



OpenRoads Earthworks Grading and working with Meshes

Todd Holt, Senior Consultant I (Civil)

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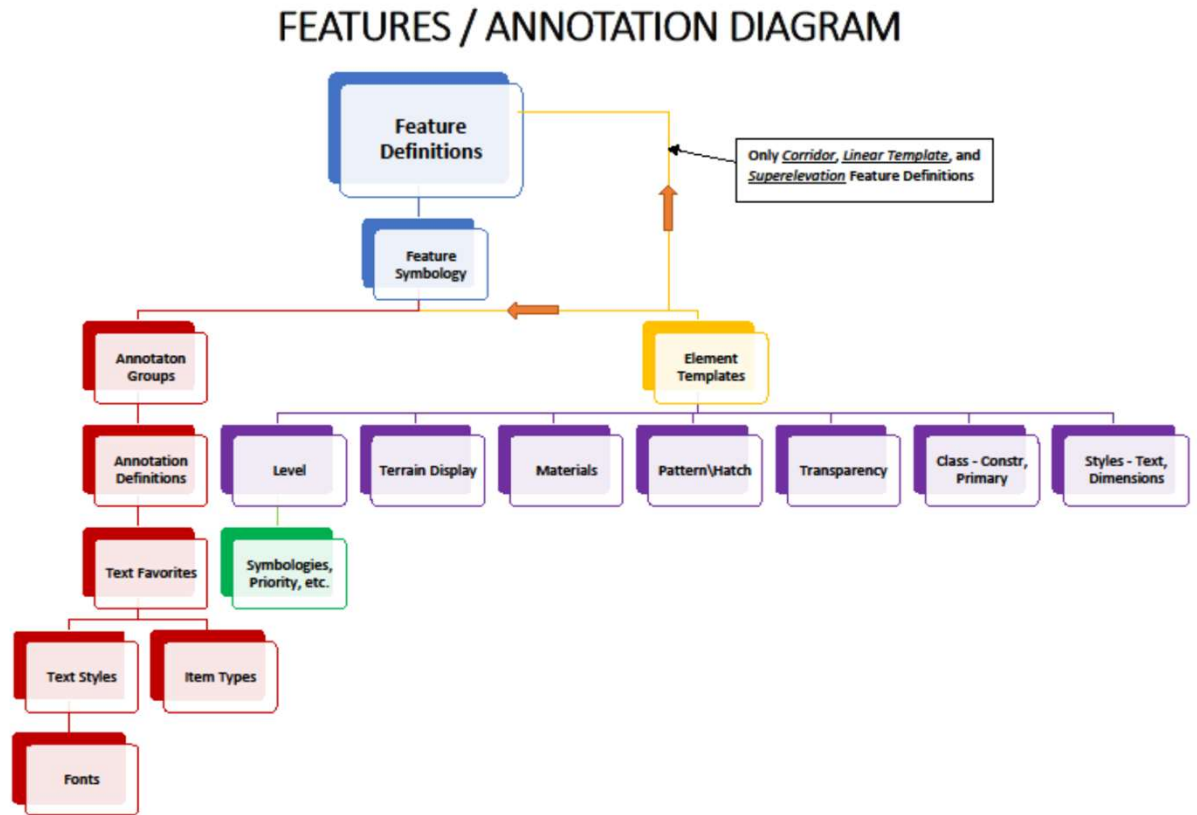
Agenda

- Feature Definitions
 - Why it Matters
 - Volume Options
- Model for Earthwork
 - Existing Features
 - Substrata
- Create Cut and Fill Meshes
- Reporting
 - End Area Volumes
 - Quantities Report by Named Boundary
- Quick Review of Legacy Tools
 - Terrain to Terrain
 - Component Quantities
 - Dynamic End Area Display
 - Element Properties

Feature Definitions

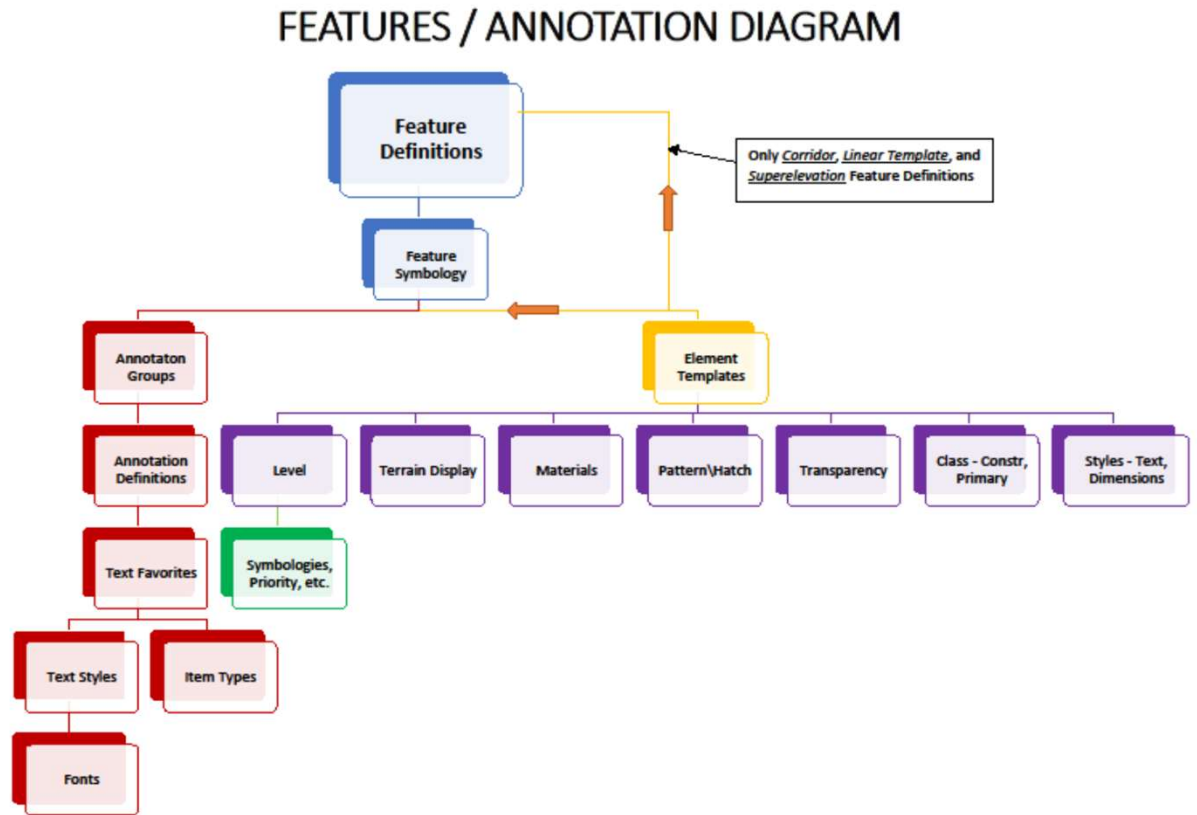
Feature Definitions

- Define the Symbology
 - Level, Color, Weight, Material
- Item Types
 - Location, Pay Items, ...
- Terrain Display Attributes
- Earthwork Classification
 - Terrain and Mesh Feature Definitions have a “Volume Option” Property
 - “Create Cut and Fill” Tool Reads Volume Option



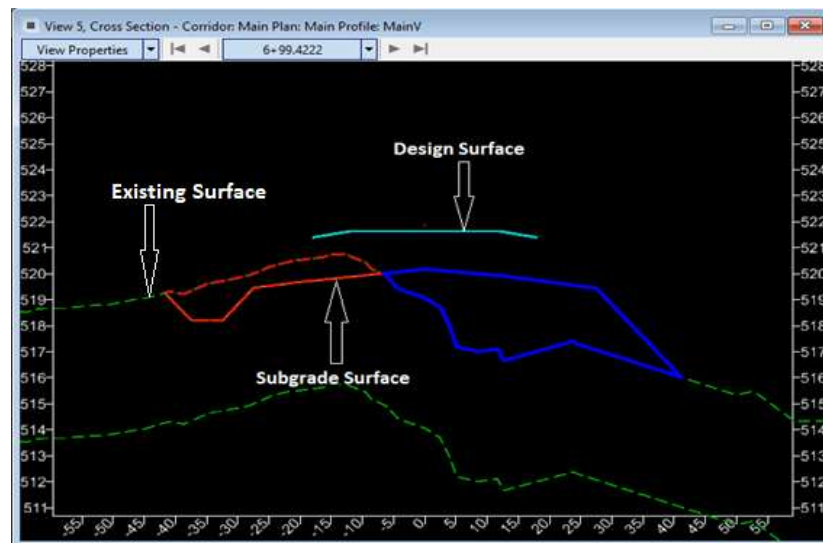
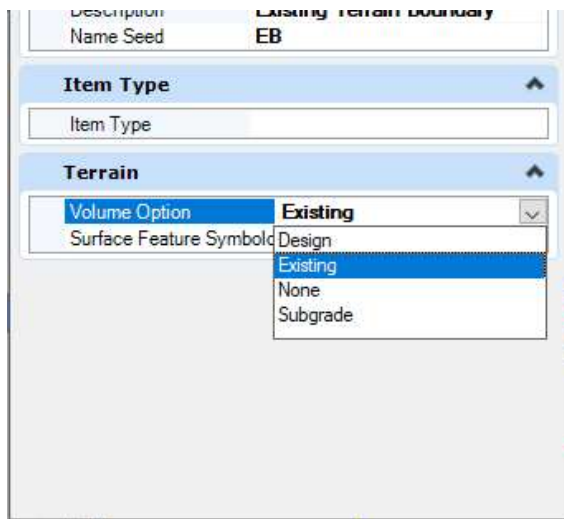
Feature Definitions

- Item Types
 - Location, Pay Items, ...
- Terrain Display Attributes
- Earthwork Classification
 - Terrain and Mesh Feature Definitions have a “Volume Option” Property
 - “Create Cut and Fill” Tool Reads Volume Option



Terrain Volume Options

- **Design:** Used by Create Cut Fill Volumes to find design surfaces.
- **Existing:** Used by Create Cut Fill Volumes to find existing surfaces.
- **None:** Ignores the surface when computing cut fill volumes.
- **Subgrade:** Legacy: Used like the old InRoads tools to give surface to surface volumes. Treated like design.

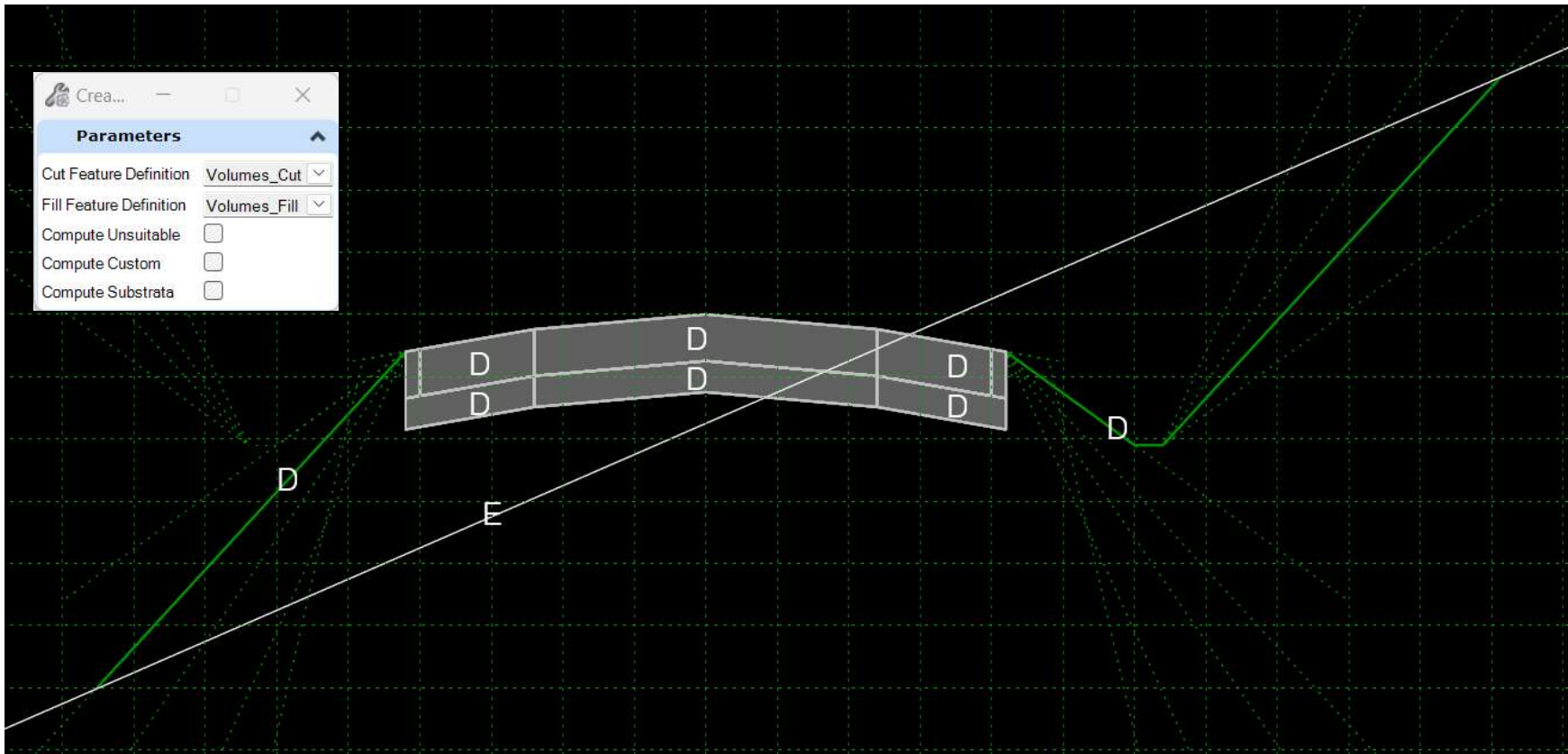


Mesh Volume Options

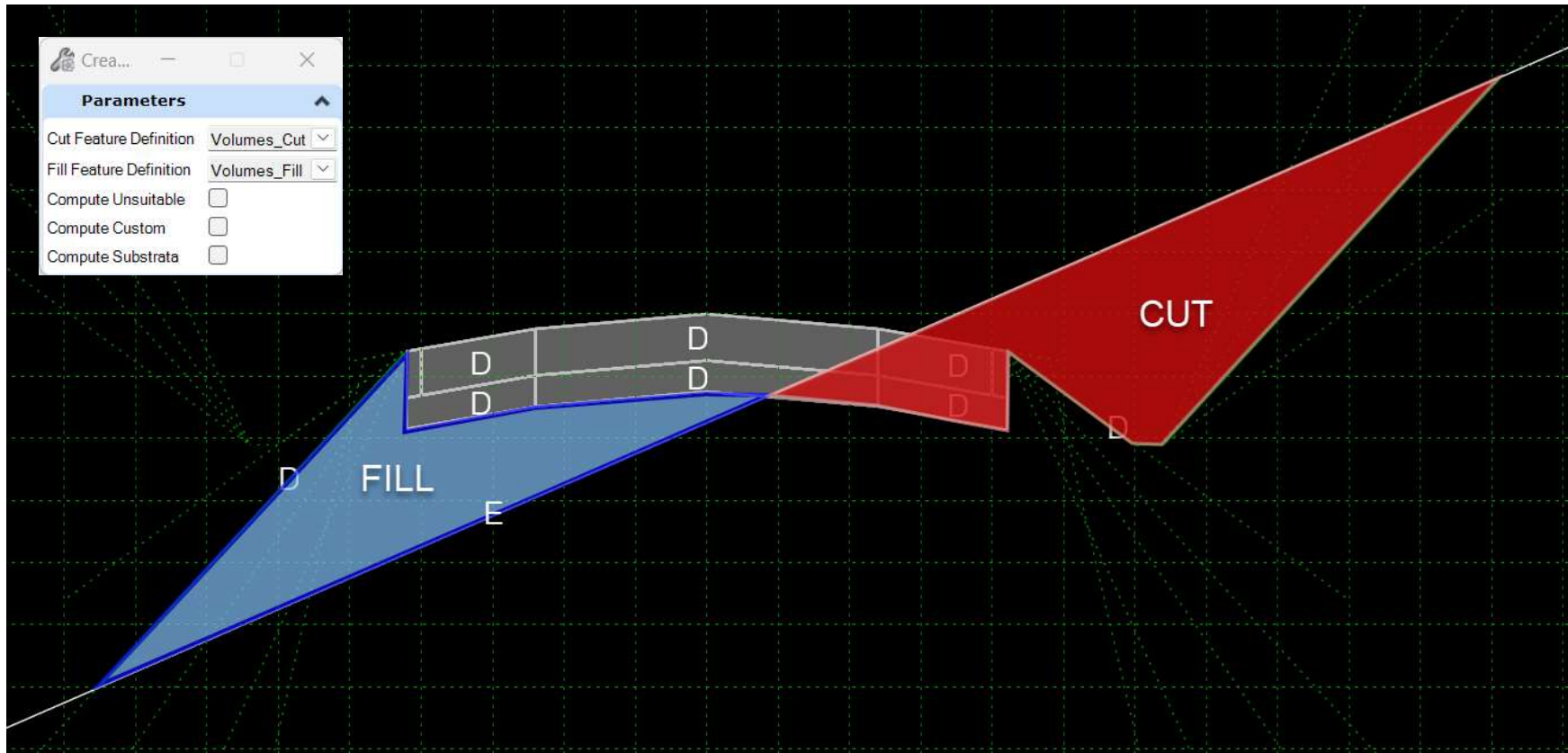
Feature Definitions Carry the Volume Option Properties

