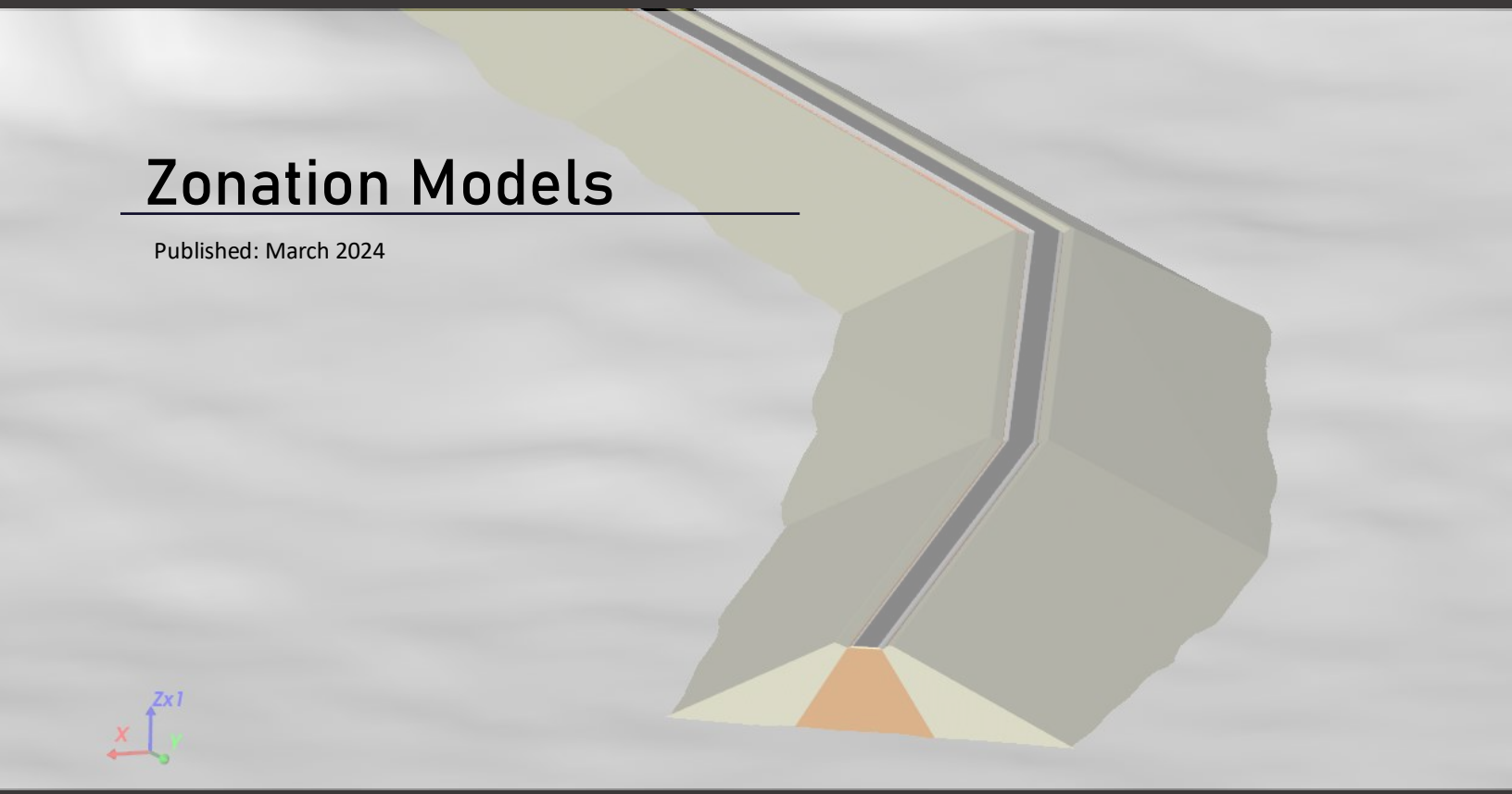
MLK 3D

Formation

Zonation Models

Published: March 2024



Contents

Introduction

The Zonation tools, within *Muk3D – Formation,* gives users the ability to quickly create and work with customizable surface models. The *zonation* models are designed to incorporate multiple material types, components, and complex structure configurations through an easy-to-use graphical editor.

Example zonation design

This document will go through the process of building and working with the final road design, shown in cross-section, in Figure 1 below:

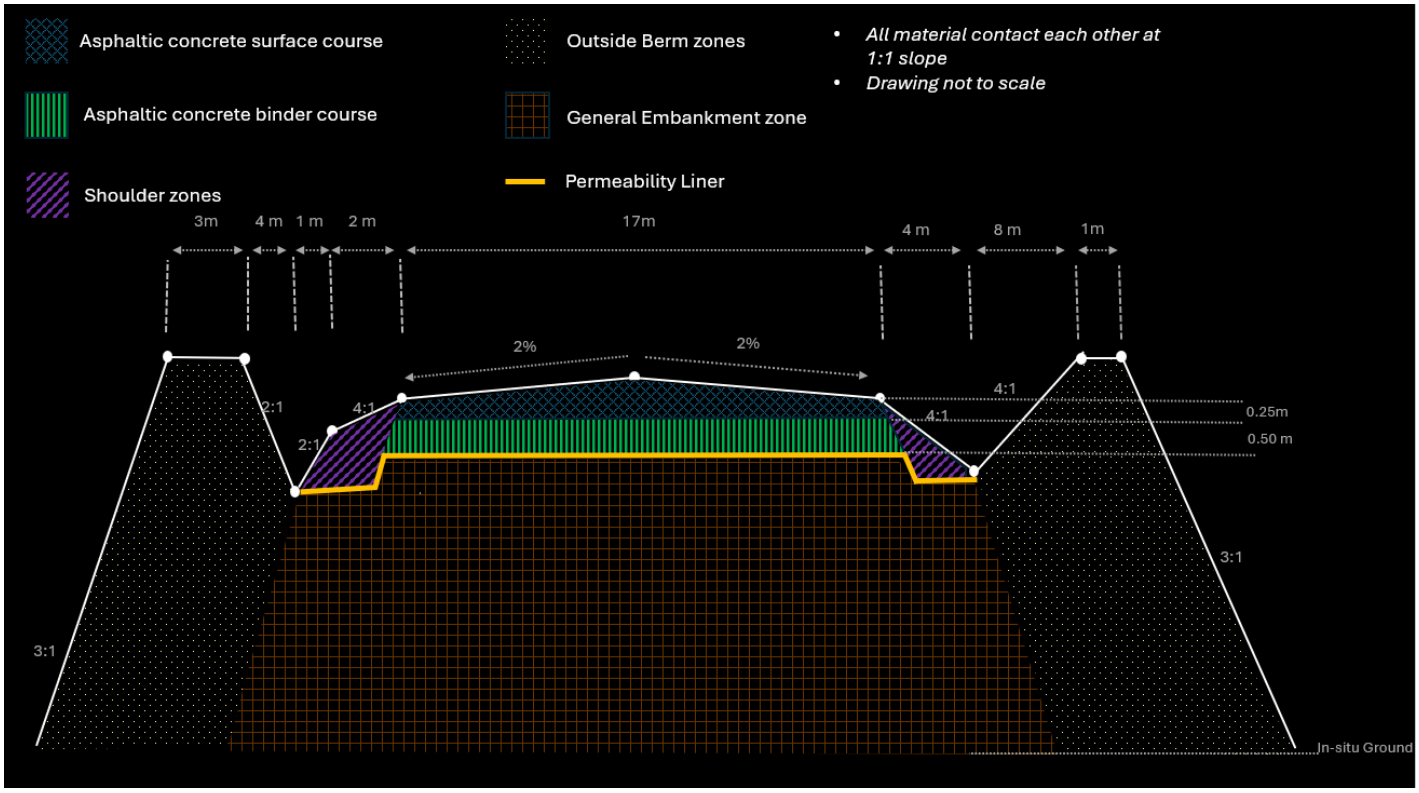


Figure 1: Road Cross-Section final design

As can be seen, this design presents a complex surface configuration and composition that includes a crowned running surface, ditching, berms, five material types and a permeability liner.

Graphical Zones Editor: Offsetting Nodes

To introduce the design detail shown in Figure 1 into *Formation*, begin by making the **Zonation** tools visible through **Showing all Commands.** Hit the hotkey located on the right-hand side of the top ribbon:

*Please note, this step is only necessary in the 2024 *Formation* release. The 2023 iteration has all commands visible.

