



# 3D Features and Sub-Surface Analysis

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Product Engineer, 3D Analysis Team

A 3D visualization of a building and its sub-surface analysis. The building is shown in a cutaway view, revealing internal structures and a sub-surface layer with topographic contours and a network of lines. The colors are primarily blue, orange, and green. The text 'GIS INSPIRING WHAT'S NEXT' is overlaid on the bottom right of the visualization.

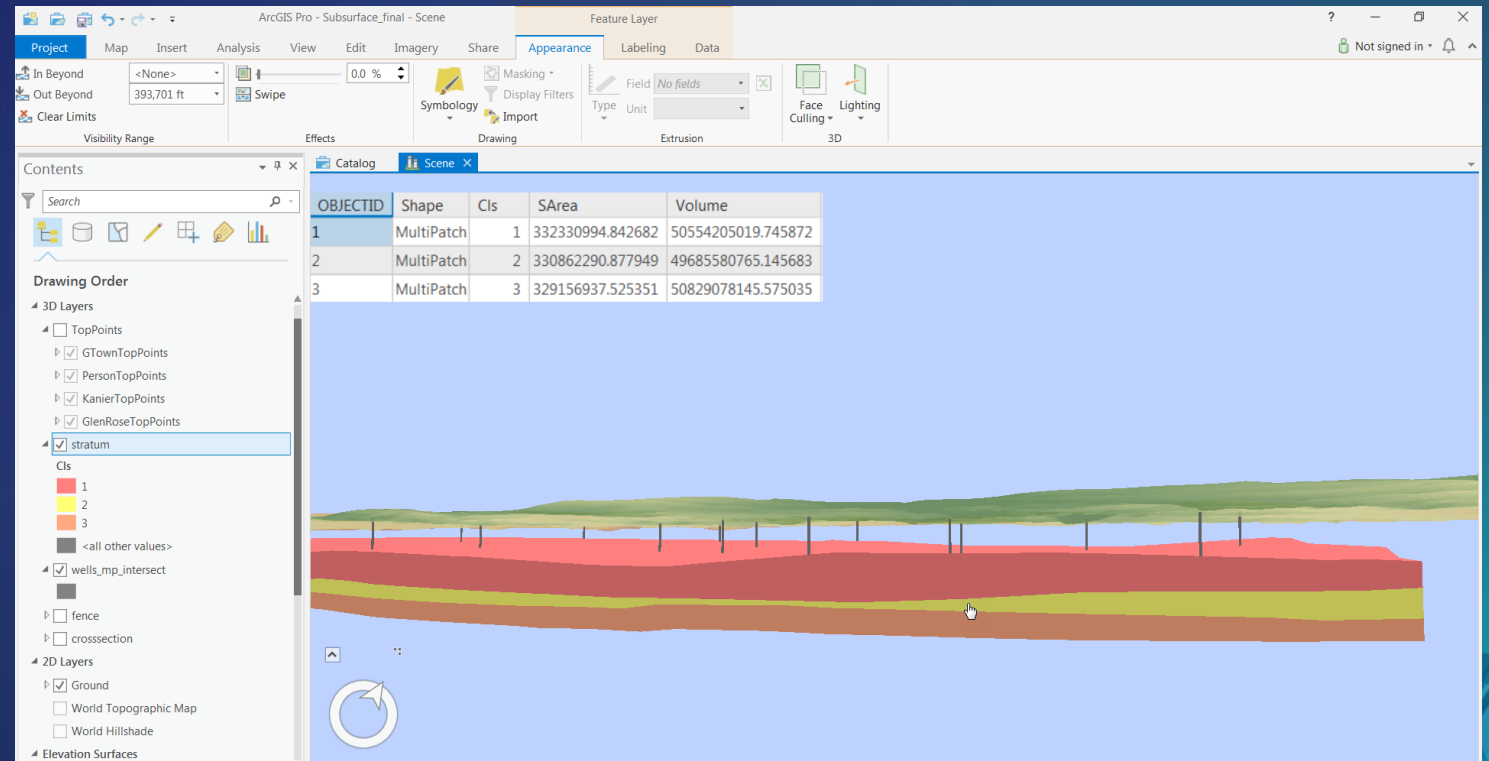
GIS  
INSPIRING  
WHAT'S  
NEXT

# Outlines

- **Introduction**
- **3D features**
- **Surfaces**
- **Sub-surface analysis**
- **Examples**
- **Q&A**

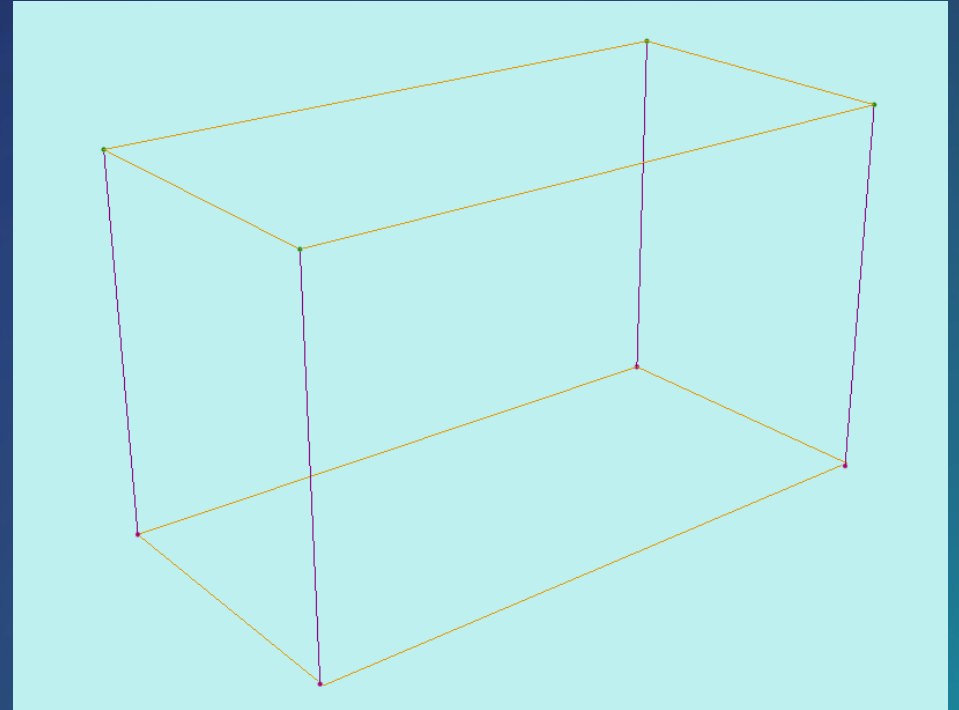
# Introduction

- **Underground objects**
  - Invisibility
  - Complexity
- **Sub-surface analysis**
  - 3D environment
  - Visual and spatial analysis