- **Design:** Defines new construction component or terrain
- **Existing:** Defines existing ground terrain or existing mesh
- **None:** Ignores when computing cut/fill volumes
- **Subgrade:** (Legacy) Uses surfaces for design
- **Substrata:** Defines a substrata layer of material for meshes (something that can be built on)
- **Cut:** Assign to a cut mesh, not design components
- **Fill:** Assign to a fill mesh, not design components
- **Unsuitable:** Defines material to be removed and not reused
- **Custom:** Same as Unsuitable but with options for mass ordinate

Cut/Fill



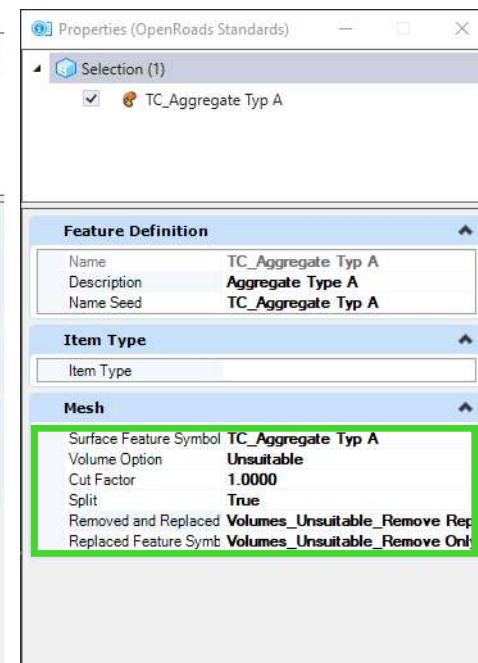
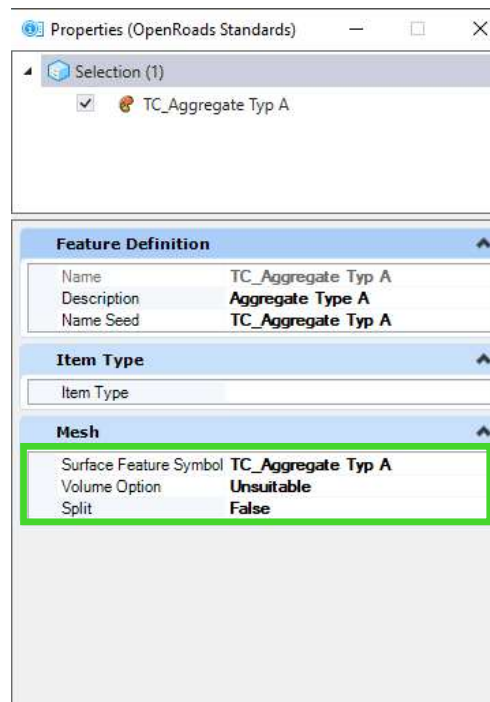
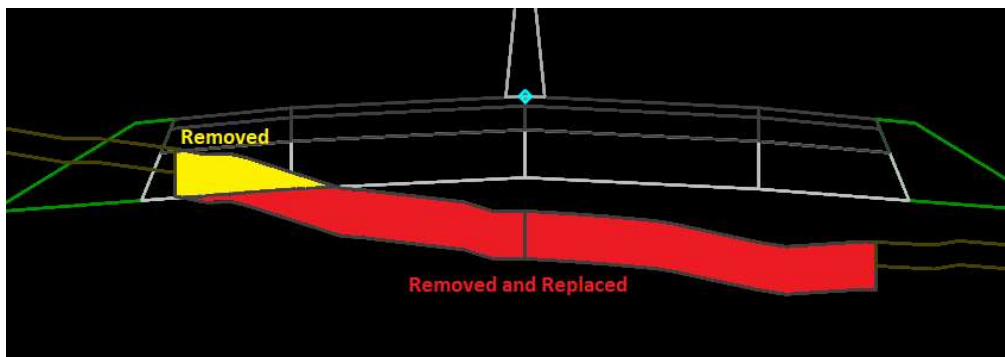
Cut/Fill



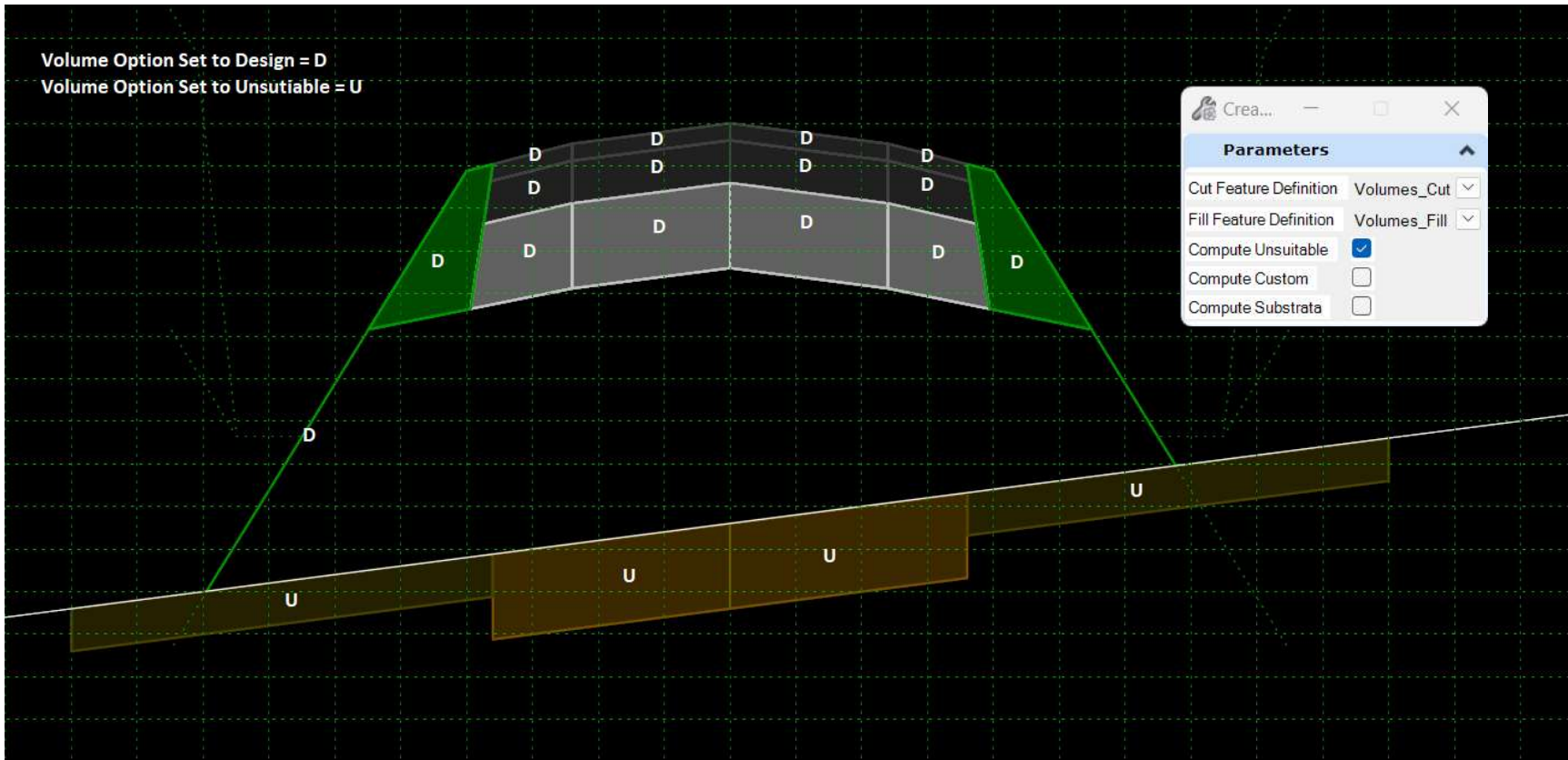
Mesh Volume Option – Unsuitable

Unsuitable: Split or Not Split

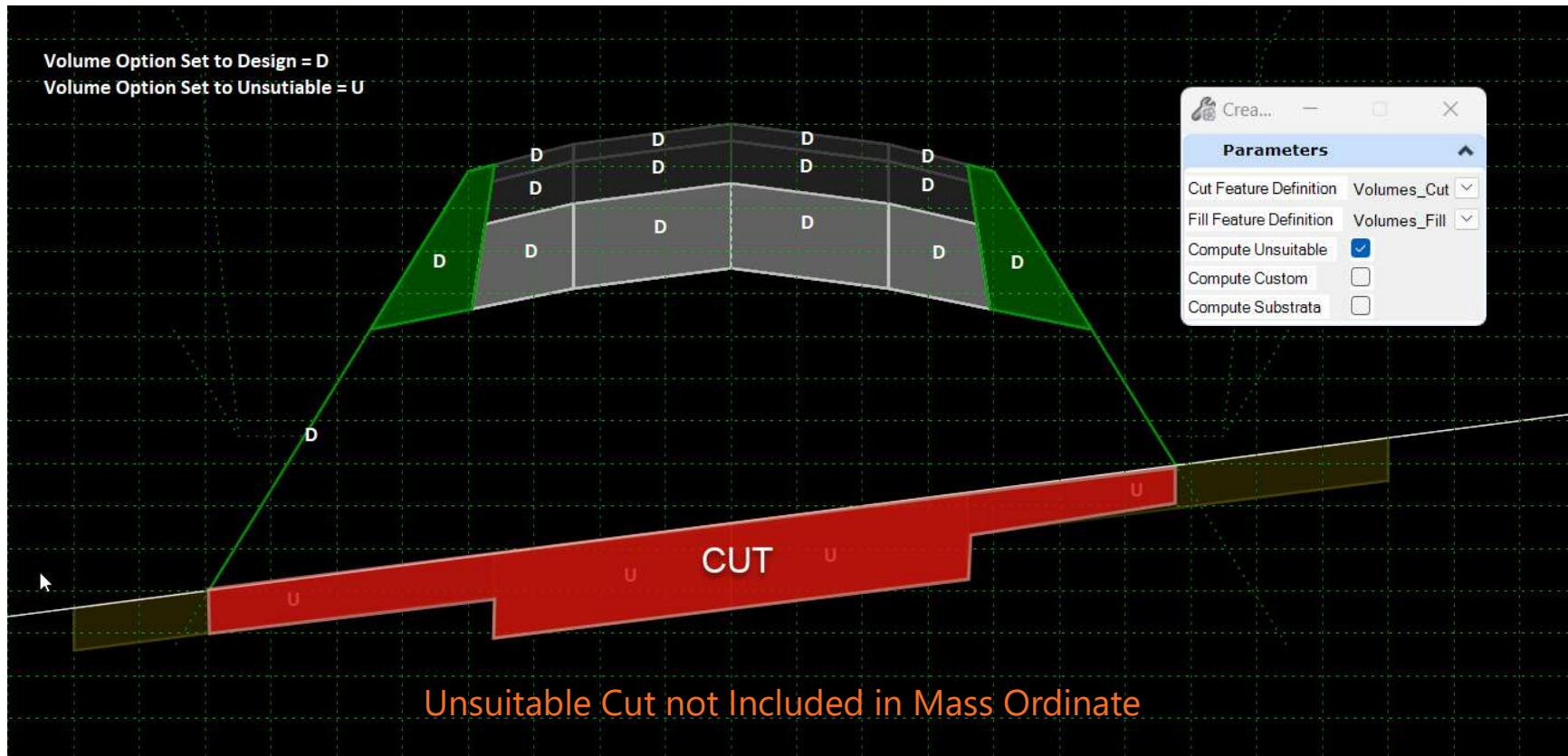
- Split = False
 - All material is removed
- Split = True
 - All material is removed
 - Only part of the material is replaced



