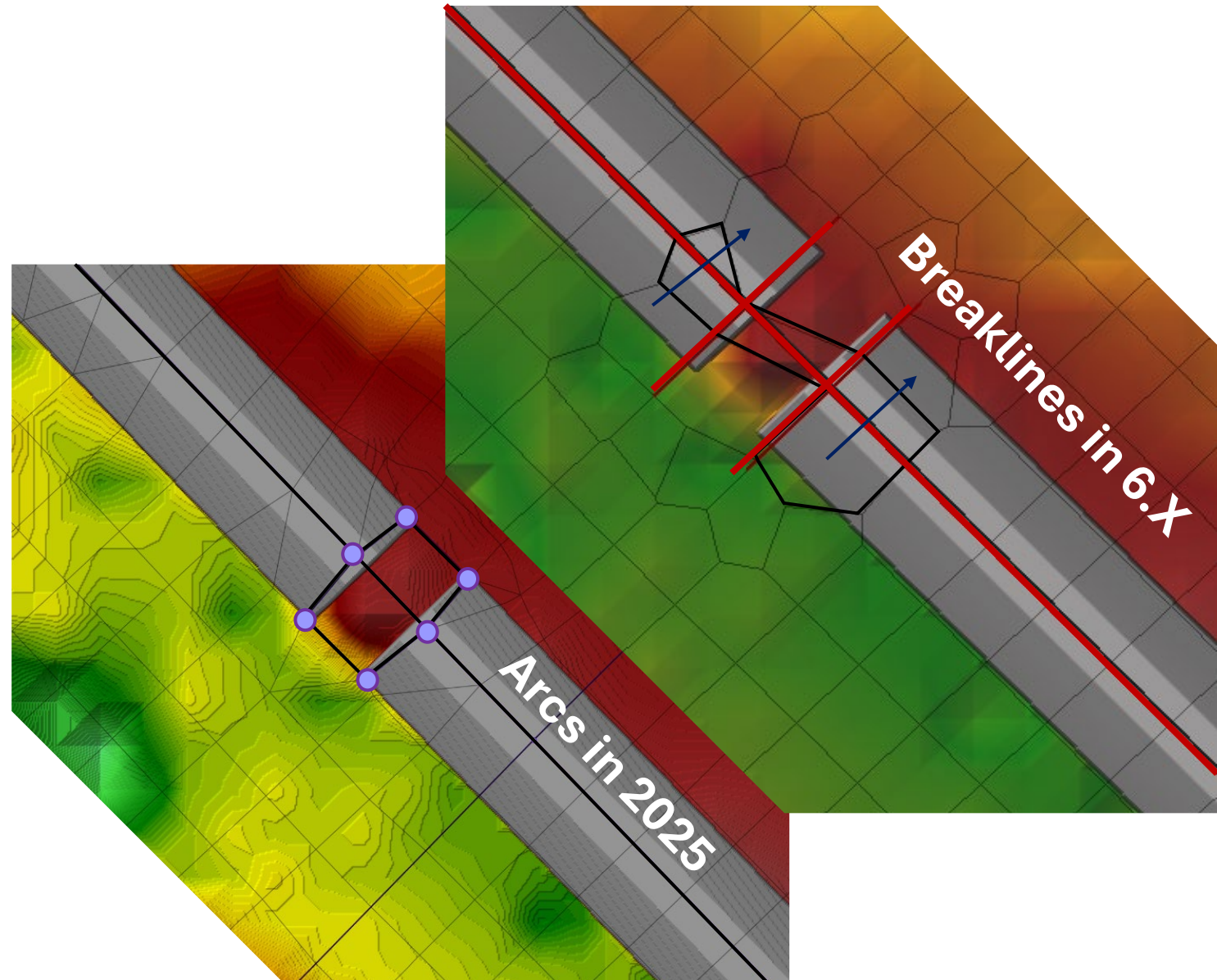
Why develop a new meshing approach?

- Light

- Easily share a fully repeatable mesh in the conceptual mesh
- Easily archive previous mesh versions

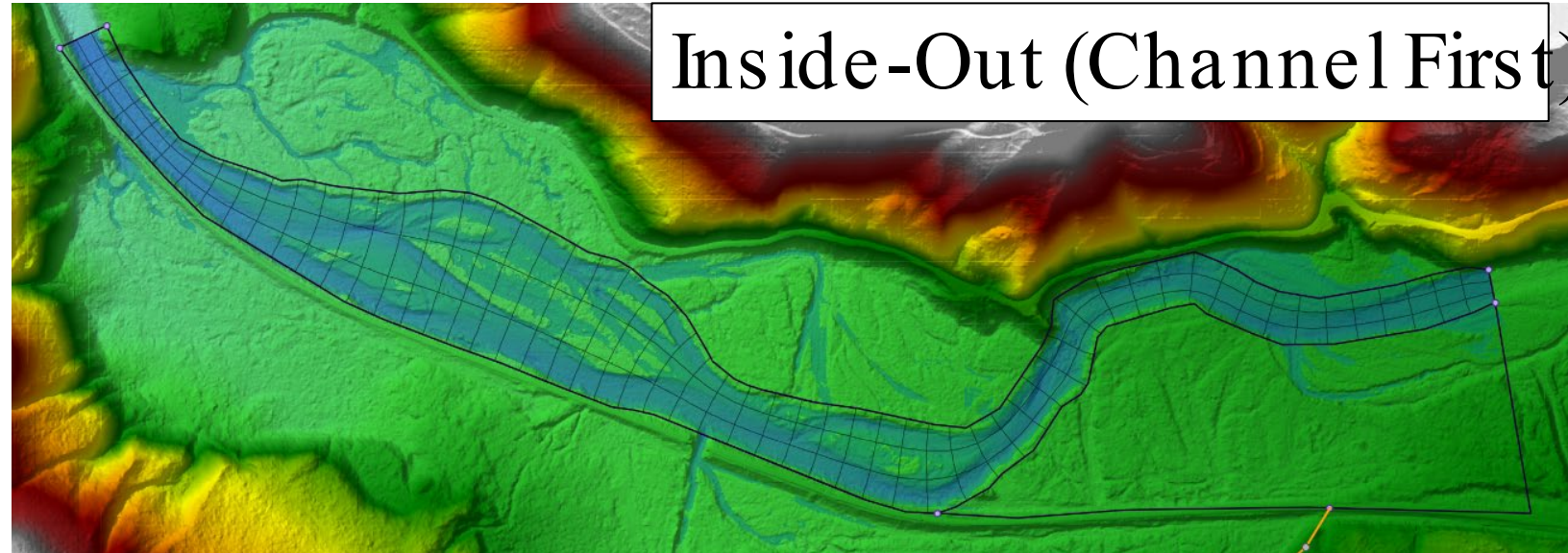
- Obedient

- The new method provides complete control of subgrid faces
- “breaklines” are not suggestions

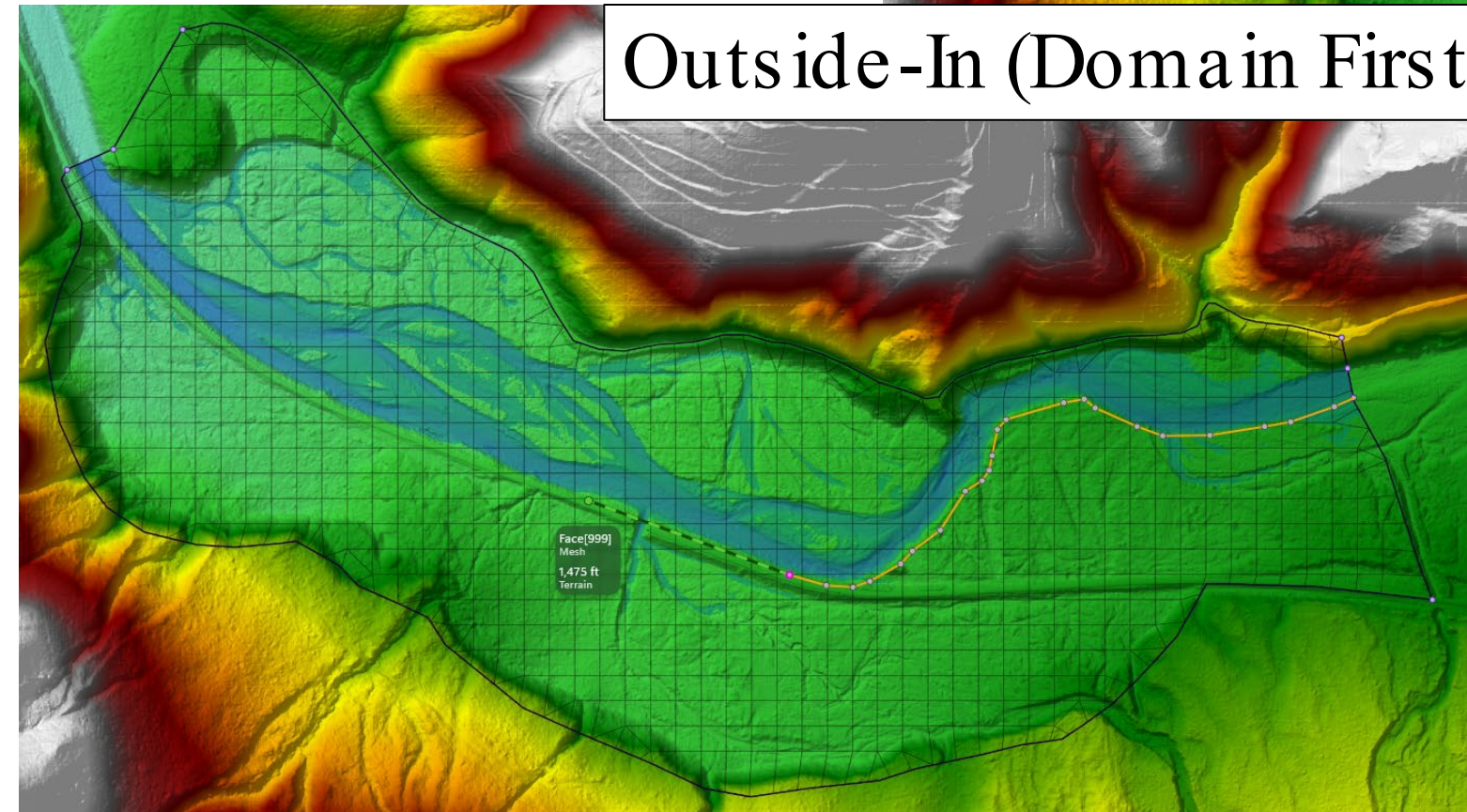




Two Meshing Approaches



Outside-In (Domain First)





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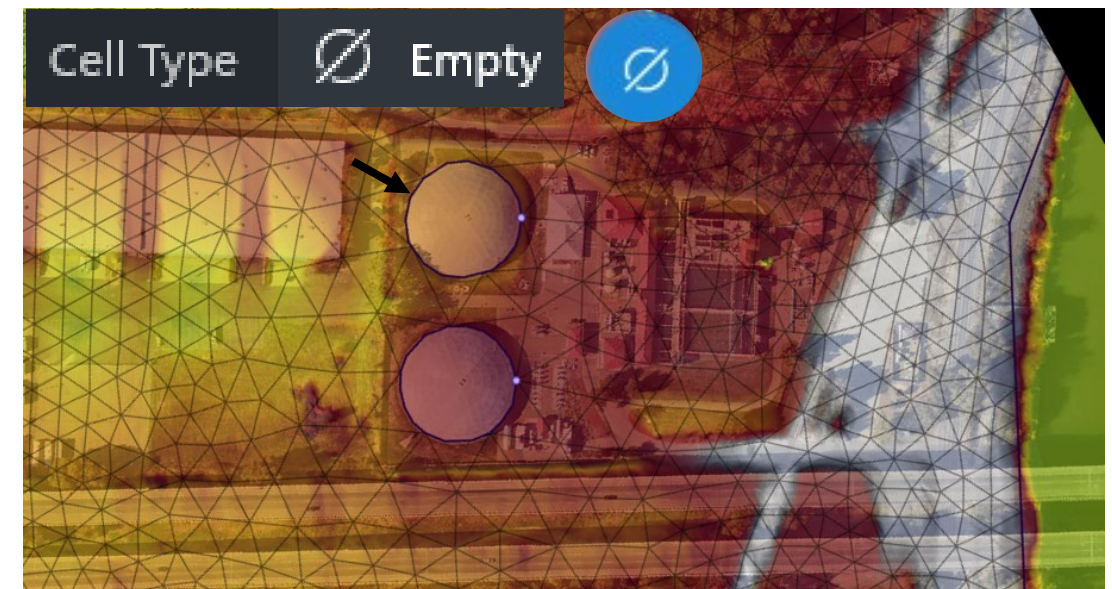
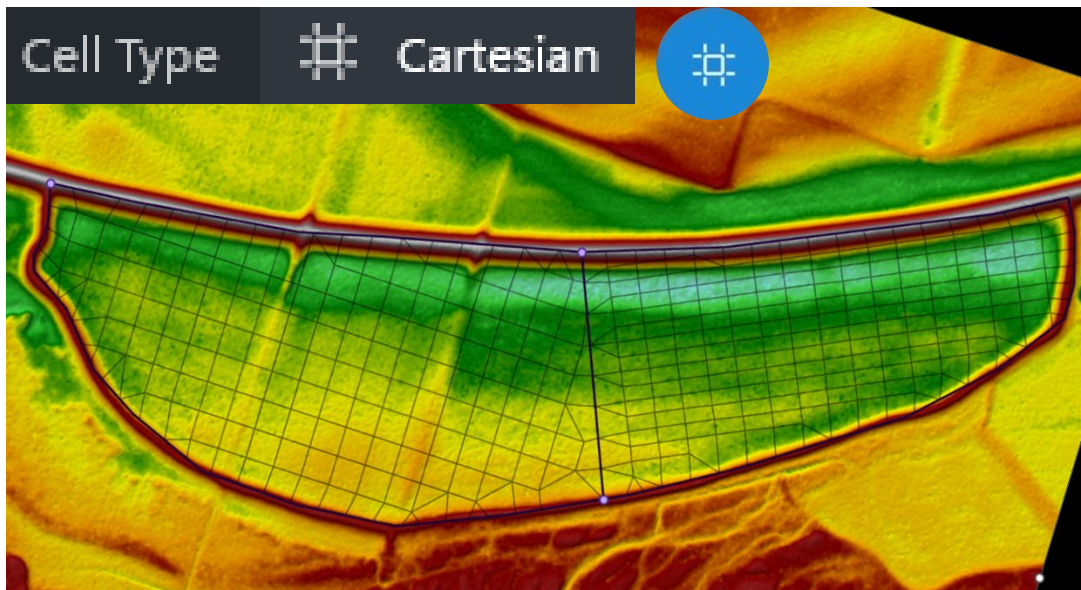
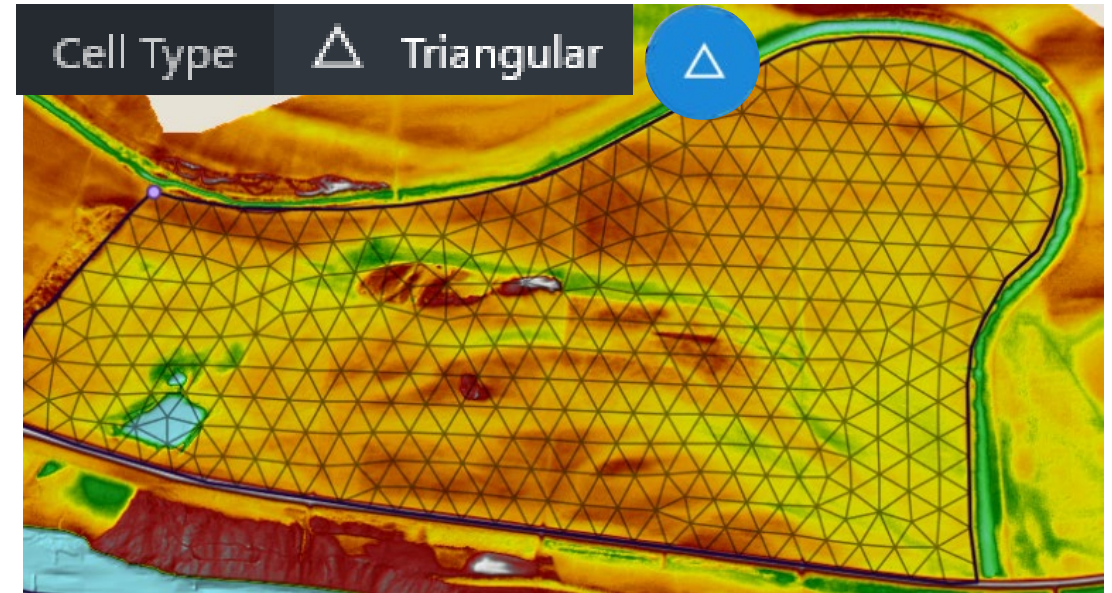
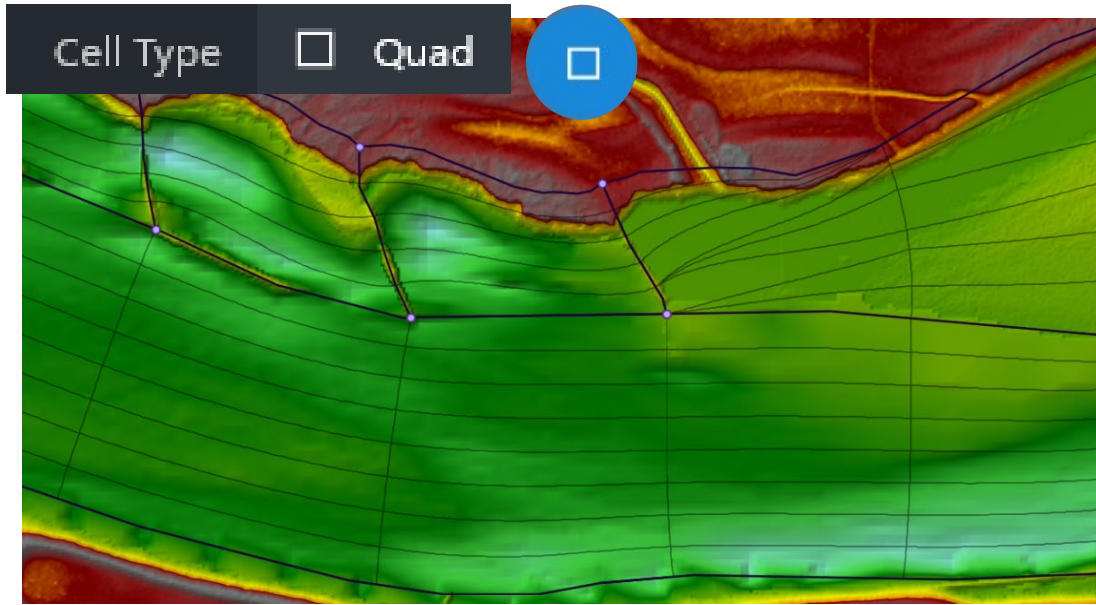
3. Application and Parameters Mesh Types

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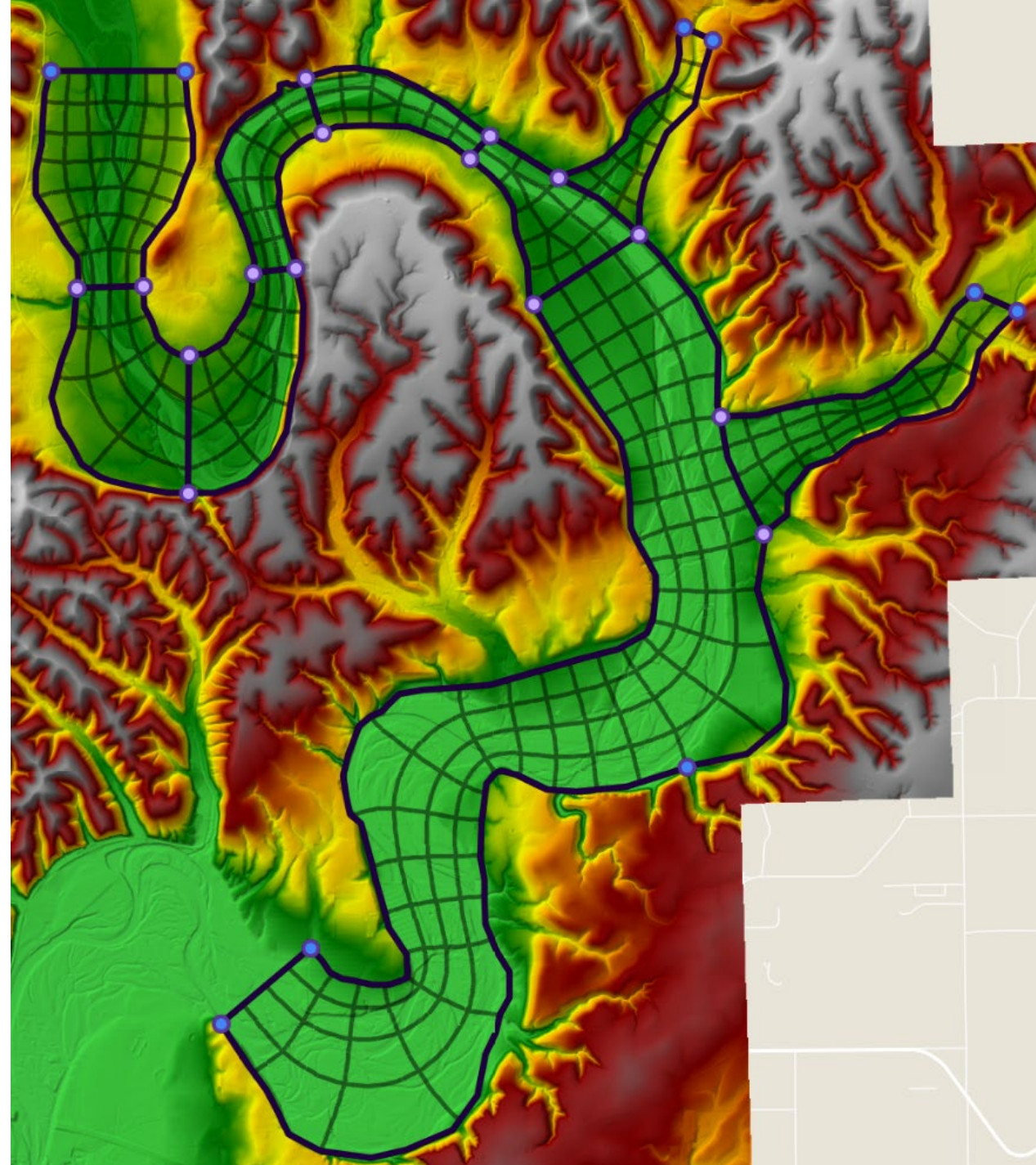