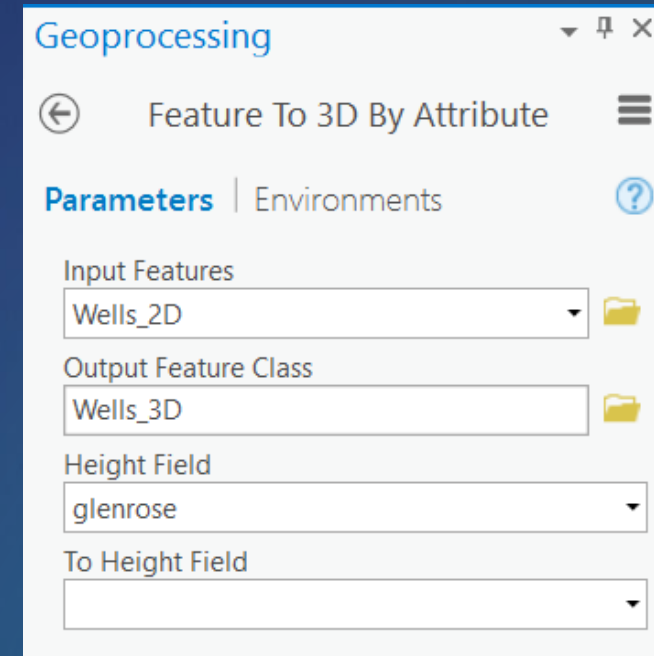
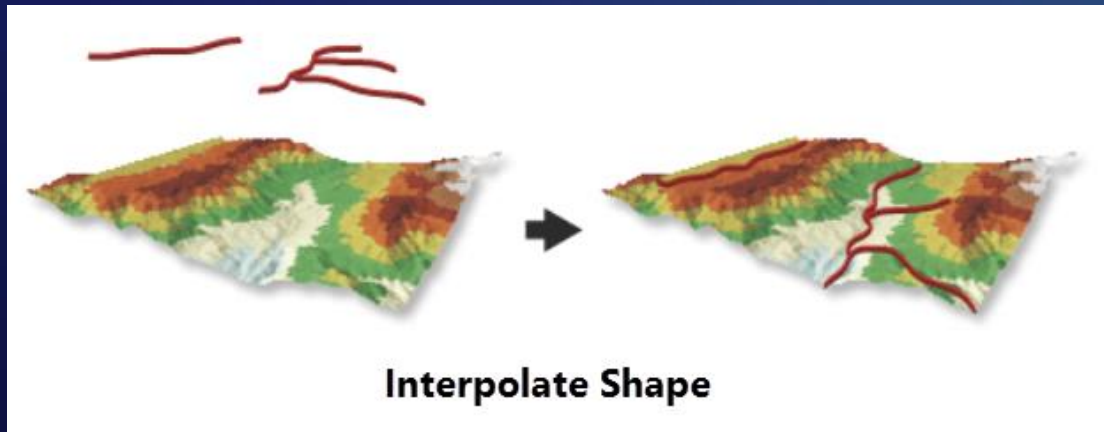
# 3D Features

- **3D Point**
  - An XYZ coordinate
- **3D Polyline**
  - A series of XYZ coordinates
- **3D Polygon**
  - A series of XYZ coordinates that enclose an area



## 3D Features (Cont.)

- How to create 3D points, polylines, and polygons?
  - Interactive editing
  - Conversion from existing 2D features