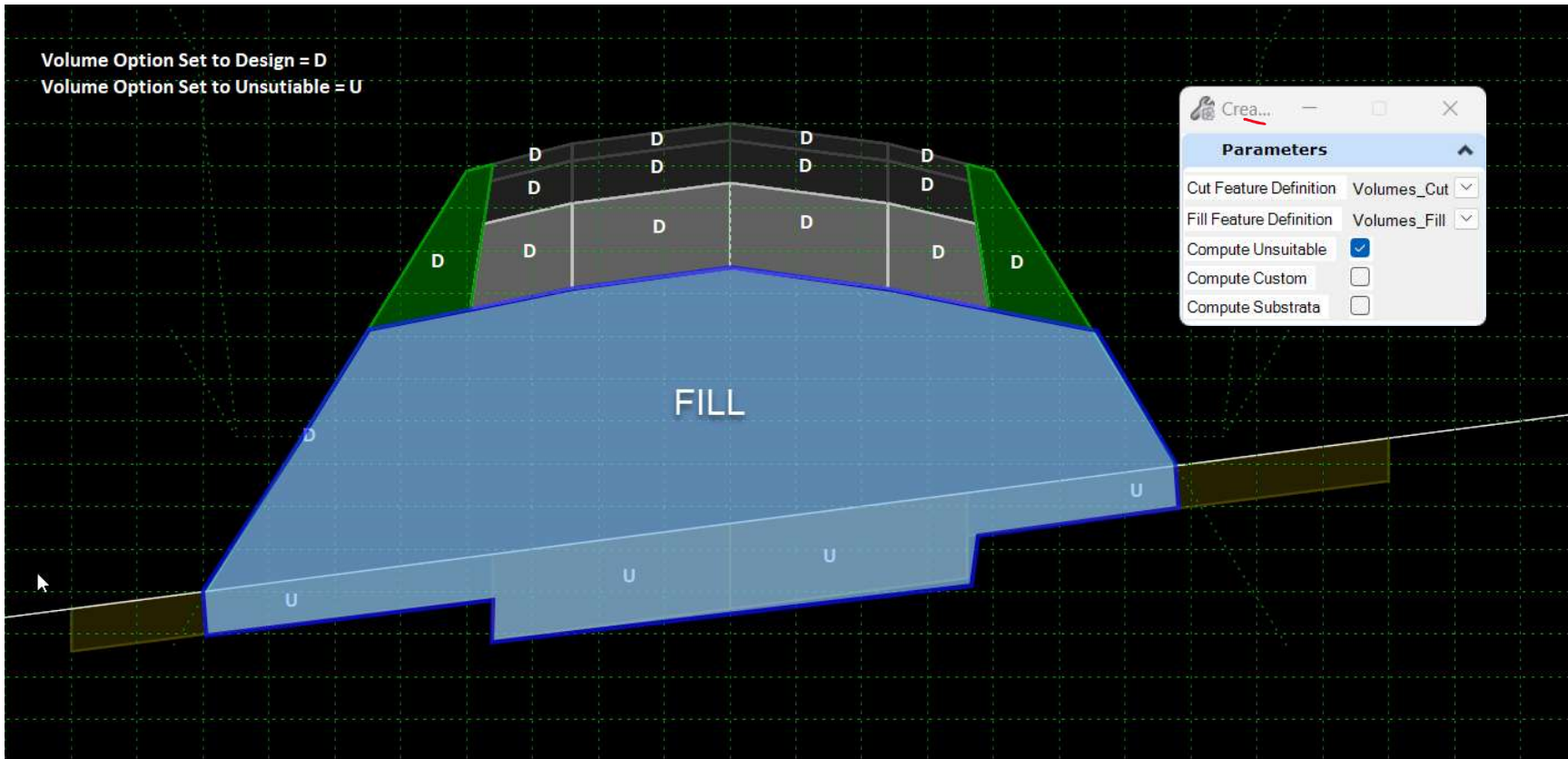
Cut/Fill + Unsuitable



Cut/Fill + Unsuitable



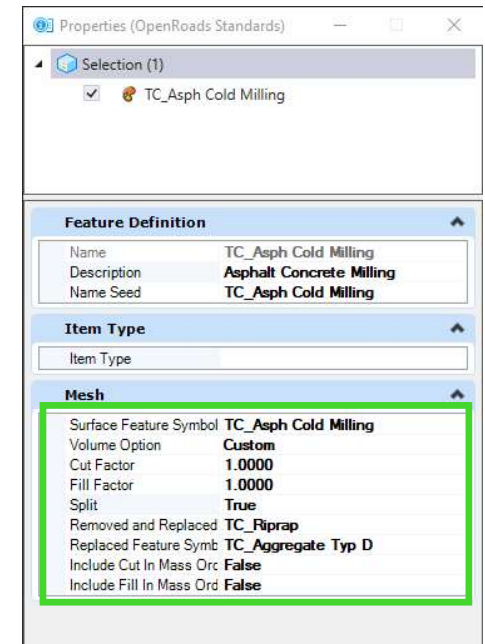
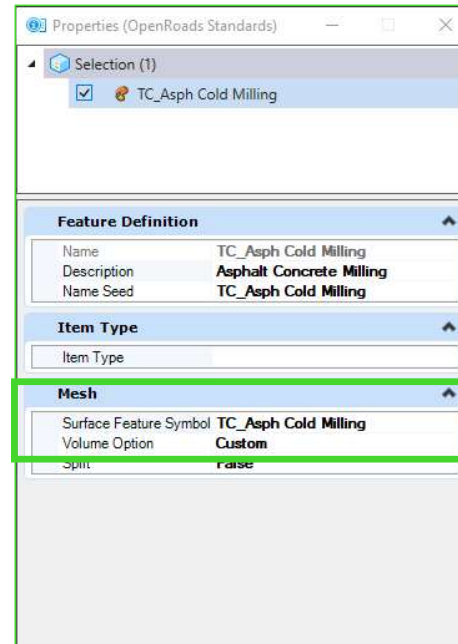
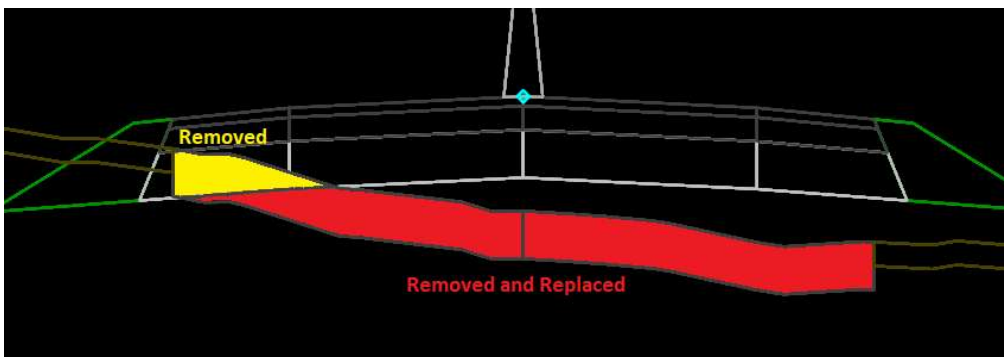
Cut/Fill + Unsuitable



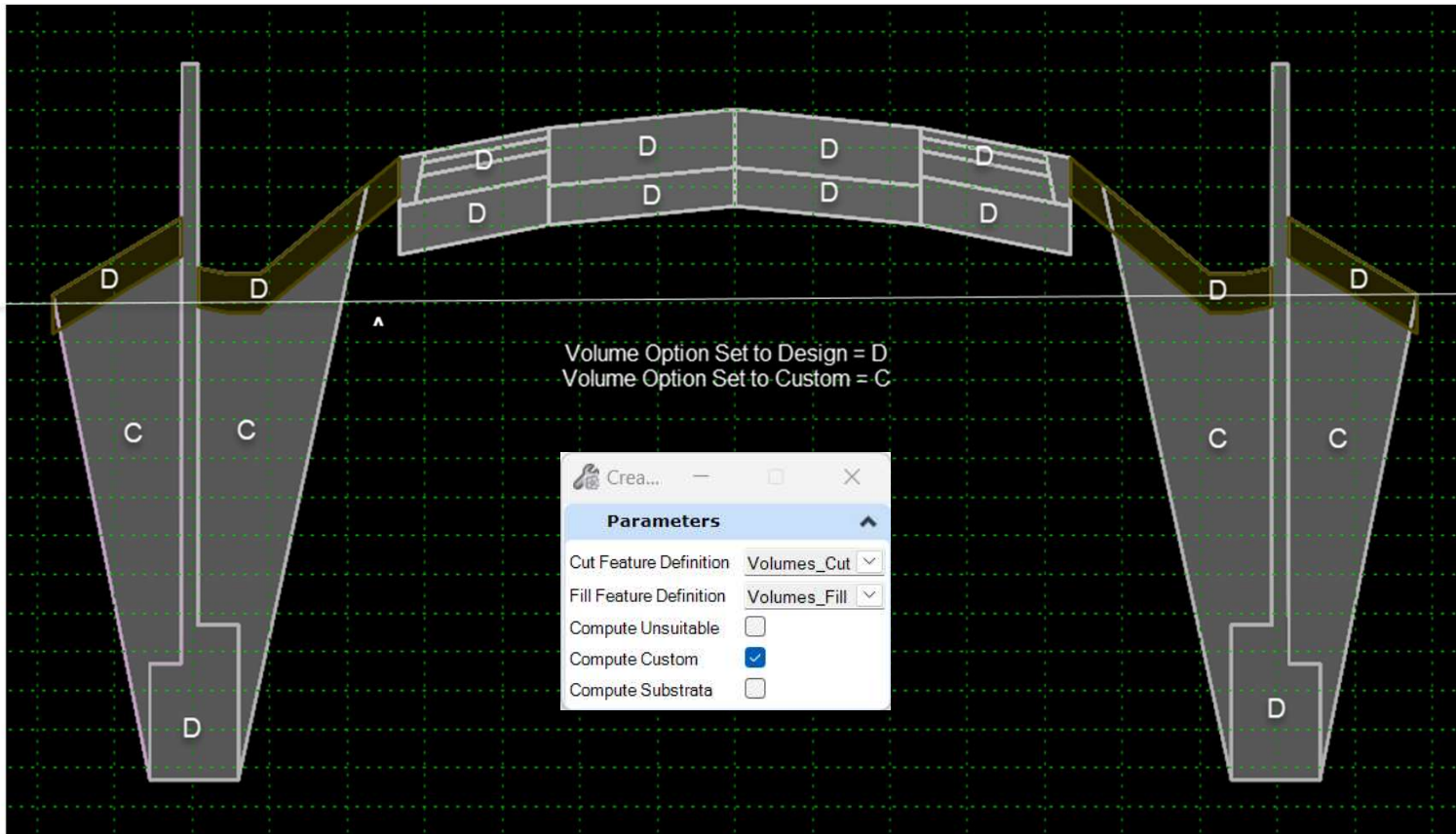
Mesh Volume Option – Custom

Custom: Split or Not Split

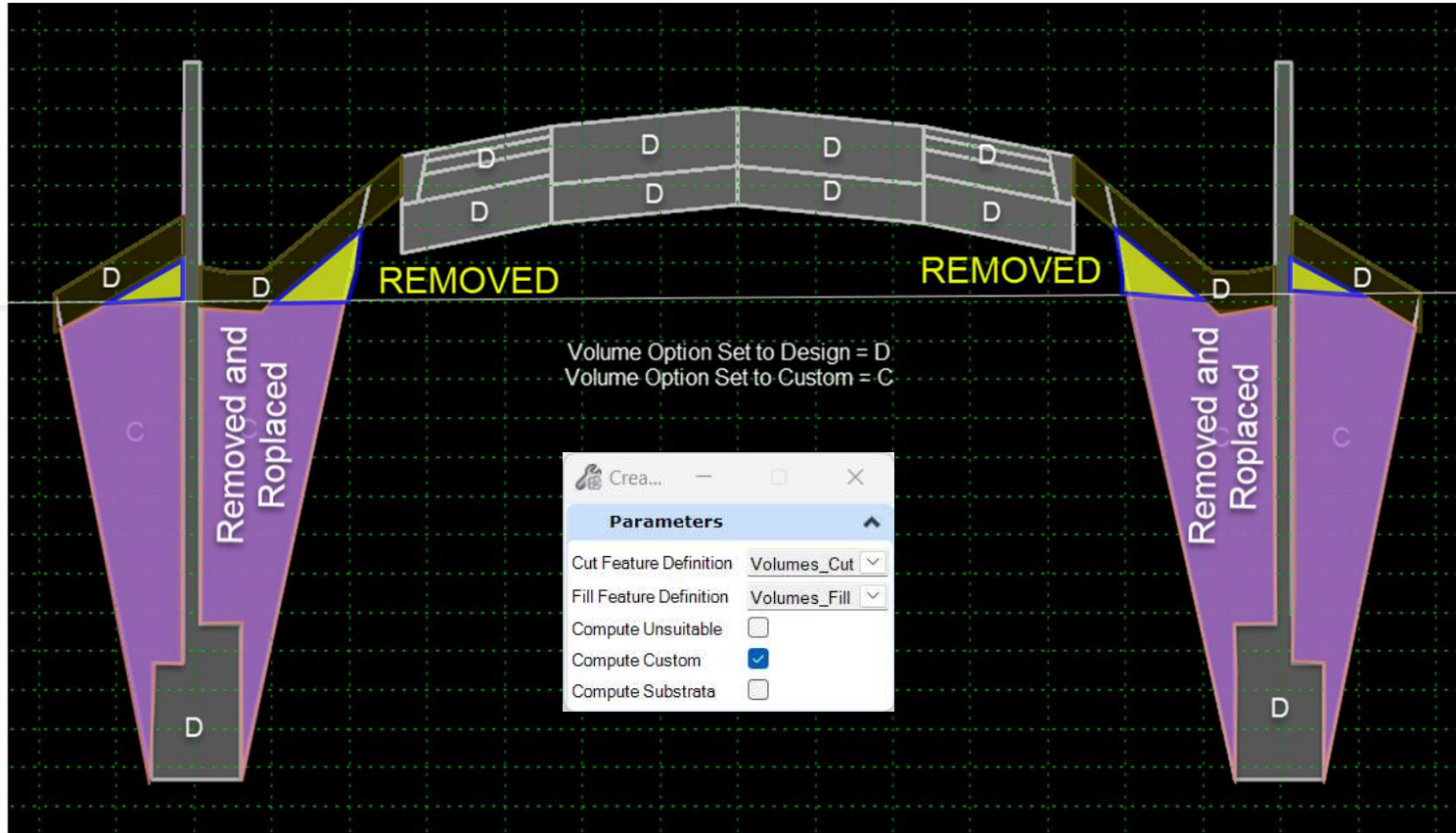
- Split = False
 - All material is removed
- Split = True
 - More Options on Split
 - All material is removed
 - Only part of the material is replaced