Four Mesh Types



◻ Quads

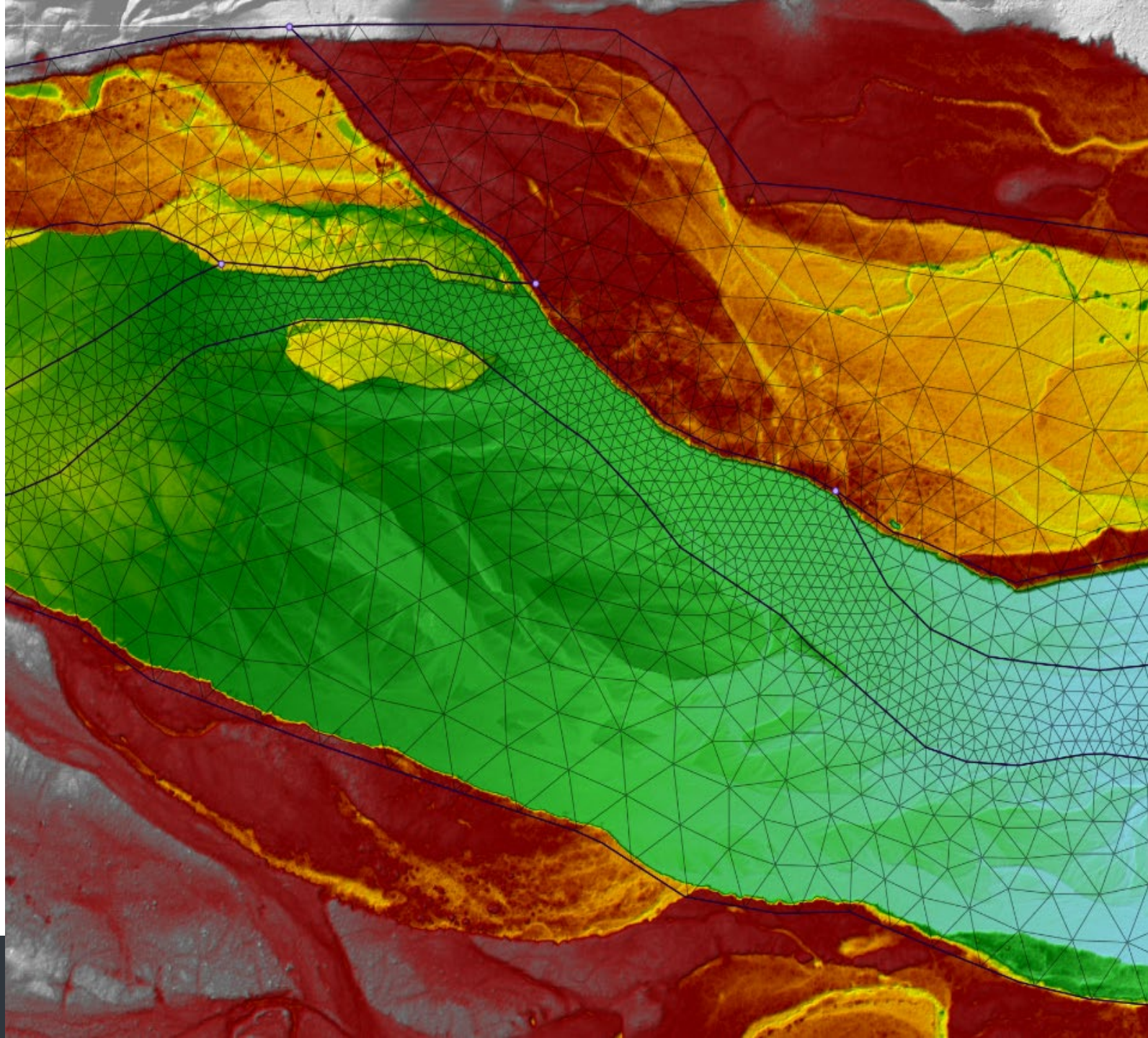
- Quadrilateral Cells
- Align cells with flow
- Mostly for channels
- Properties primarily defined on arcs and regions



Cell Type ◻ Quad

△ Triangles

- Most flexible
- Can transition between cell sizes within a region
- Floodplain or irregular shape regions
- Can get very small and drive run time



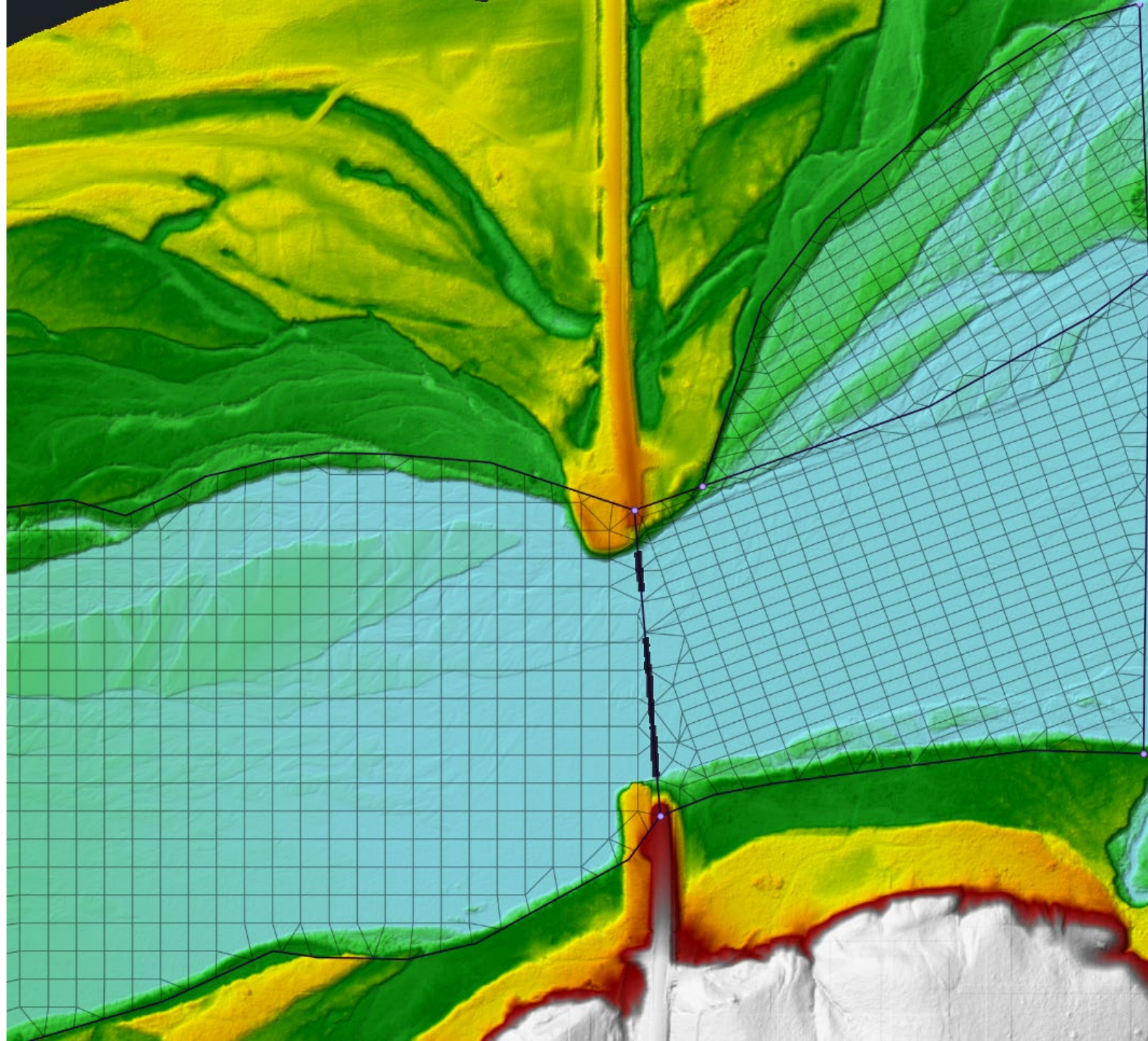
Cell Type



Triangular

Cartesian

- RAS Mapper Vibe
- Can change aspect ratio and rotation angle
- Uses triangles to transition to irregular boundaries



Empty

- Water excluded from cells
- No-friction boundary
- Arc spacing can still be set



Cell Type



Empty



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Mesh Region Options



 Properties ▼

Cell Type Quad ▼

Cell Size

Secondary Cell Size


Curved Faces

Laplace Resolution

Quad/Triangle Tolerance

Post Processor Options



 Properties ▼

Cell Type Cartesian ▼

Cell Size


Secondary Cell Size

Rotation

Cell Stretching Rate

Post Processor Options



 Properties ▼

Cell Type Triangular ▼

Cell Size

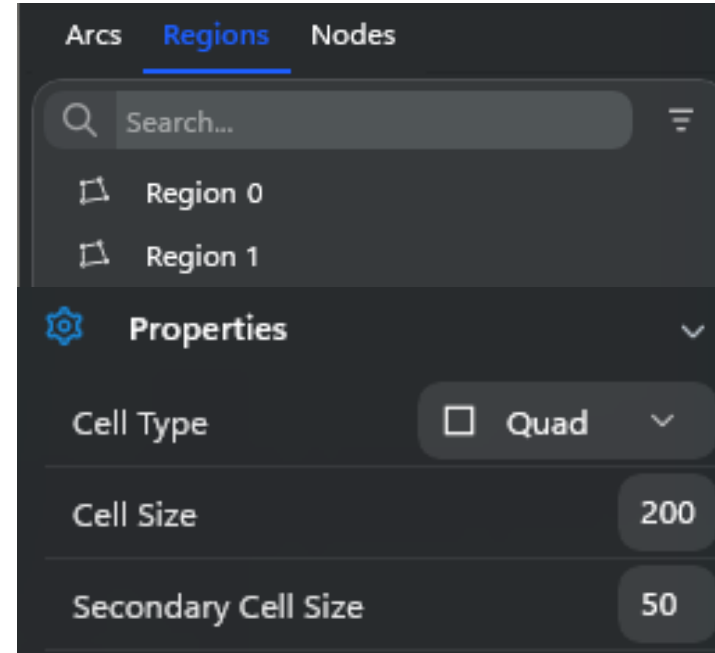
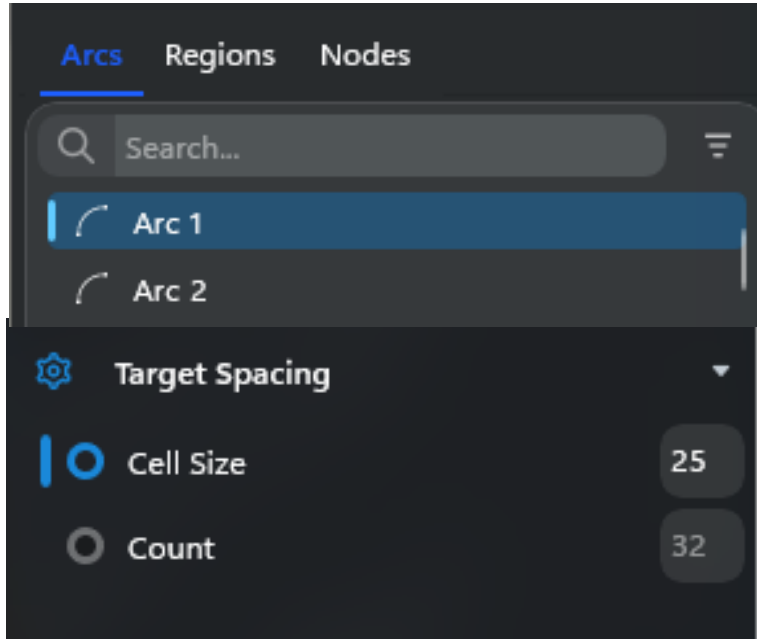
Secondary Cell Size

Cell Stretching Rate

Post Processor Options



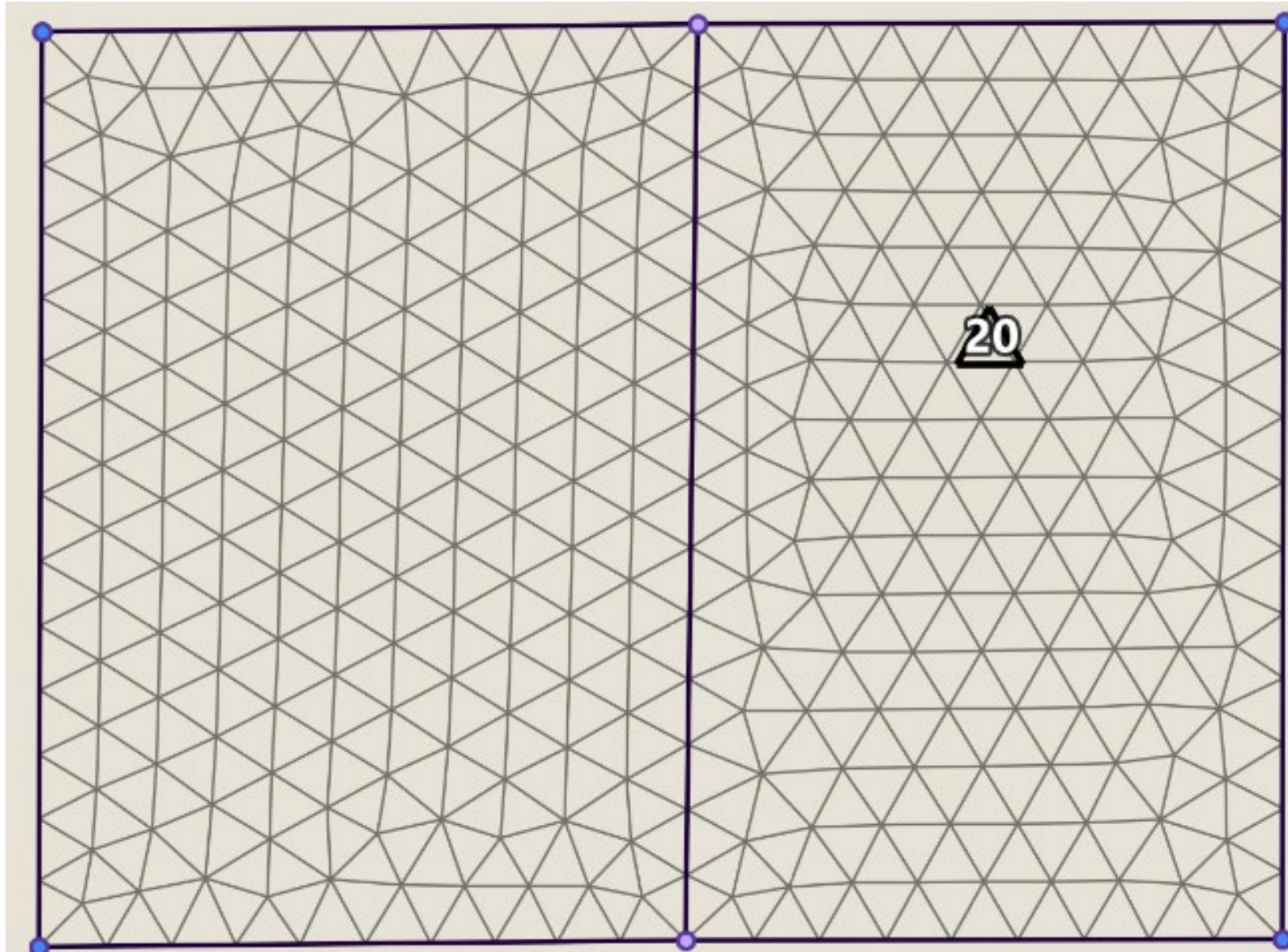
Arc Spacing \succ Region Spacing



- Region spacing is worked out by “interpolating” arc spacing as necessary, and working through conflicts
- You can override these decisions by setting arc spacing



Simplest Case



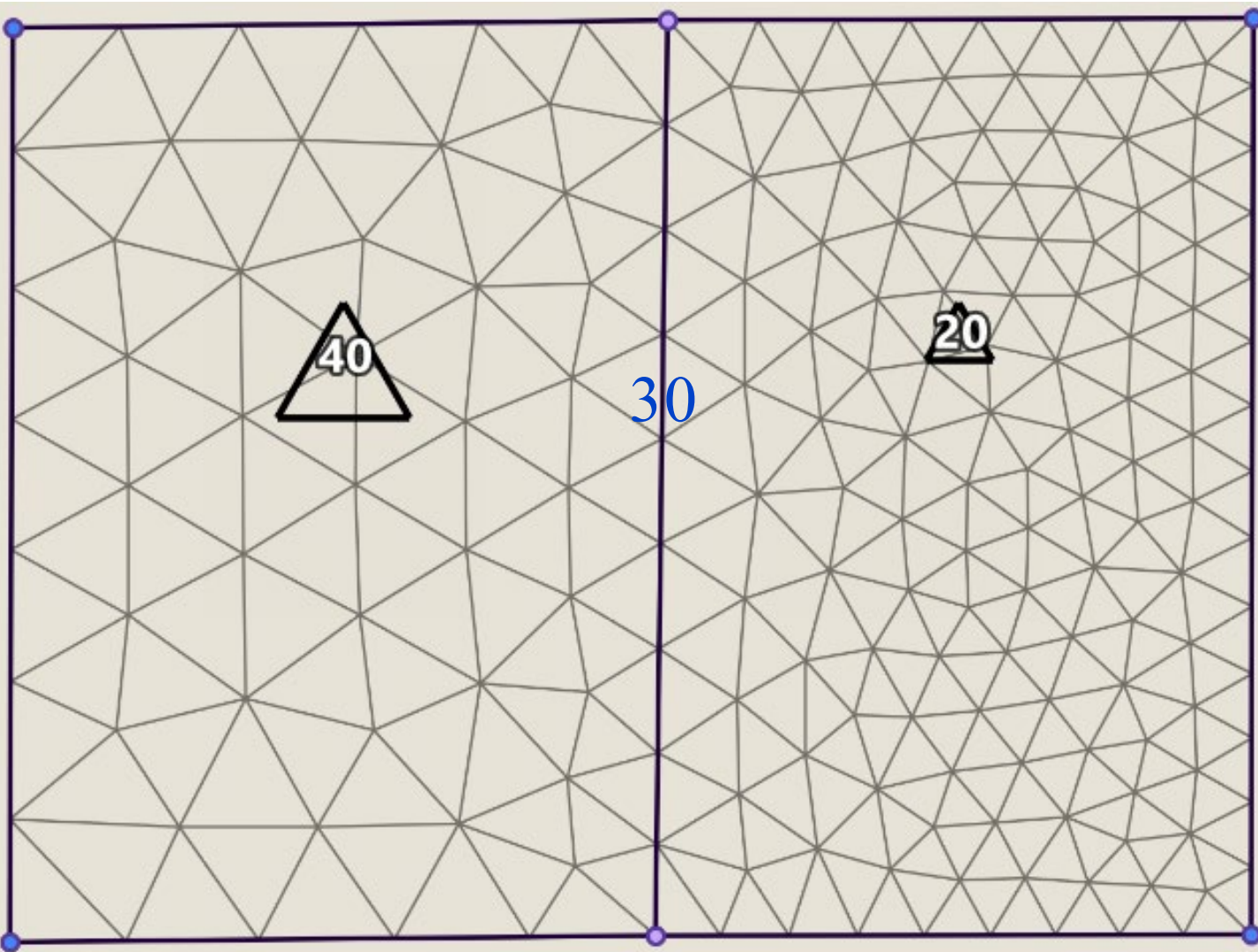
- Set cell spacing in only one region or arc
- Adjacent regions and arcs adopt that spacing