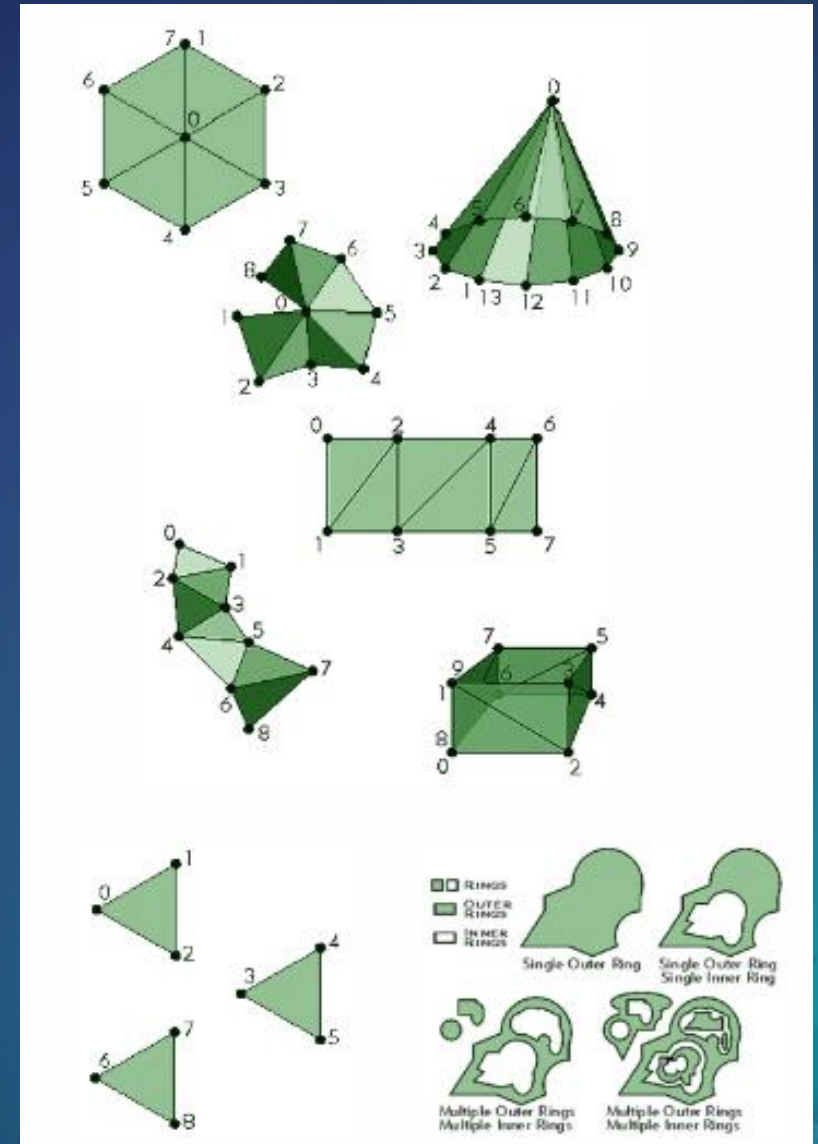
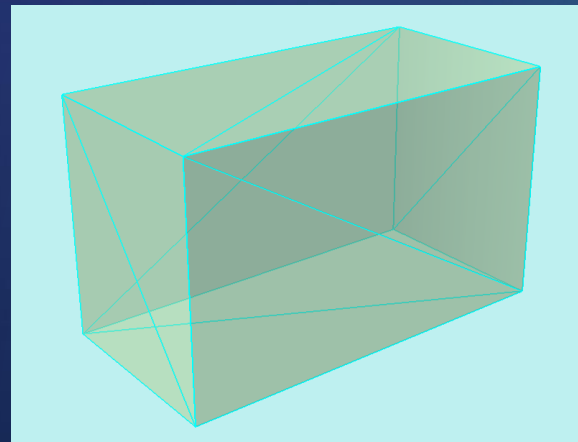
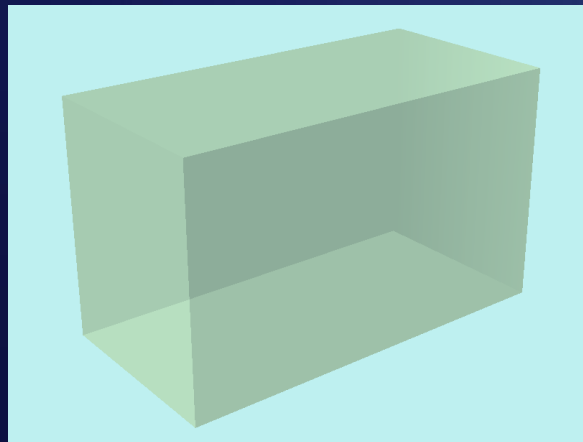




## 3D Features (Cont.)

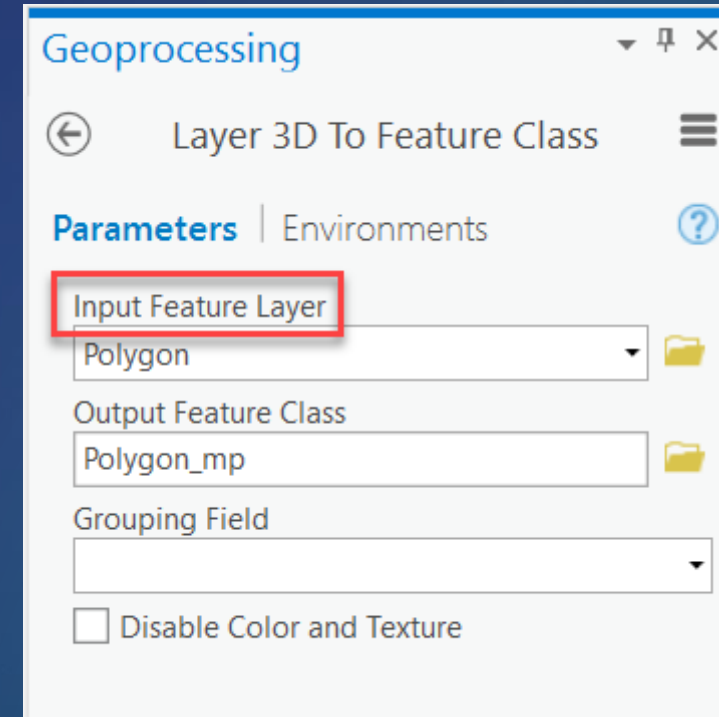
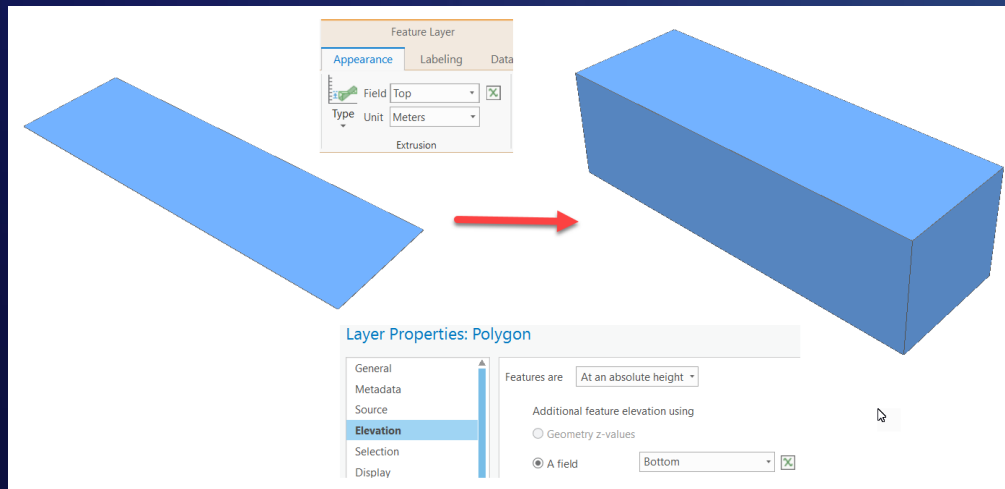
- Multipatches

- Model objects that occupy discrete area or volume
- Composed of a collection of patches (triangles, triangle fan, triangle stripes or rings)
- Patches store texture, color, transparency and geometric information