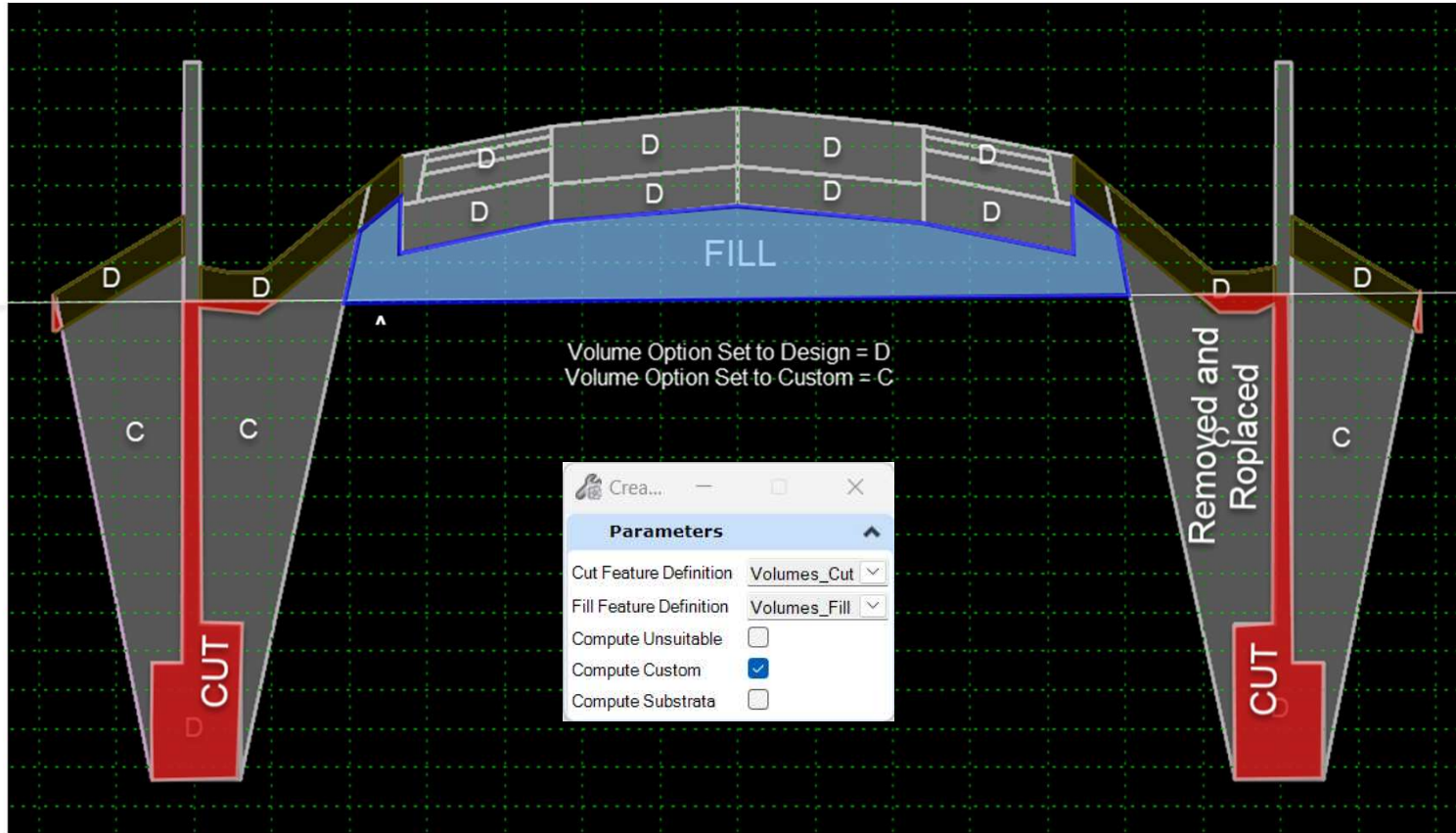
Cut/Fill + Custom



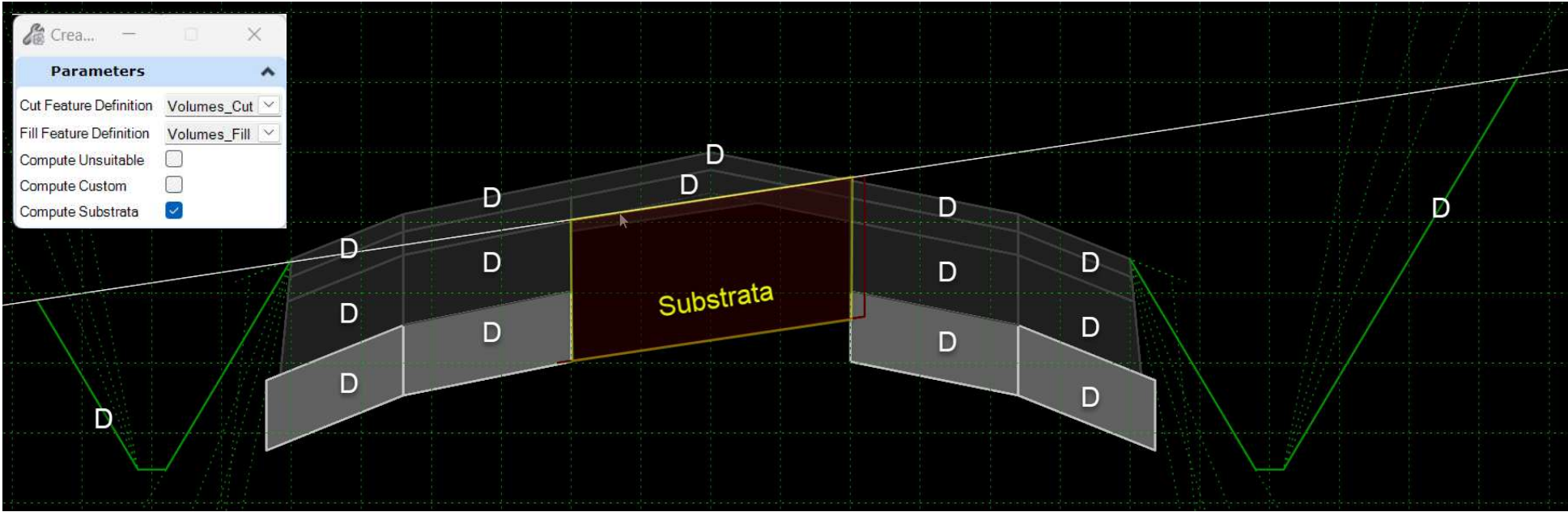
Cut/Fill + Custom



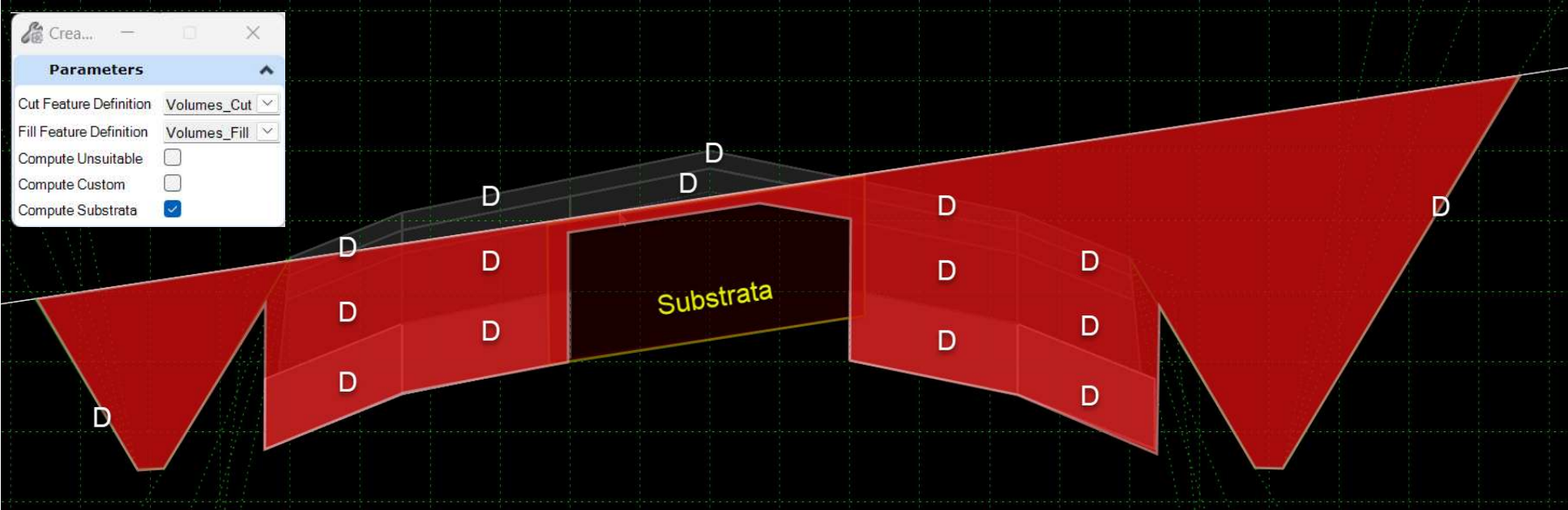
Cut/Fill + Custom



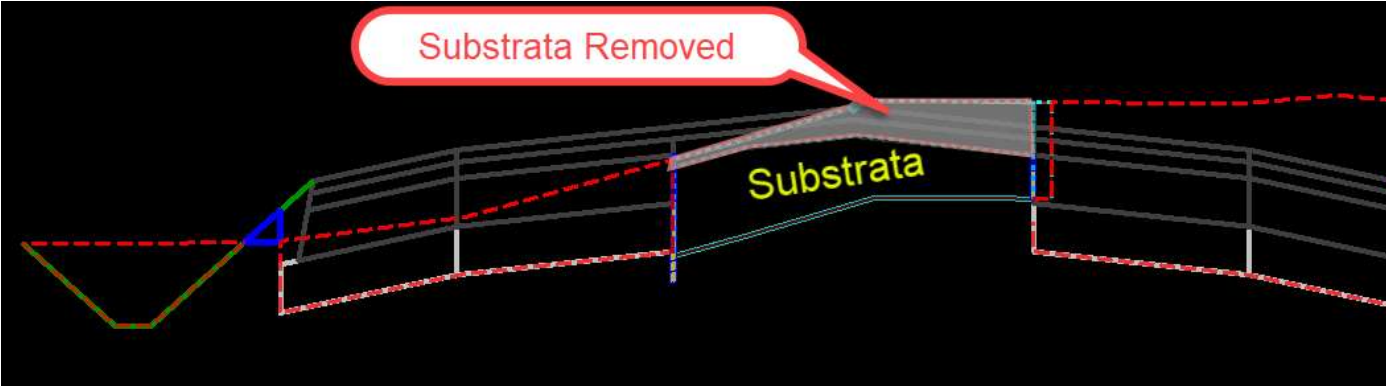
Cut/Fill + Substrata



Cut/Fill + Substrata



Cut/Fill + Substrata



Properties (OpenRo...)

Selection (1)

- TC_Existing Pavt

Selection

Name TC_Existing Pavt

Feature Definition

Name TC_Existing Pavt
Description Existing Pavement
Name Seed TC_Existing Pavt

Mesh

Surface Feature S TC_Existing Pavt
Volume Option Substrata
Cut Factor 1.0000
Replaced Feature Volumes_Unsuitable_Remov
Include Cut In Mas False

Items

Items Attached None

Modeling for Earthwork

Modeling for Earthwork

- Design
- Existing Features
- Substrata



Model Existing Features

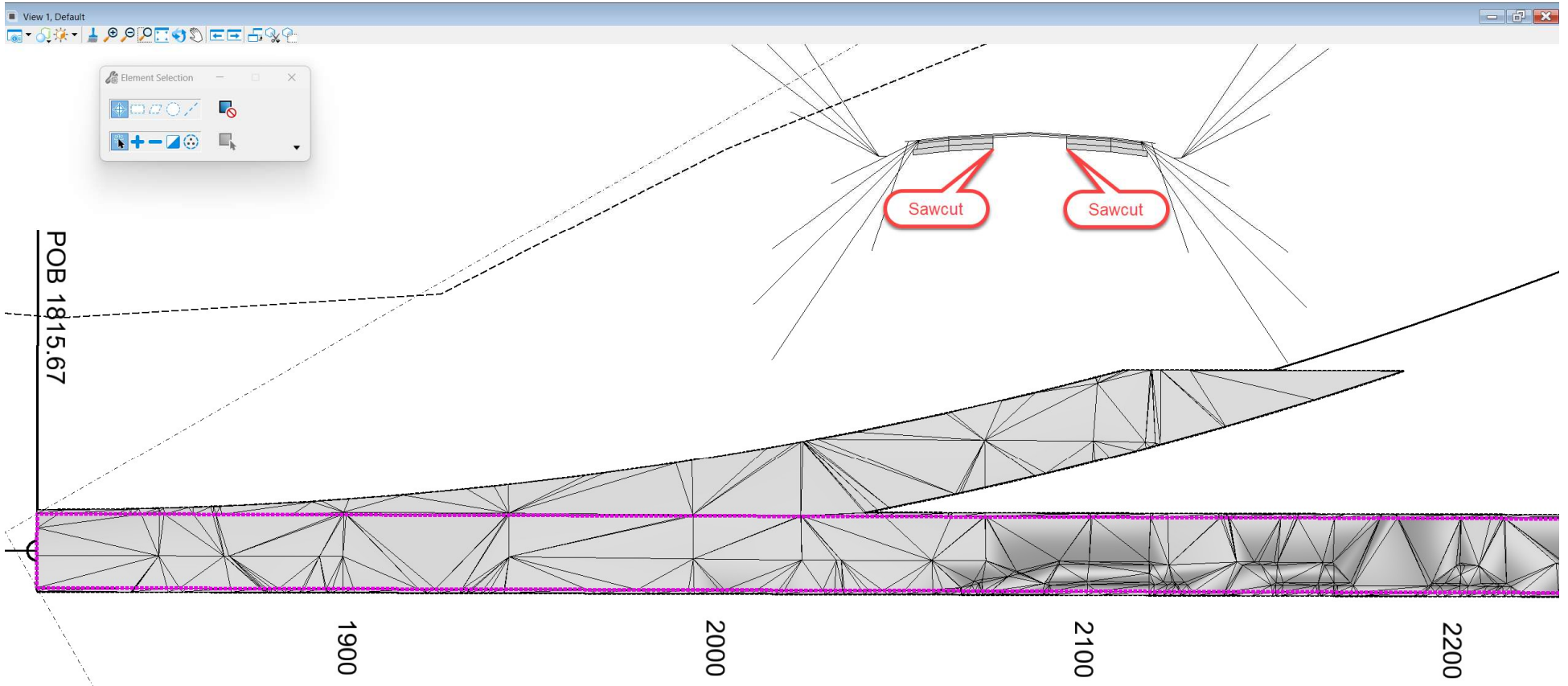
- Think of everything inside the project limits and consider if it can be built on top of or be reused as fill elsewhere on the project.
- If ***it can be built on*** but cannot be used as fill feature should be set as a “Substrata” volume option.
- If ***it cannot be built on*** or reused as fill its feature should be set as a an “Unsuitable” Volume Option.
- Existing Pavement, Sidewalks, Curb, Pads, Topsoil, Rock, Clay, Muck, ...
- Can be in multiple files
 - Corridors
 - Linear Templates
 - Surface Templates
 - Create Closed Mesh