Different Region Spacings

Transition from 40 to 30

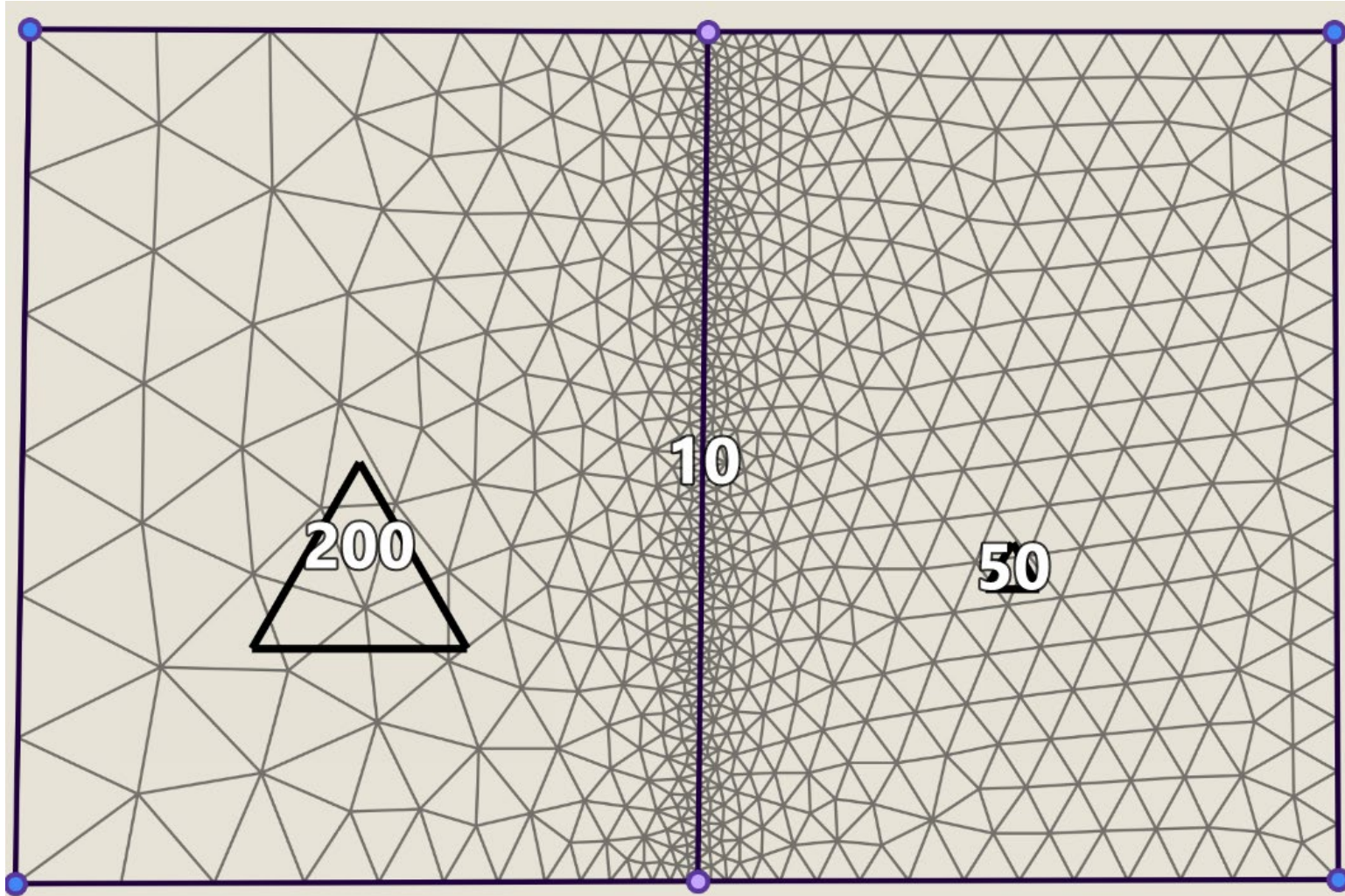
Transition from 20 to 30



- The mesh will interpolate arc spacing between regions with different spacings



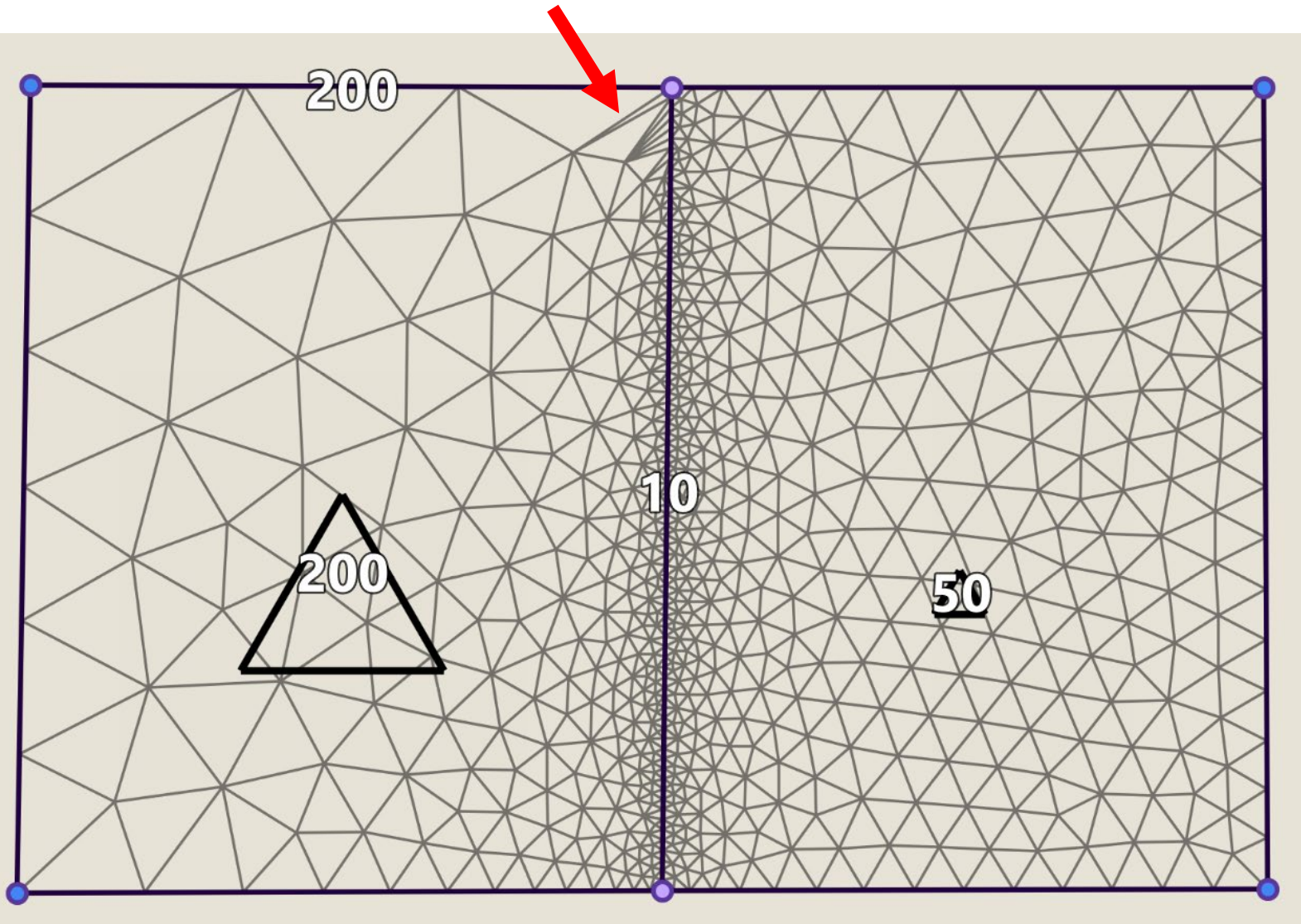
Arcs Have Final Word



- Arcs have priority
- Regions will try to conform to arc spacing



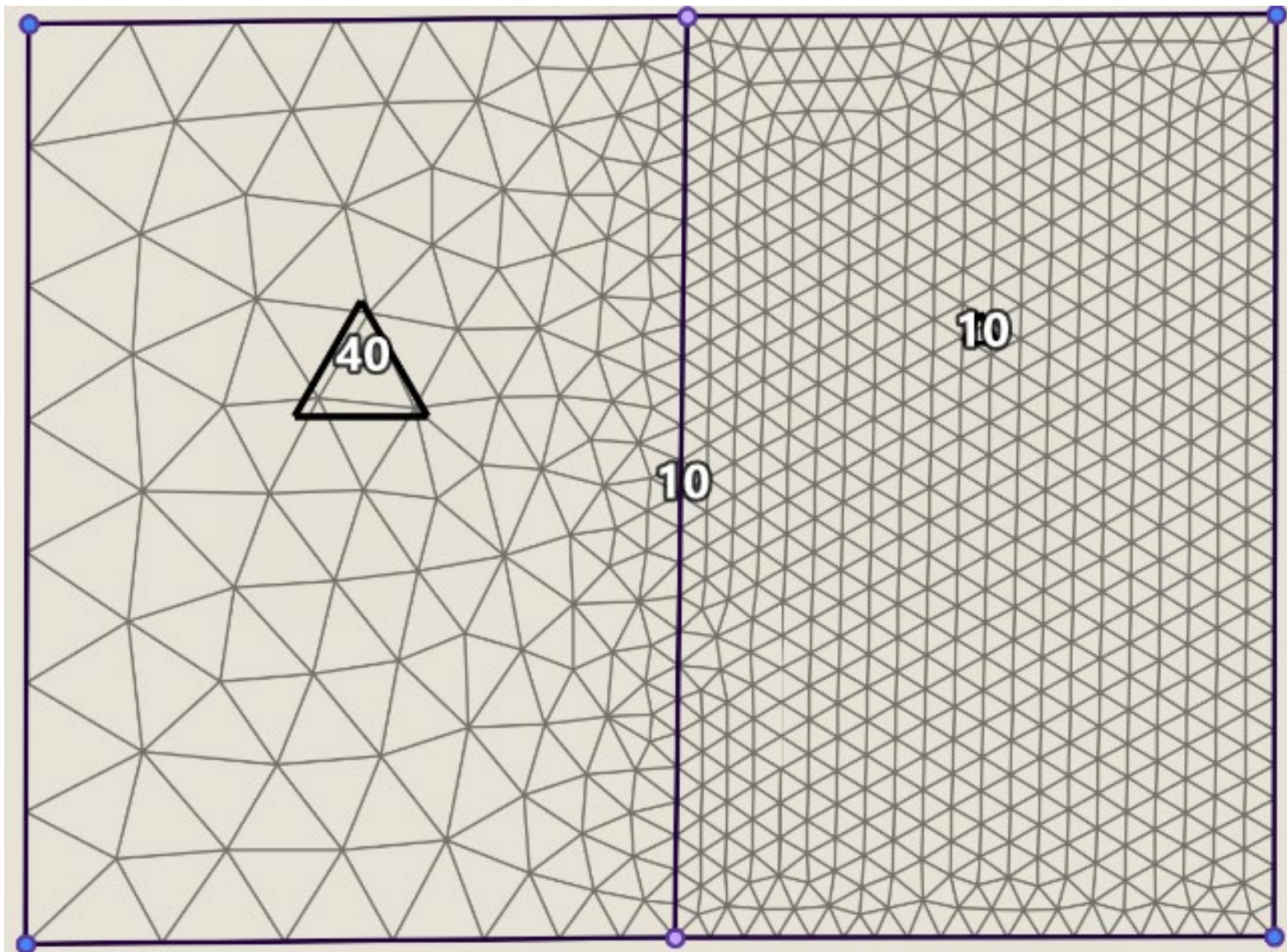
Over Specifying Mesh



- Defining too many arcs can over-constrain your mesh



Which arcs / regions are specified?



Components **Layer**

Layer

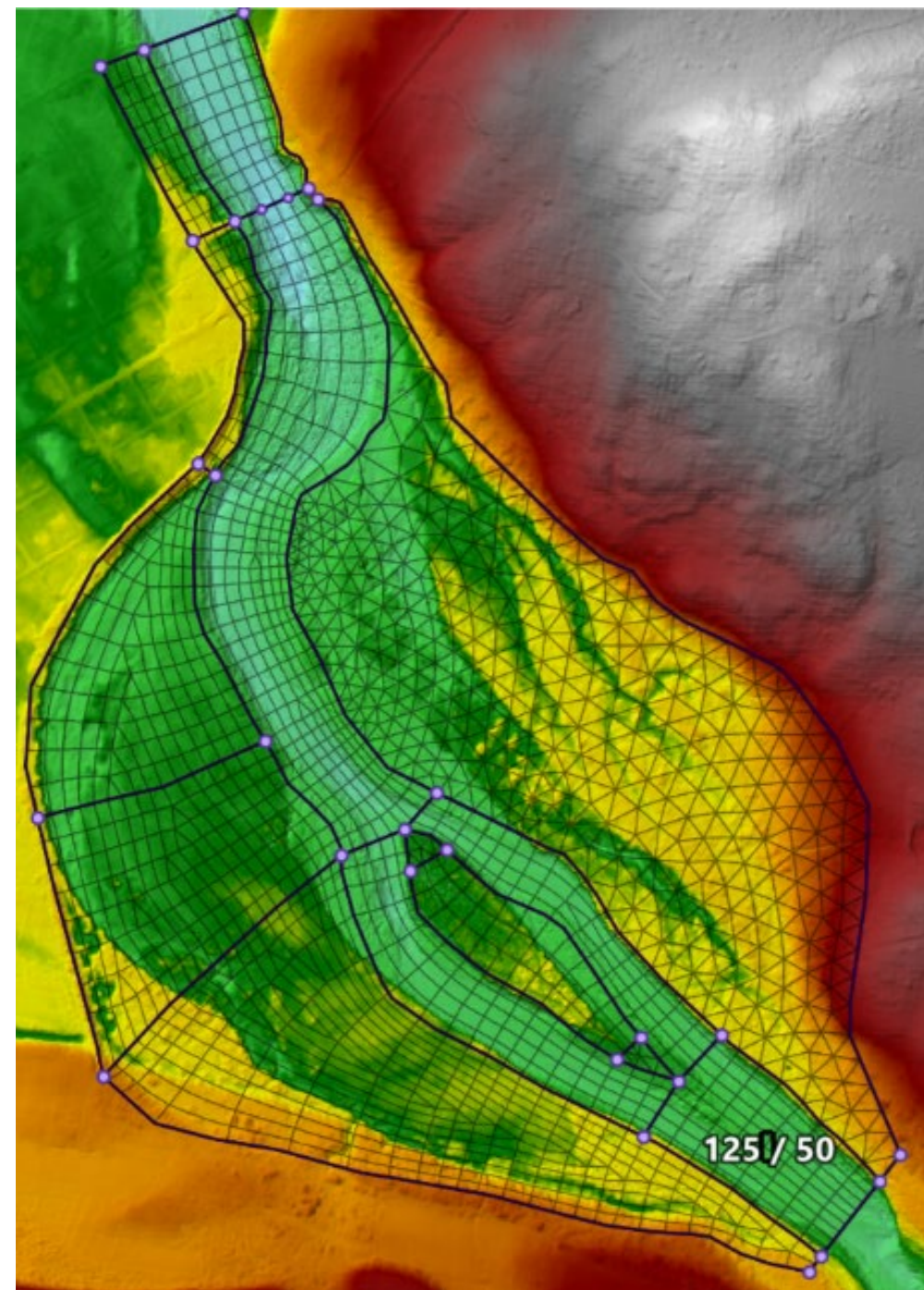
Additional Options

- Show Arc Indices
- Show Region Indices
- Show Global Size Function
- Show Size Function TIN
- Show Arc Direction Arrows
- Show Arc Cell Sizes
- Show Region Cell Sizes
- Show Arc Vertices
- Show Region Size Previews



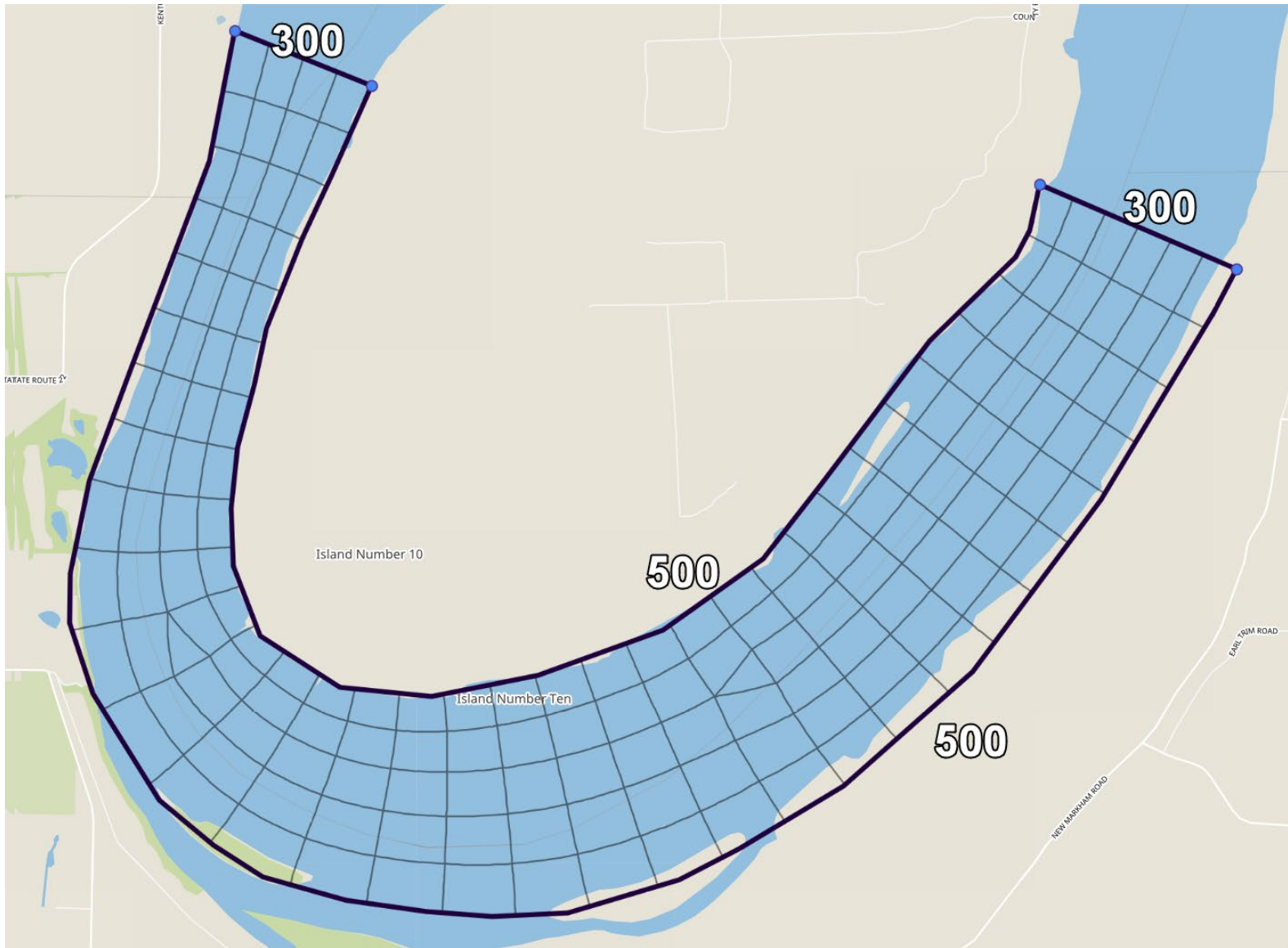
The Power of Inferred Cell Size

- Define the cell size in one place and it propagates throughout the model



Quads

- Interior cell spacing is controlled by the bounding arcs cell sizes
- Setting cell sizes:
 - Specify size in Region
 - OR
 - Specify size on Arcs



Quads

- Bounding arcs use the region primary /secondary cell sizes
- Can override this by setting the arc spacing
- Spacing Mode is how strictly to override