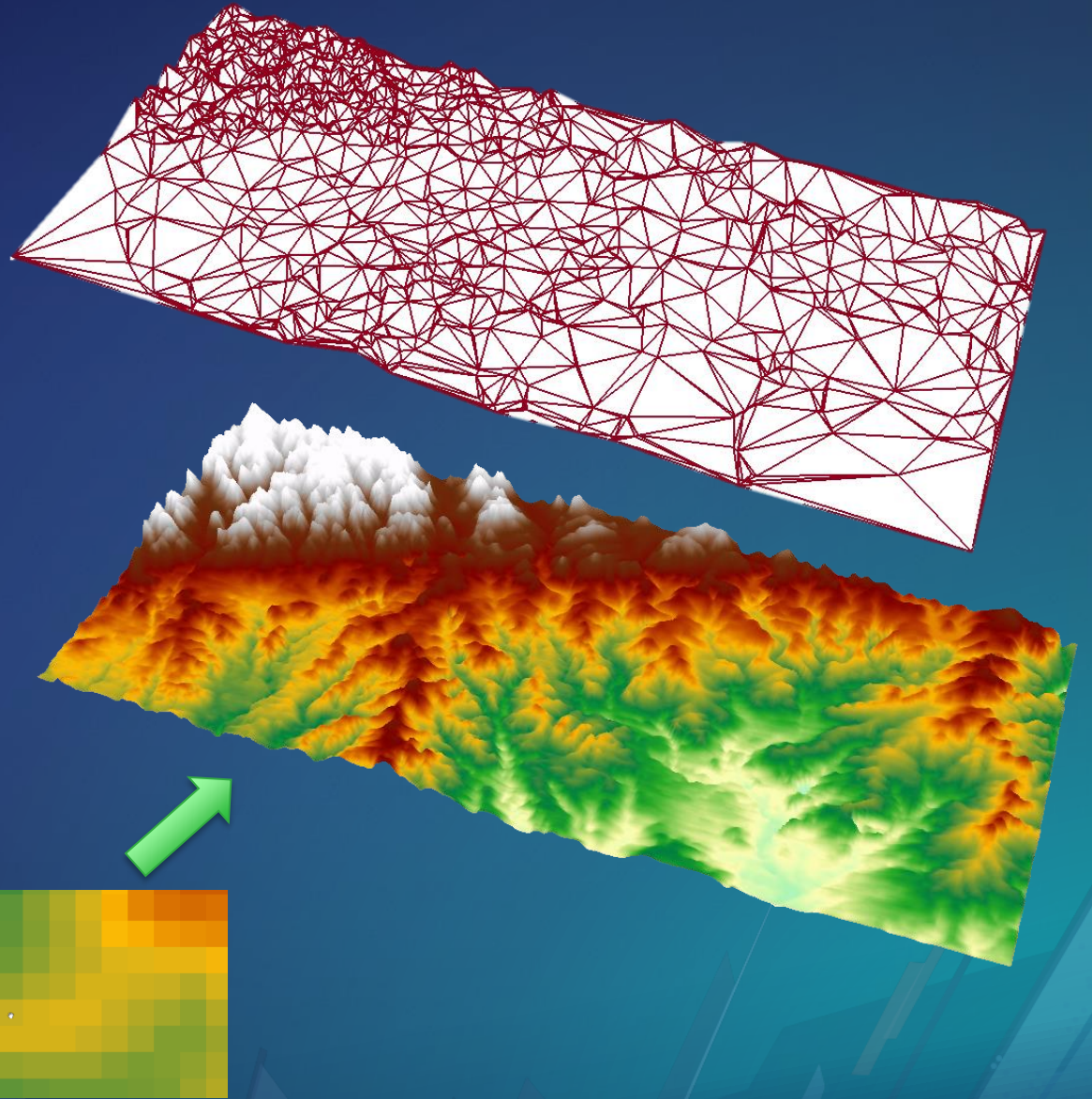
# 3D Features (Cont.)

- How to create multipatches?
  - Interactive editing
  - Conversion from 3D symbols, extrusions, or existing 3D models
  - Create using CityEngine rules
  - Construct programmatically



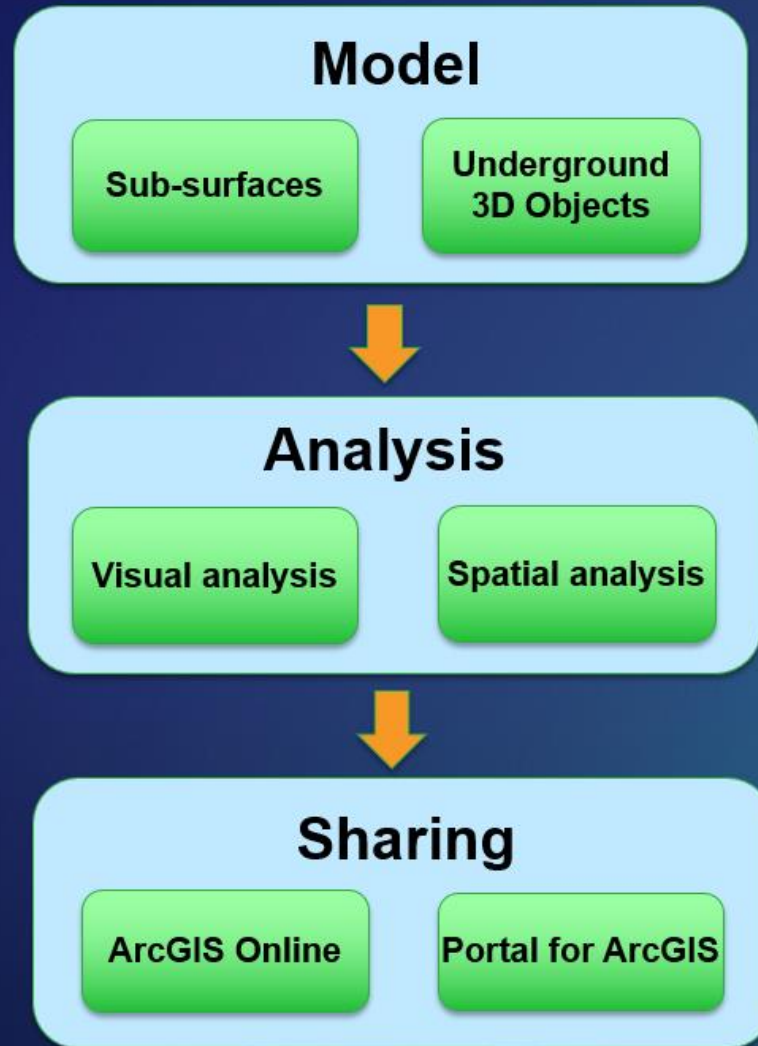
## Surfaces (2.5D)