Resurfacing and Widening

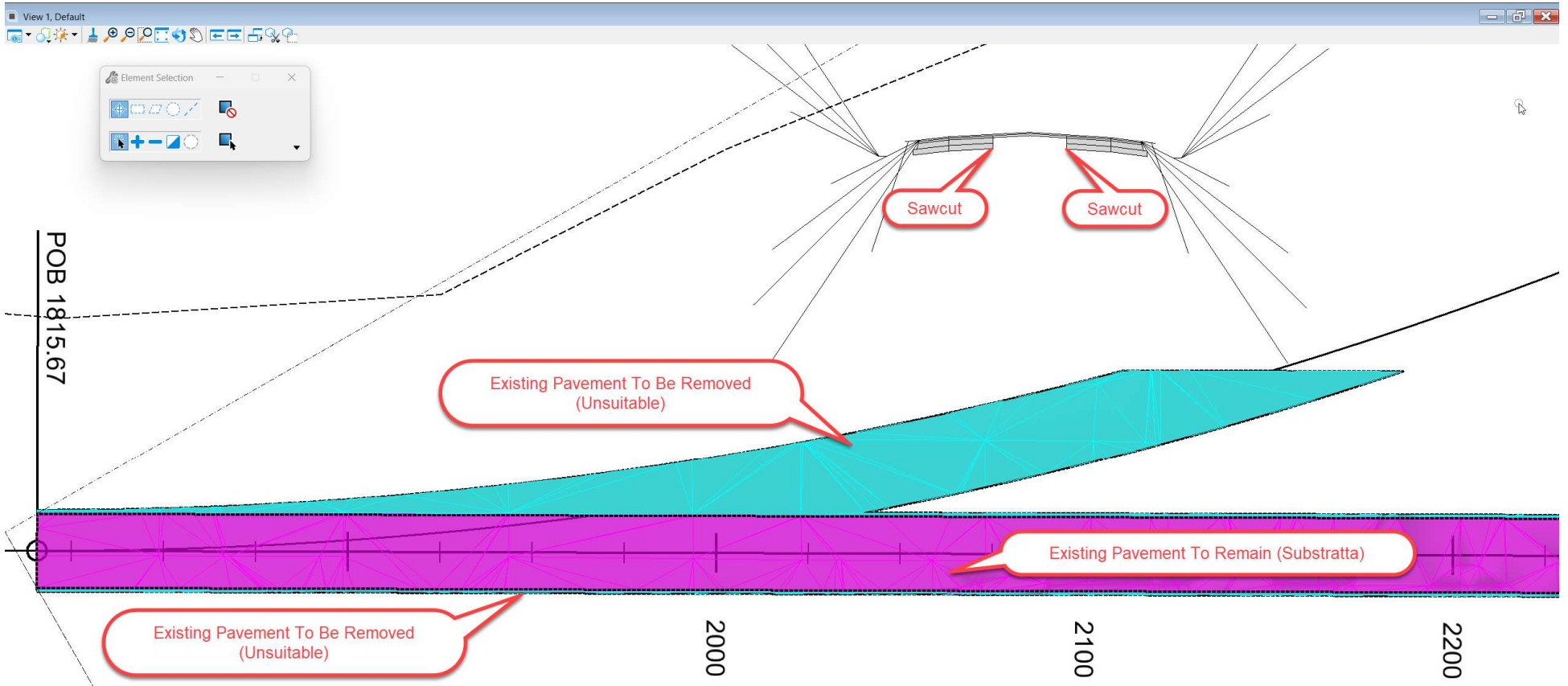
- Existing Pavement Model



Resurfacing and Widening

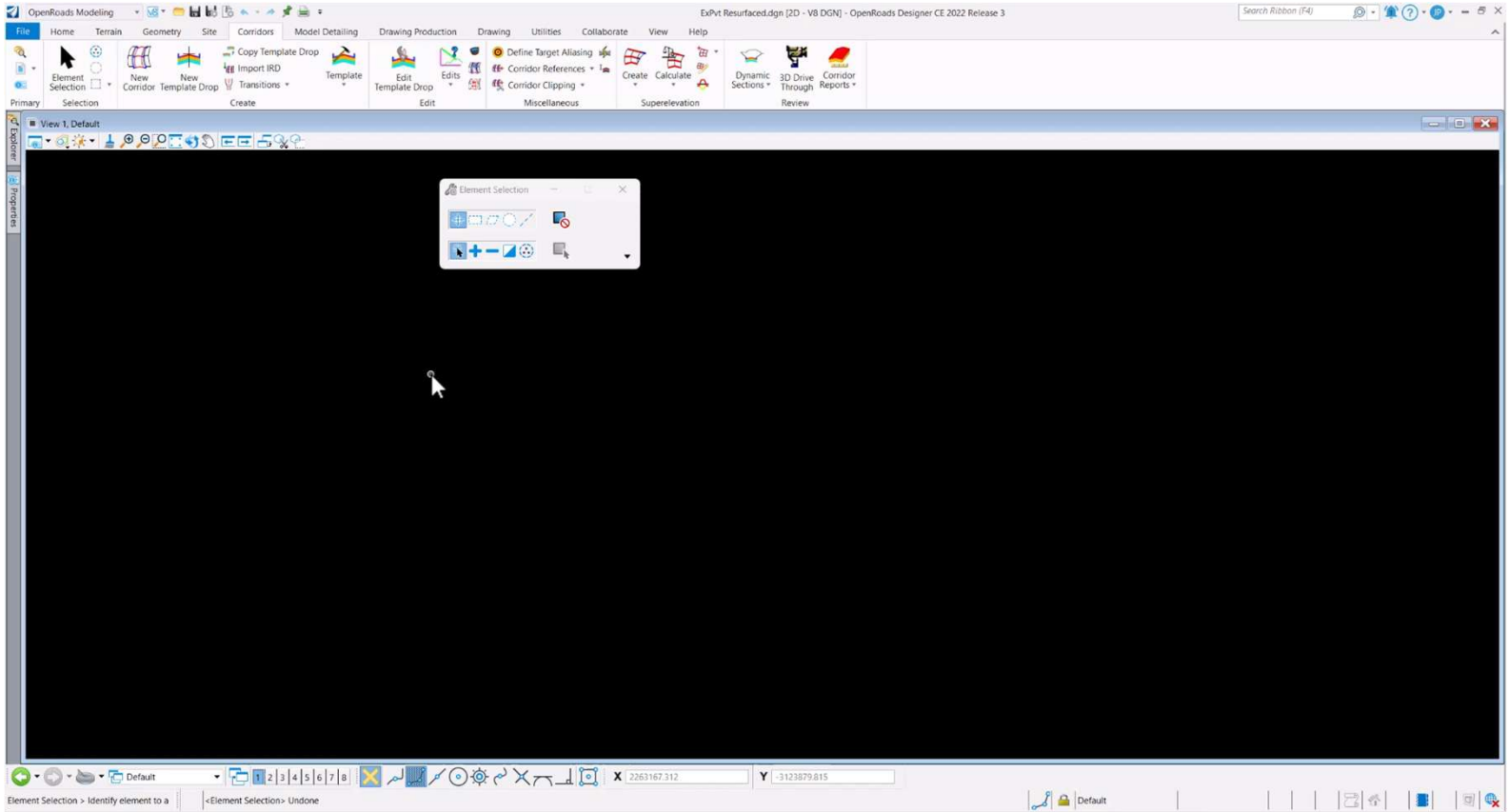


Resurfacing and Widening

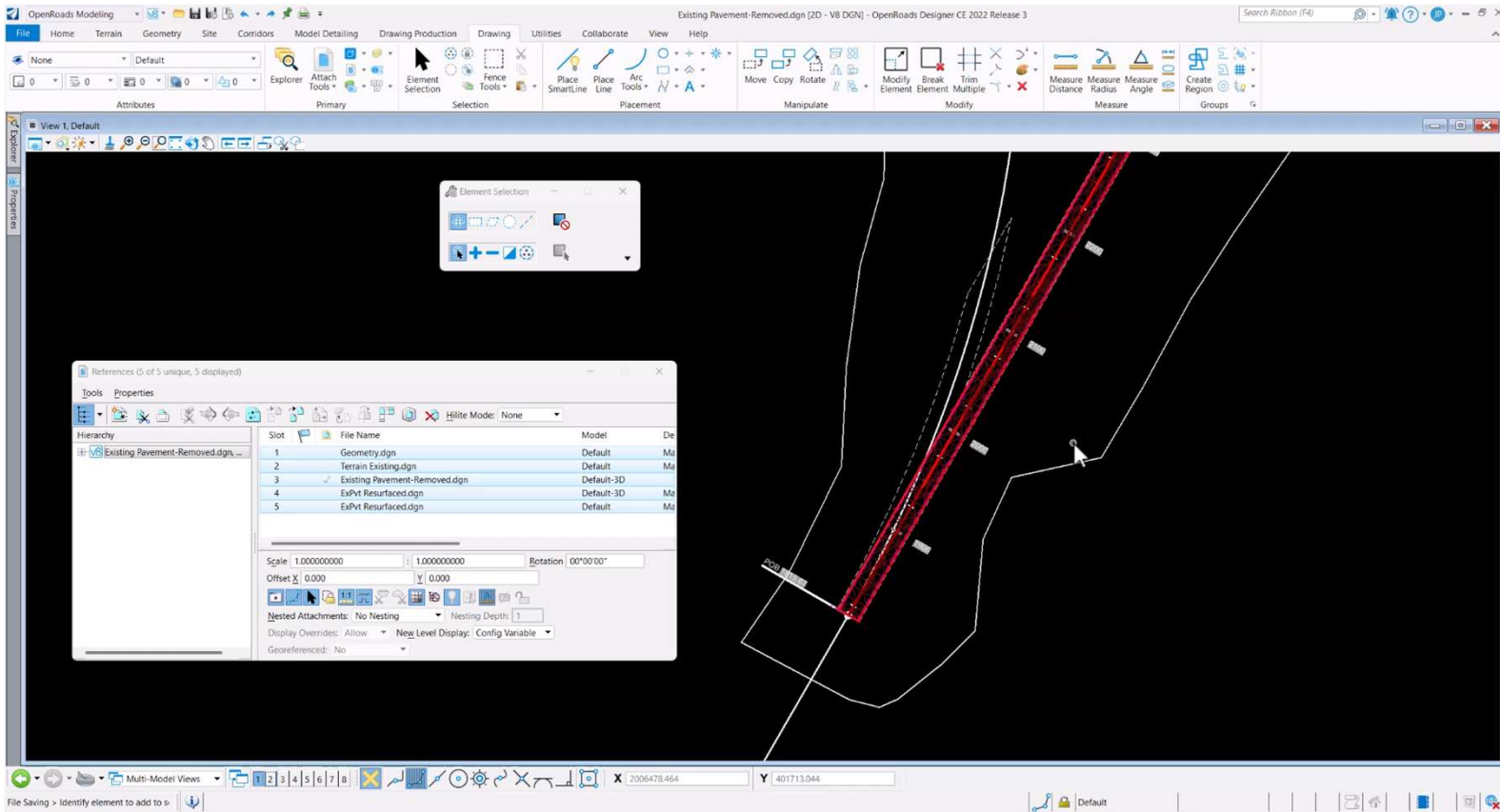


Corridor

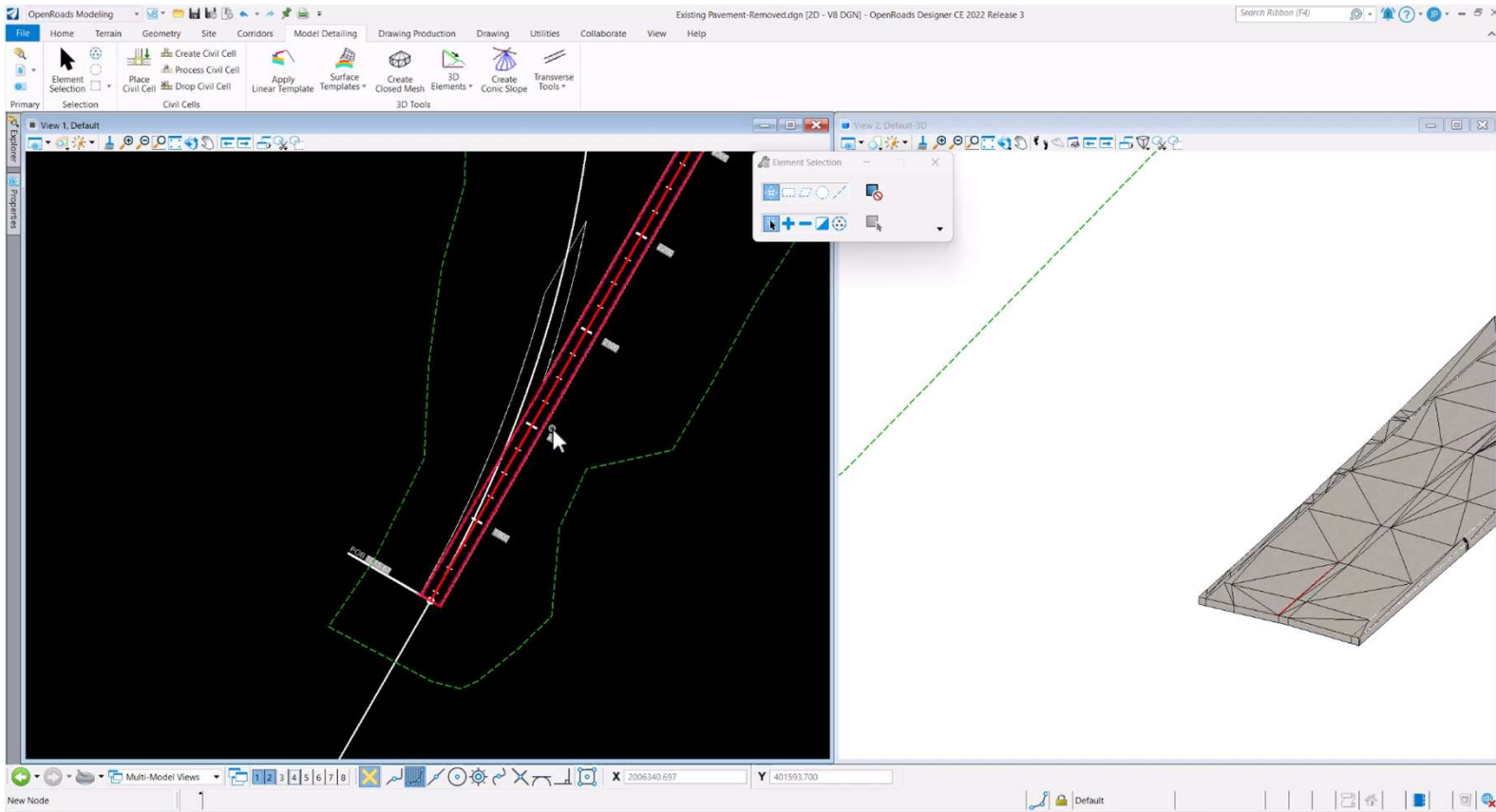
(Existing Pavement for Resurfacing)



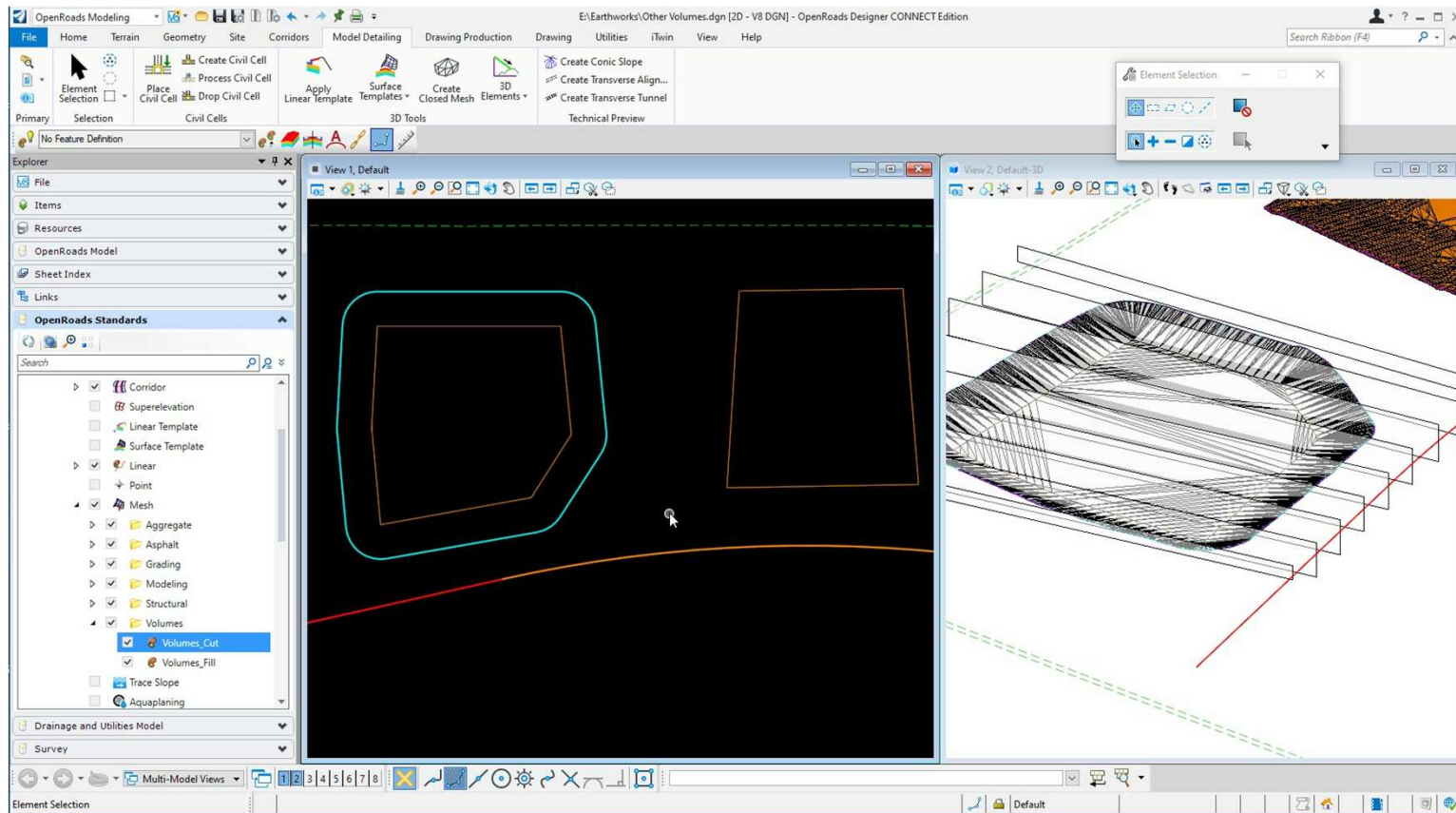
Clipped Terrains + Surface Template (Existing Pavement To Be Removed)



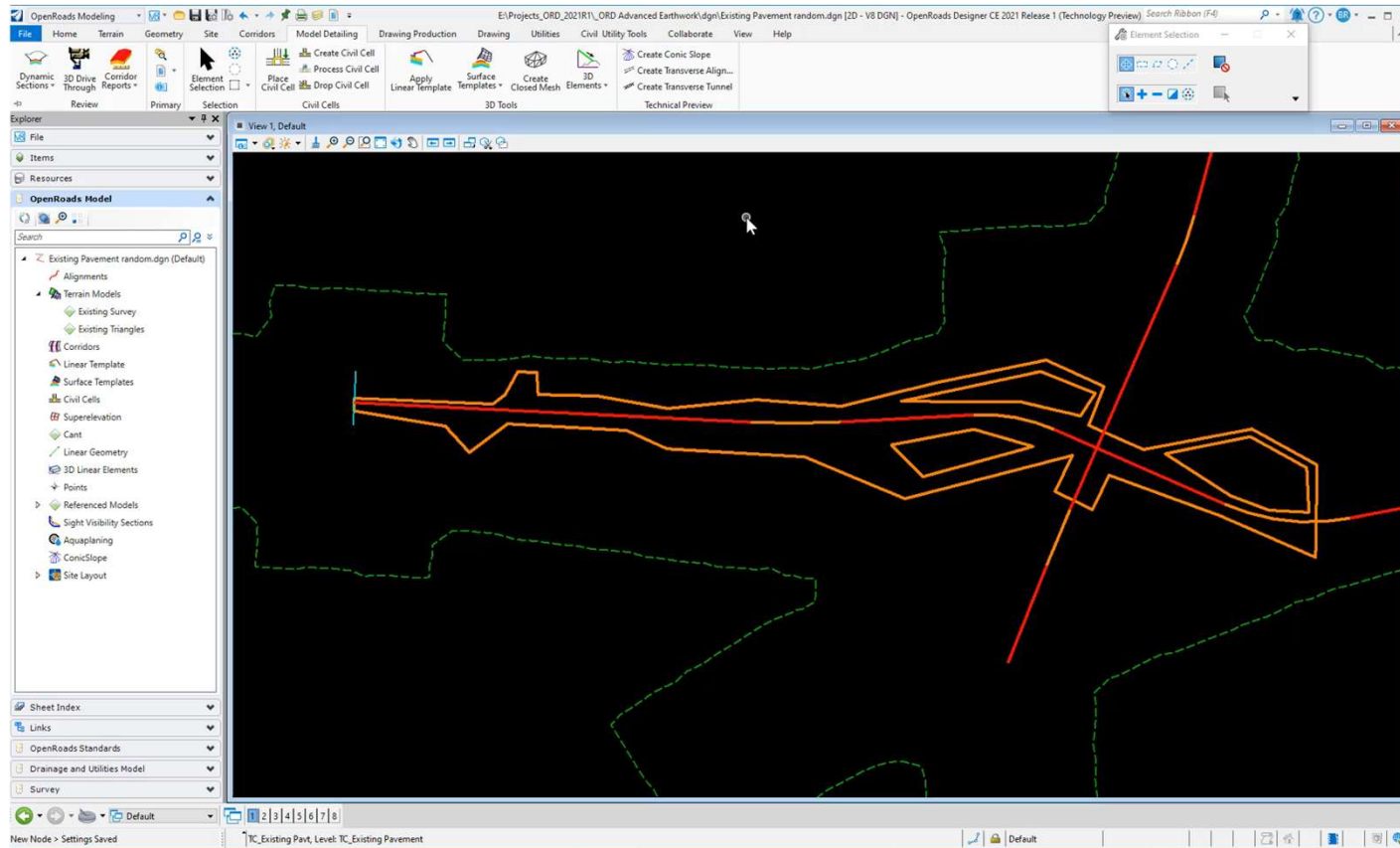
Linear Templates (Existing Curbs)