Target Spacing ▼

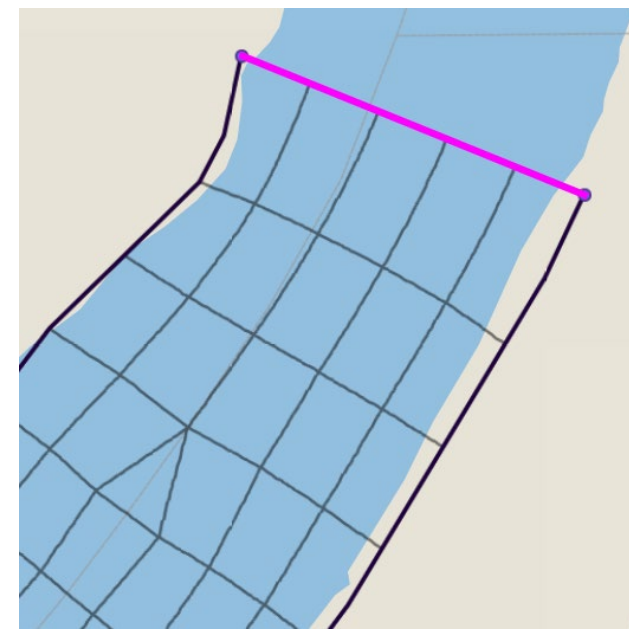
Cell Size

Count 5

Properties ▼

Cell Spacing Mode Floating ▼

Cell Density Ratio 1



Target Spacing ▼

Cell Size

Count 5

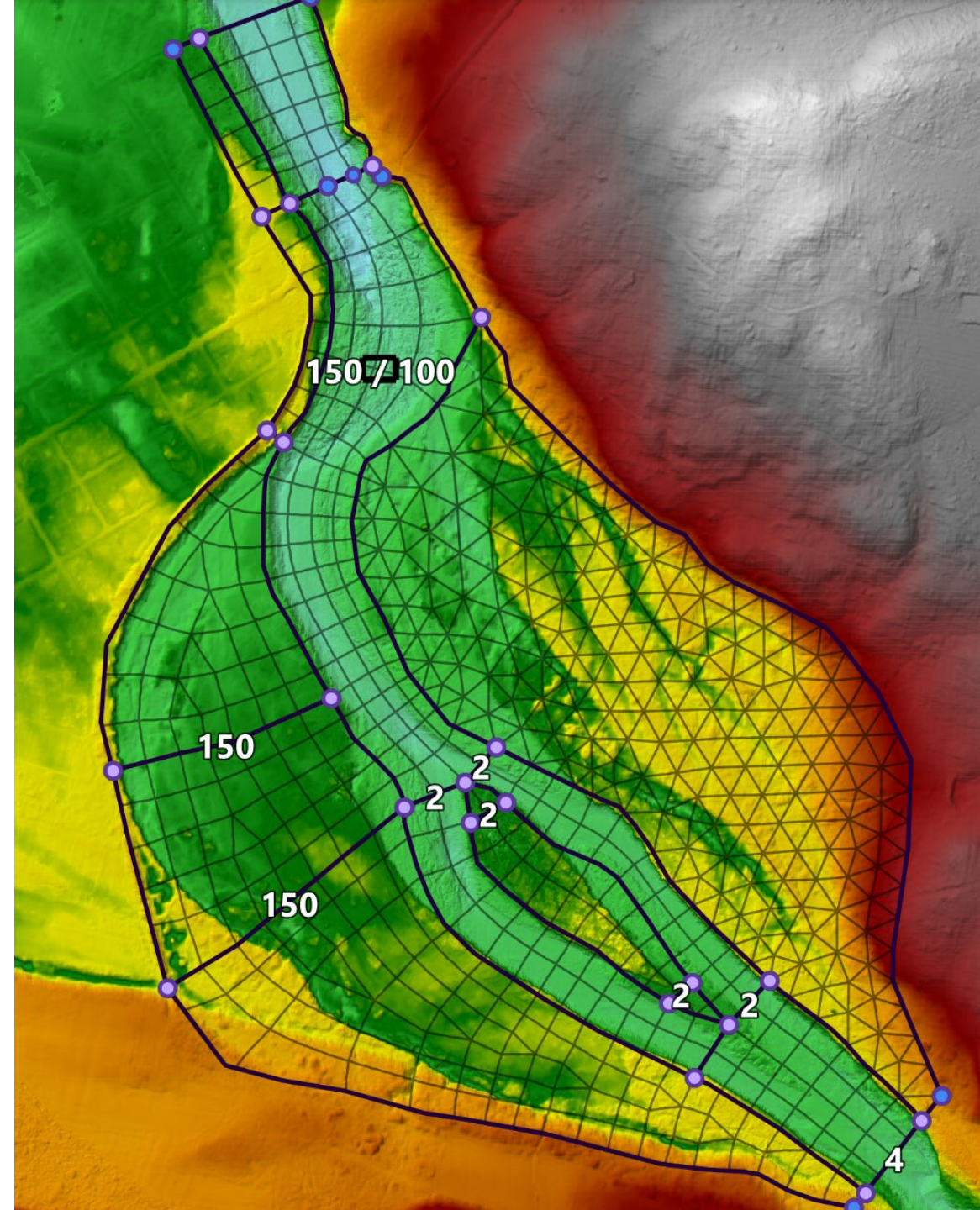
Properties ▼

Cell Spacing Mode Constrained ▼

Cell Density Ratio 1

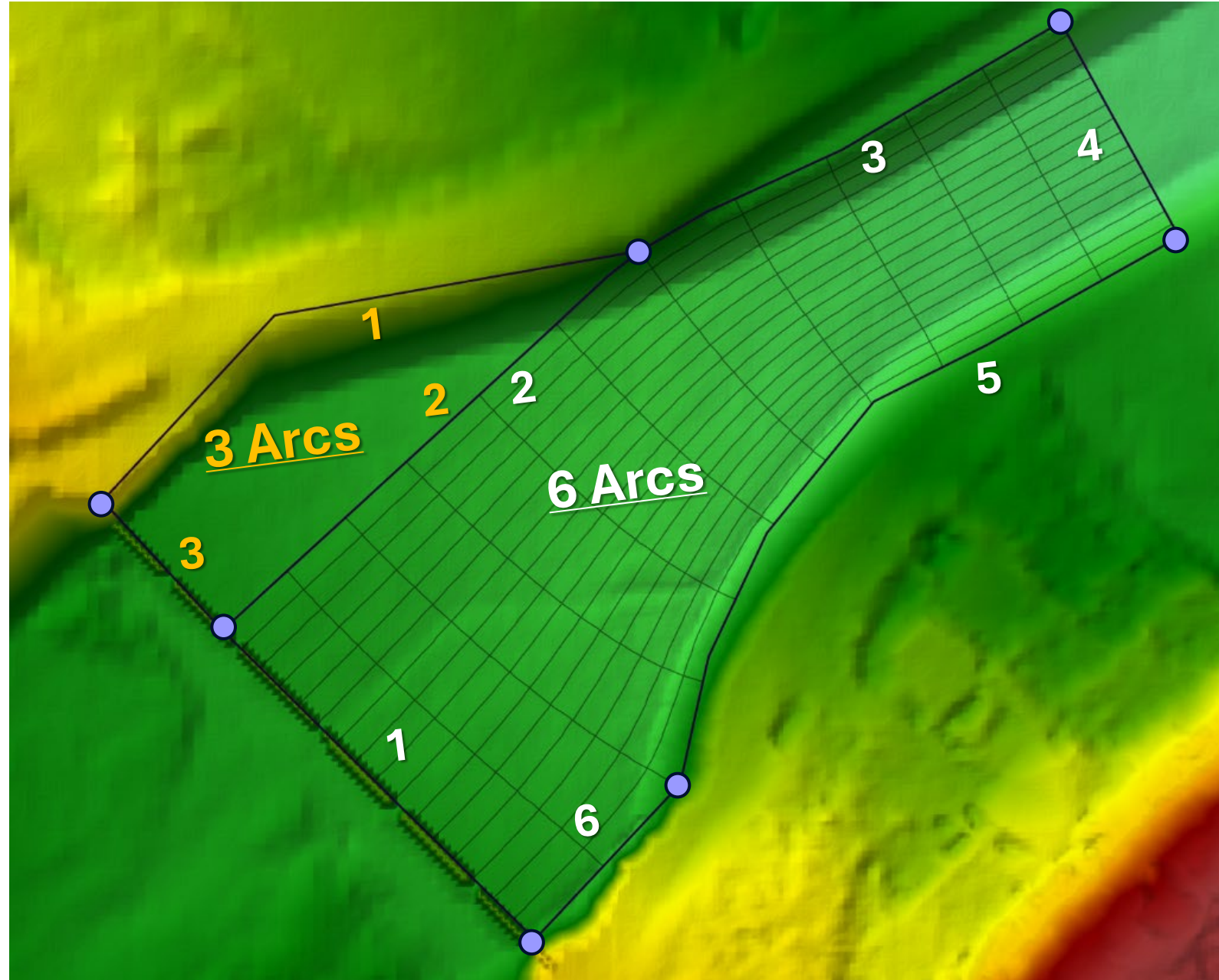
□ Quads

- Quads prioritize width spacing
- Fixing width arcs tends to produce better meshes than length
- Quads spacing takes take priority over other adjacent regions



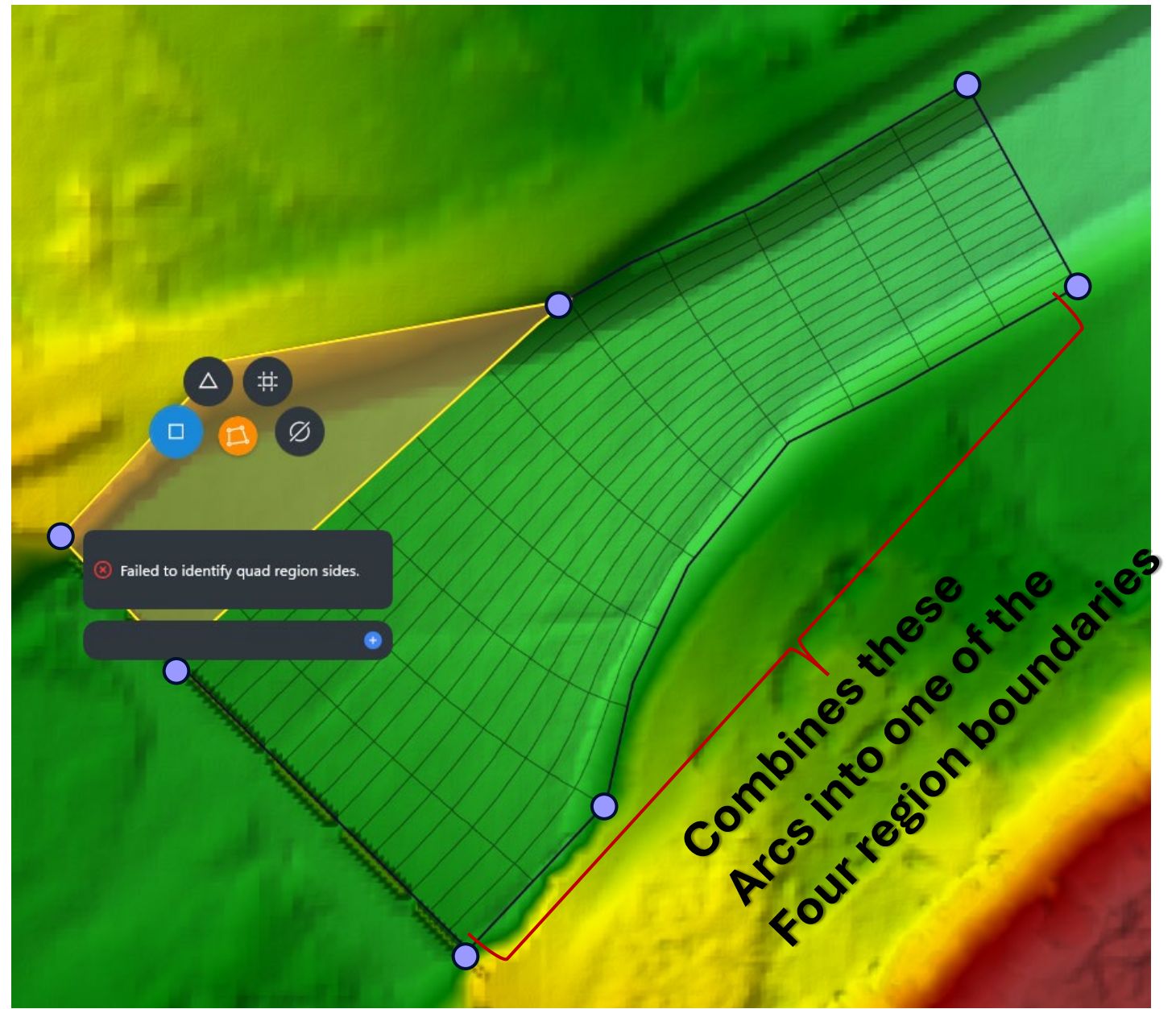
▣ Quads - Unique Properties: 4 Side Requirement

- Quads regions require four boundaries / sides
- Therefore, quad regions require at least 4 arcs
- When quad region has >4 arcs the meshing tool will combine them



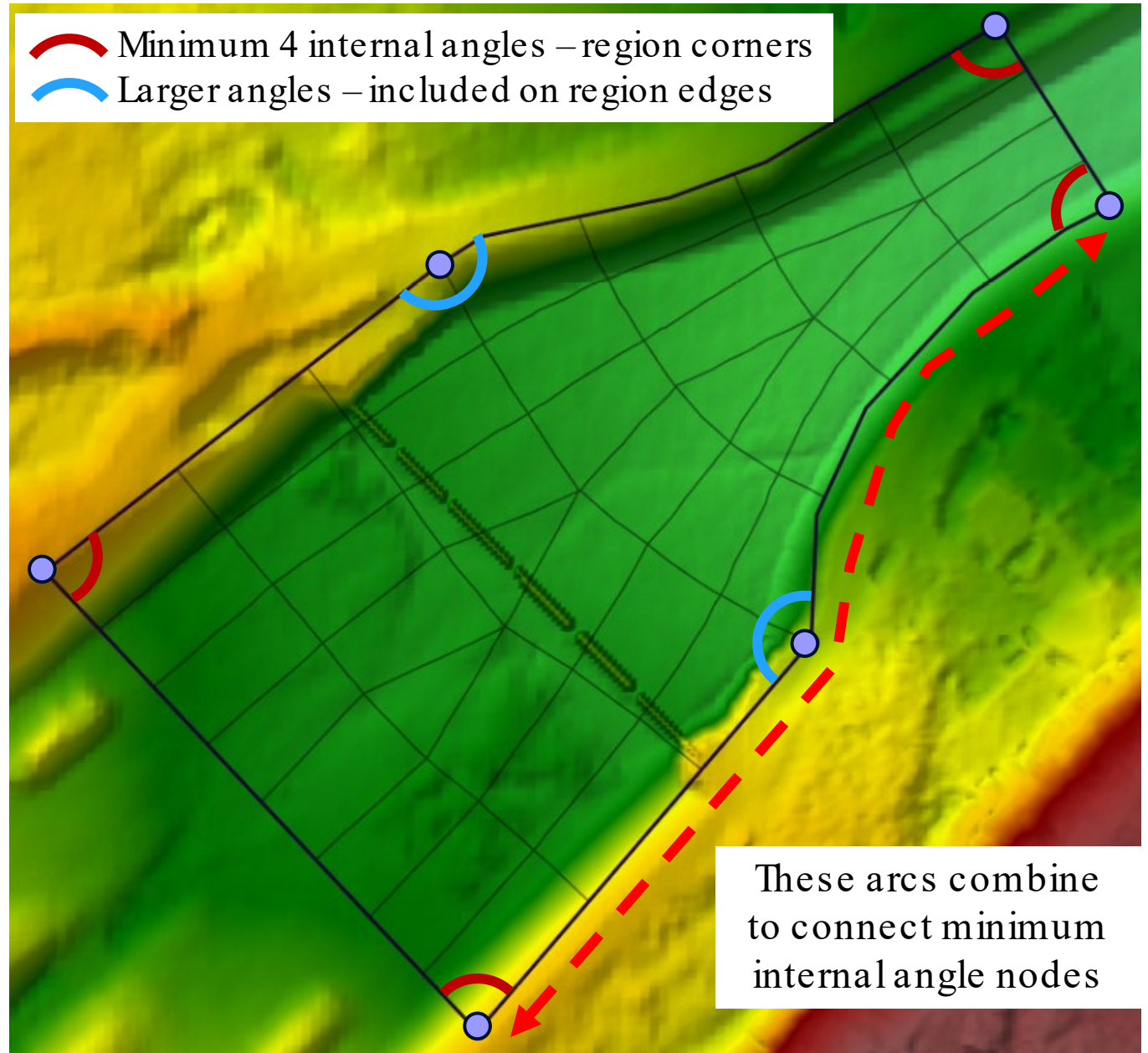
Quads - Unique Properties 4 Side Requirement

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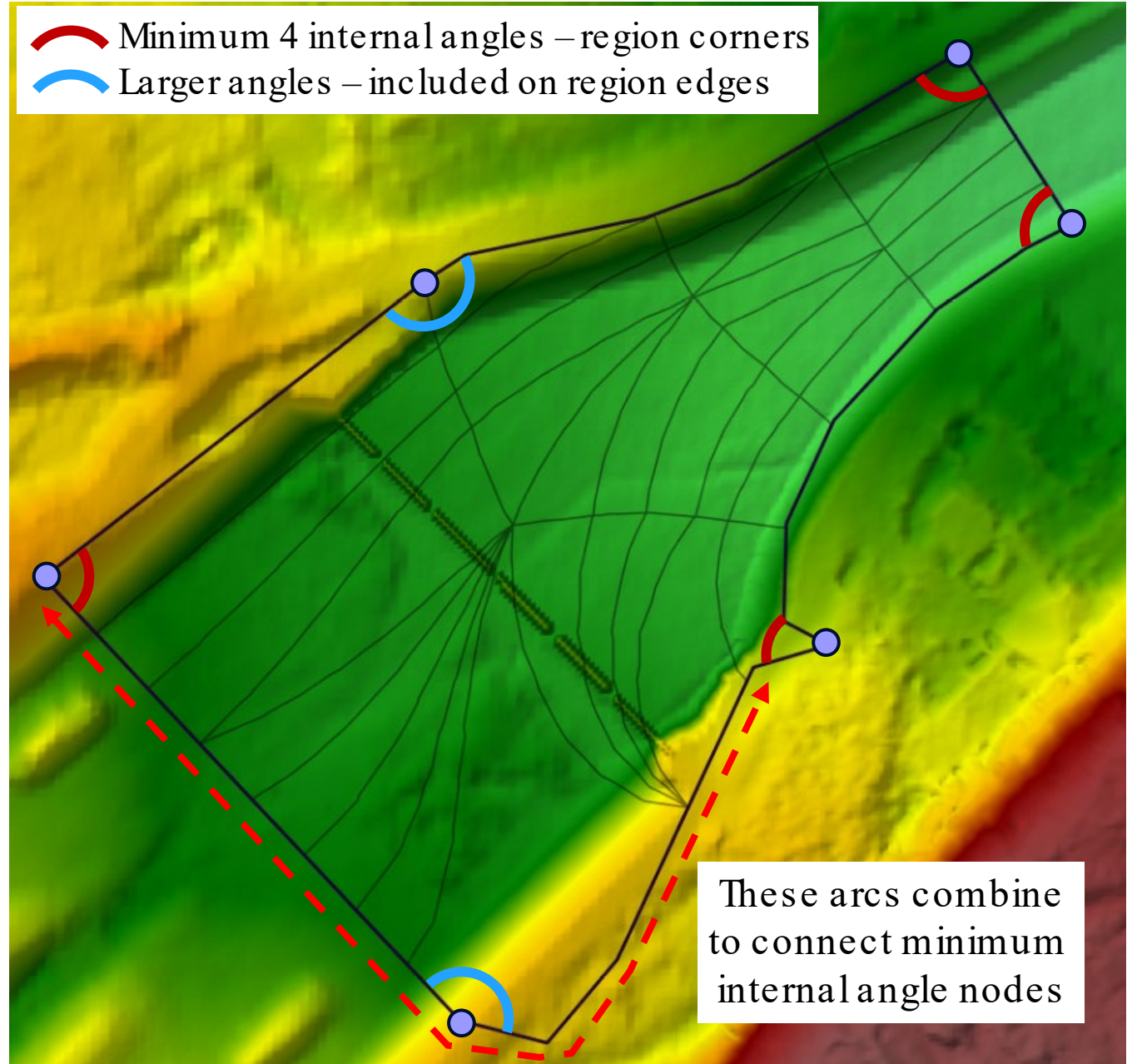
□ Quad - Side Selection for >4 Arcs

- If a region has >4 Arcs, RAS identifies the corners of a quad region
- RAS selects the four corners with the smallest internal angles
- Arc are combined into quad sides