- **Rasters**
  - Interpolation
- **TINs (Triangulated Irregular Network)**
  - Triangulation
- **2.5 D**
  - Each XY location can only have one Z value





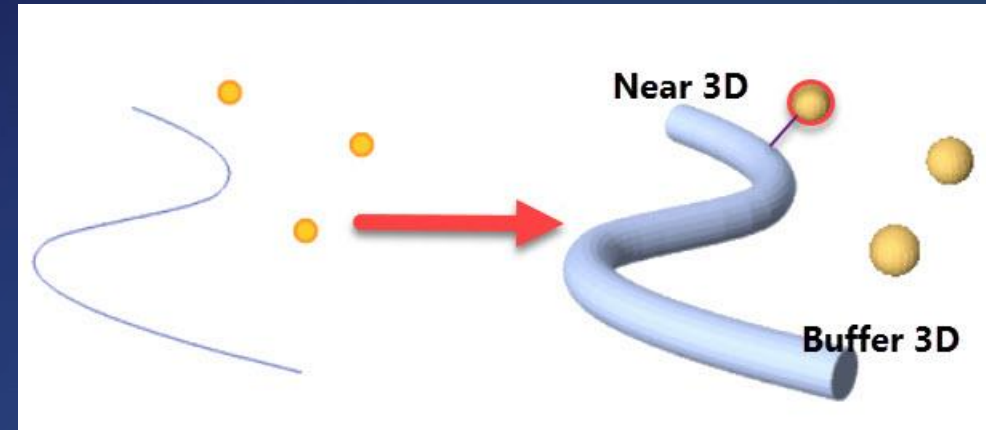
# Sub-Surface Analysis Workflow



# Sub-Surface Analysis GP Tools

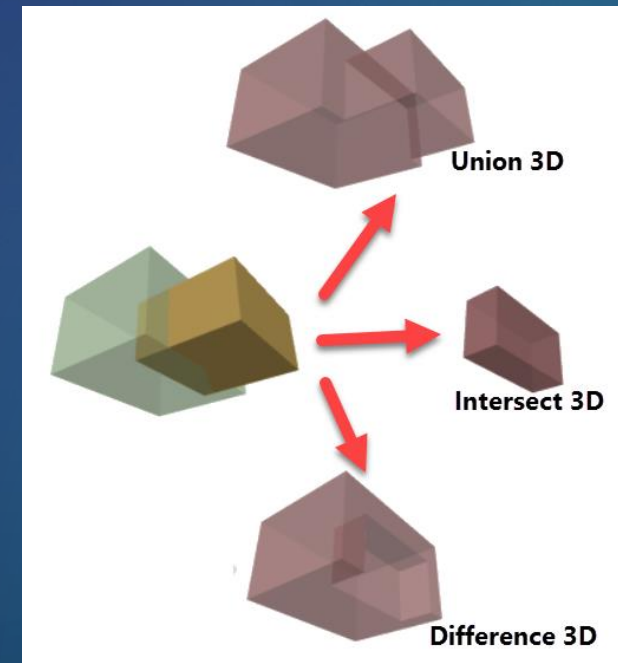
- **Proximity**

- Near 3D
- Buffer 3D



- **Overlay**

- Intersect 3D
- Intersect 3D Line With Multipatch
- Intersect 3D Line With Surface
- Union 3D
- Difference 3D
- Inside 3D



## Sub-Surface Analysis GP Tools (Cont.)

- **Area and volume**

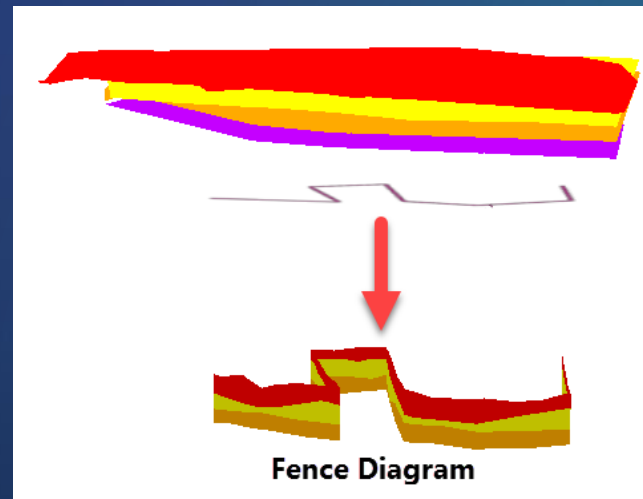
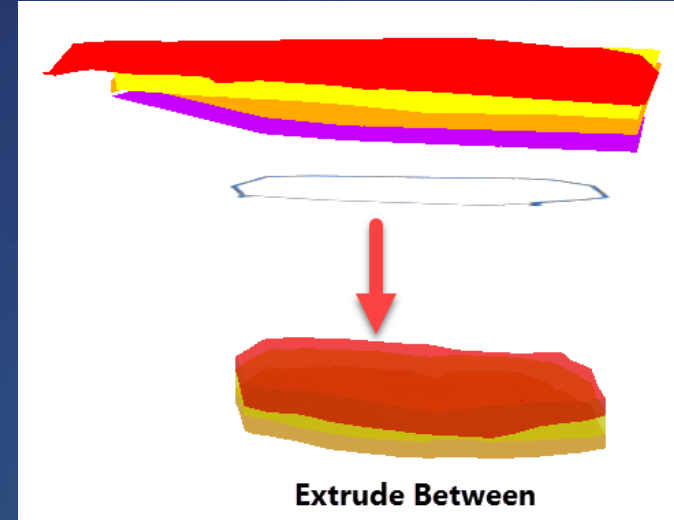
- Extrude Between
- Surface Volume
- Polygon Volume
- Minimum Bounding Volume