Next, under the **Zonation** menu select **Graphical zones editor (Figure 2)**

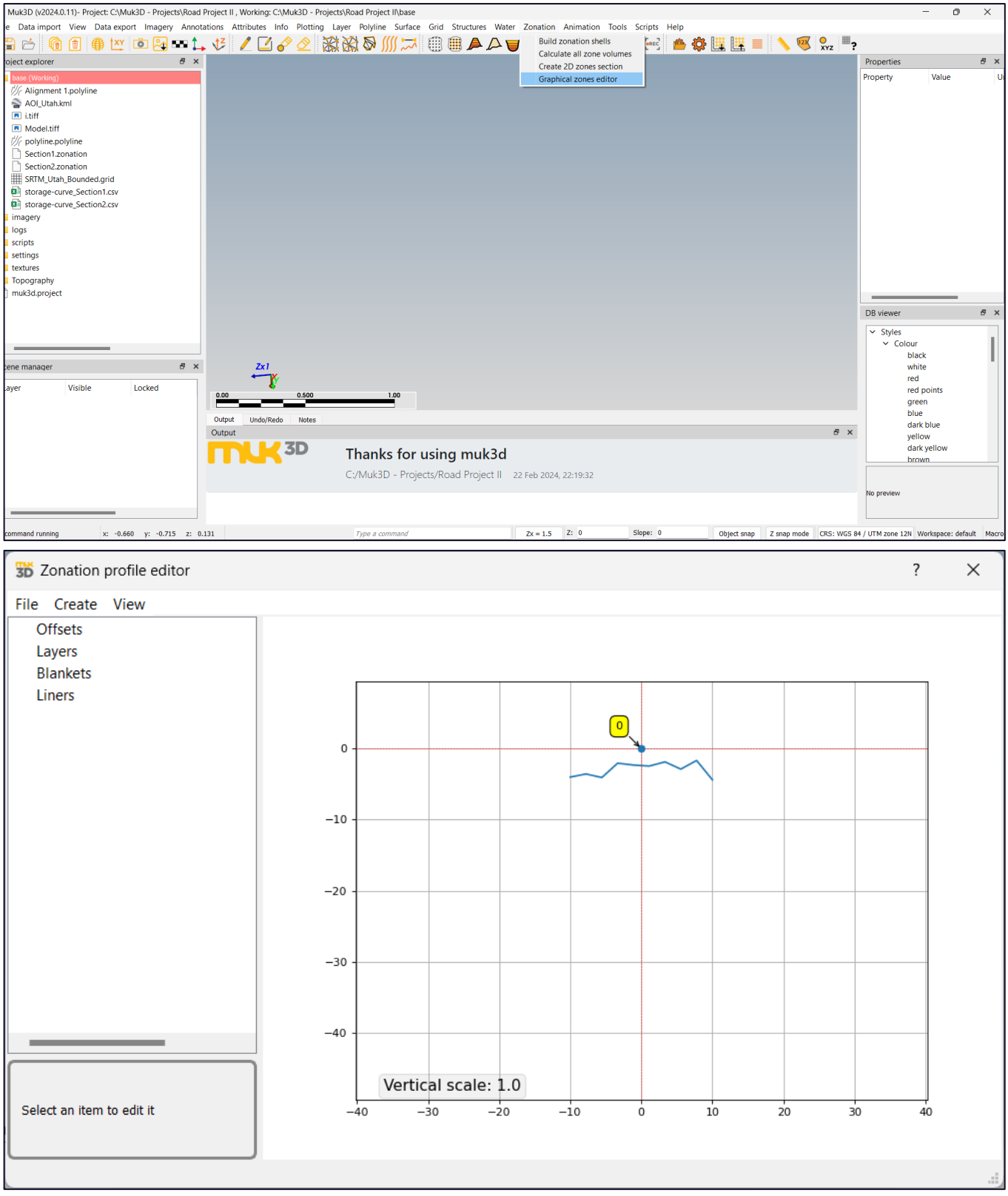
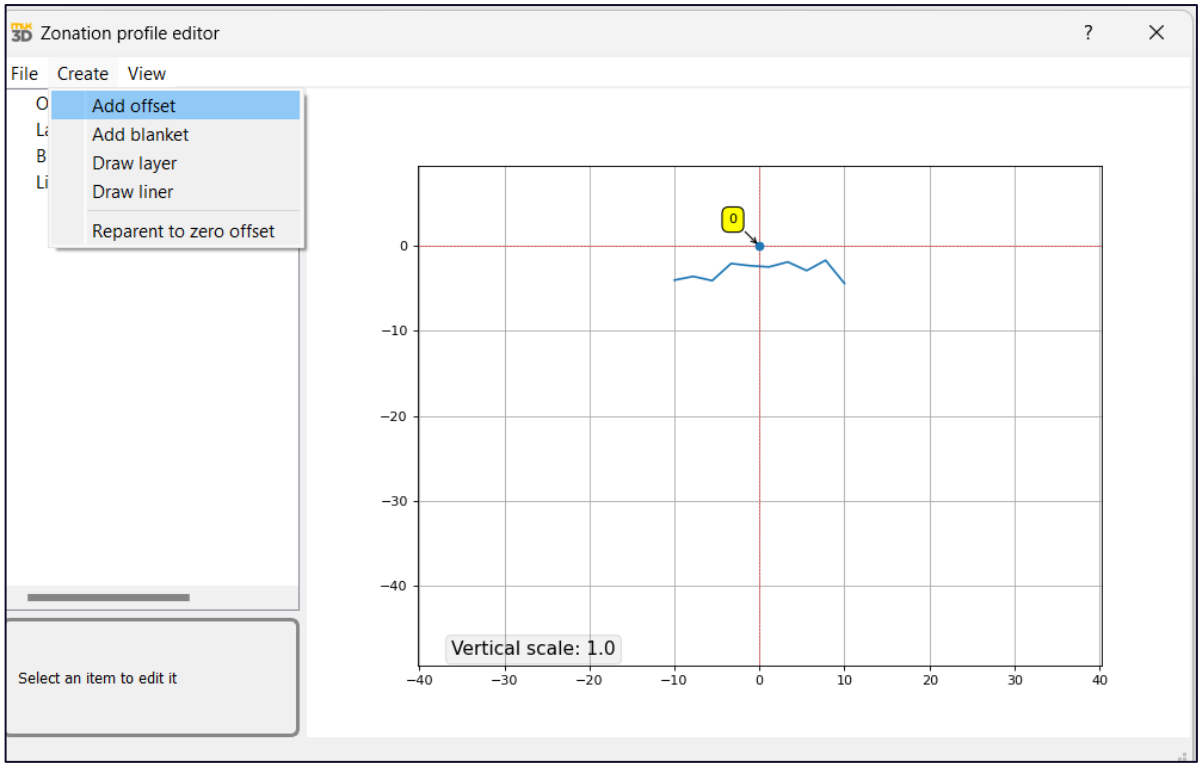


Figure 3: Graphical zones editor

Different offset nodes need to be defined to reconstitute the design of Figure 1. Everything will be defined relative to Node #0, which in this case is the centerline of the road.

Within the Zonation profile editor select **Create** then **Add offset** (Figure 3)



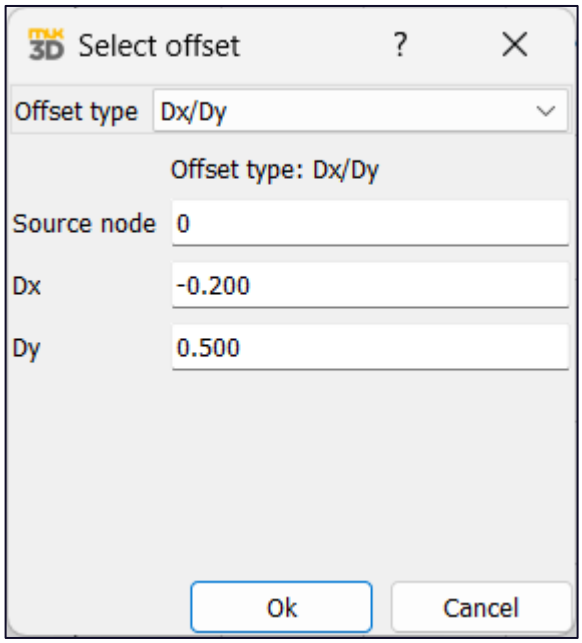


Figure 4: Offsetting nodes

Click on Node 0 with your cursor. Nodes can initially be placed 'manually', by holding down the left mouse button, after selecting the source node, and placing the subsequent node with your cursor.

Once you let go of the left mouse button, a window with multiple types of options for offsetting the nodes from each other will appear. This will show you the current position of the new node from the source node which you can edit. My favorite is the straightforward Dx/Dy, which is defined, in meters, by the horizontal and vertical distance between the nodes.

Knowing that Node 0 is the centerline, we will begin by creating the nodes on the shoulders of the 2% crowned running surface seen in Figure 1. The crowned running surface is 17m wide with a -2% slope running from the centerline.

As a result the shoulders will be:

- Dx = 8.5m from Node 0
- Dy = 8.5m * - 2% = - 0.17m from Node 0.