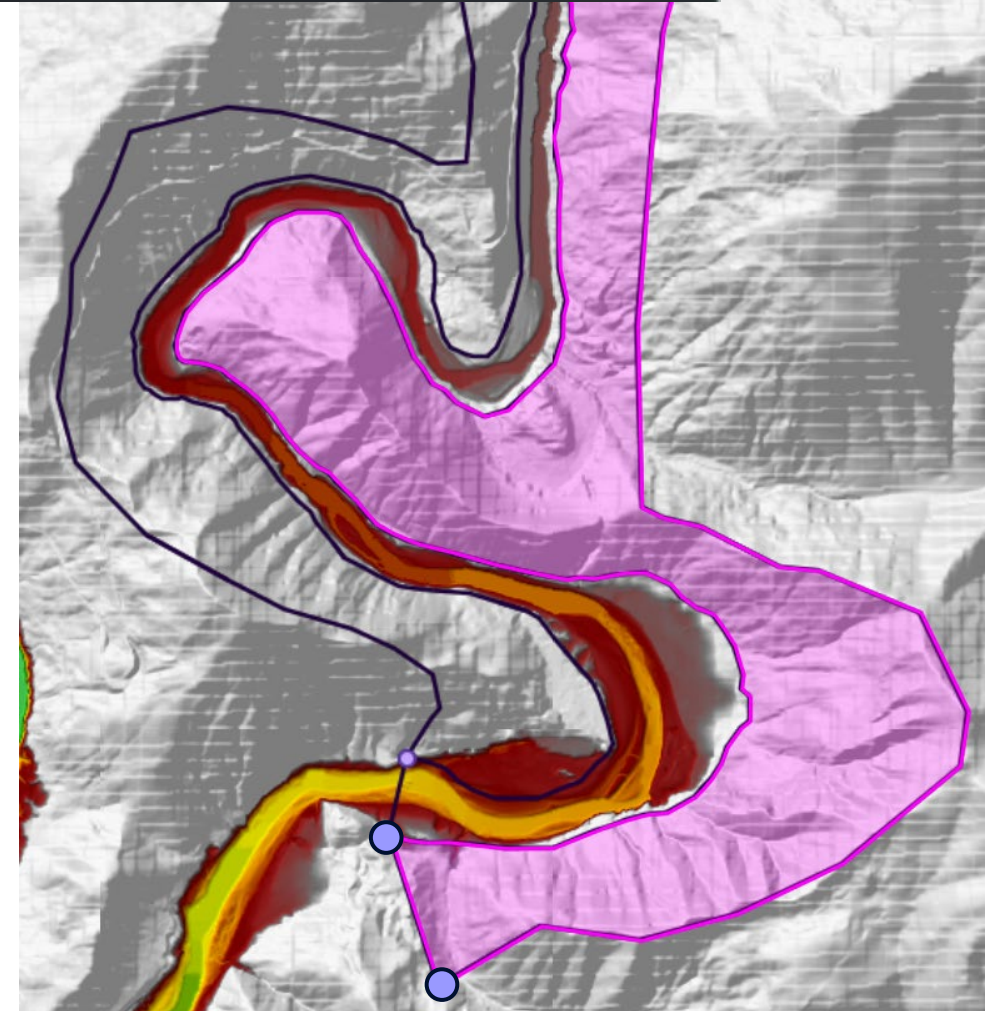
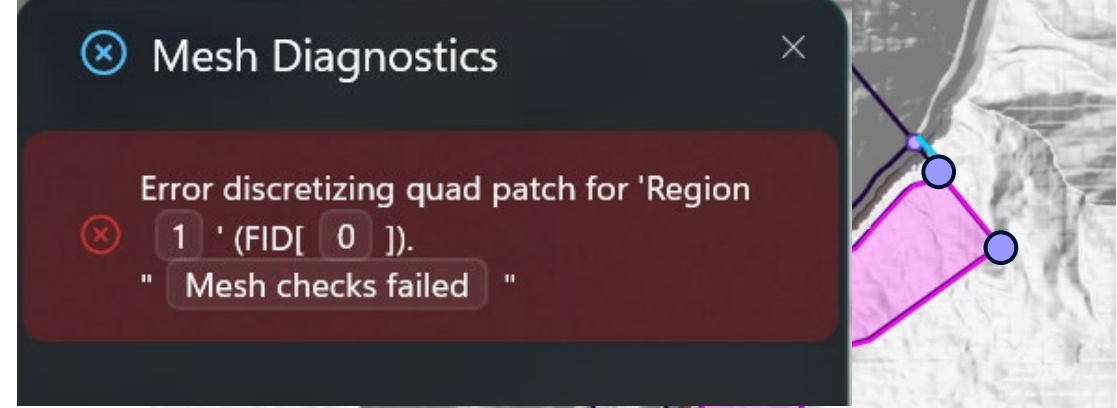
□ Quad- Side Selection for >4 Nodes

- Watch out for small internal angles along the arcs you want to combine
- You control which arcs combine by the minimum internal angle



Quad Limits

- The meshing generation can struggle with irregularly shaped regions
- This example has exactly 4 arcs but is too irregularly shaped to solve the Laplacian equation
- Mesh Diagnostics tool will show you the offending feature





Quad Region Options

General Arcs **Regions** Nodes

Search...

Region 0

Tags +

Properties

Cell Type Quad

Cell Size 1000

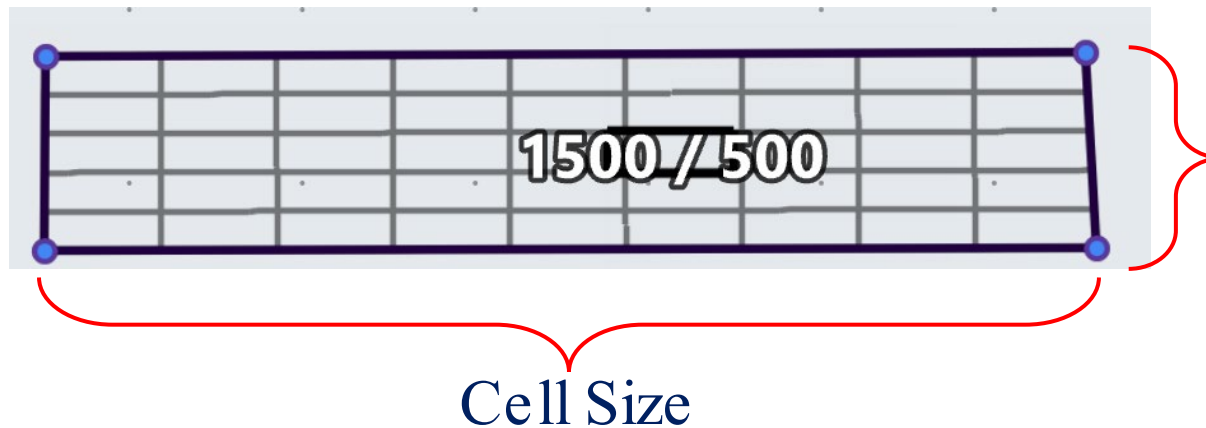
Secondary Cell Size 500

Curved Faces

Laplace Resolution 1

Quad/Triangle Tolerance 1

Post Processor Options Default()



Secondary
Cell size

Channel Cell Length

Channel Cell Width

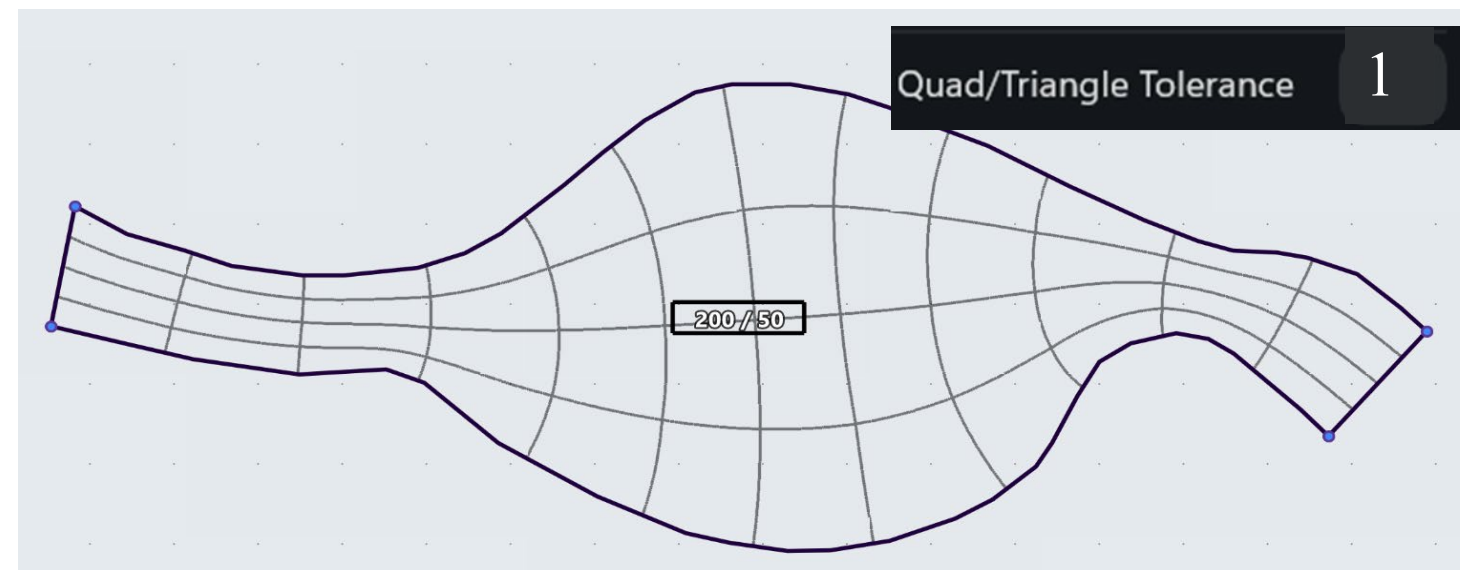
Curved faces OR straight faces

>1 Smooths cell faces but \uparrow meshing time

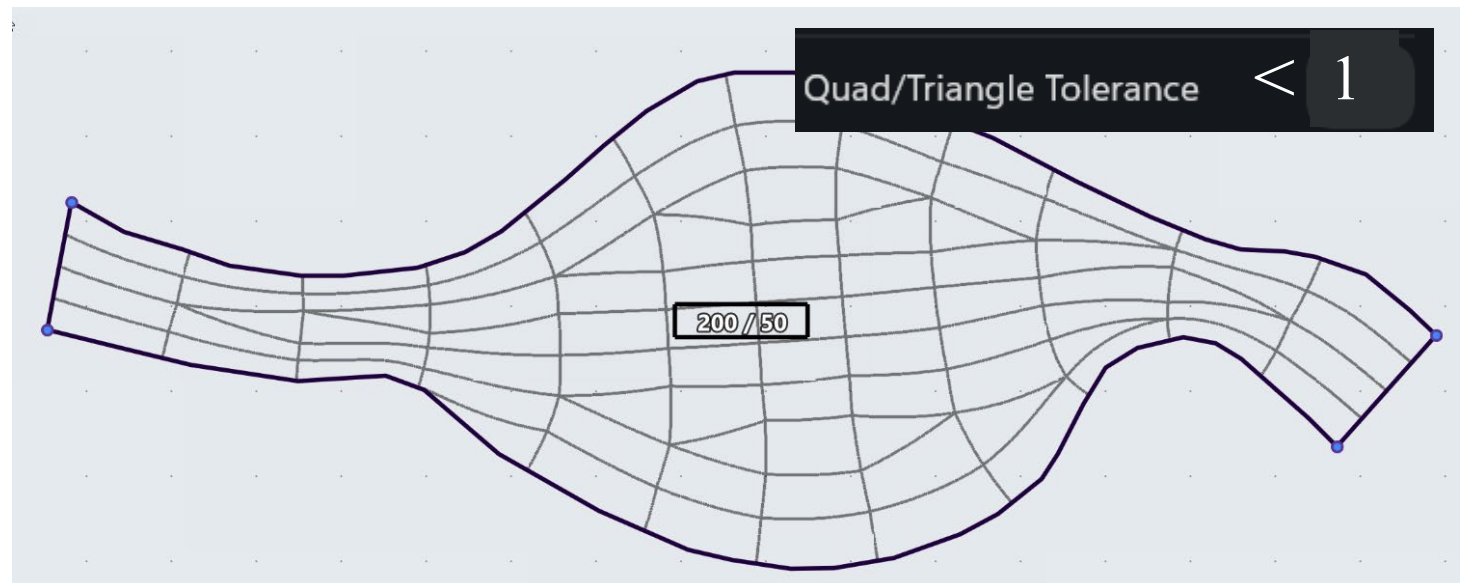
<1 Split quads into triangles

□ Quad/Triangle Tolerance

- 1 = Favor maintaining quads over cell size

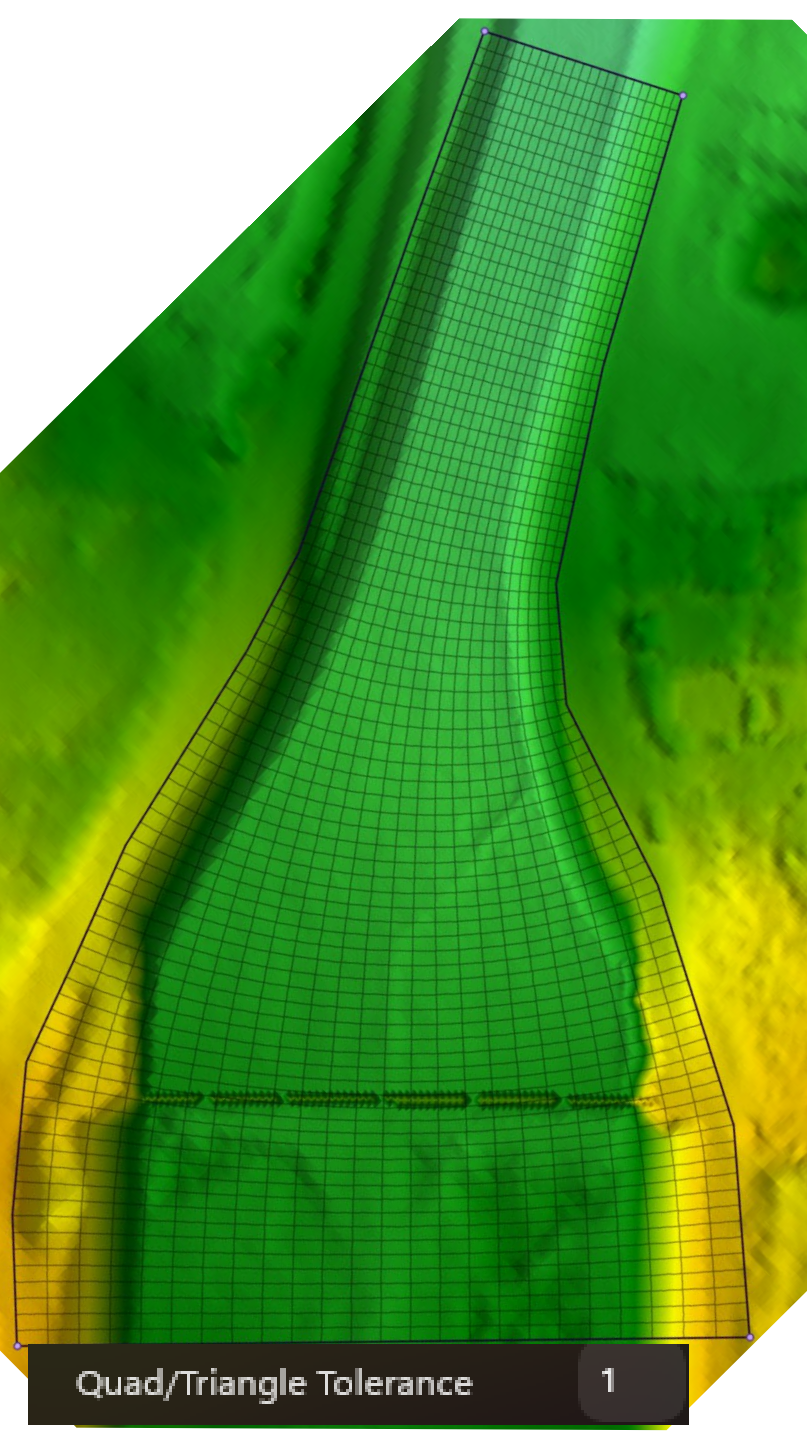
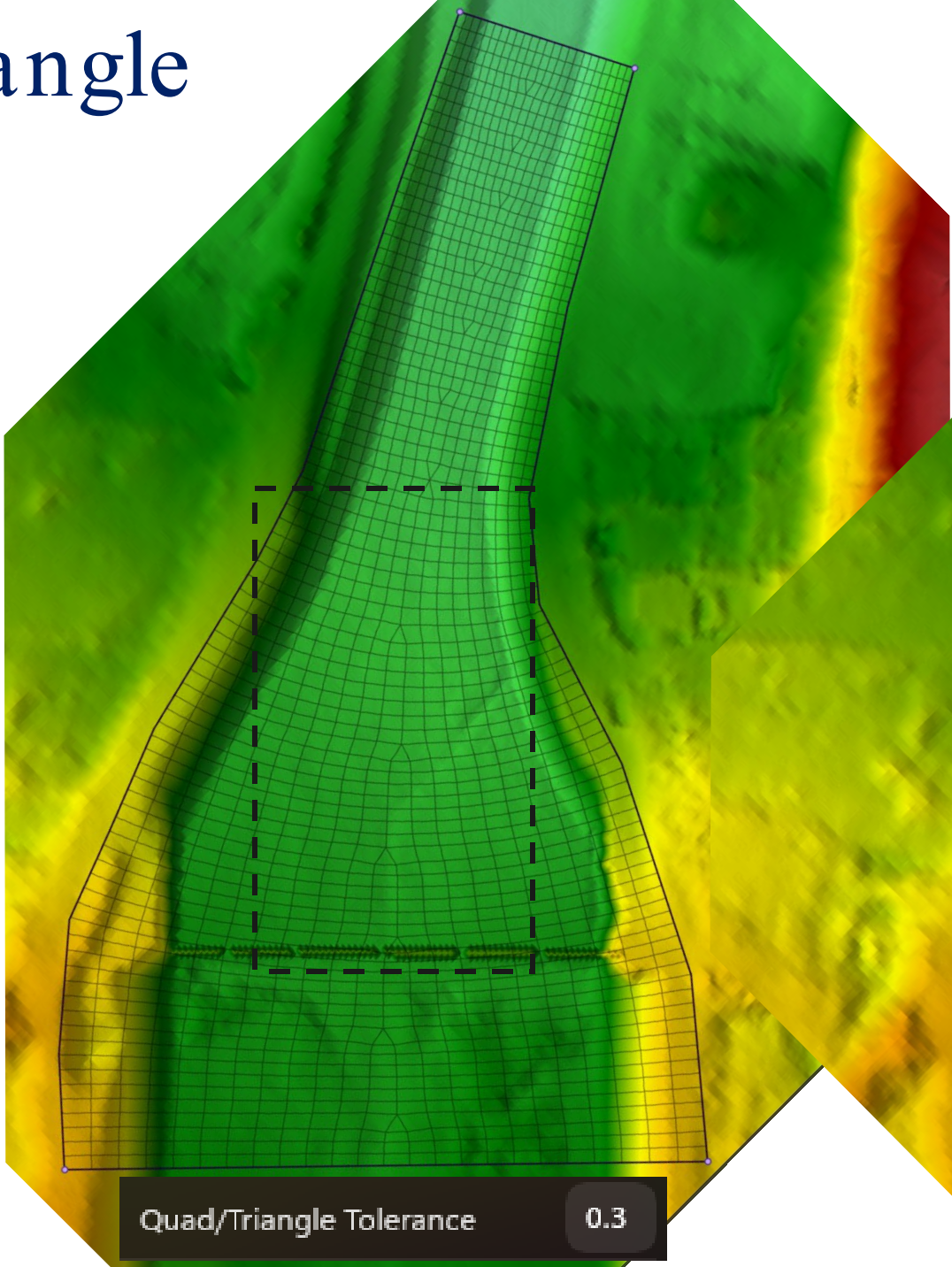
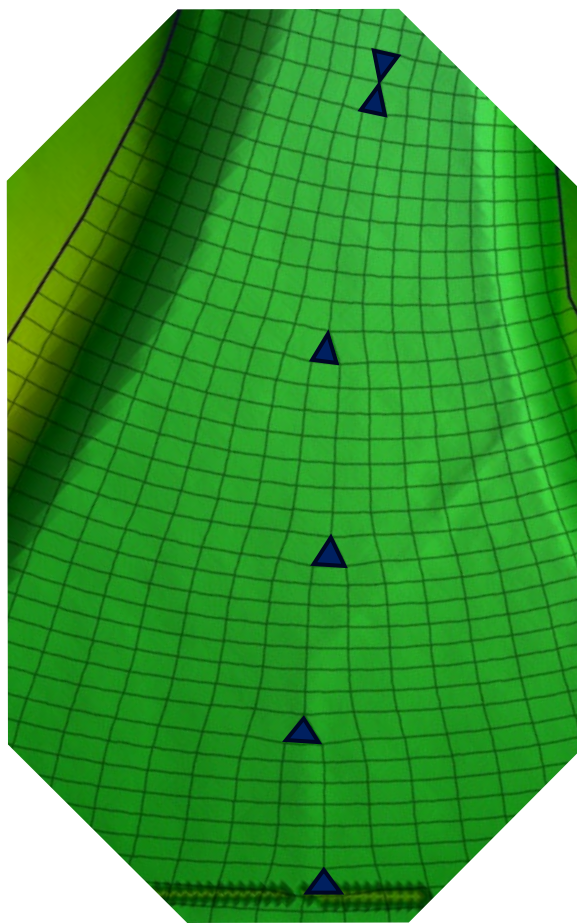


- < 1 Favours maintaining cell size over quads







Quads/Triangle Tolerance








△ Triangular Region Options



General Arcs **Regions** Nodes

Search... 