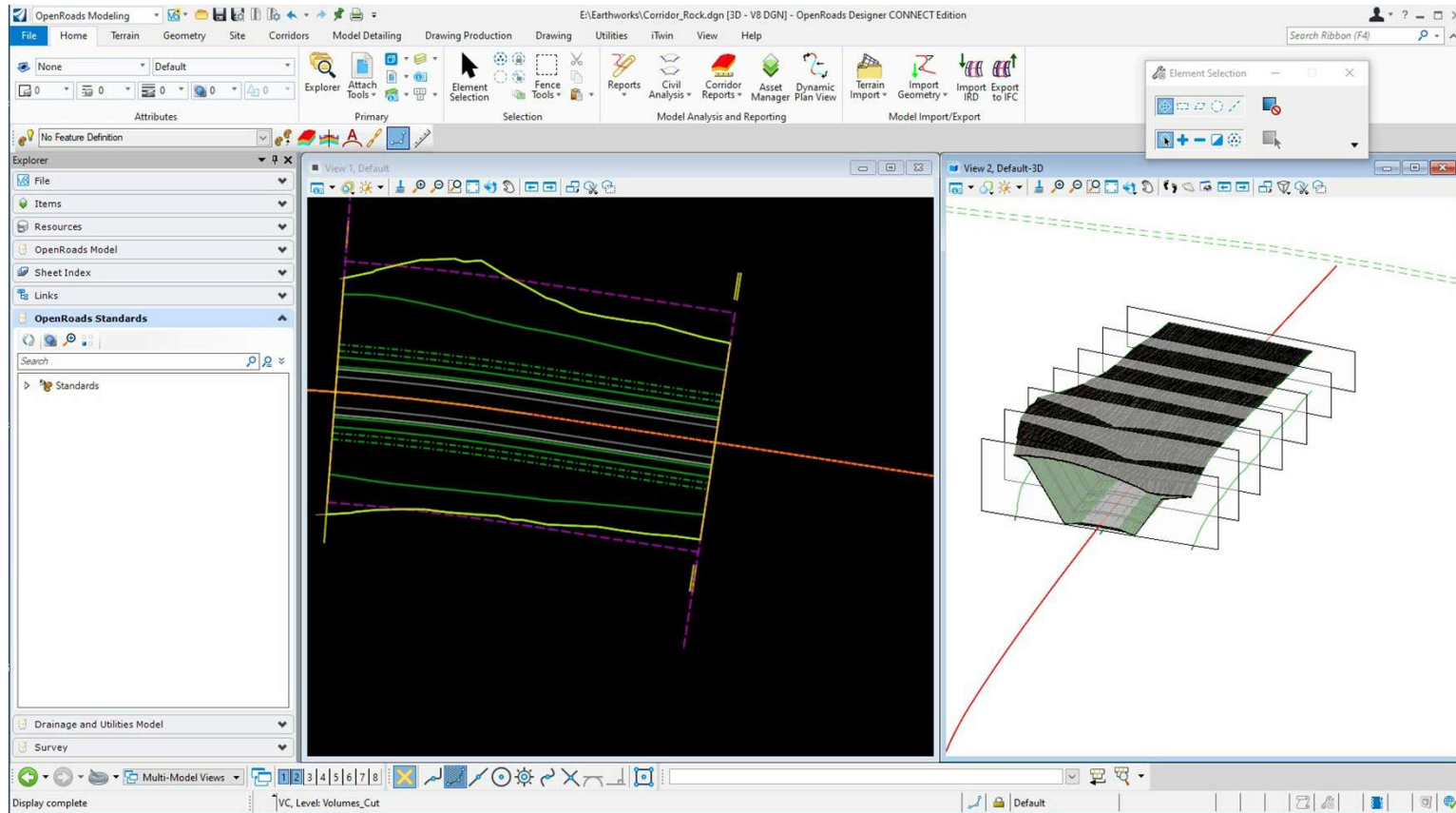
Create Closed Mesh – Surface to Depth



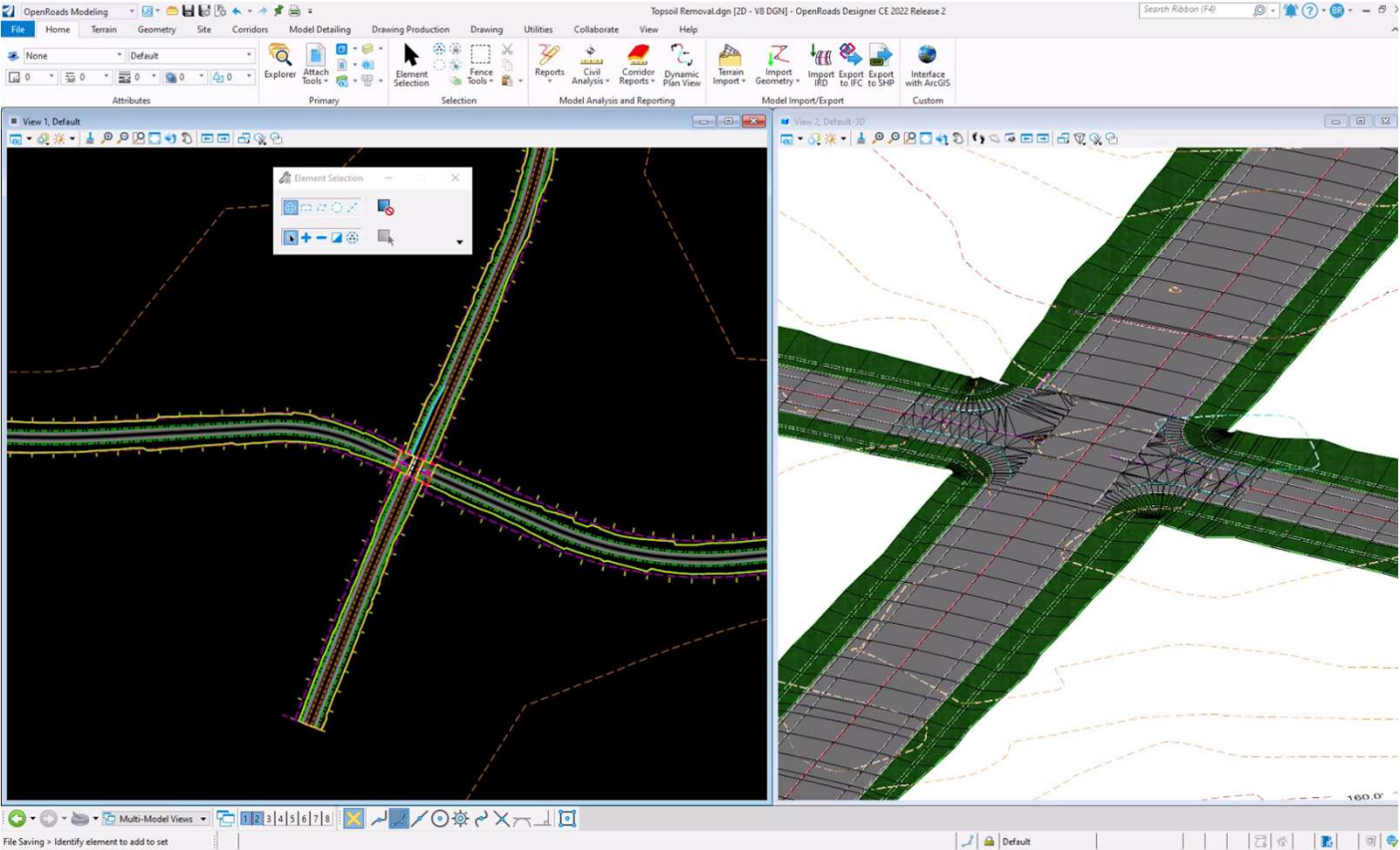
Clipped Terrains + Create Closed Mesh



Substrata - Rock Cut



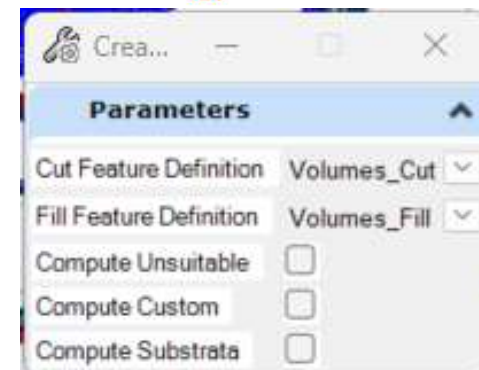
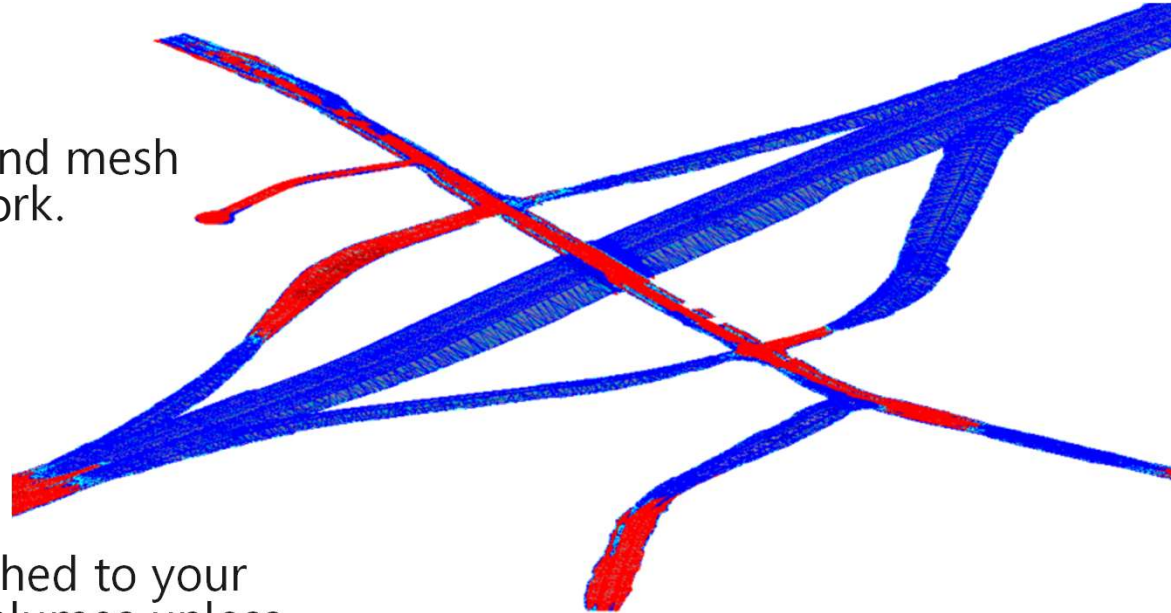
Topsoil Removal



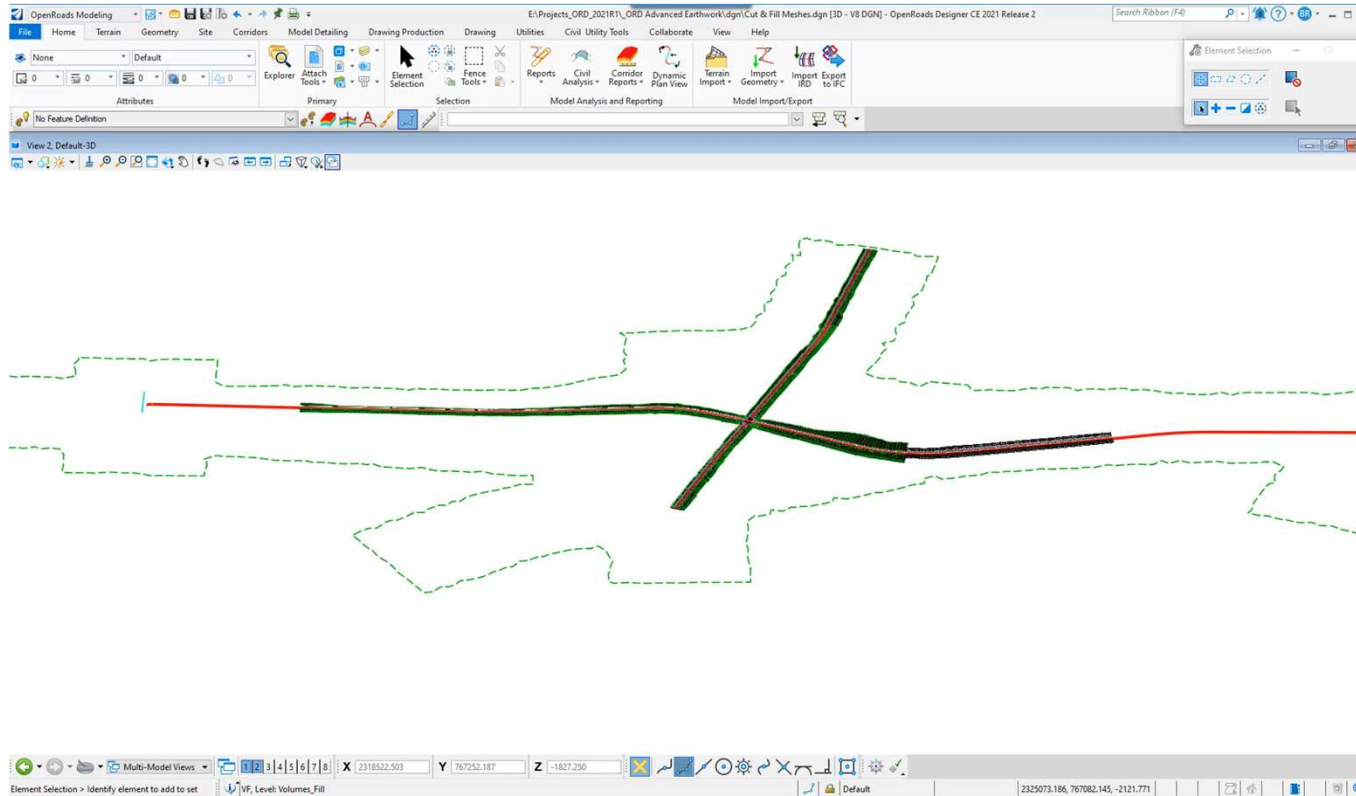
Create Cut \ Fill Volumes

Create Cut/Fill Meshes

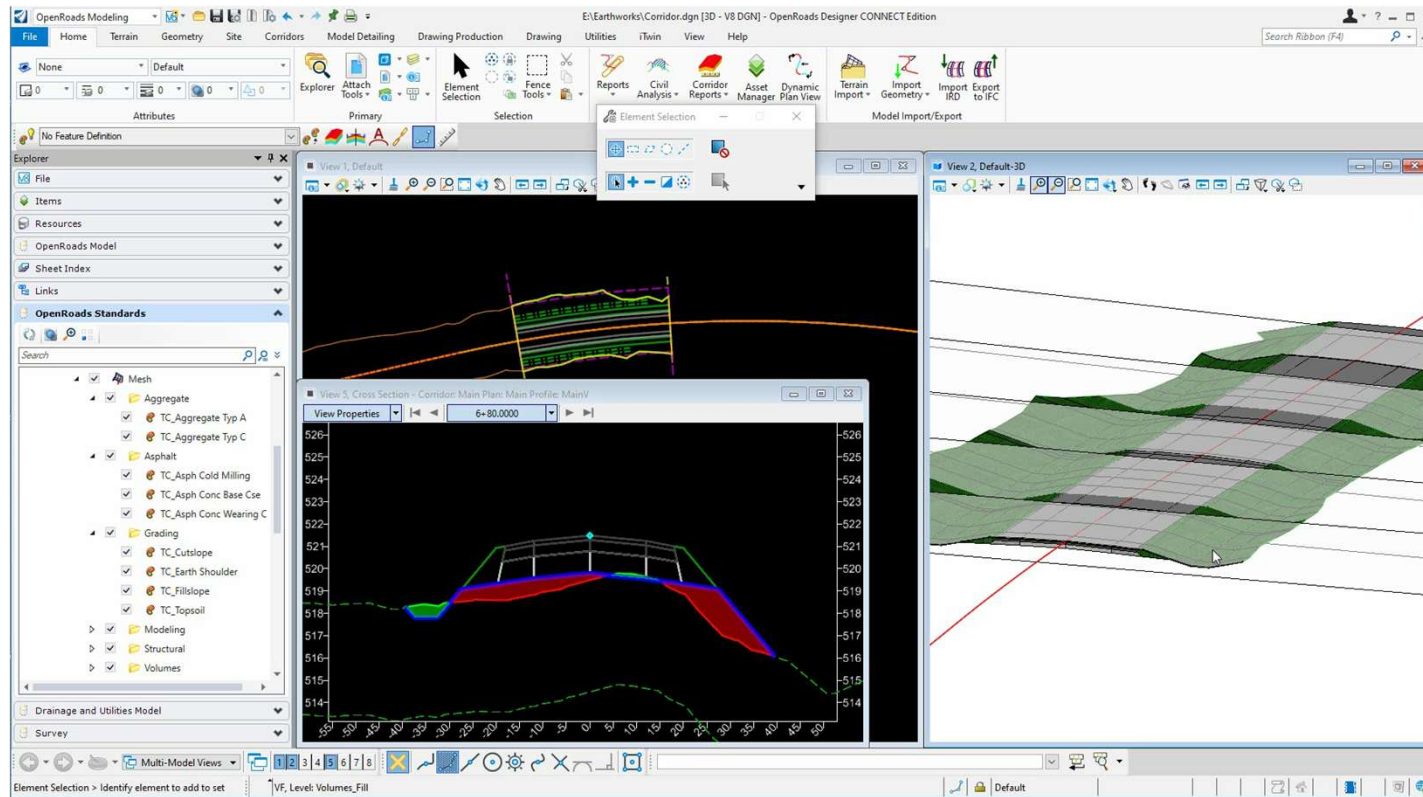
- Create 2d File for Earthwork
- Reference in files containing terrain and mesh elements to be considered in earthwork.
 - Corridors
 - Civil Cells
 - Ponds
 - Stock Piles
 - Existing Feature
 - Etc...
- Whatever is in the design file or attached to your file will be used to compute cut/fill volumes unless the volume option is marked as None.
 - Turning off the display of the reference does not matter. All files **ATTACHED** are considered.
- Run Create Cut Fill Volumes