This will create a **Node 1** on the right hand side of your centerline. To create a **Node 2** on the left hand side of your centerline, **click on Node 0 again** and this time use a negative Dx value and the same Dy value as for **Node 1:**

- Dx = - 8.5m
- Dy = - 0.17m

Your X-section should look like Figure 4 below:

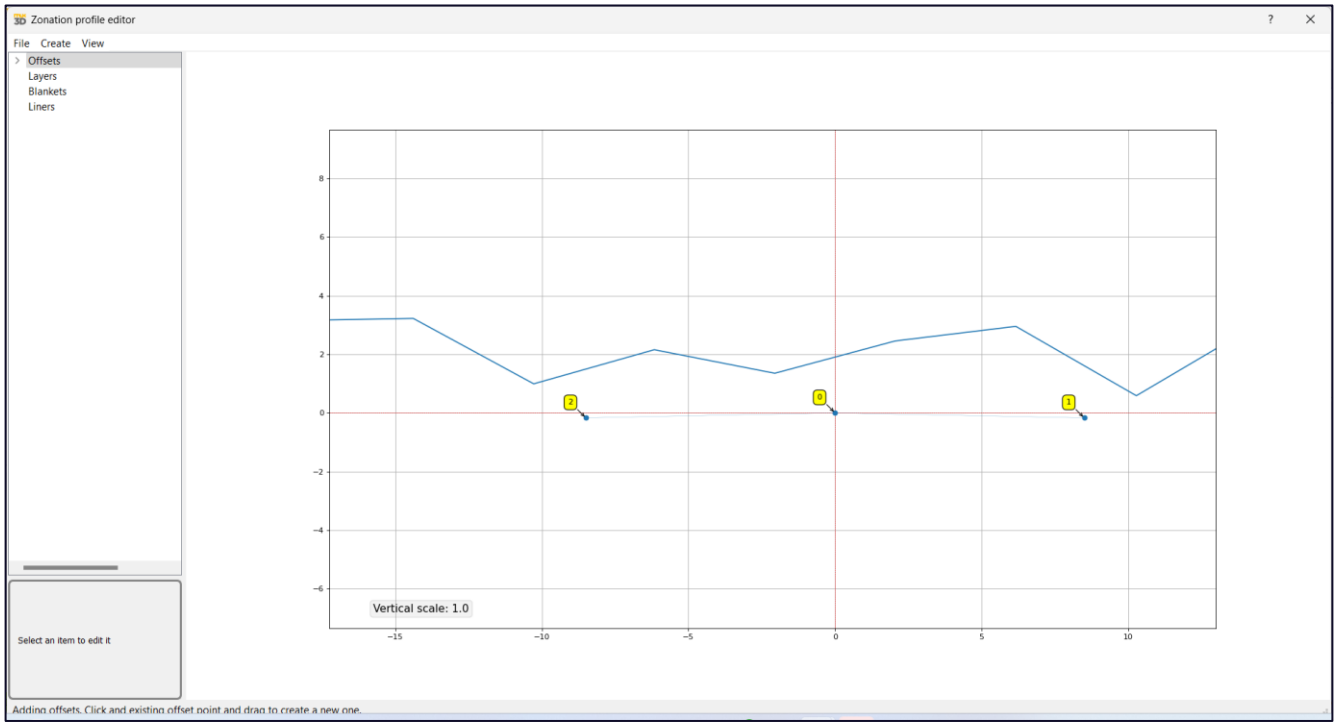


Figure 5: Nodes 0, 1 and 2

Lets complete the right-hand side of the design by adding **nodes 3, 4, 5 and 6**. As per Figure 1, **Node 3** will be offset from Node 1, such that:

- Dx = 4m
- Dy = 4m * - 1/4 slope = - 1m

Node 4 will be offset from Node 3, such that:

- Dx = 8m
- Dy = 8m * 1/4 slope = 2m

Node 5 will be offset from Node 4, such that:

- Dx = 1m
- Dy = 0m

Node 6 will be offset from Node 5, such that the design surface generated has enough heigh to it to always cut below the base topography. As a result, it is advisable to select a relatively large negative for Dy, in this case.

- **Dy = - 50m**
- Dx = 3/1 slope * Dy = 150m

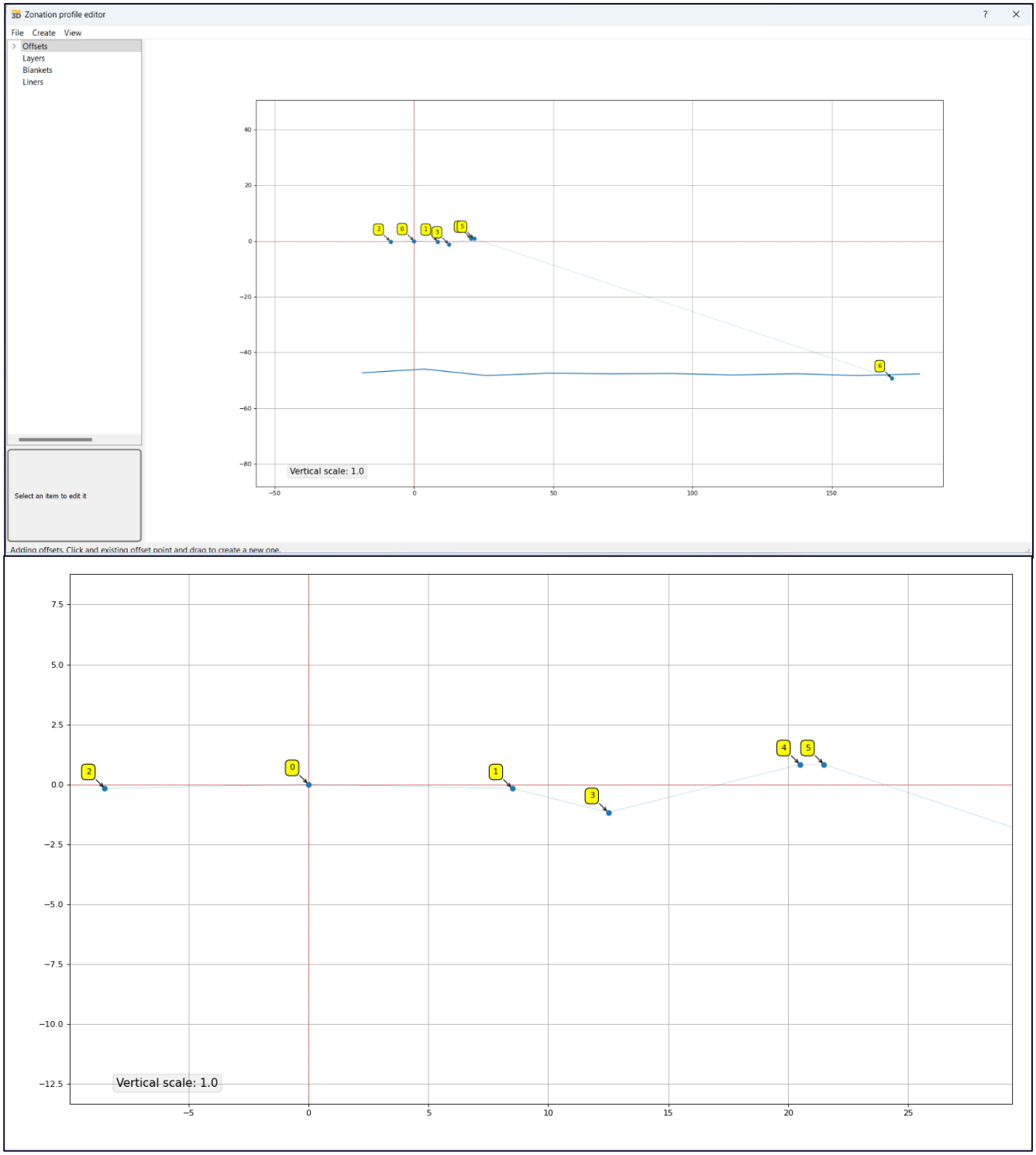


Figure 6: Nodes 0 to 6

Your X-section, at this point, should look like what's shown in Figure 6 above.

Let's complete the left-hand side of the design by adding **nodes 7, 8, 9, 10 and 11**.
Please note, we are now offsetting in the negative X direction.
As per Figure 1, **Node 7** will be offset from **Node 2**, such that:

- Dx = **-** 4m
- Dy = 2m * - 1/4 slope = - 0.5m

Node 8 will be offset from Node 7, such that:

- Dx = - 1m
- Dy = 1m *- ½ slope = -0.5m

Node 9 will be offset from Node 8, such that:

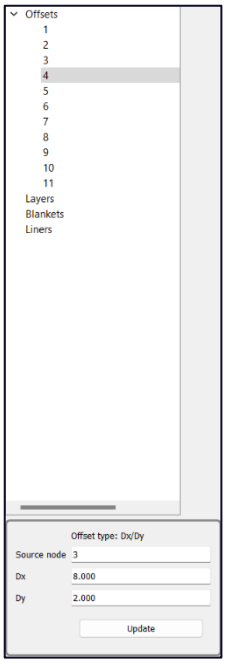
- Dx = - 4m
- Dy = 4m * ½ slope = 2 m

Node 10 will be offset from Node 9, such that:

- Dx = -3m
- Dy = 0

Node 11 will be offset from Node 10, such that:

- Dx = - 150m
- Dy = - 50m



If the offset parameters of a Node need to be adjusted retroactively, select the Node from the Offset dropdown on the left-hand side, and adjust the parameters values in the boxes below (Figure 7). If you want to remove a node, right-click on the node and delete it from the *Offsets* dropdown menu.