 Region 0

 Tags  

 Properties 

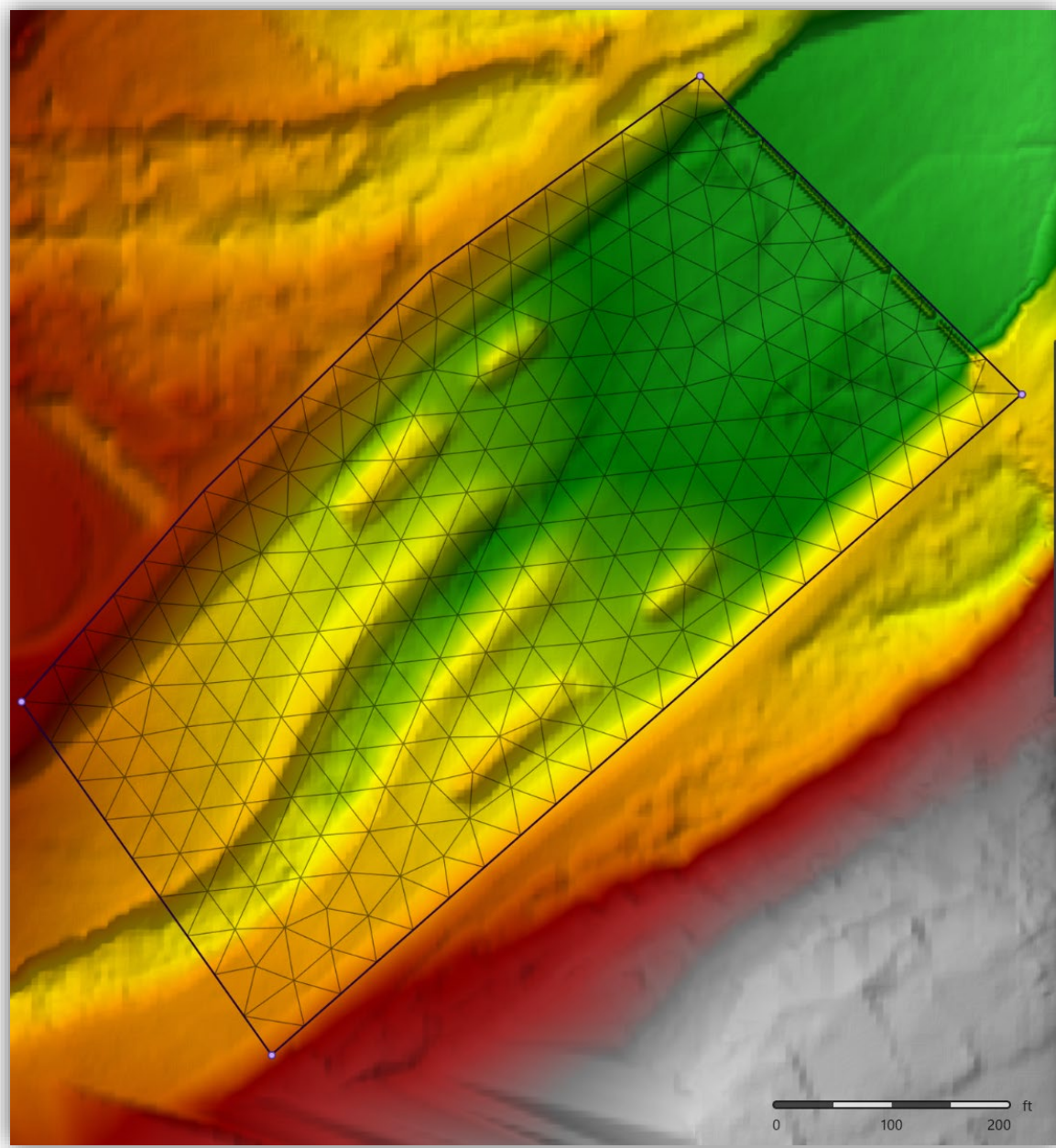
Cell Type  Triangular 

Cell Size 25

Secondary Cell Size

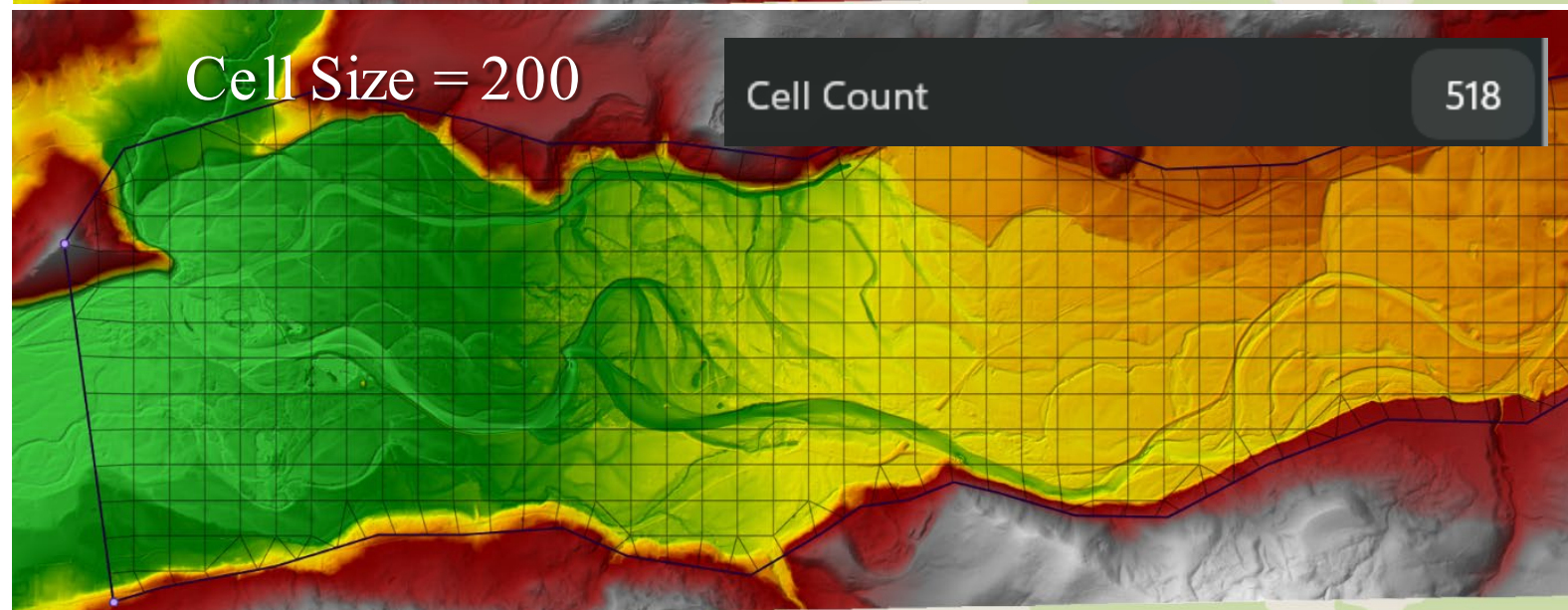
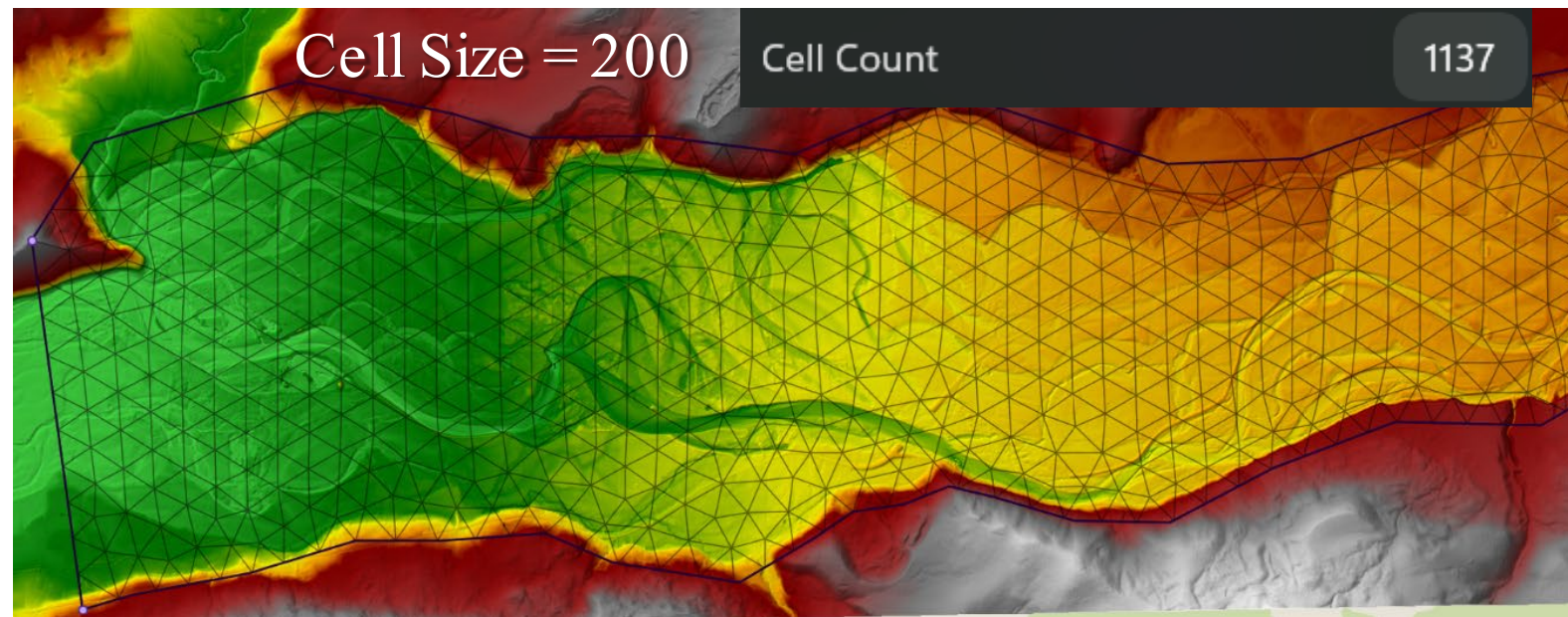
Cell Stretching Rate 0.1

Post Processor Options Default()

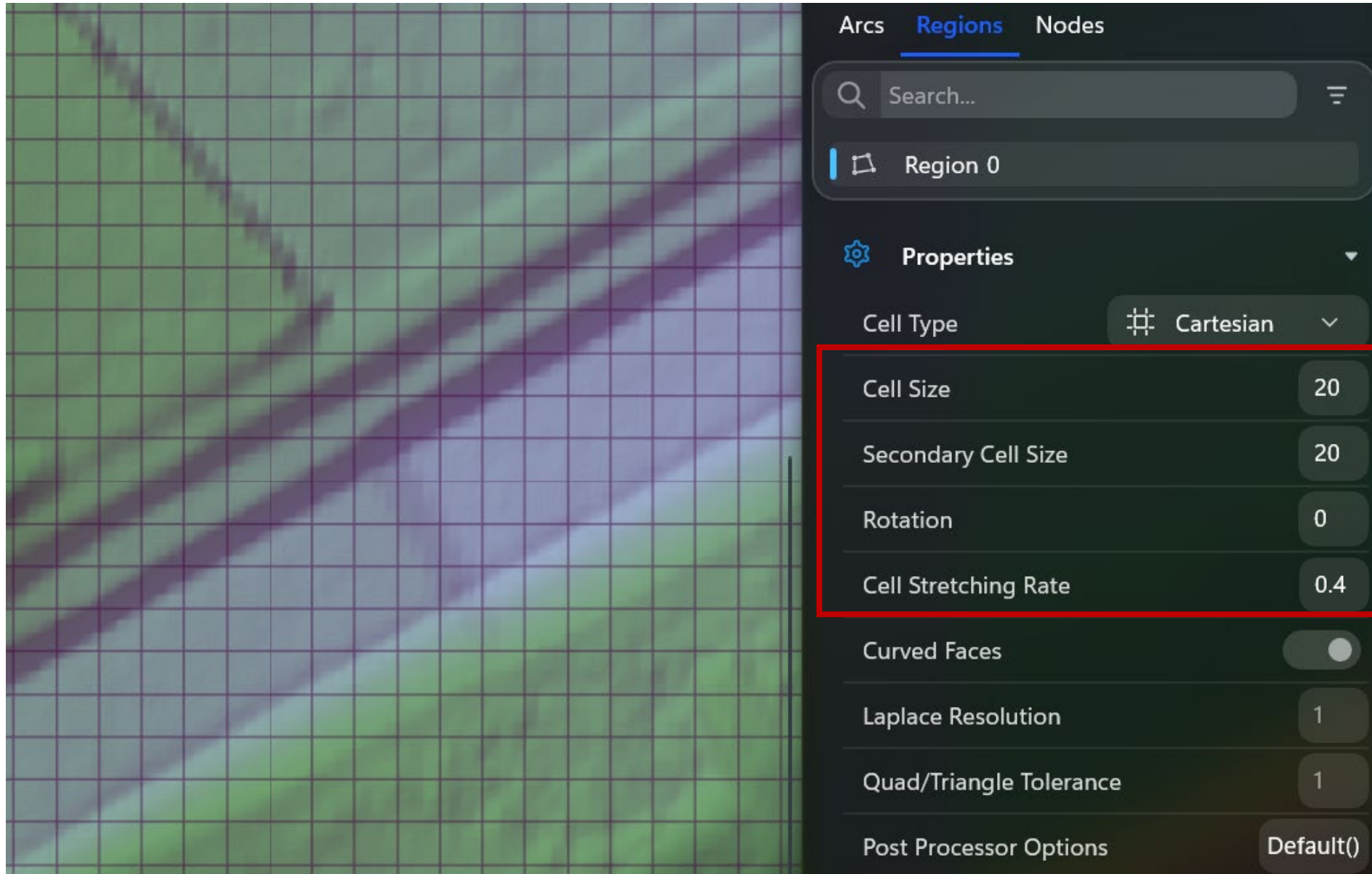


△ Cell Size is Length of Side

- Cell size is the length of the side
- 2x more triangle cells for same size cartesian
- # of cells is a better measure of “cell size”



Cartesian Tools



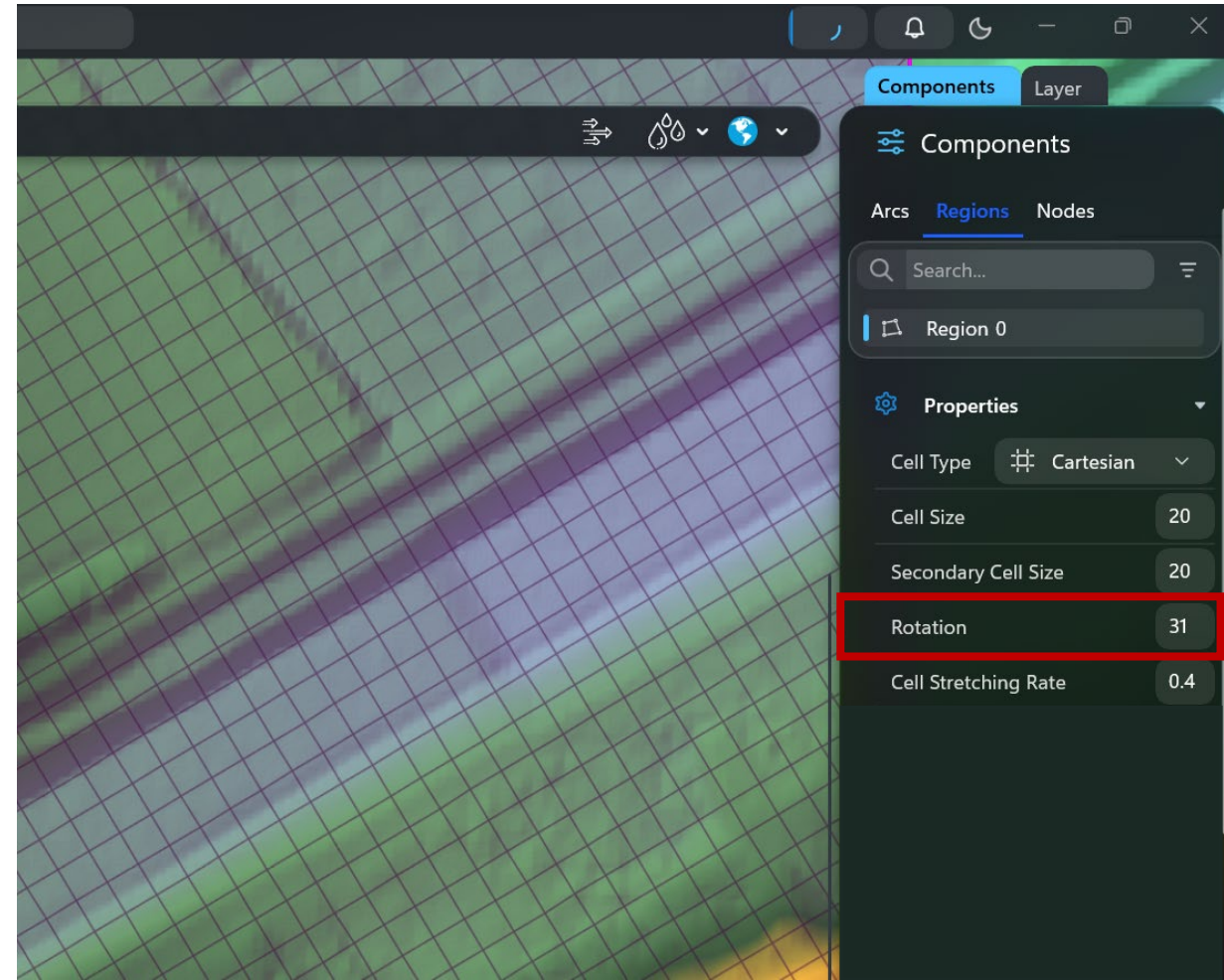
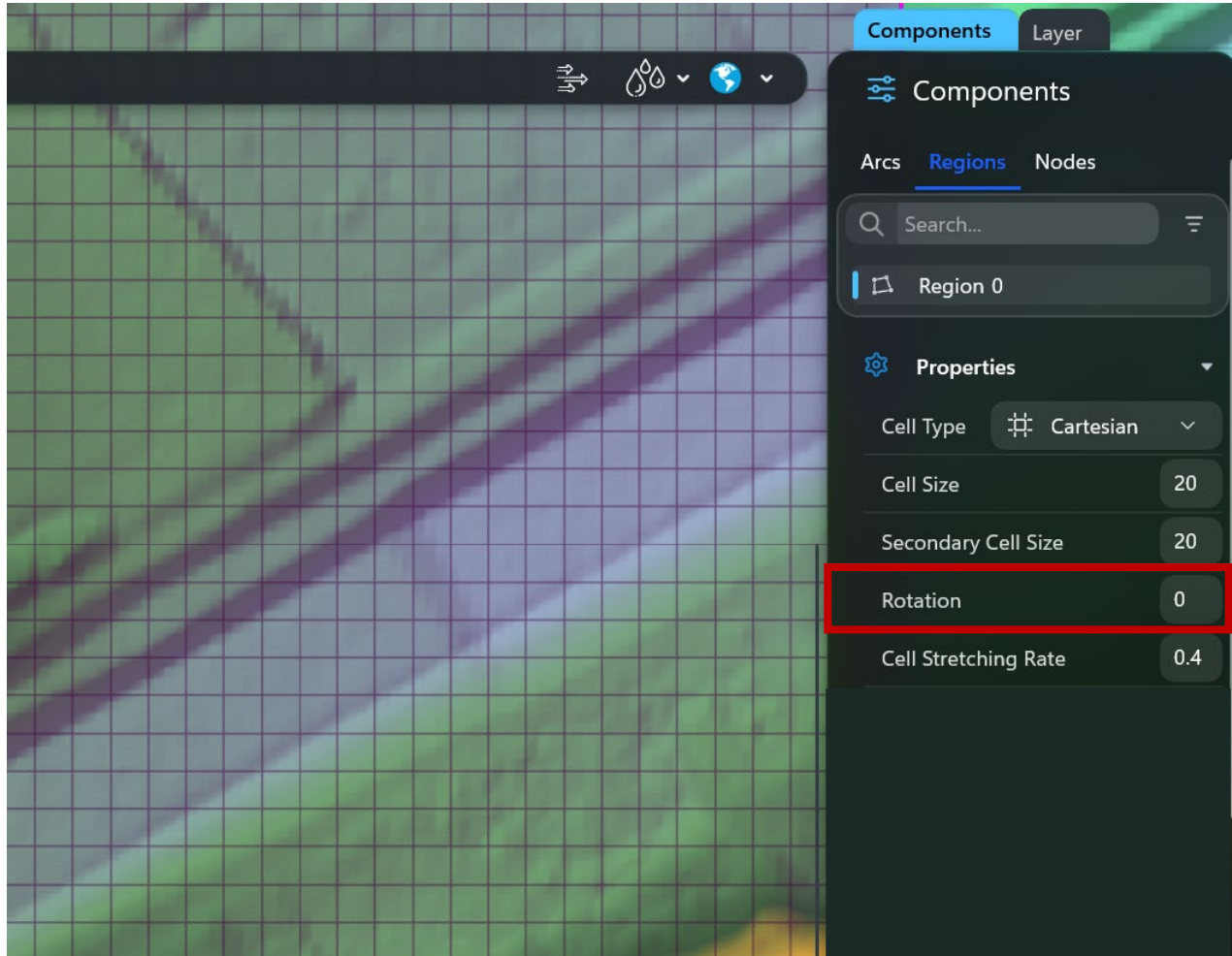
The image shows a software interface with a grid overlay on a terrain map on the left and a settings panel on the right. The settings panel is titled "Regions" and includes a search bar, a region selector for "Region 0", and a "Properties" section. The "Cell Type" is set to "Cartesian". A red box highlights the following settings:

Property	Value
Cell Size	20
Secondary Cell Size	20
Rotation	0
Cell Stretching Rate	0.4

Other settings visible in the panel include "Curved Faces" (disabled), "Laplace Resolution" (1), "Quad/Triangle Tolerance" (1), and "Post Processor Options" (Default()).