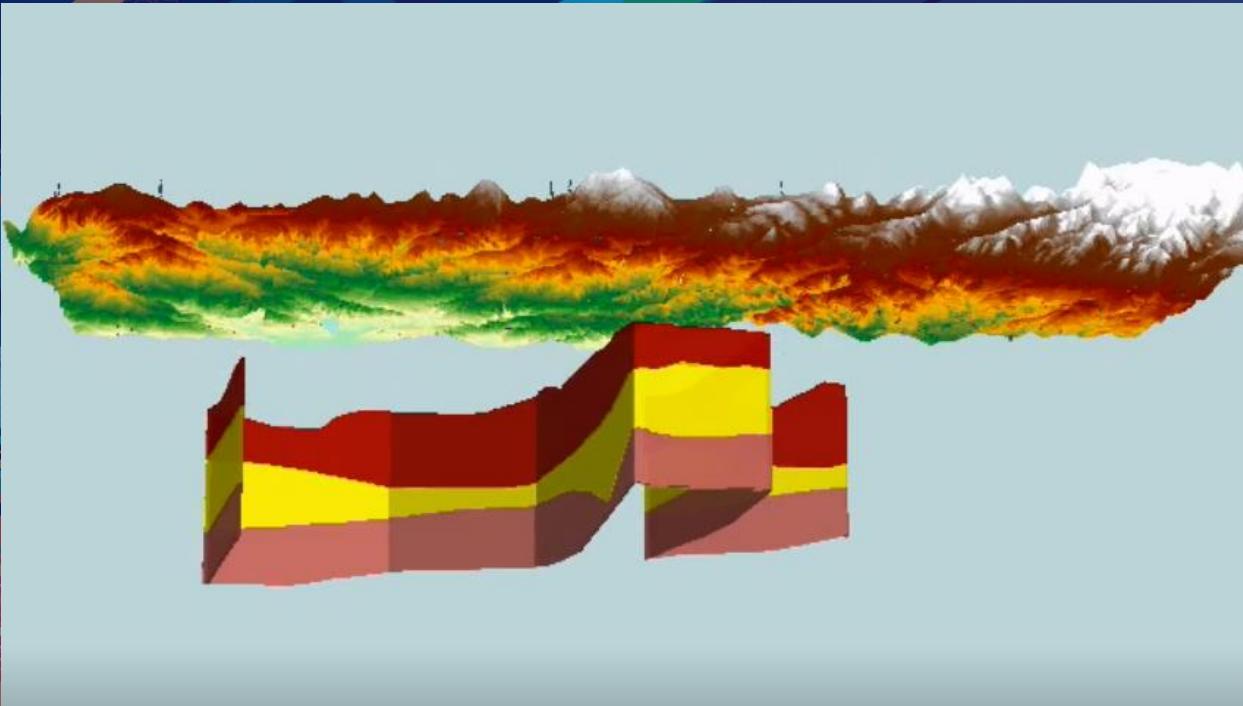
- **Diagram and profile**

- Fence Diagram
- Stack Profile

- **Statistics**

- Add Z Information

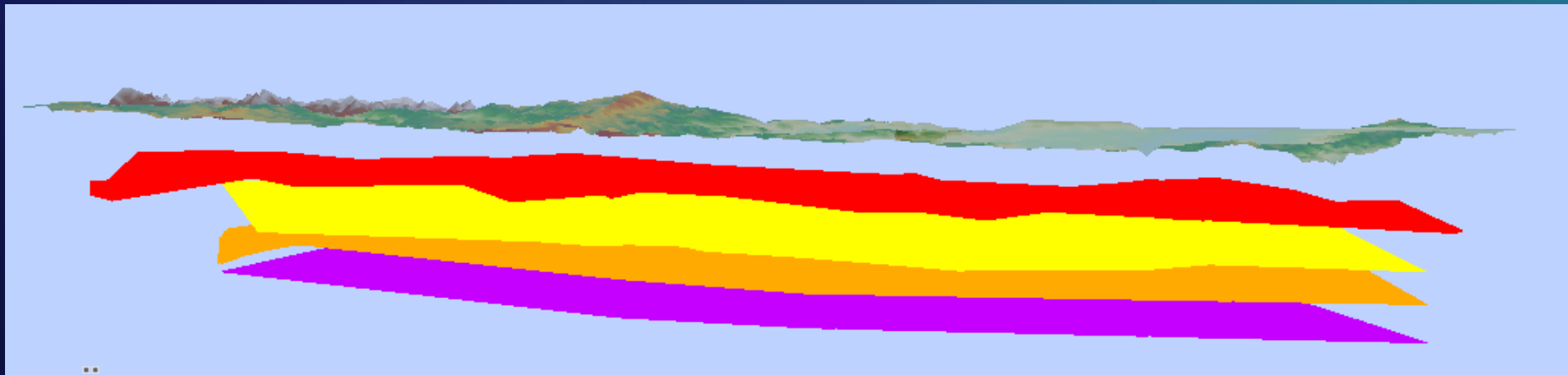
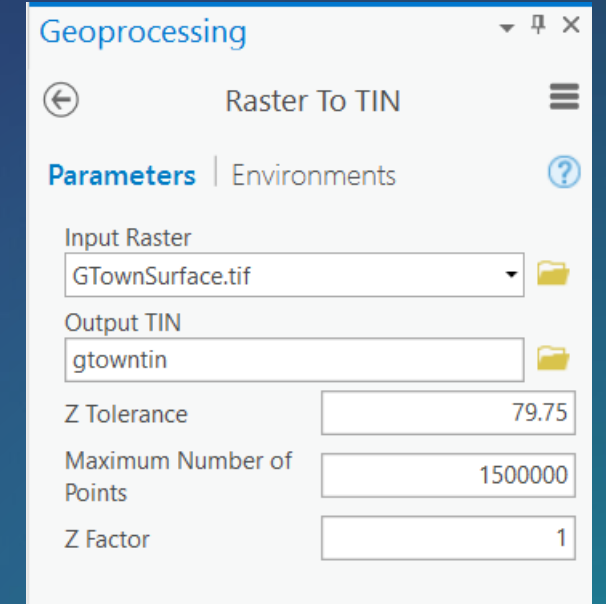
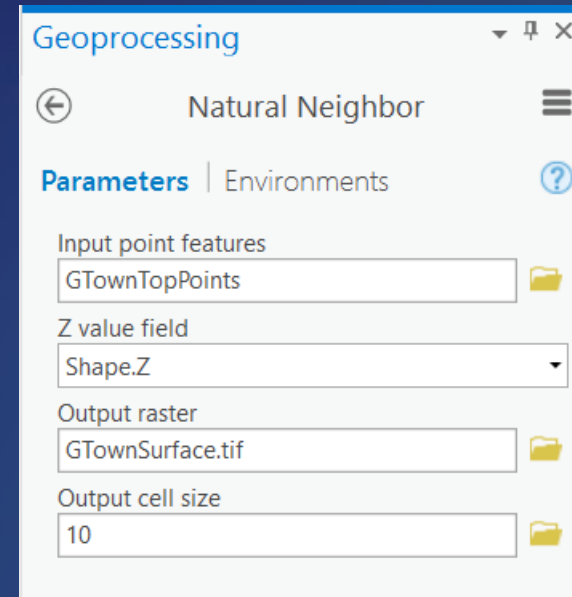
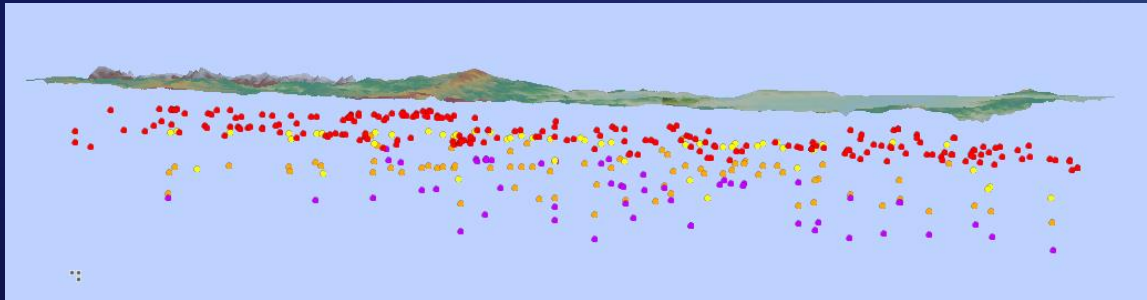