Figure 7: Adjusting Node parameters

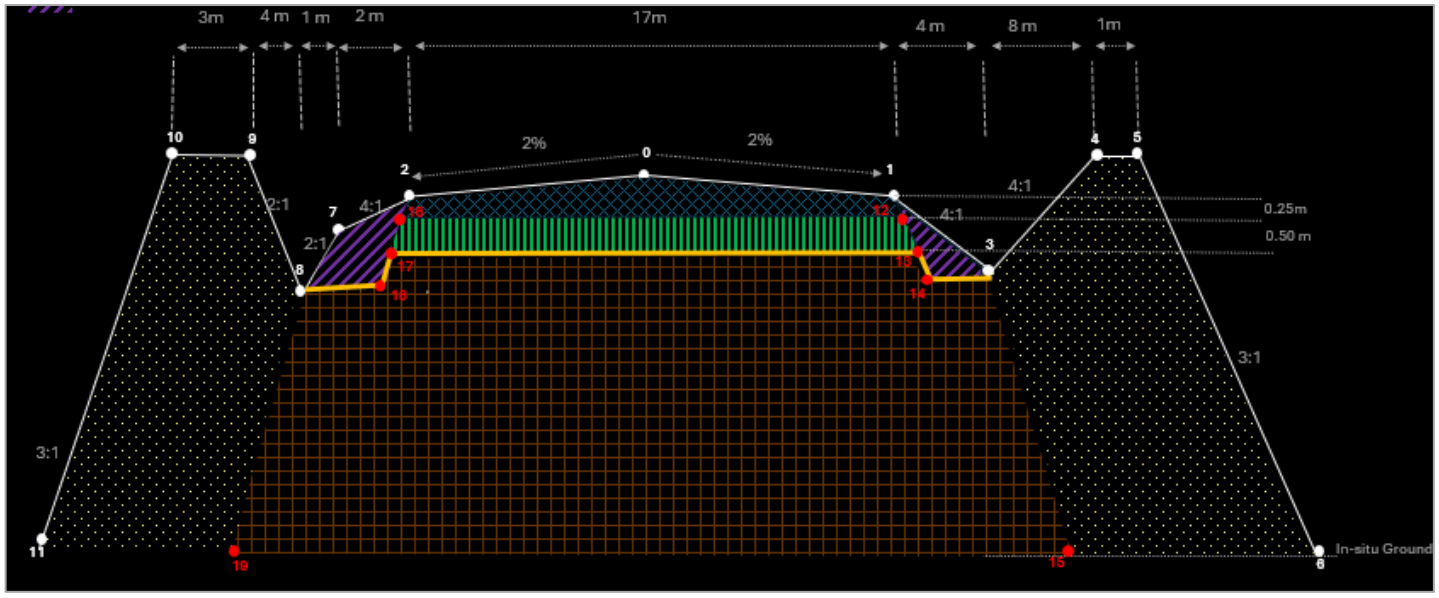


Figure 8: Missing Nodes

To define all the components within the design, additional nodes will be required. As can be seen in Figure 8 above, the red points represent the additional nodes required to fully define the layers within the design surface. As noted in Figure 1, all materials contact each other at a **1:1 slope**.

Let's add the missing **nodes 12 to 15**, on the right-hand side of the design, as per the specifications defined in Figure 1:

Node 12 will be offset from **Node 1** such that:

- Dx = 0.25m
- Dy = - 0.25m

Node 13 will be offset from **Node 12** such that:

- Dx = 0.5m
- Dy = - 0.5m

Node 14 will be offset from **Node 13** such that:

- Dx = 0.25m
- Dy = - 0.25m

Node 15 will be offset from **Node 3** such that:

- Dx = 50m
- Dy = - 50m

Similarly, let's add the missing **nodes 16 to 19**, on the left-hand side of the design.

Node 16 will be offset from **Node 2** such that:

- Dx = - 0.25m
- Dy = - 0.25m

Node 17 will be offset from **Node 16** such that:

- Dx = - 0.5m
- Dy = - 0.5m

Node 18 will be offset from **Node 17** such that:

- Dx = - 0.25m
- Dy = - 0.25m

Node 19 will be offset from **Node 8** such that:

- Dx = - 50m
- Dy = - 50m

Graphical Zones Editor: Defining Components

Now lets add the different Layers and Liner to the Zonation profile. Layers/liner include:

- *Asphaltic concrete surface course*
- *Asphaltic concrete binder course*
- *Shoulder zones (left and right of centerline)*
- *Outside Berm zones (left and right of centerline)*
- *General Embankment zones.*
- *Permeability Liner.*

Within the Zonation profile editor, under the **Create** menu, select **Draw layer.** You'll then be prompted to select a color and name for the layer. Then, draw a polygon joining the nodes that define that layer.

- In this case, the *Asphaltic concrete surface course* is composed of Nodes 0,1, 12 and 16 (Figure 9). Make sure the layer is a closed polygon.

To modify a layer retroactively, select the layer from the dropdown. You can then modify the name, colour and point ids. The point ids correspond to the node sequence that was drawn to define the layer. To modify the shape of the layer, add and remove nodes in the point ids sequence. (figure 9)

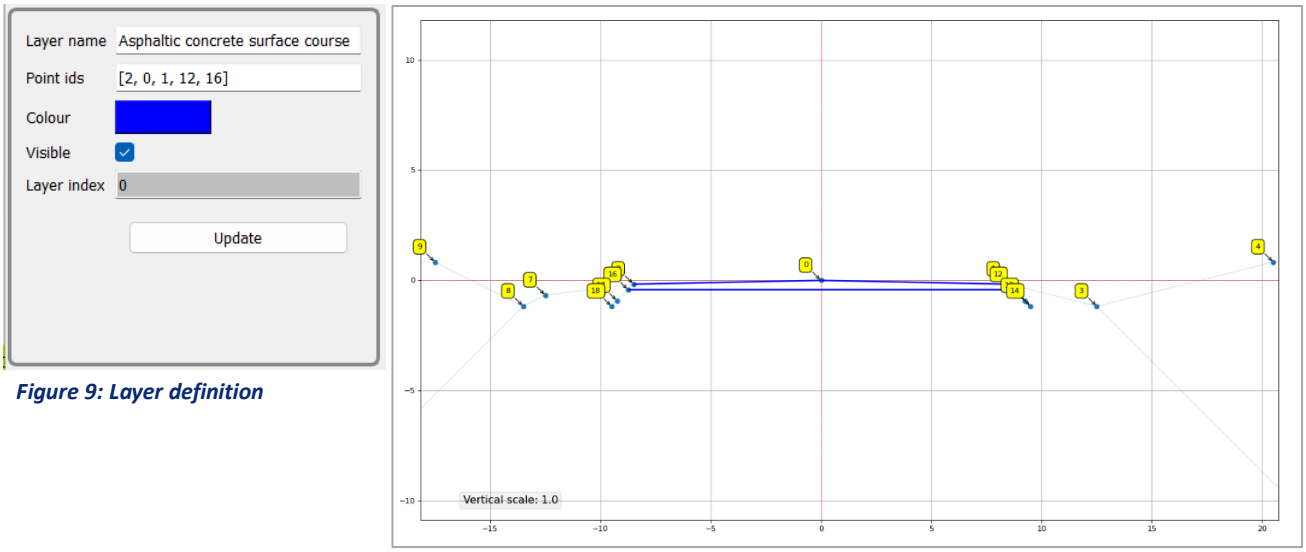


Figure 9: Layer definition

Node sequence details for the remaining layers can be seen below in Figure 10

Figure 10: Layer details

Similarly, from the **Create** menu, select **Draw liner** and add the *permeability liner*. Liner details can be see in Figure 11 on the right.

The completed Zonation model, within the Graphical Editor can be seen in Figure 12 below.