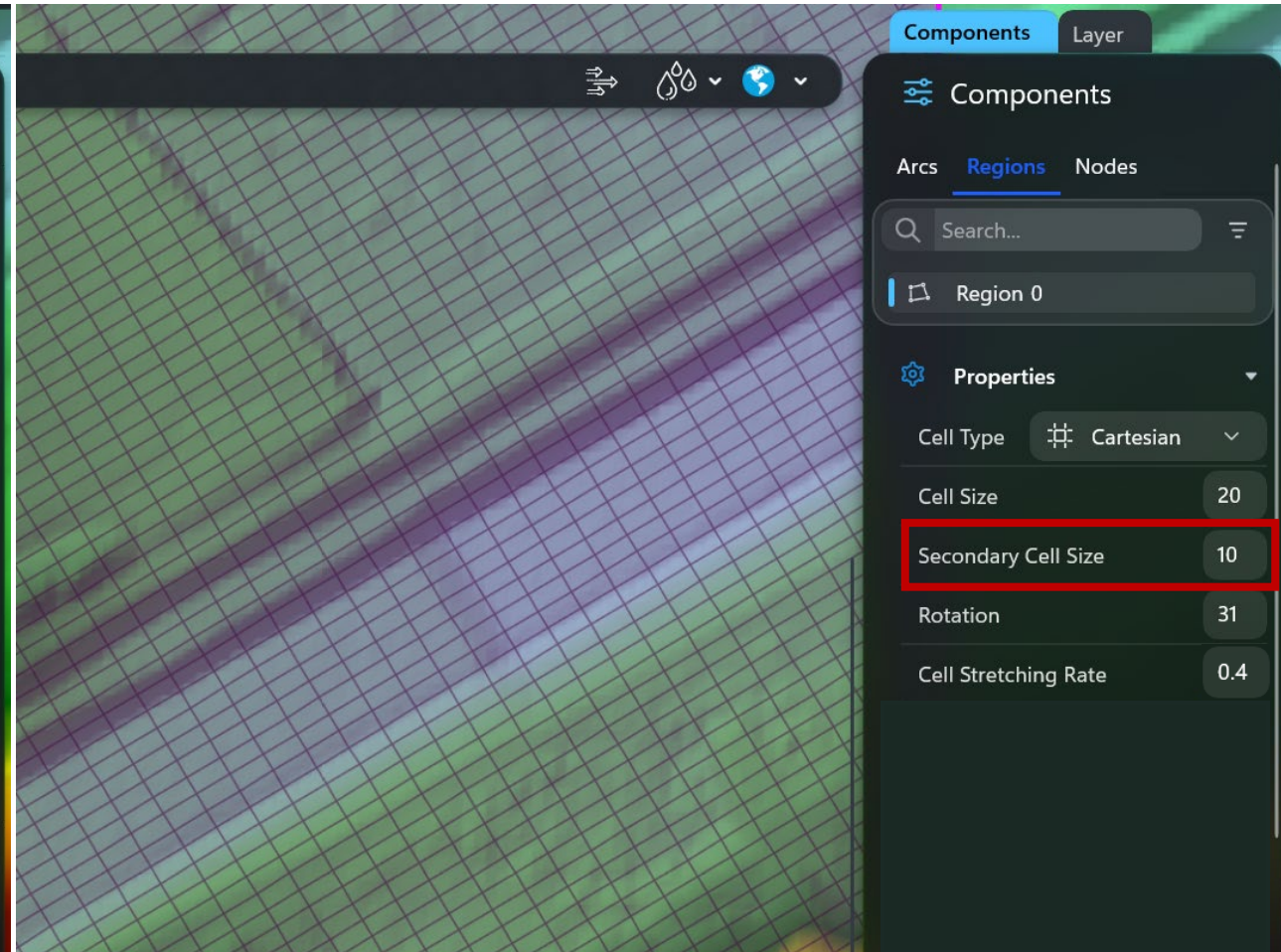
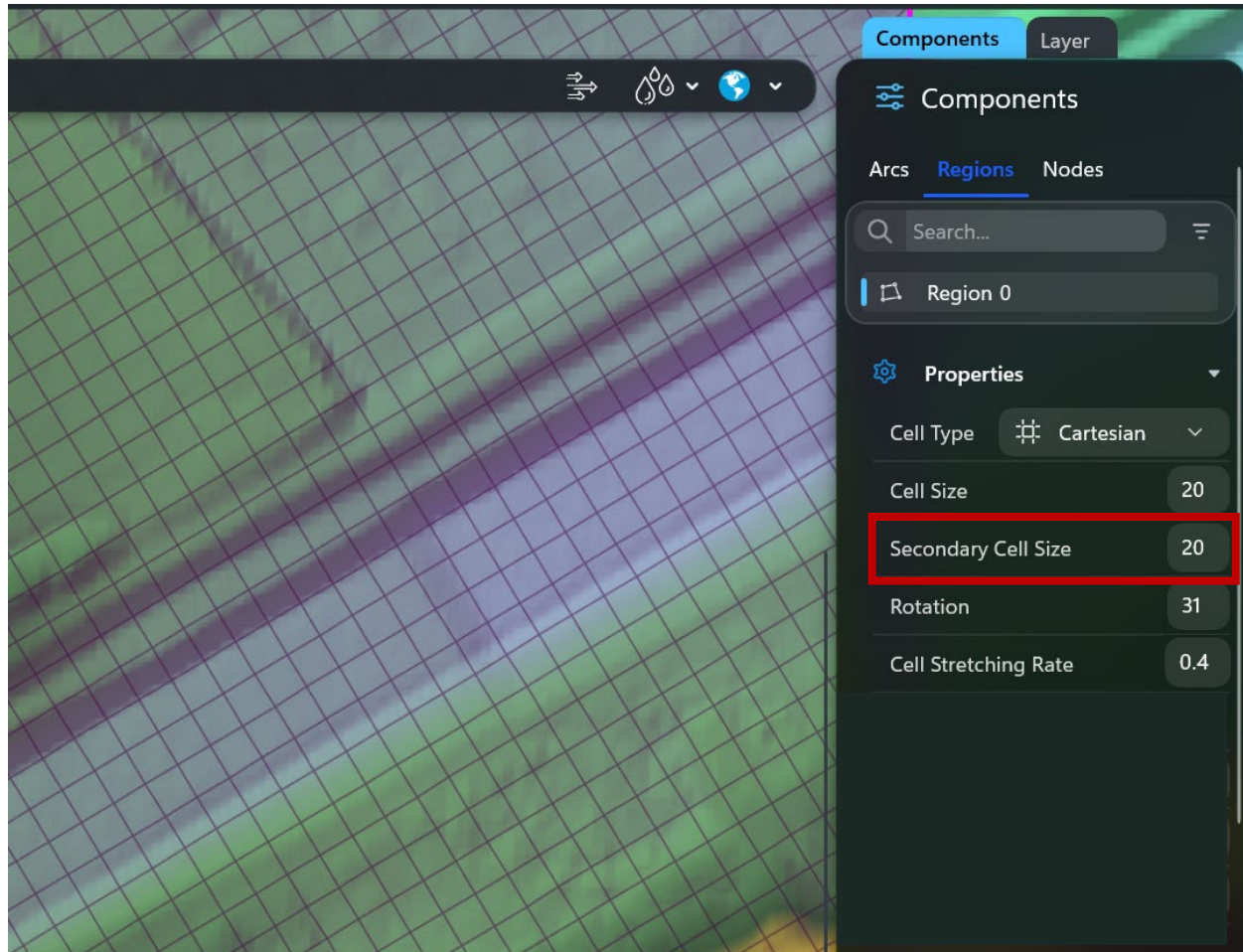


Cartesian Tools: Rotation Angle





Cartesian Tools: Secondary Cell Size

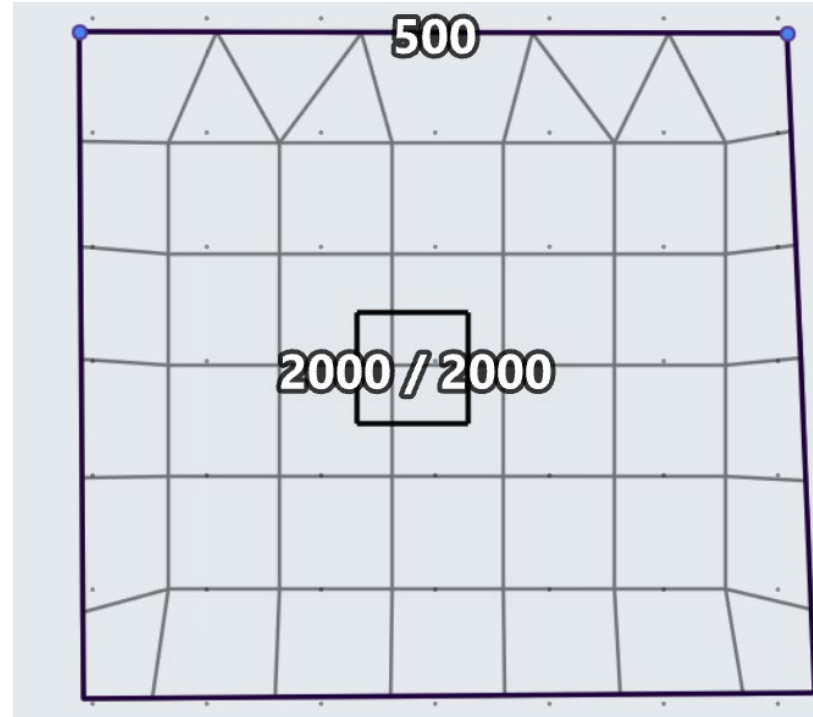


Allows asymmetrical cells



Cartesian Edges

- Cartesian-only regions have a single cell size
- They do not stretch in response to different cell sizes specified on one or more edge



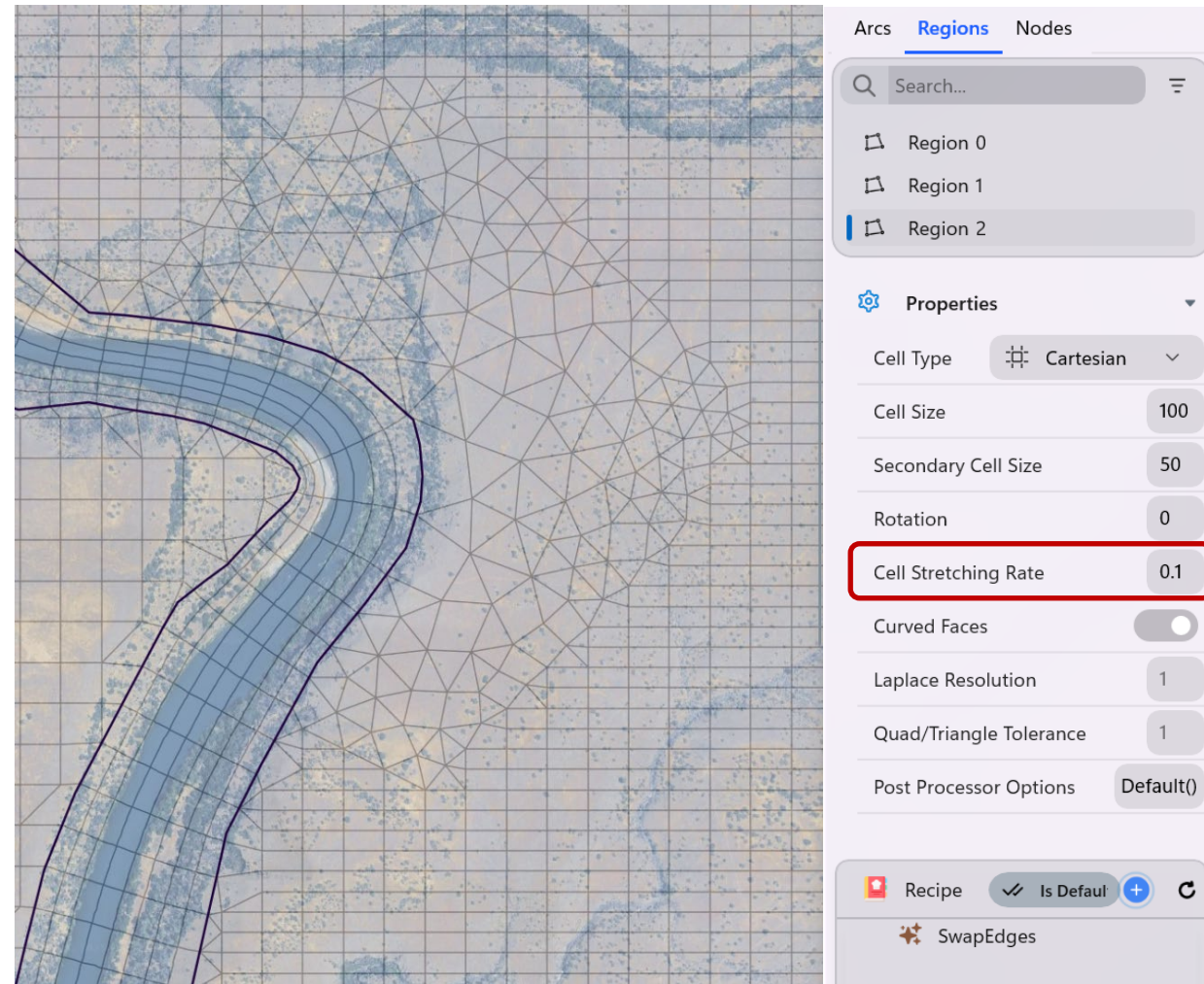
Properties

Cell Type	Cartesian
Cell Size	200
Secondary Cell Size	200
Rotation	0
Cell Stretching Rate	0.1
Post Processor Options	Default()

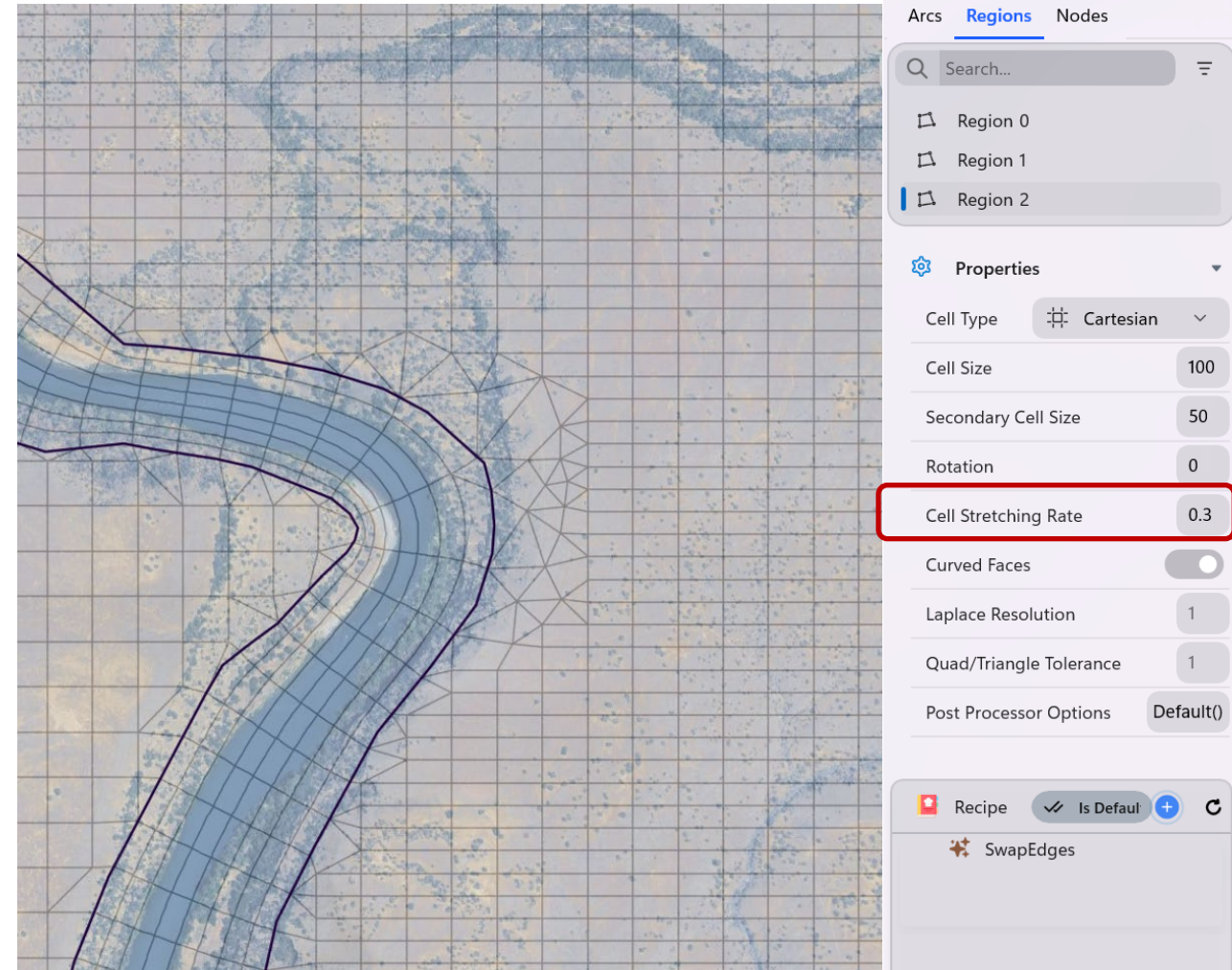


Cartesian Transitions

- The stretching rate does control transitions to Quad channels



Lower Stretching Rate → More Gradual Transition



Higher Stretching Rate → More Abrupt Transition



Cartesian Transitions

The image displays a mesh transition interface. The main area shows a mesh transitioning from a triangular mesh on the left to a Cartesian grid on the right, separated by a vertical yellow line with arrows. A tooltip indicates a 'Constant Size 20' with a $\frac{1}{2}$ to 2 ratio. The right sidebar shows the 'Regions' tab with 'Region 0' and 'Region 1'. The 'Properties' section for 'Cartesian' cells includes:

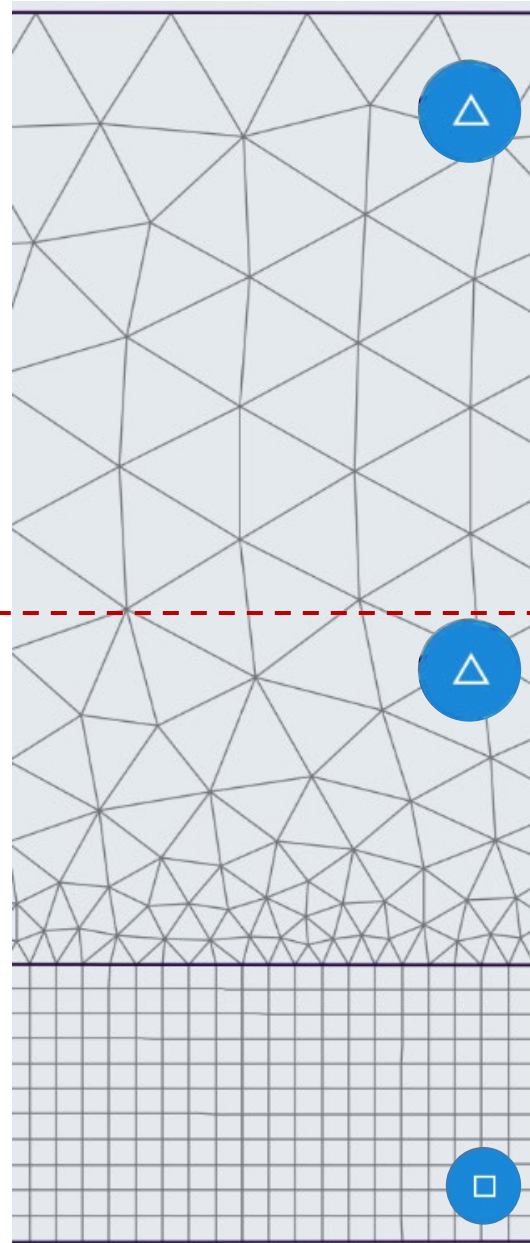
- Cell Type: Cartesian
- Cell Size: 20
- Secondary Cell Size: 20
- Rotation: 0
- Cell Stretching Rate: 0.4
- Curved Faces:
- Laplace Resolution: 1
- Quad/Triangle Tolerance: 1
- Post Processor Options: Default()

At the bottom, the 'Recipe' section shows 'SwapEdges'.