Create Cut/Fill Meshes



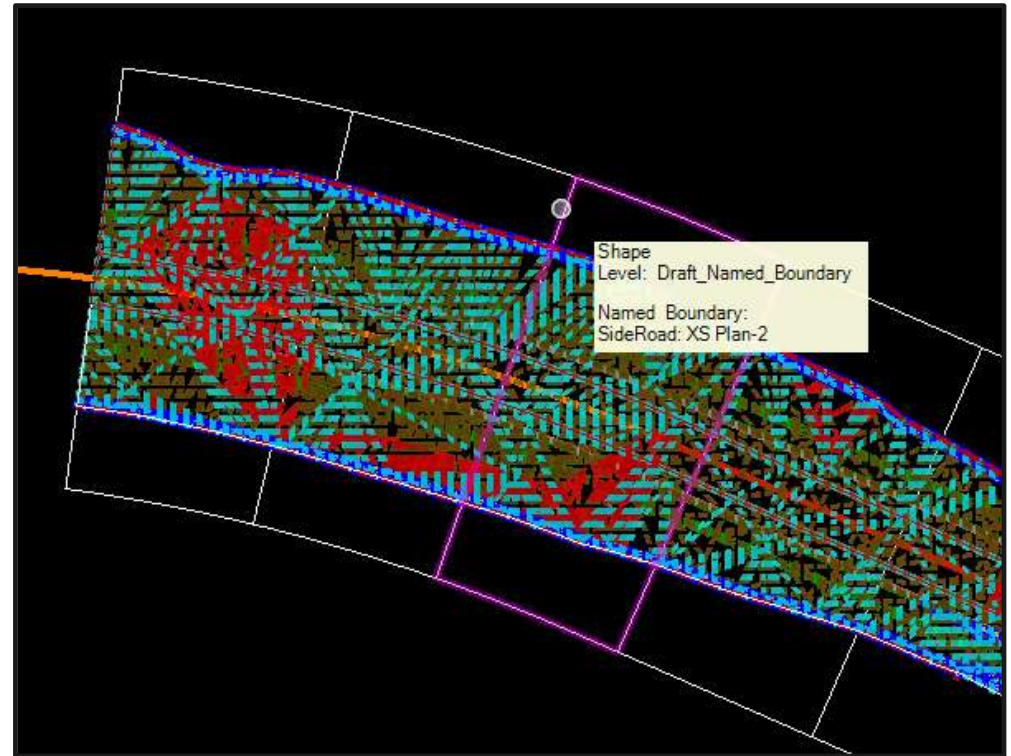
Create Cut/Fill Meshes - Unsuitable Substrata Custom



Reporting

Plan Named Boundaries Volumes

- Reference Surfaces
 - Components
 - Terrains
 - Mesh
- Feature Definitions
- Cut Fill Meshes
- Plan Named Boundaries
- Can Create Clipped Graphics



Plan Named Boundary Volumes

- Simulates End Area Volume (More Accurate)
- Set Plan Named Boundary Length to Cross Section Increment
- Run Quantities by Named Boundary
- Will Not Match End Area Volumes
 - Prismoidal Volume Inside Boundaries
 - Not Average of Area

Volumes Report

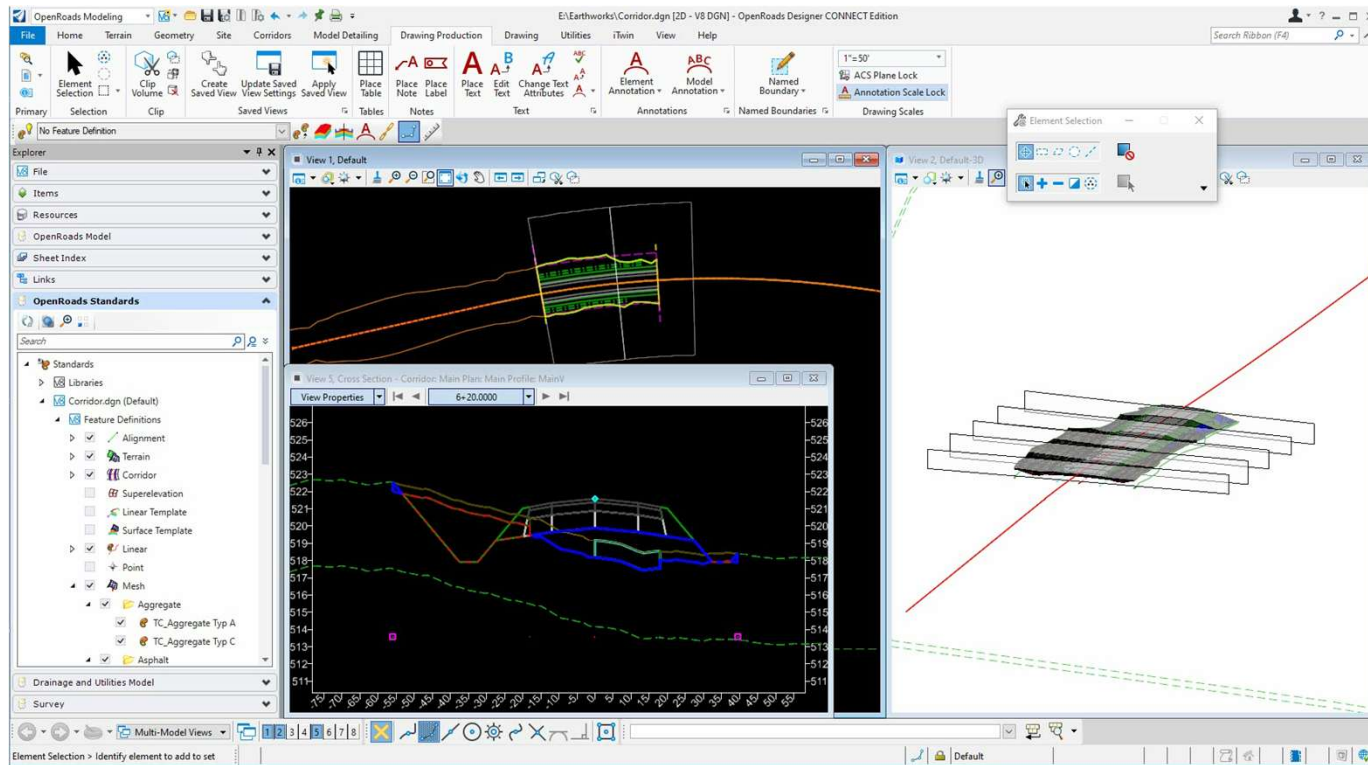
Report Created: Tuesday, April 6, 2021
Time: 10:47:43 AM

Cross Section Set Name: SideRoad
Alignment Name: SideRoad
Input Grid Factor:

Note: All units in this report are in feet, square feet and cubic feet unless specified otherwise.

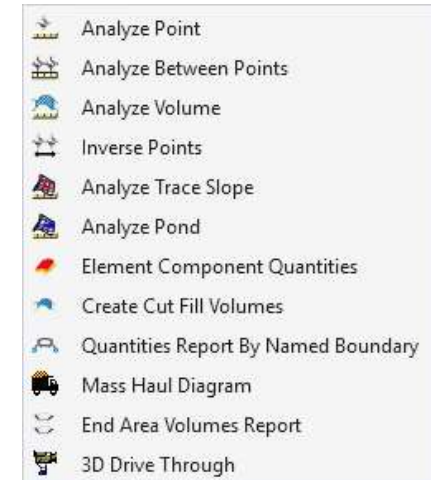
Station	Type	Area	Volume	Factor	Adjusted Volume	Included in Mass Ordinate?	Mass Ordinate
38+00.000							1463.217
	TC_Existing Pavt (removed):		2399.955	1.000	2399.955	No	
	Total TC_Existing Pavt:		2399.955	1.000	2399.955		
	TC_Existing Topsoil (removed):		10084.657	1.000	10084.657	No	
	Total TC_Existing Topsoil:		10247.976	1.000	10247.976		
	TC_Shale (removed):		1506.510	1.200	1807.812	No	
	Total TC_Shale:		154539.283	1.000	154539.283		
	TC_Sandstone (removed):		34999.190	1.200	41999.028	No	
	Total TC_Sandstone:		115461.284	1.000	115461.284		
	Volumes_Cut:		1626.536	1.000	1626.536	Yes	
	Volumes_Fill:		163.319	1.000	163.319	Yes	
	TC_Concrete Pavt:		2999.946	1.000	2999.946	No	
	TC_Aggregate Typ A:		1349.976	1.000	1349.976	No	
	TC_Aggregate Typ A Ext:		899.938	1.000	899.938	No	
	TC_Topsoil:		4224.104	1.000	4224.104	No	
	TC_Limestone:		600001.260	1.000	600001.260	No	
39+00.000							1426.523
	TC_Existing Pavt (removed):		2399.955	1.000	2399.955	No	

Plan Named Boundary Volumes

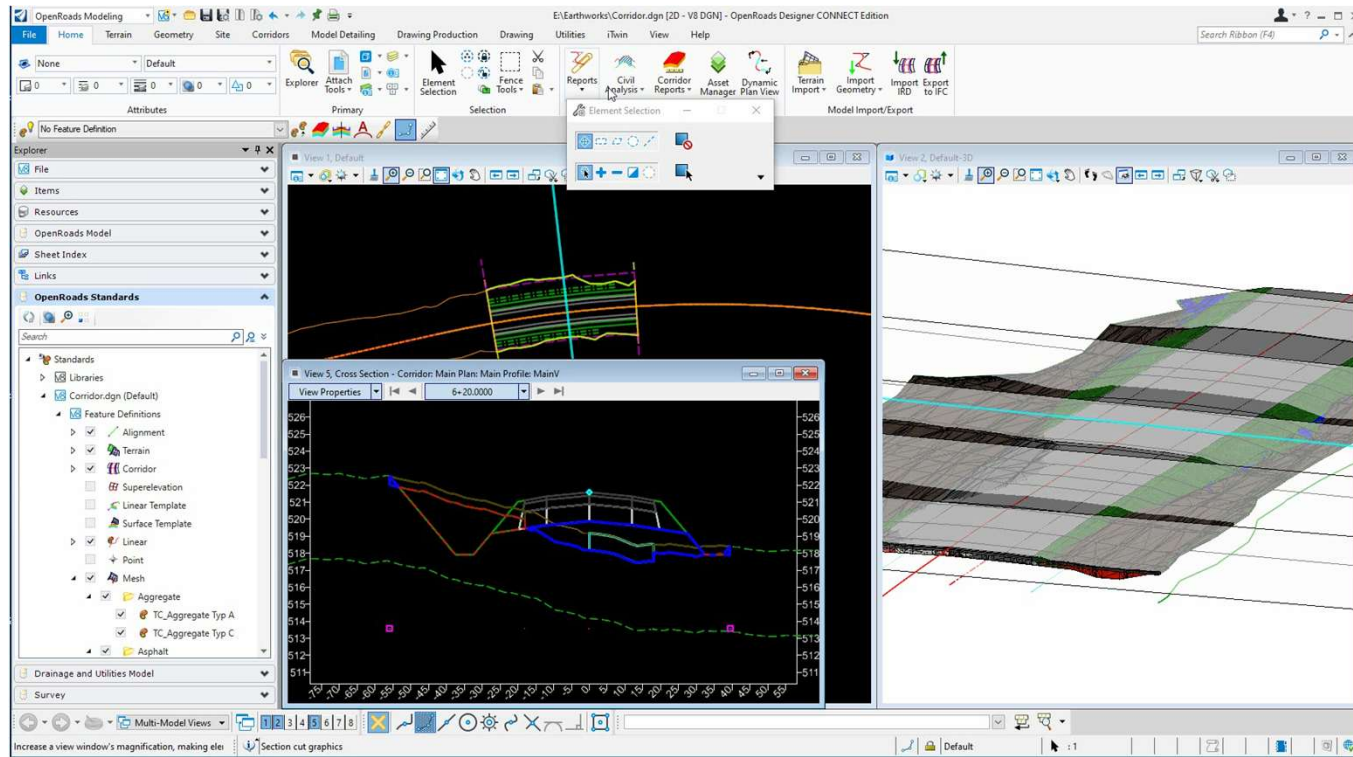


End Area Volume Report

- Requires Cross Section Named Boundaries
 - Location/Interval Defined by Named Boundaries
 - Can be referenced in Quantity \ Earthwork File
 - If use for Cross Section Sheet Annotation must be ran in file containing
- True End Area Calculations
 - Calculated from Cut/Fill Meshes
 - Does Not Consider Centroid



End Area Volume Report



Cut/Fill Factors (Shrink/Swell)

- Cut/Fill Factors (Shrink/Swell) are associated with the Feature Definitions
- Taken into account when reported

The screenshot displays the Bentley Civil Report Browser interface. On the left, the 'Properties (OpenRoads Standards)' window shows the 'Volumes_Cut' feature definition with the following details:

- Feature Definition:** Name: Volumes_Cut, Description: Cut Volumes Mesh, Name Seed: VC
- Item Type:** No Item Type
- Mesh:** Surface Feature Symbol: Volumes_Cut, Volume Option: Cut, Cut Factor: 1.2000

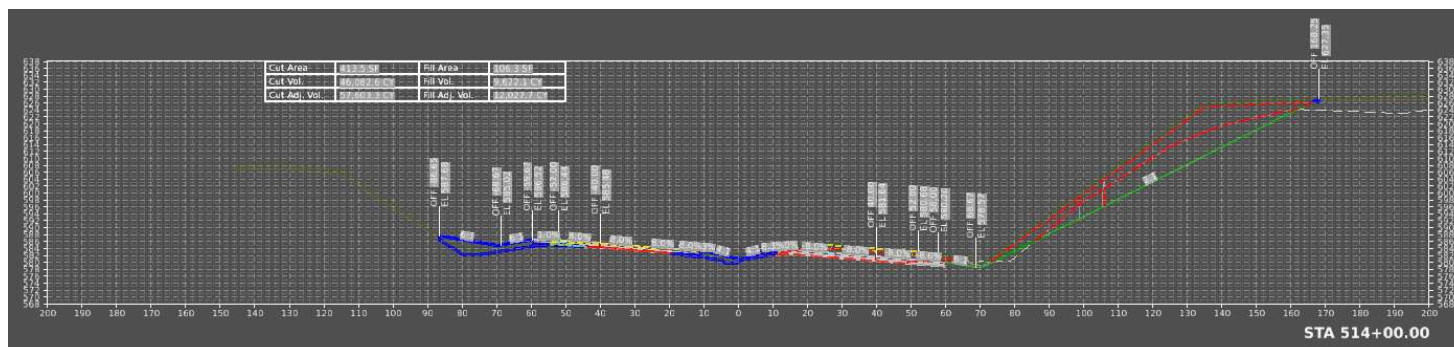
The main window shows the 'End Area Volume Report' for 'HWY 72'. The report includes a table of station quantities with columns for Baseline Station, Factor, Area, Volume, Adjusted, and Mass Ordinate. The data is summarized in the table below:

Baseline Station	Factor	Cut			Fill			Mass Ordinate
		Area	Volume	Adjusted	Area	Volume	Adjusted	
510+00.00	1.25	193.19	0.00	0.00	0.00	0.00	0.00	
511+00.00	1.25	210.89	748.30	935.37	142.94	413.58	516.98	
512+00.00	1.25	378.05	1090.63	1363.29	81.57	415.76	519.69	
513+00.00	1.25	508.16	1641.13	2051.41	86.15	310.59	388.24	
514+00.00	1.25	413.49	1706.76	2133.46	106.29	356.37	445.47	
515+00.00	1.25	88.30	929.25	1161.56	167.18	506.42	633.03	
516+00.00	1.25	51.10	258.14	322.68	125.57	542.13	677.66	
517+00.00	1.25	49.49	186.28	232.85	127.85	469.30	586.63	
518+00.00	1.25	74.45	229.52	286.90	92.52	408.10	510.12	
Grand Total:			6790.01	8487.51		3422.26	4277.82	