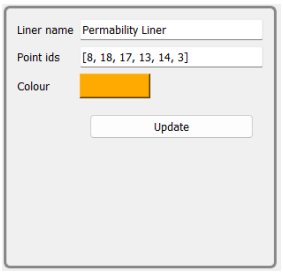


Figure 11: Liner details

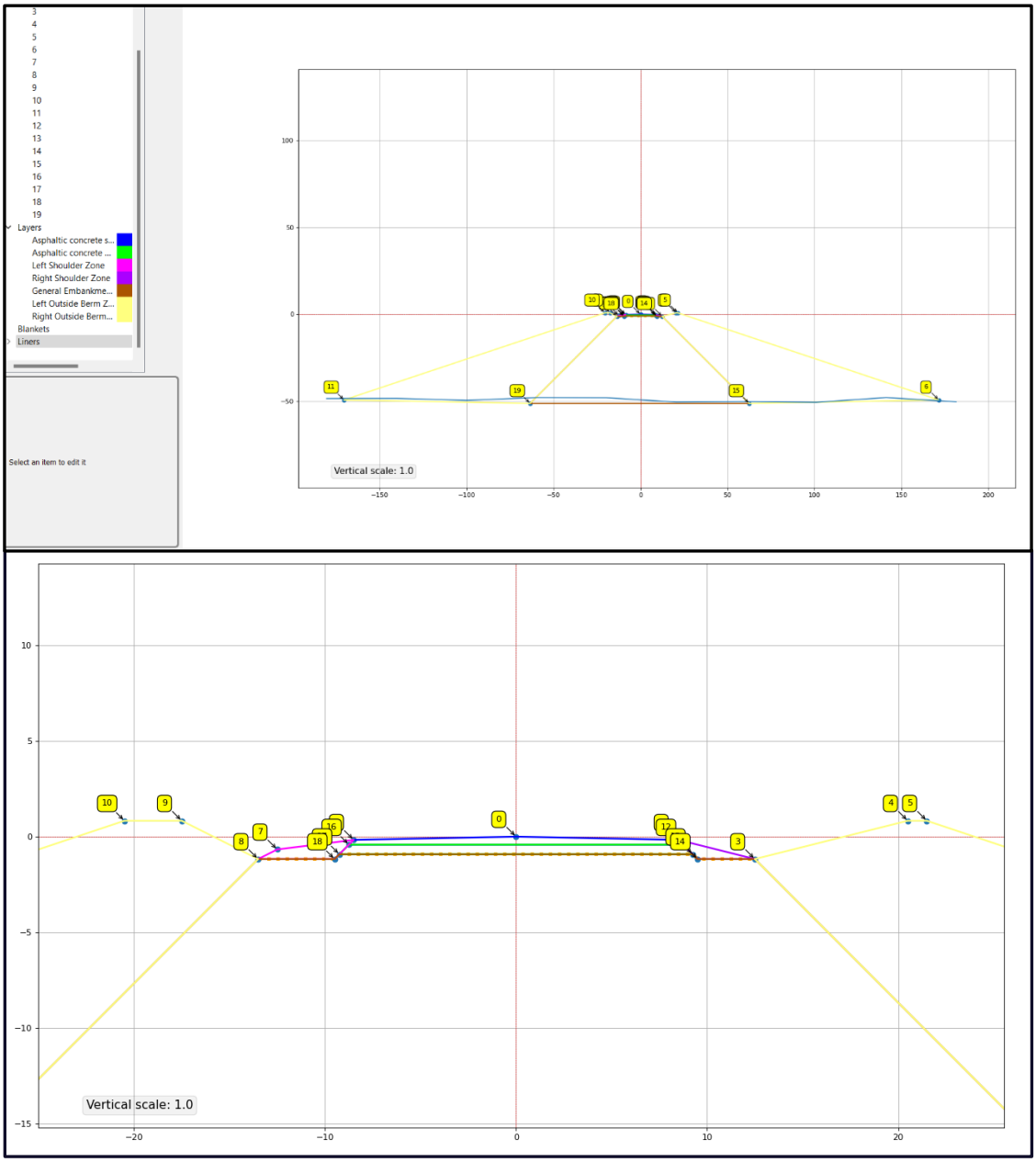


Figure 12: Zonation Model

Applying Zonation models

In this particular example, the design in Figure 1 is the final design for a road construction corridor project where Node 0 represents the road centerline.

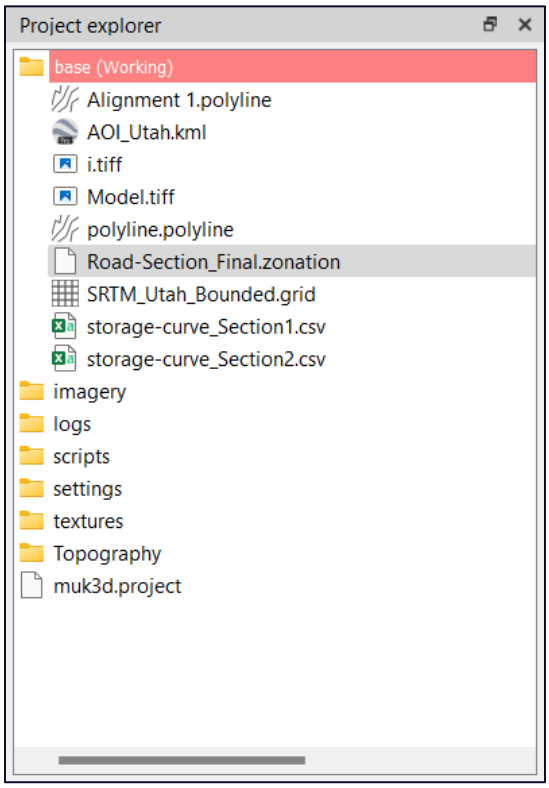


Figure 13: .zonation model

In order to apply the model, firstly save your model in the **Zonation profile editor** under the **File** menu. This will create a .zonation file in your working directory (figure 13).

Next you can apply the zonation model directly and construct the designed surface/components along an alignment. Drag and drop the .zonation model file into your main *Formation* viewer. The program will then ask you for a reference line to apply your design to. In this case, the model should be applied to the centerline.
Using the reference line as Node 0, *Formation* will generate the linework and modeled components along the entire alignment reference line. Each component will be output to a different layer in the scene manager that can be saved (figure 14).

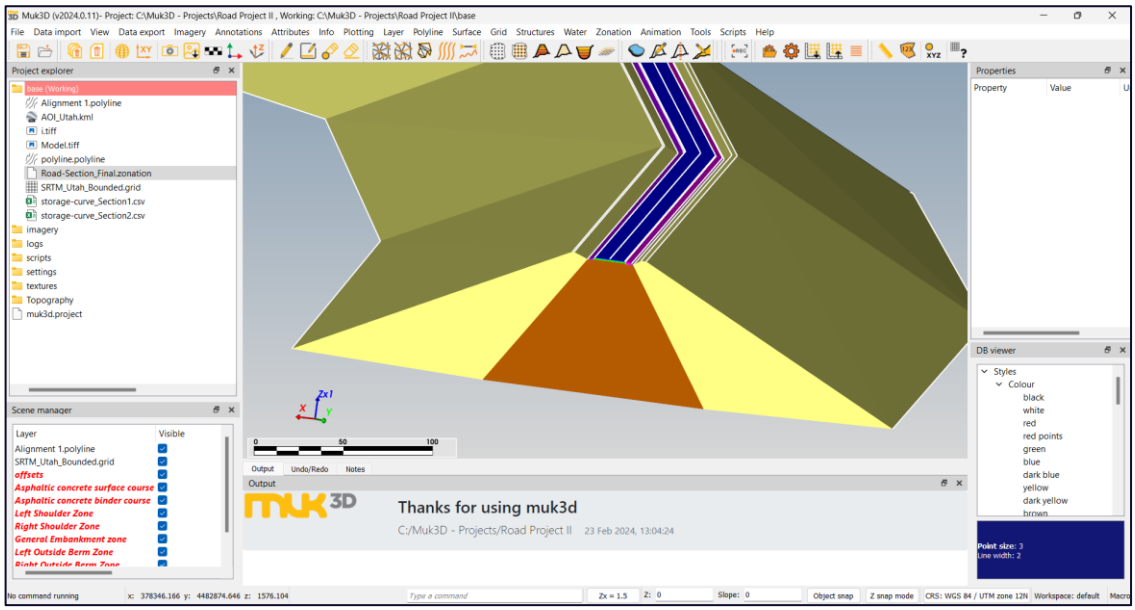


Figure 14: Applied zonation model

The fill volumes, by layer, can now be determined by running the **Calculate all zone volumes** under the **Zonation** menu (Figure 15).

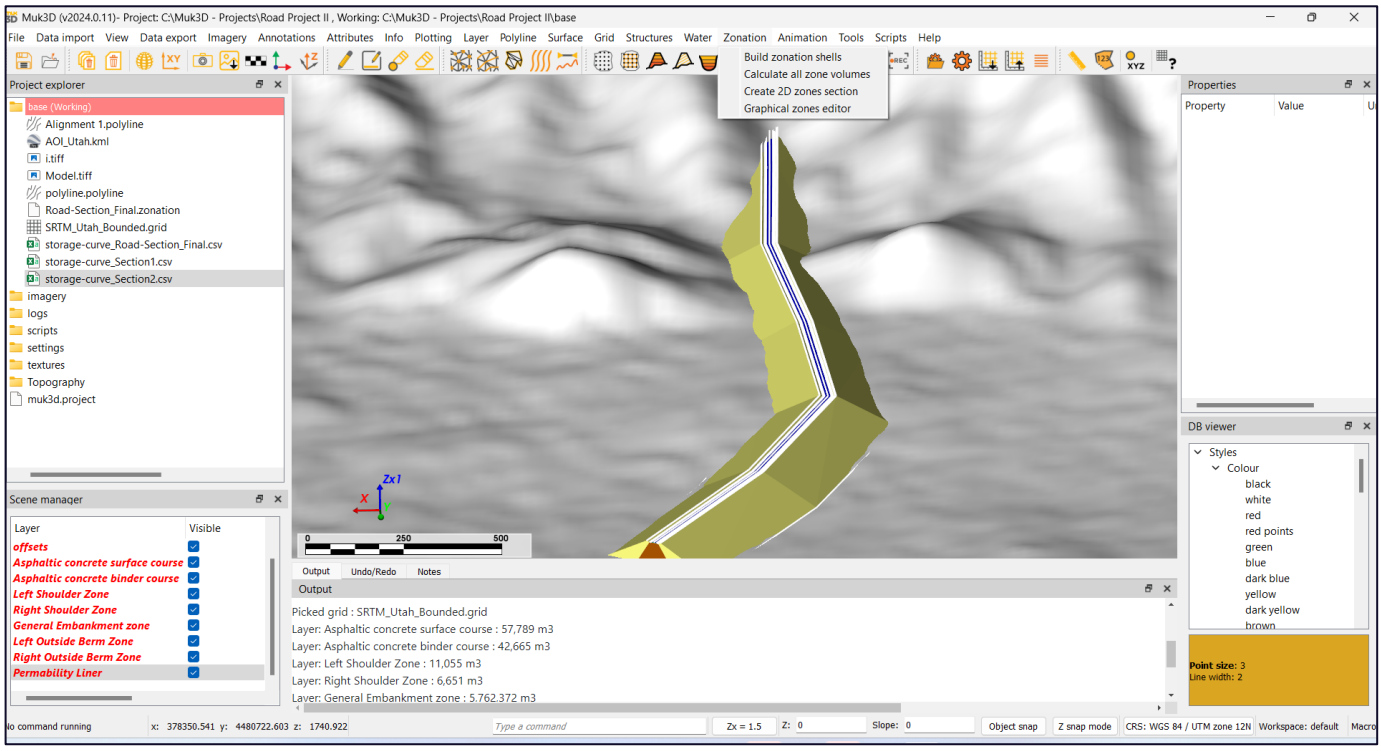


Figure 15: Calculate all volumes tool

The program will then ask you to select your .zonation model, to select the Grid to run volumes against and your reference line (centerline). Subsequently, total volumes will be generated in the Output window (Figure 16) and a .csv of layer volumes by 1m elevation iterations will be created (Figure 17).