## Model Geological Structures

# Create Sub-Surfaces

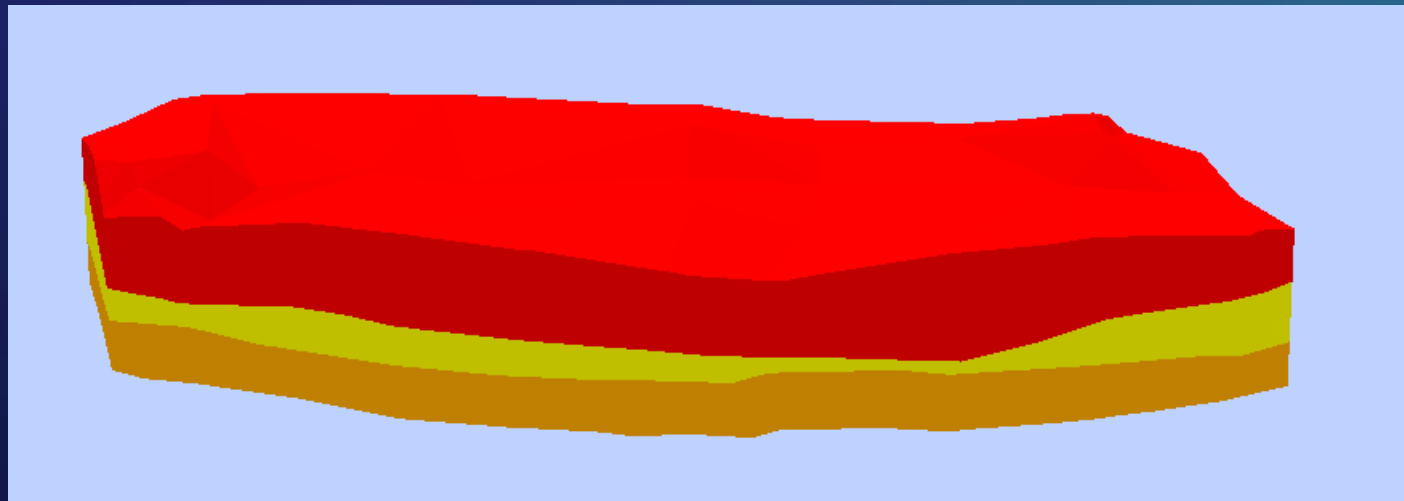
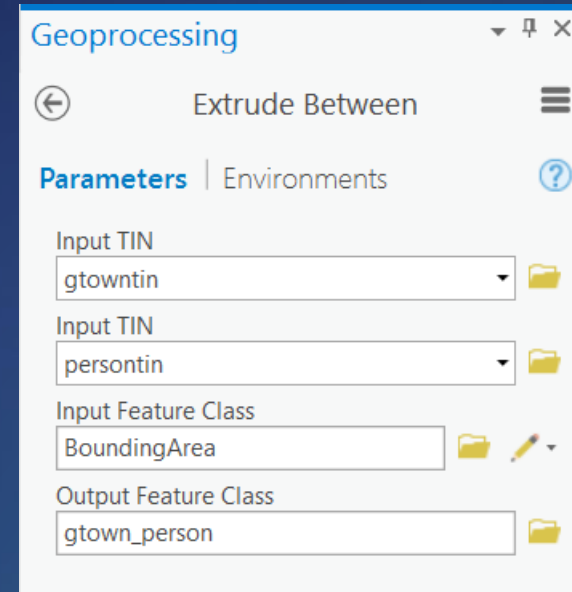
- Natural Neighbors
- Raster To TIN