Cross Section Annotation

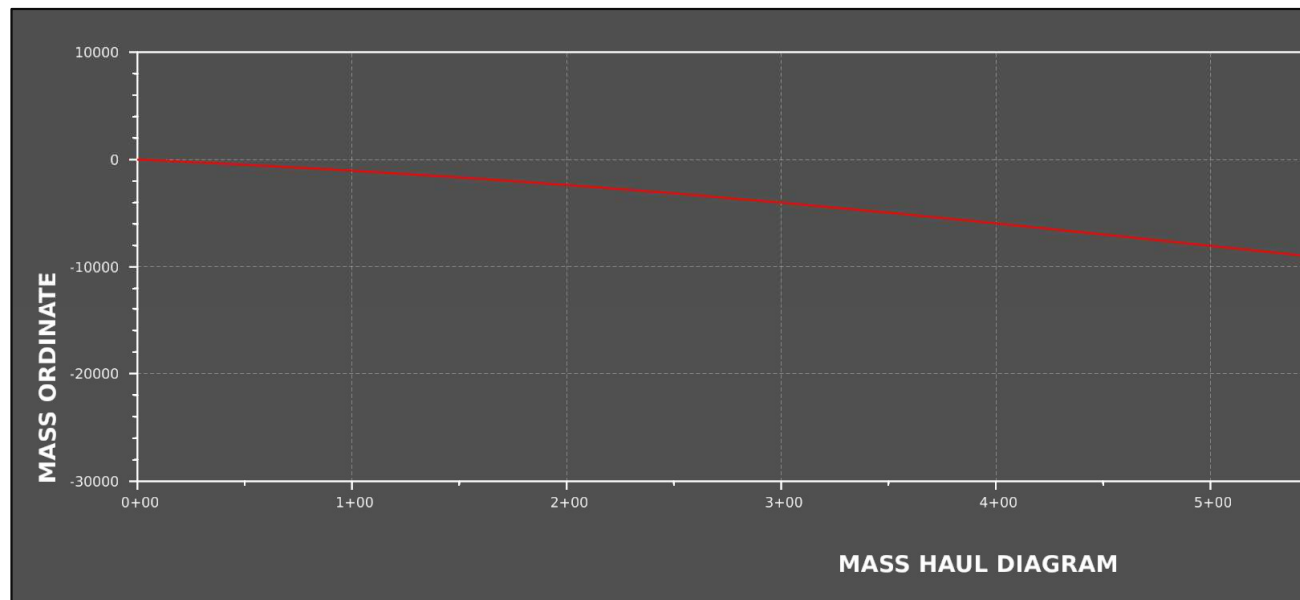
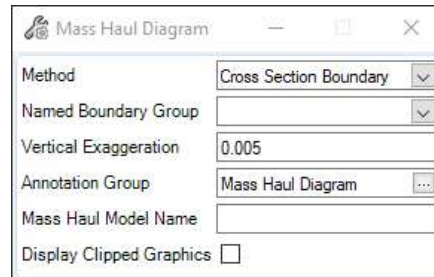
- End Area Volume Report and Annotation on Cross Section Sheets
- Only Cut & Fill can be Annotated on XS

Cut Area	413.5 SF	Fill Area	106.3 SF
Cut Vol.	46,082.6 CY	Fill Vol.	9,622.1 CY
Cut Adj. Vol.	57,603.3 CY	Fill Adj. Vol.	12,027.7 CY



Mass Haul

- Methods
 - Interval
 - Plan Named Boundary
 - Cross Section Boundary



Legacy Tools

Legacy Tools

- Terrain to Terrain
- Component Quantities
- Dynamic End Area Display
- Element Properties
- Measure Volume

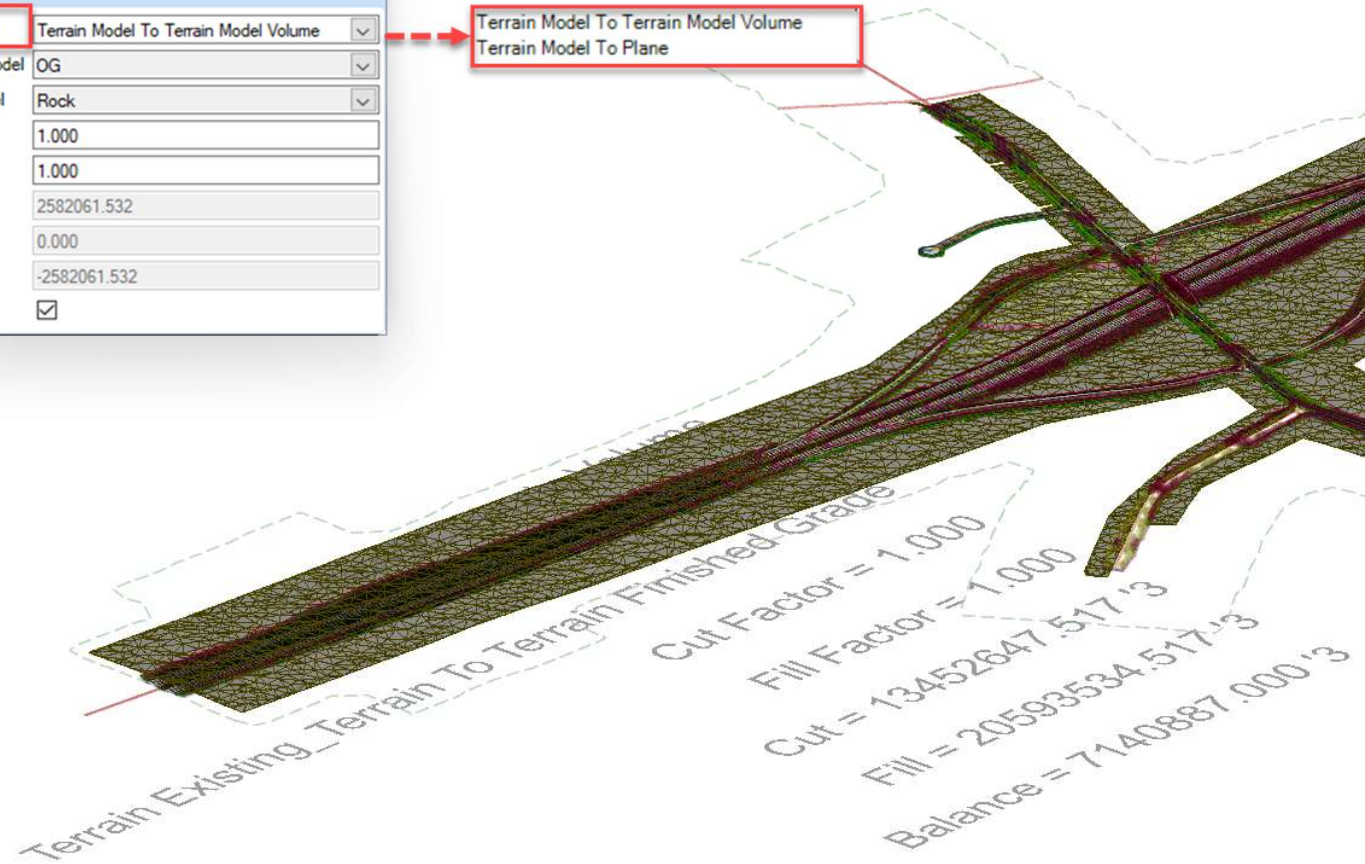
Terrain to Terrain Volumes

- Terrain to Terrain
- Terrain to Plane

Analyze Volume Terrain Model

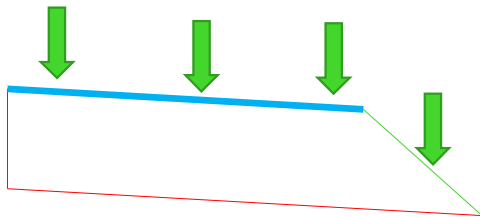
Parameters	
Volume Method	Terrain Model To Terrain Model Volume
From Terrain Model	OG
To Terrain Model	Rock
Cut Factor	1.000
Fill Factor	1.000
Cut	2582061.532
Fill	0.000
Balance	-2582061.532
Save Result	<input checked="" type="checkbox"/>

Terrain Model To Terrain Model Volume
Terrain Model To Plane



Element Properties

- Civil Quantities:
 - Volume
 - Planar Area
 - Top Sloped Area
- Displayed in Master Units
- The Surface That a Drop of Water May Hit
- Will require Separate component if wedge not included in area



Properties

Elements (1)

- ShoulderAggregate_R
 - Items

General

Element Description	ShoulderAggregate_R
Level	TC_Aggregate
Color	ByLevel (64)
Line Style	ByLevel (0)
Weight	ByLevel (3)
Class	Primary
Template	(None)
Transparency	0

Feature

Feature Definition	TC_Aggregate Typ C
Feature Name	ShoulderAggregate_R

Civil Quantities

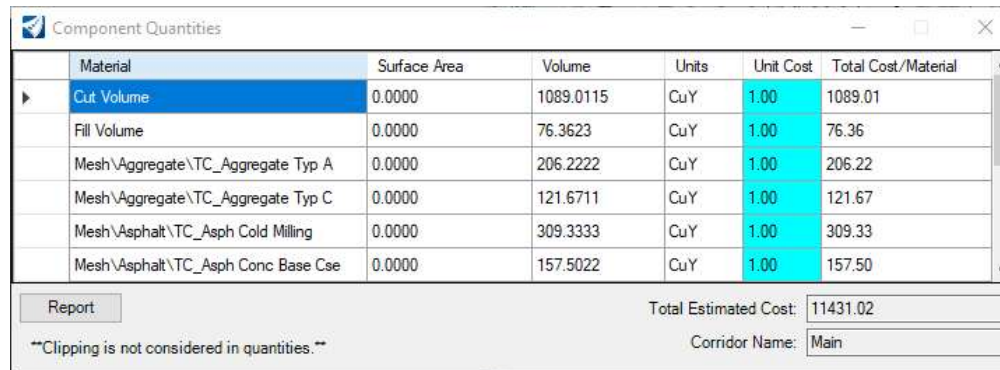
Top Sloped Area	1883.127 Sq.'
Planar Area	1772.224 Sq.'
Volume	1629.615 Cu.'

Component Layer

Description	
Start Station	499.000000
End Station	731.000000
Volume Option	Design

Component Quantities

- Only one corridor at a time
- Does not recognize clipping
- Computes Cut/Fill from lowest components

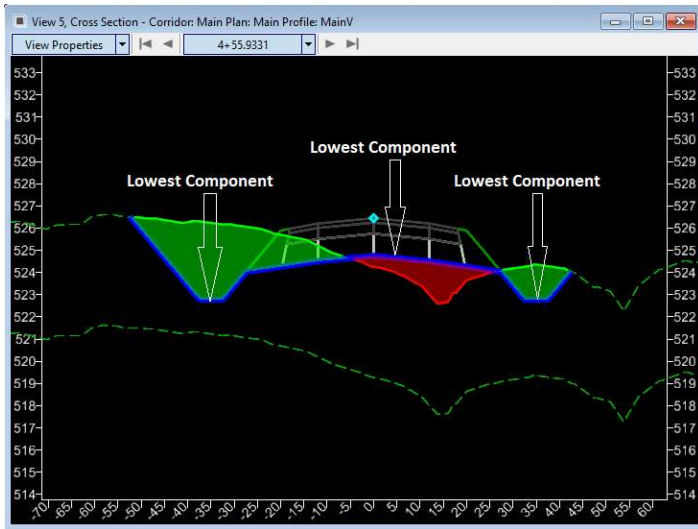


Material	Surface Area	Volume	Units	Unit Cost	Total Cost/Material
Cut Volume	0.0000	1089.0115	CuY	1.00	1089.01
Fill Volume	0.0000	76.3623	CuY	1.00	76.36
Mesh\Aggregate\TC_Aggregate Typ A	0.0000	206.2222	CuY	1.00	206.22
Mesh\Aggregate\TC_Aggregate Typ C	0.0000	121.6711	CuY	1.00	121.67
Mesh\Asphalt\TC_Asph Cold Milling	0.0000	309.3333	CuY	1.00	309.33
Mesh\Asphalt\TC_Asph Conc Base Cse	0.0000	157.5022	CuY	1.00	157.50

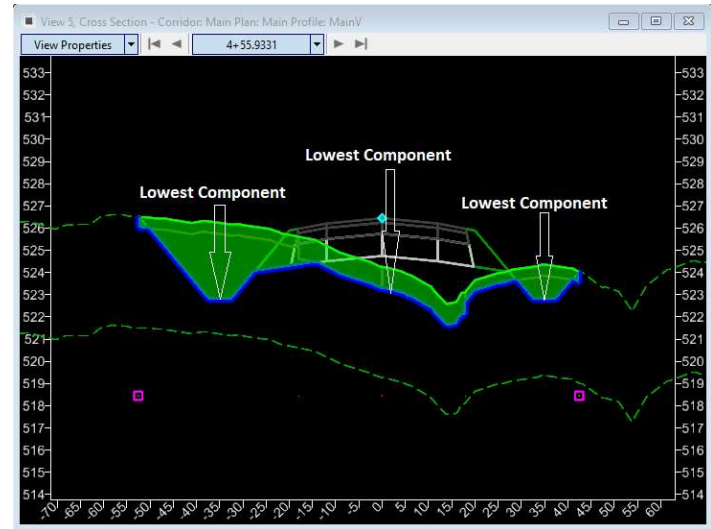
Report Total Estimated Cost: 11431.02

****Clipping is not considered in quantities.**** Corridor Name: Main

Dynamic End Area Volumes



With No Unsuitable/Milling

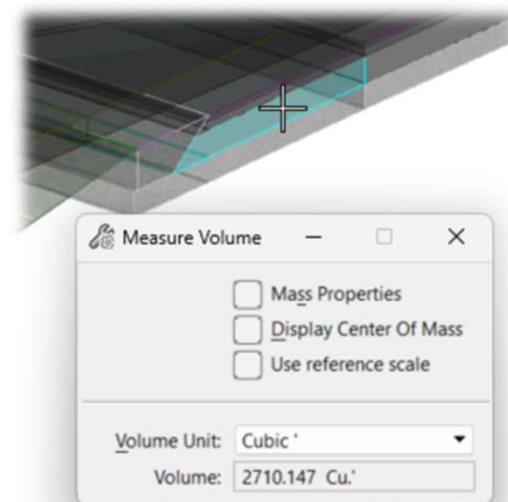
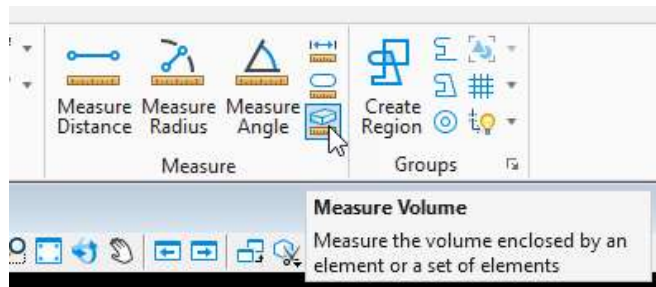


With Unsuitable/Milling

NOTE: Example shows Cut/Fill in Dynamic Sections.
Values in Dynamic Section Will Reflect the Same

Measure Volumes

- MicroStation Measure Volume Tool
 - Can be Used with Selection Set



Setting	Description
Mass Properties	If on, the Mass Properties window displays the mass property analysis for the measured volume.
Display Center of Mass	If on, a graphic crosshair that represents the center of mass for the measured element(s) is displayed.
Use reference scale	Allows users to measure in true model units while in a Sheet model that contains a scaled reference file. This checkbox is off by default. Note: This setting is only applicable in the Sheet models.



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We want to hear from you.
Scan the QR code to take the survey.



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courses



Instructor-
Led classes



Accreditation
programs



Curated
YouTube
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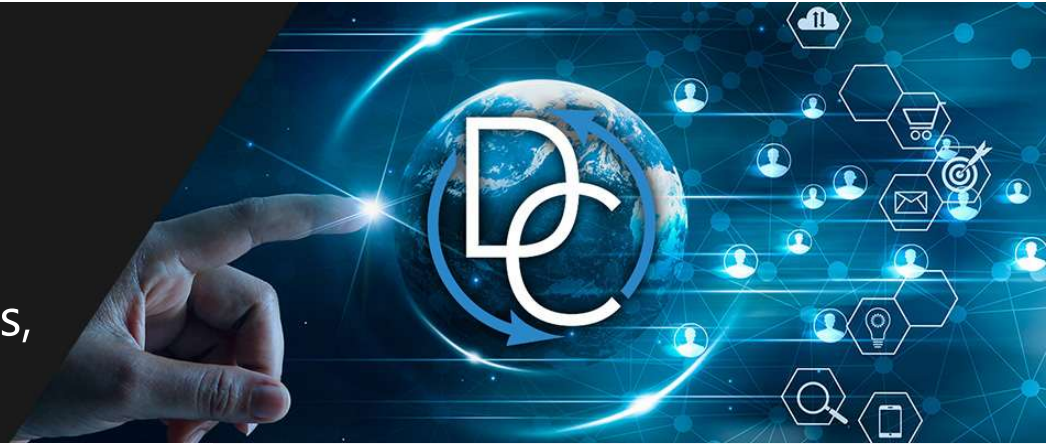
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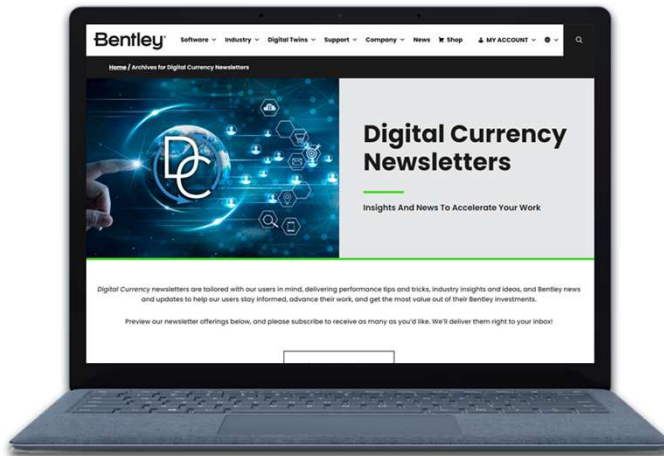
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