Figure 16: Zonation total volumes

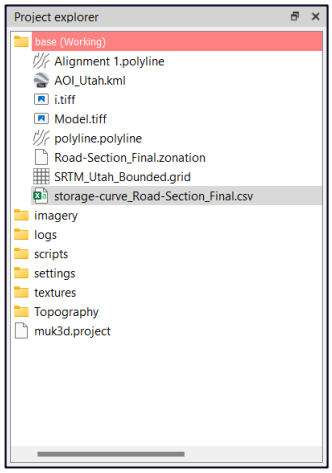


Figure 17: .csv layer volumes by 1m increments

Applying Zonation models in Cut and Fill projects

In this example, the centerline of the road is both above and below, in elevation, the original base topographic surface it is being designed against. As a result, this project will require both the placement and excavation of material to construct.
However, this zonation model is only defined to account for material that is placed above existing grade. The model did not define what to do in excavation situations. As can be seen in Figure 18 below, no surface exists in areas where the road would need to be excavated to build the design.

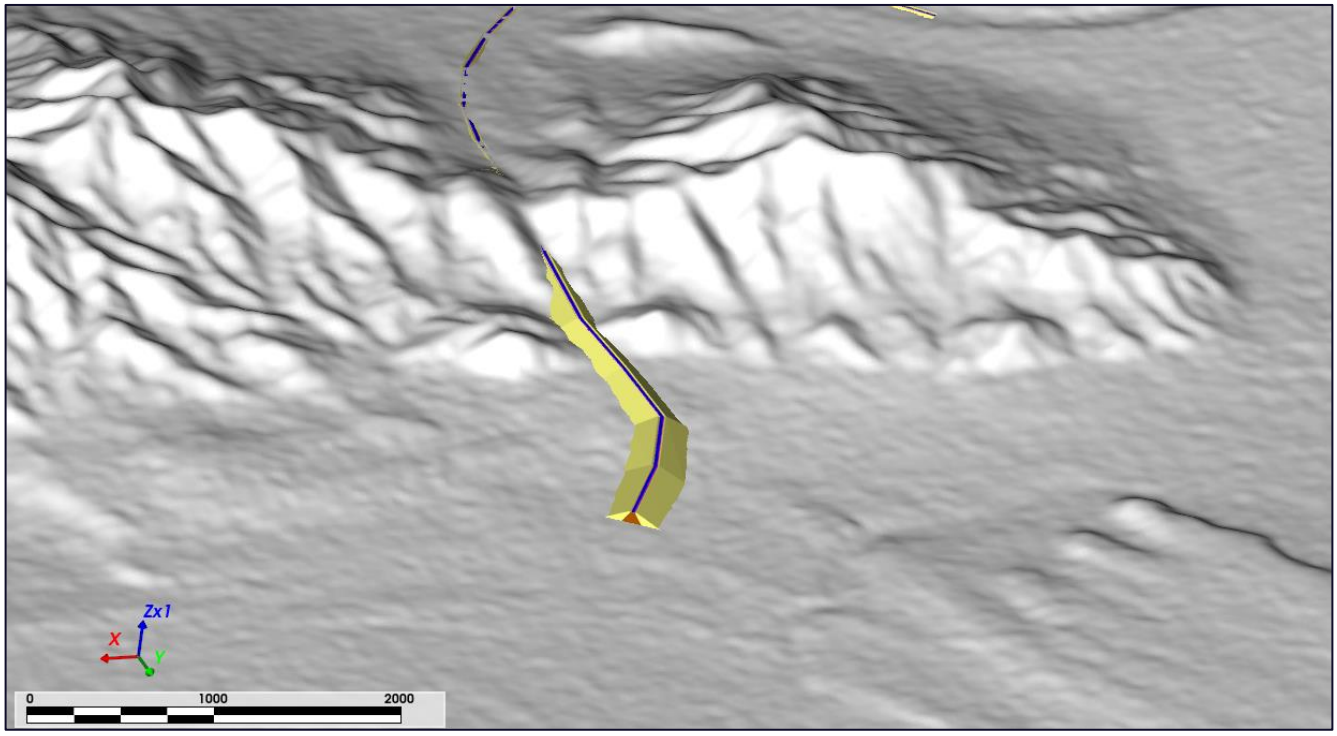


Figure 18: Zonation model only present when constructing above grade.

In this example, all layers above the permeability liner will exist along the alignment regardless of whether centerline is above or below existing grade. In other words, the road will be constructed by either placing material up to the permeability liner or the topography will be excavated to the permeability liner and the asphalt and shoulder layers above will then be placed above.
The X-sections applicable to construct where excavation is needed, can be seen below in Figure 19.

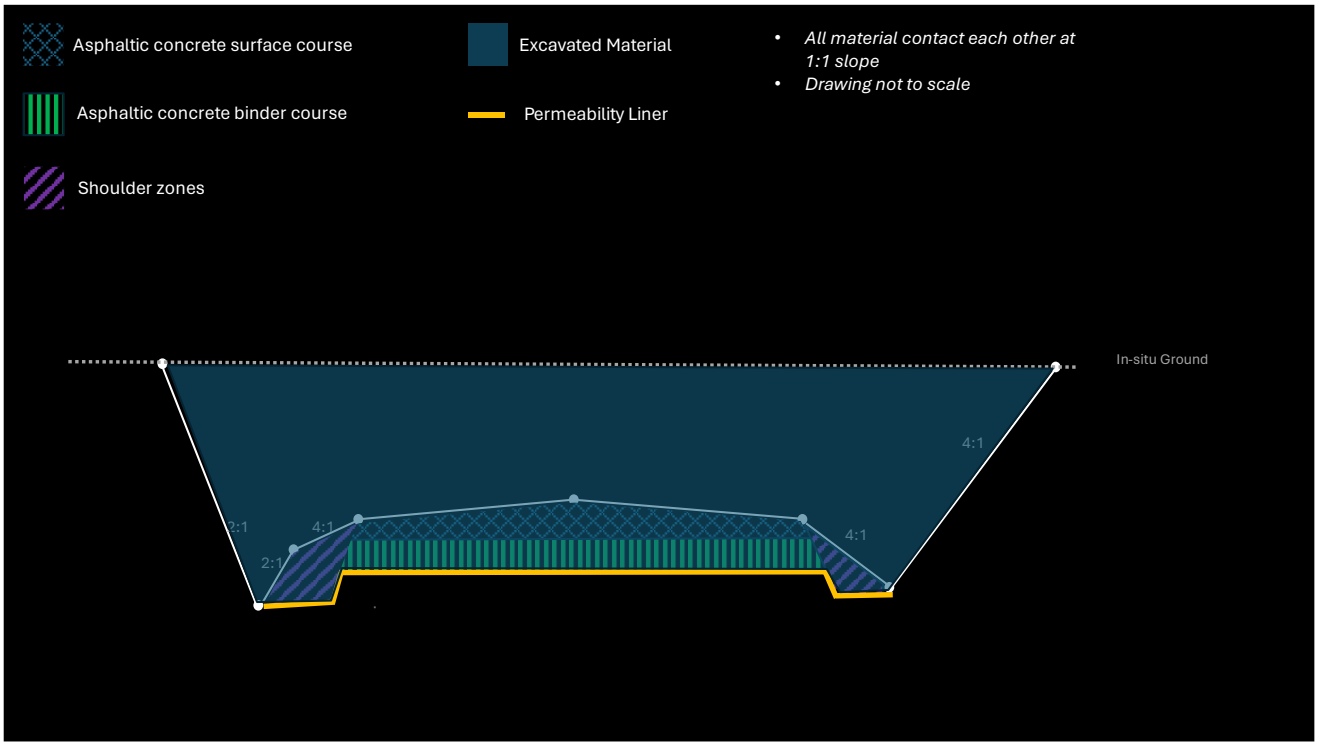


Figure 19: Road design X-Section when below grade

To account for this, we will create the linework of a Cut Surface in the Zonation profile editor to modify our Base Grid.

In the Zonation profile editor, create a new zone model that matches the X-section in Figure 20 below. No layers are needed.