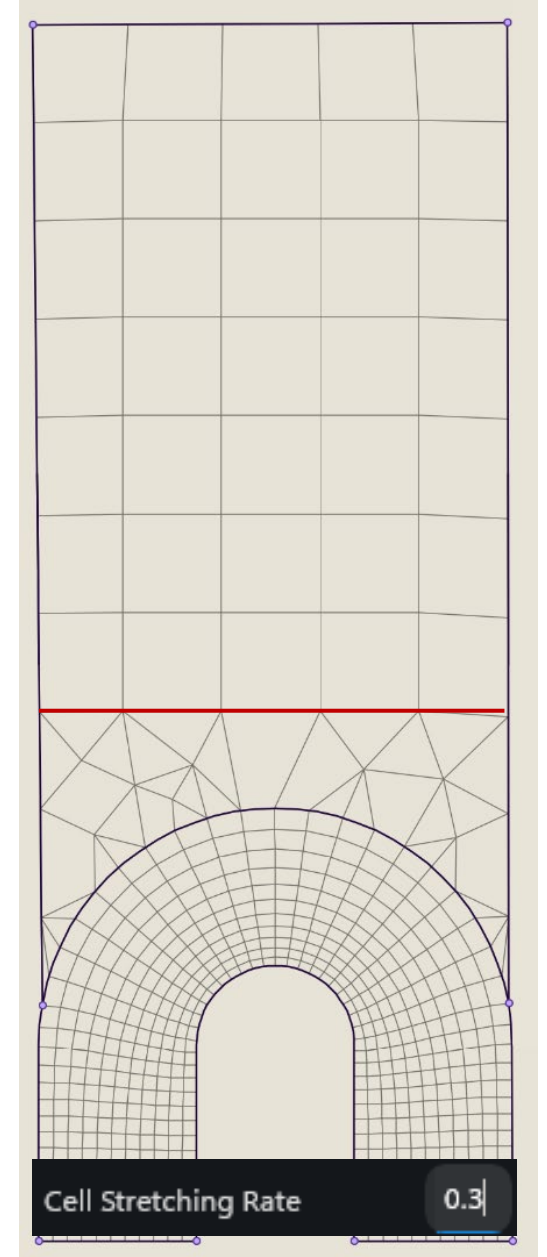
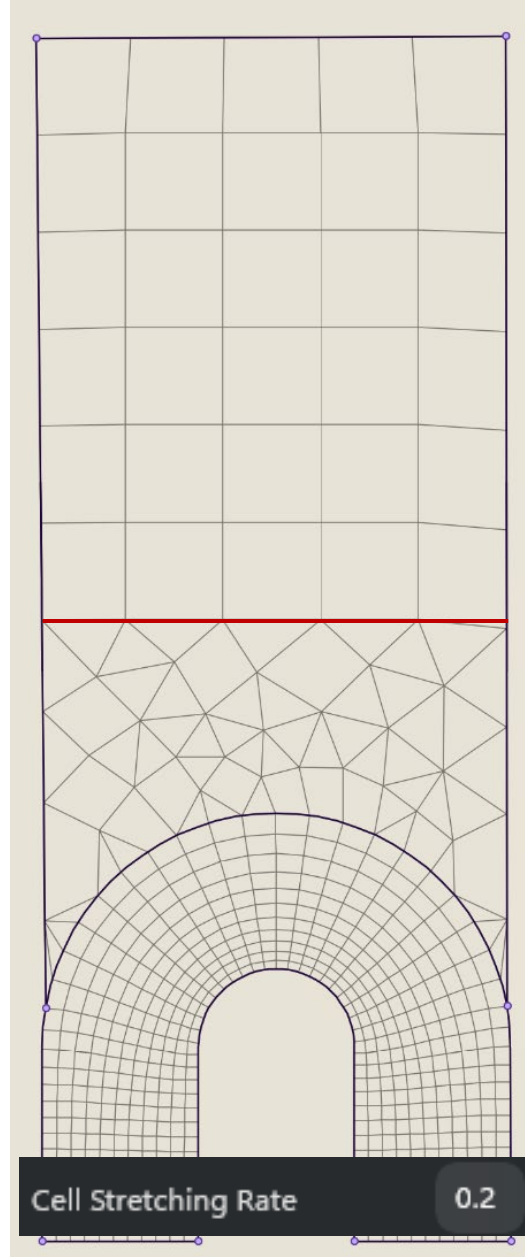
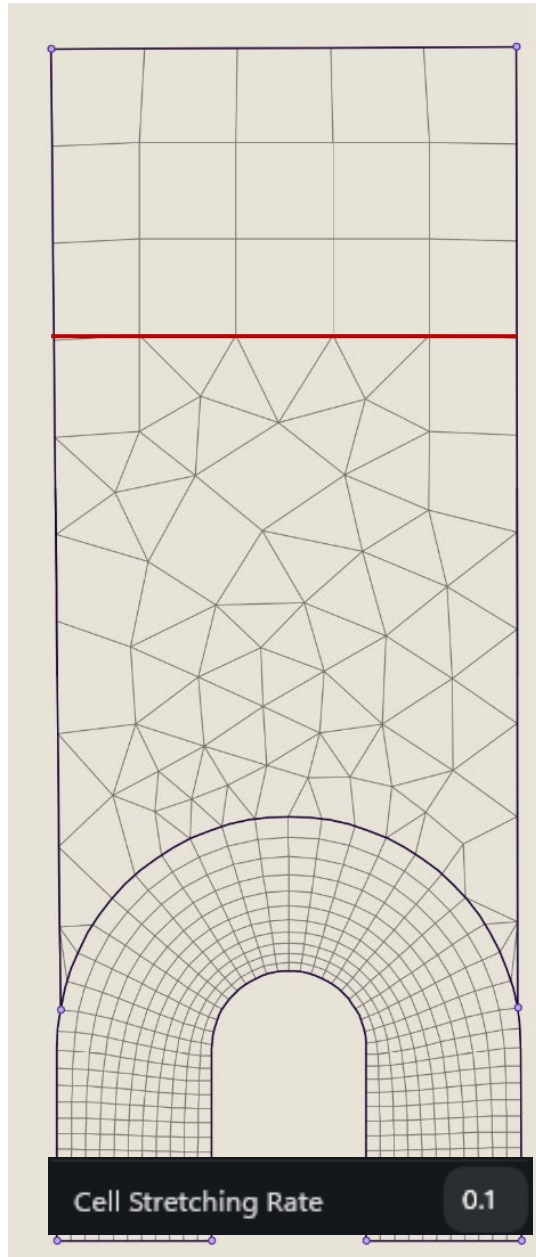
Cell Stretching Ratio

- Higher Stretching Ratio \rightarrow More Abrupt Transition
- Lower Stretching Ratio \rightarrow More Gradual Transition





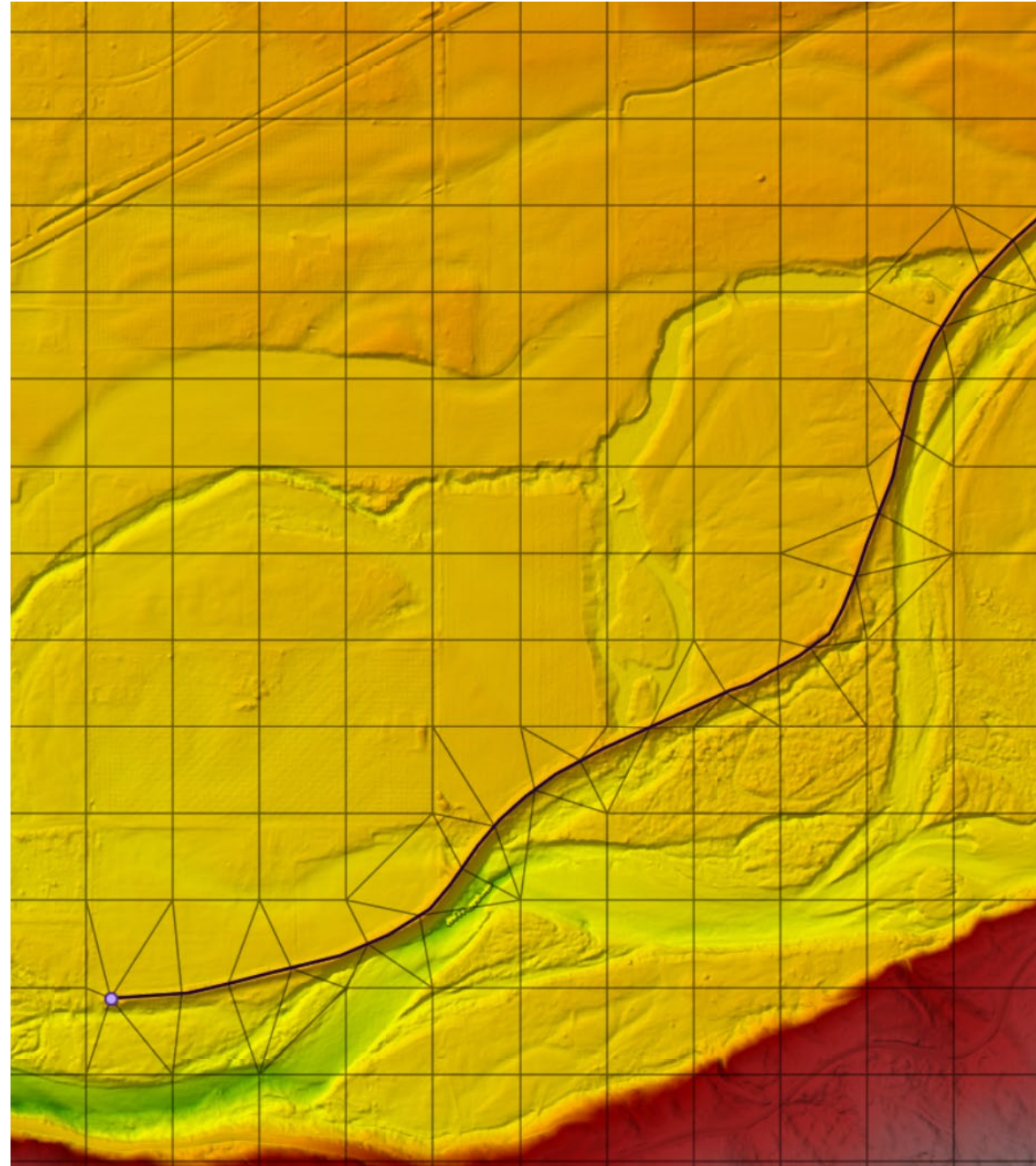
Cell Stretching Ratio





Triangles Around Arcs

- Cartesian regions will use triangles to accommodate internal and bounding arcs





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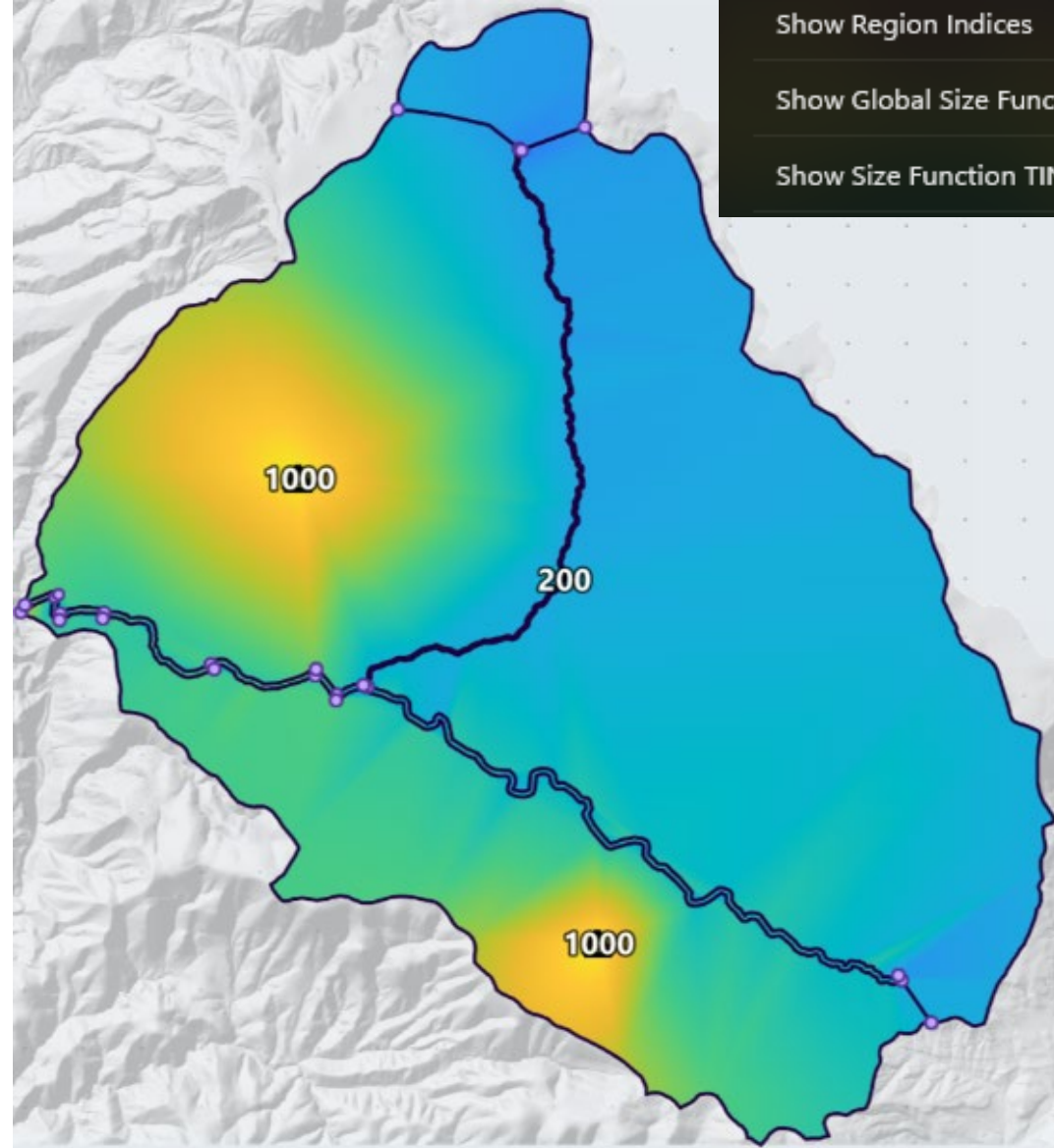
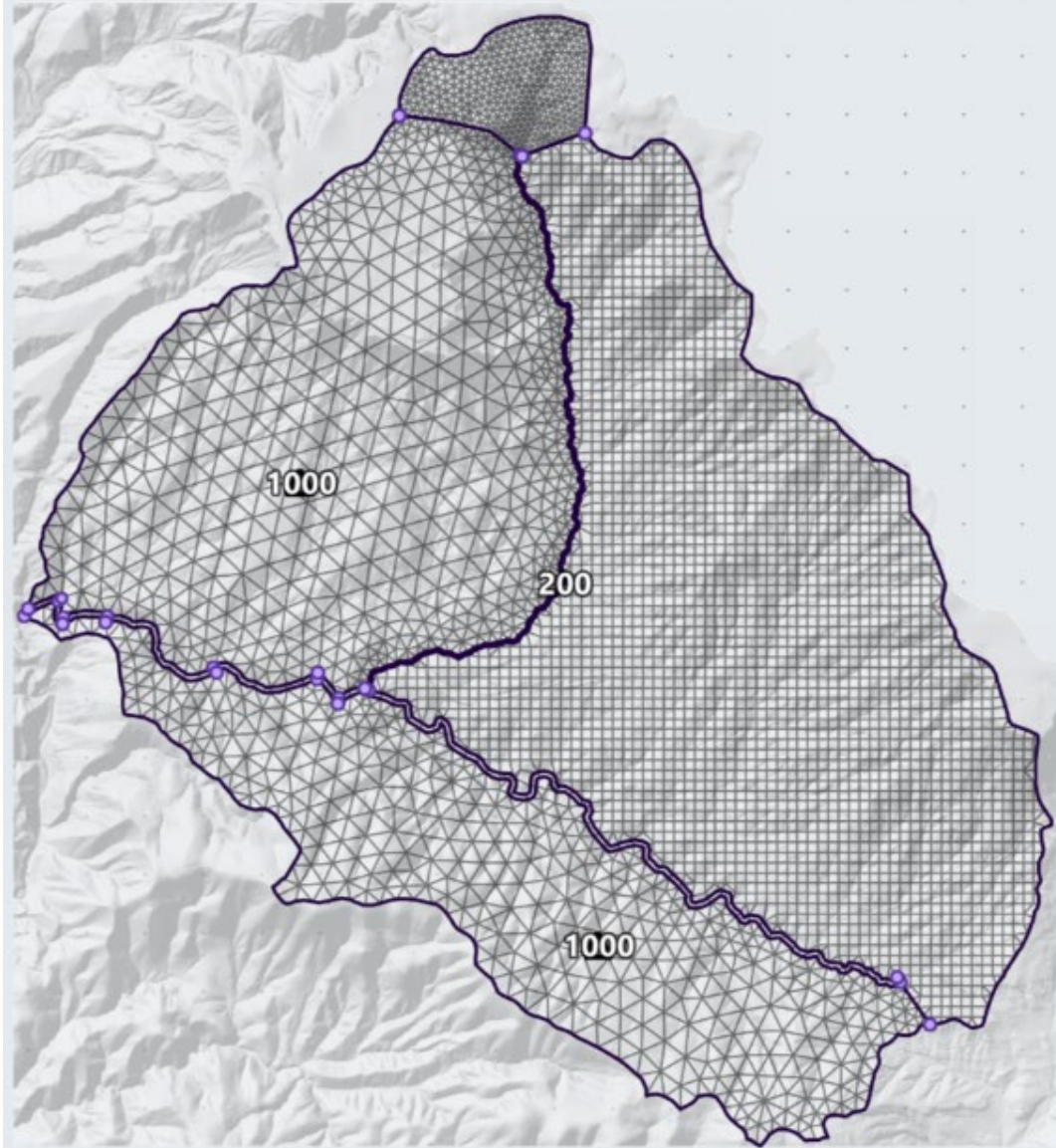
3. Application and Parameters Mesh Types

1. Quads 3. Cartesian

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Cool Diagnostics

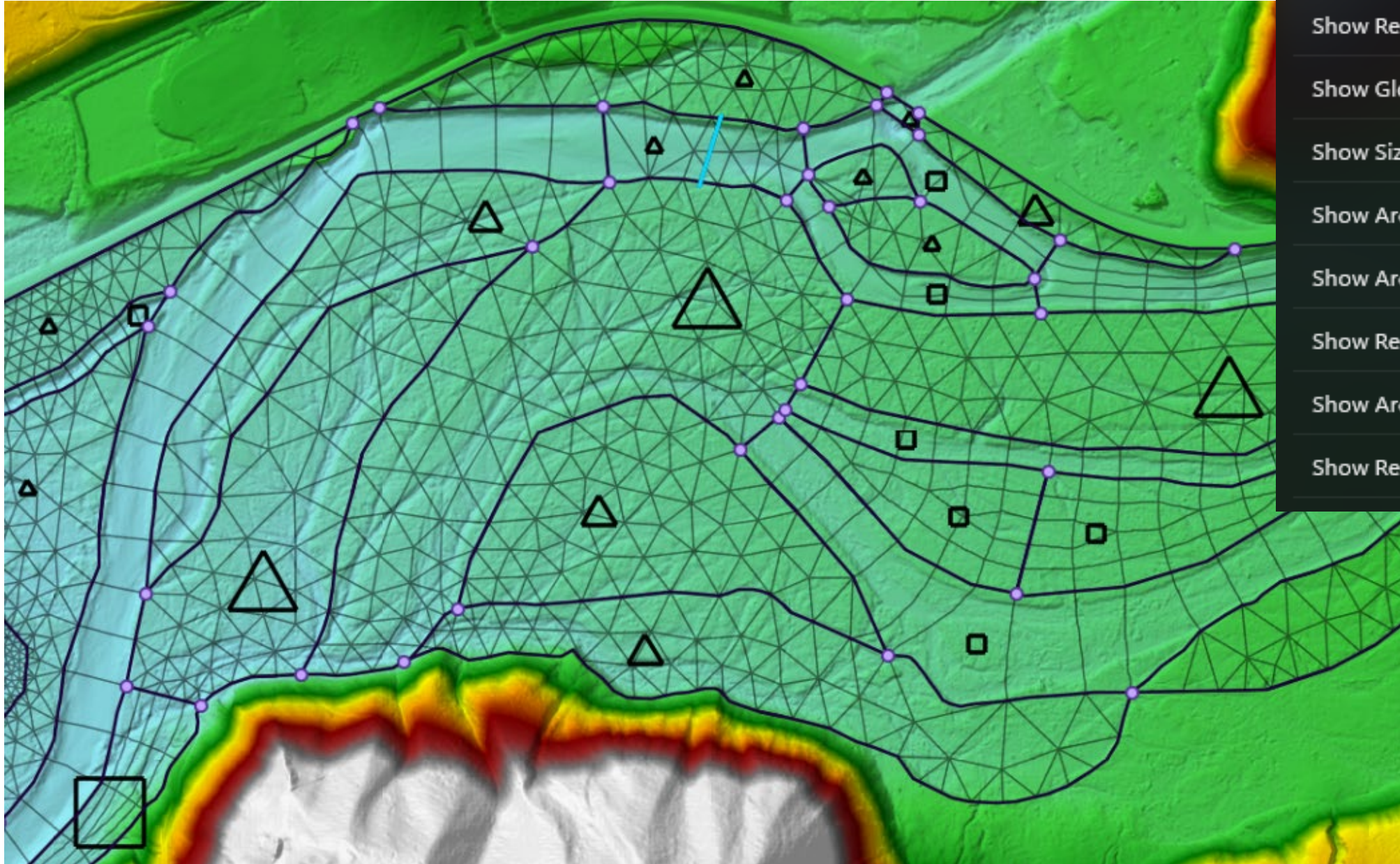




Additional Options

- Show Arc Indices
- Show Region Indices
- Show Global Size Function
- Show Size Function TIN



More Cool Diagnostics



 Additional Options 

- Show Arc Indices
- Show Region Indices
- Show Global Size Function
- Show Size Function TIN
- Show Arc Direction Arrows
- Show Arc Cell Sizes
- Show Region Cell Sizes
- Show Arc Vertices
- Show Region Size Previews