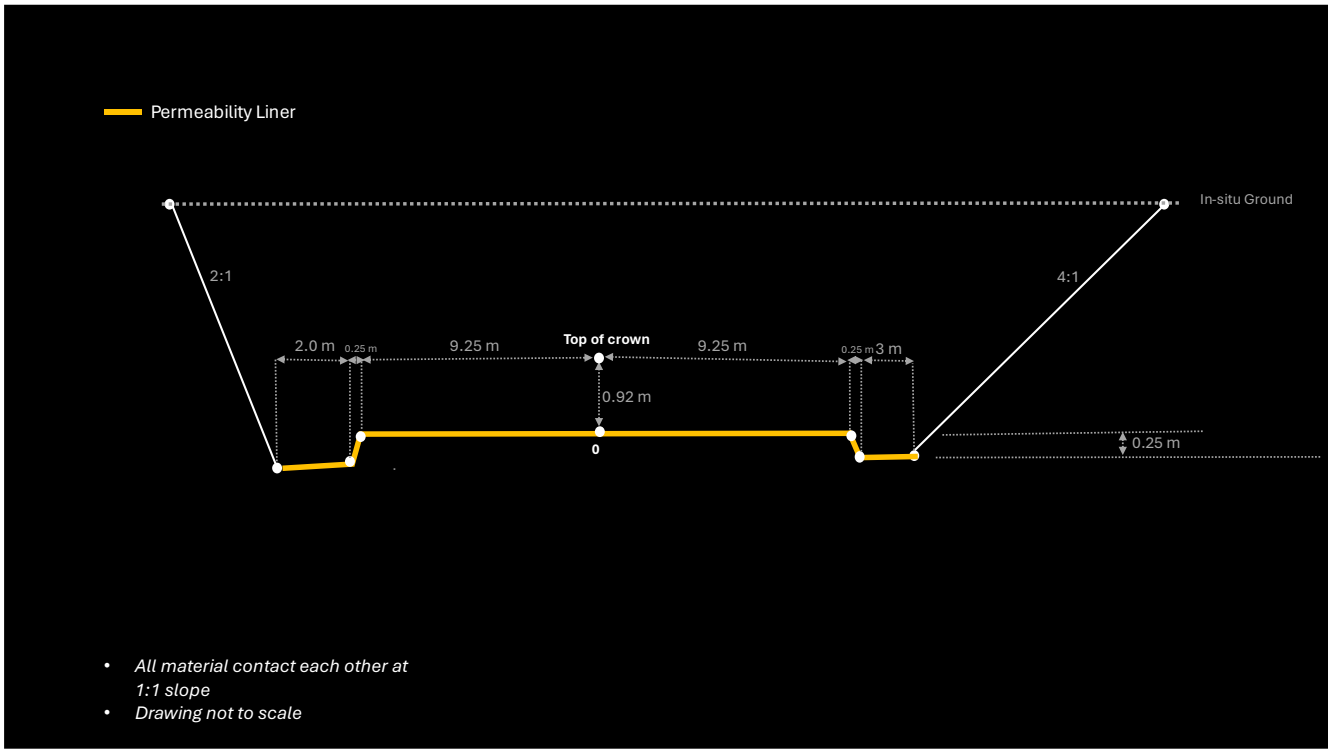


Figure 20: Cut Surface X-Section

It is important to note, the Cut model cannot be applied to the initial alignment centerline. In this case, the Cut model should be applied to an alignment that accounts for the difference in elevation between the Top of the crowned asphalt concrete surface course and the Permeability Liner. In this case, it is 0.92m.

Apply the new Cut zonation model to your new lowered alignment centerline. This will create the *offset* layer with the linework needed to create a Cut Surface (Figure 21).

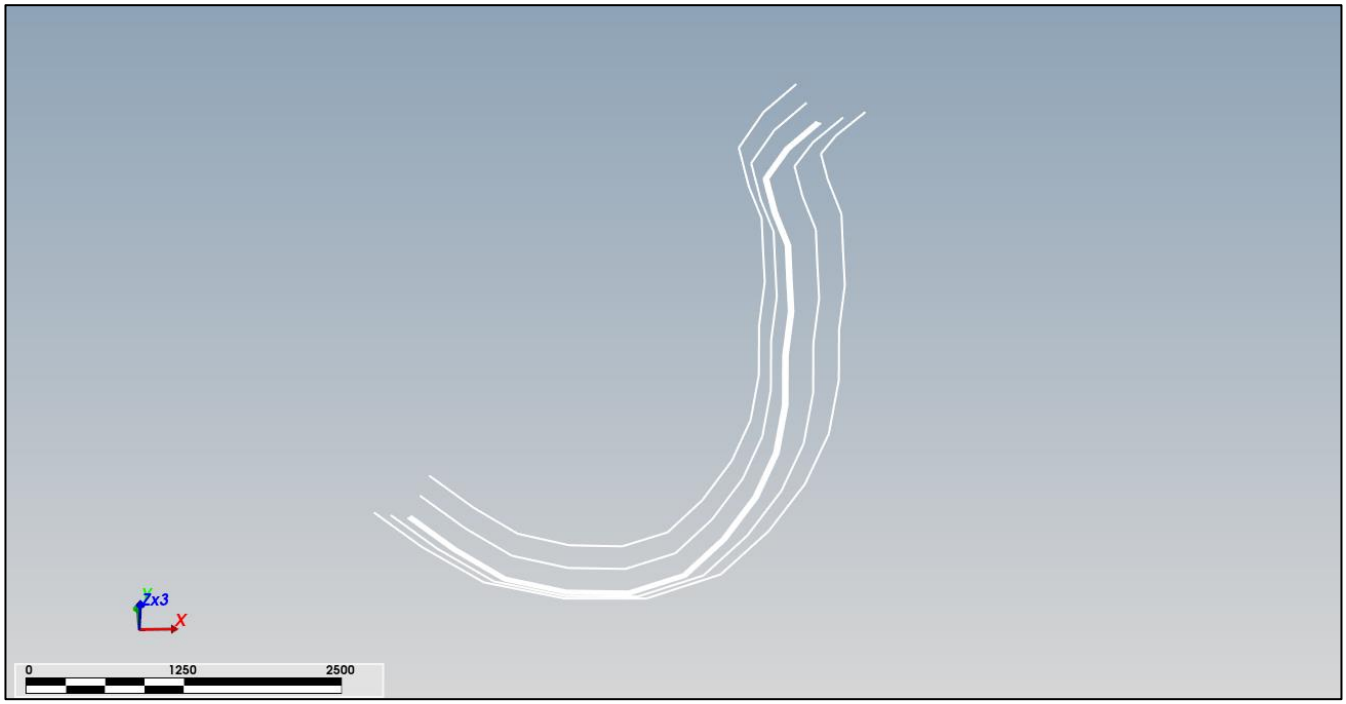


Figure 21: Cut Surface breaklines

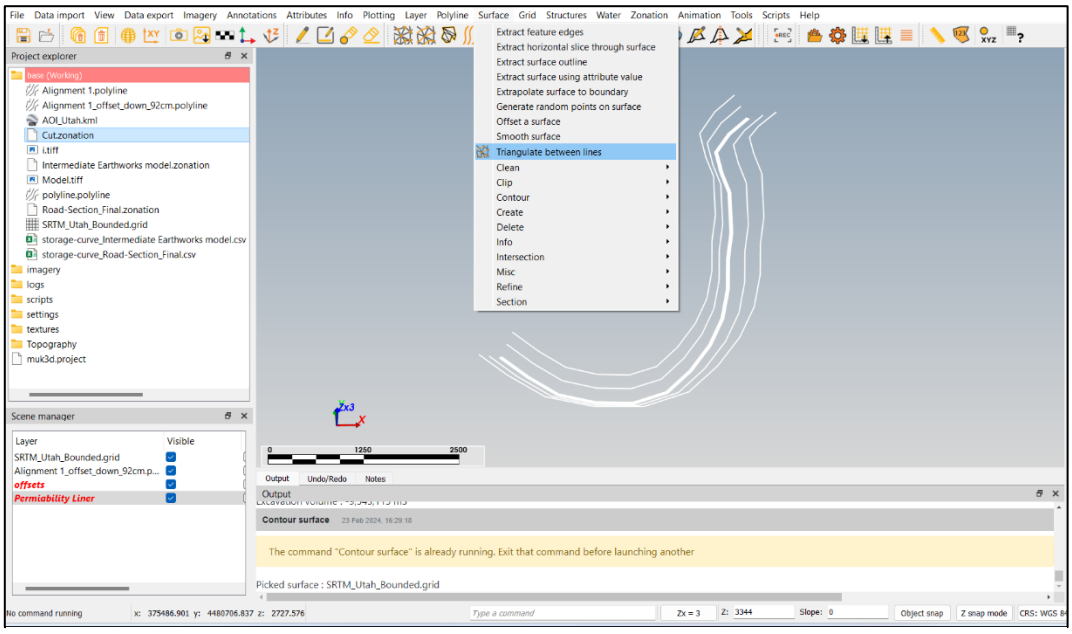


Figure 22: Triangulate between lines tool

Then utilize the **Triangulate between lines** tool in the **Surface** menu (Figure 22) and create a surface from the lines in the offsets layer (Figure 23).

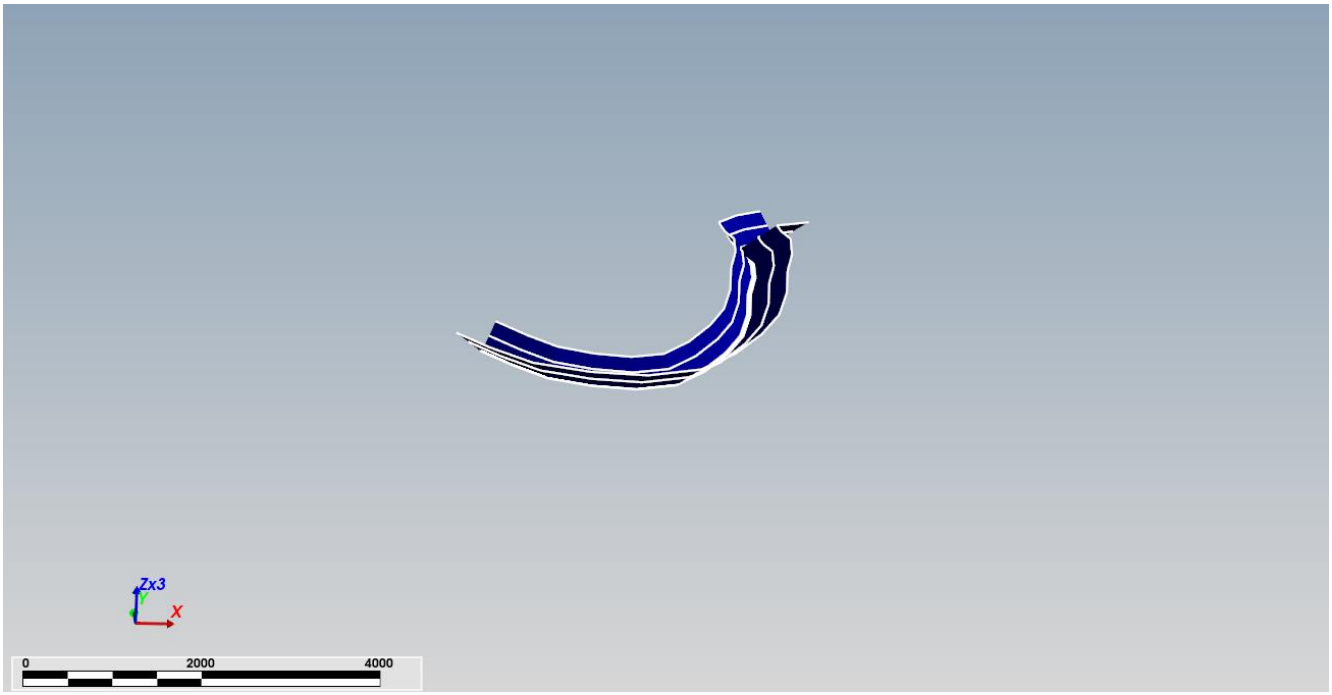


Figure 23: Cut Surface

Next, in the **Grid** menu, under the **Merge** category, utilize the **Merge excavation into Grid** tool (Figure 24 and 25). Select your base grid and cut surface. This will overwrite the original grid surface with the cut surface wherever the cut surface is below. Note, the excavation volume between the original grid and cut surface will be calculated in the output window.

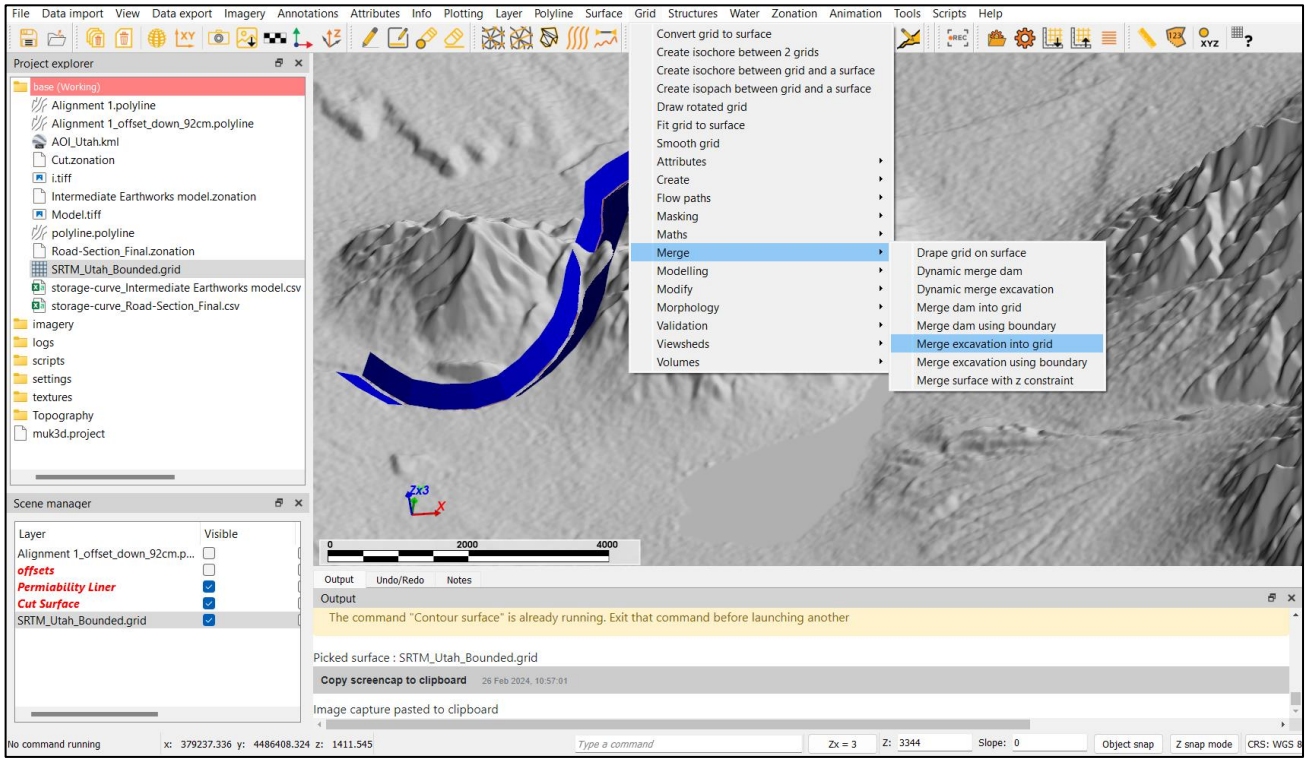


Figure 24: Merge Cut Surface into Grid Topo to create modified 'Cut Topo'

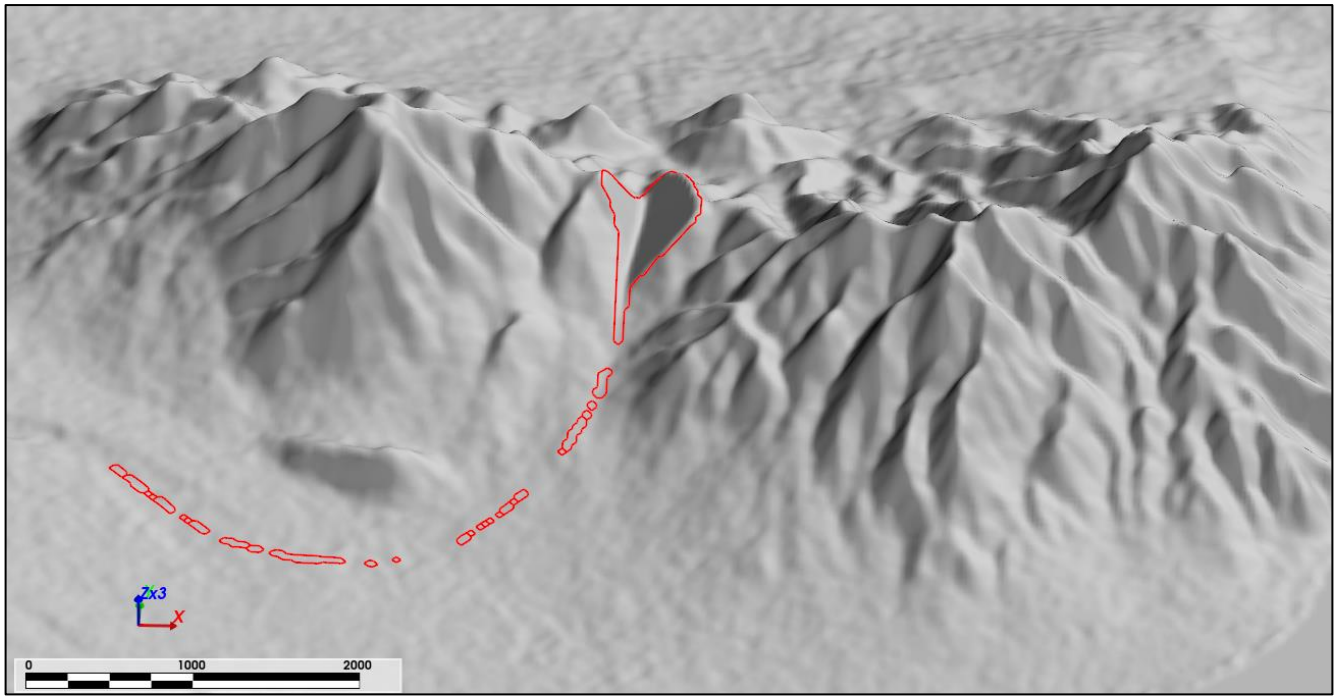


Figure 25: 'Cut Topo' created from Merged Cut Surface & Grid Topo

From there, run the **Calculate all zone volumes tool** under the **Zonation** menu. This time, utilize the initial zonation model (Figure 13), the original centerline alignment and the cut modified grid surface.

Given that the grid is either at or below the desired *Permeability liner* height, the software will then be able to place and calculate, by layer, all material quantities throughout the alignment.