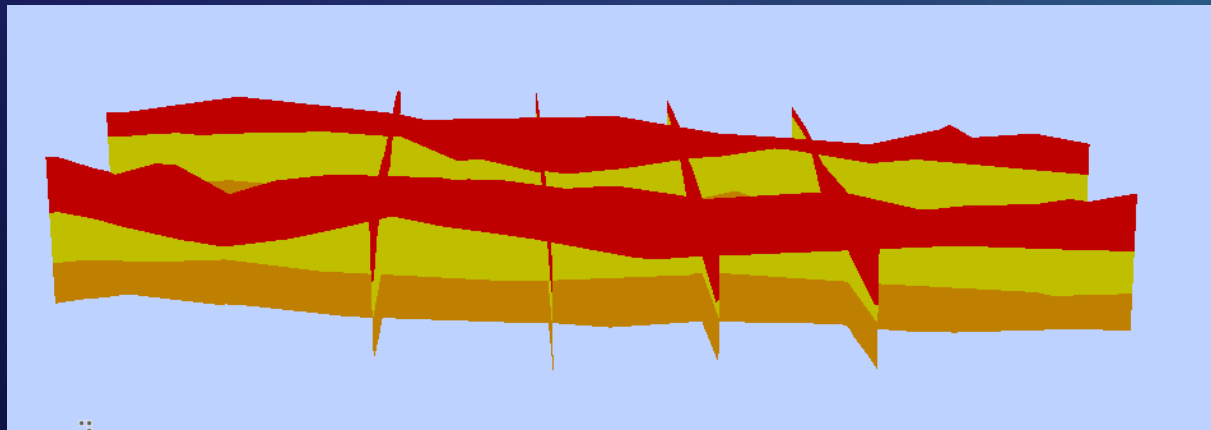
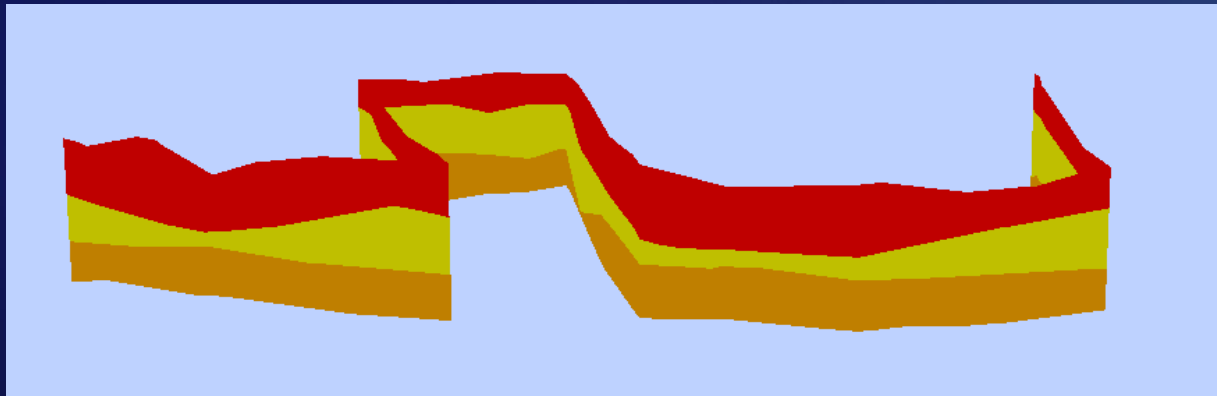
# Create Stratums

- Extrude Between



# Create Fence Diagrams

- Fence Diagram



Geoprocessing

Fence Diagram

Parameters | Environments

Input Line Features  
FenceLine\_2D

Input Surface

- gtowntin
- persontin
- kaniertin
- glenrosetin

Output Multipatch Feature Class  
fence

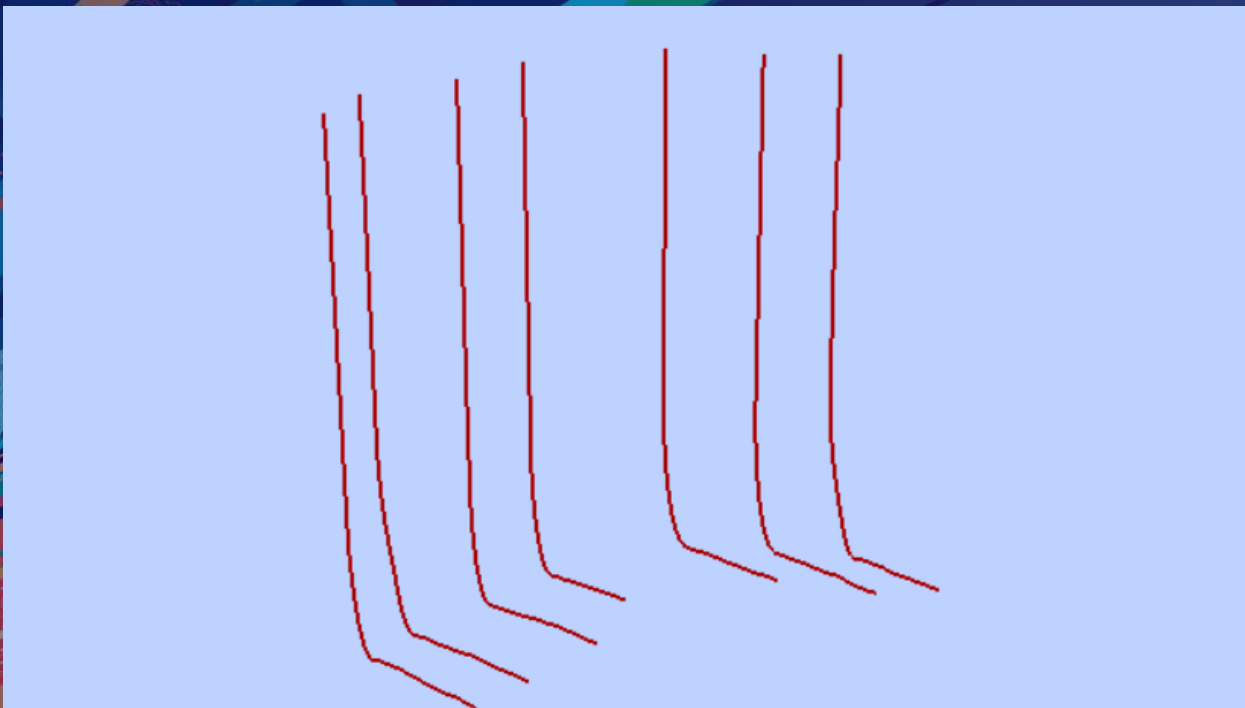
Interpolation Method  
Linear

Sample Distance  
Unknown

Height Extensions

- Floor Height  
Unknown
- Ceiling Height  
Unknown

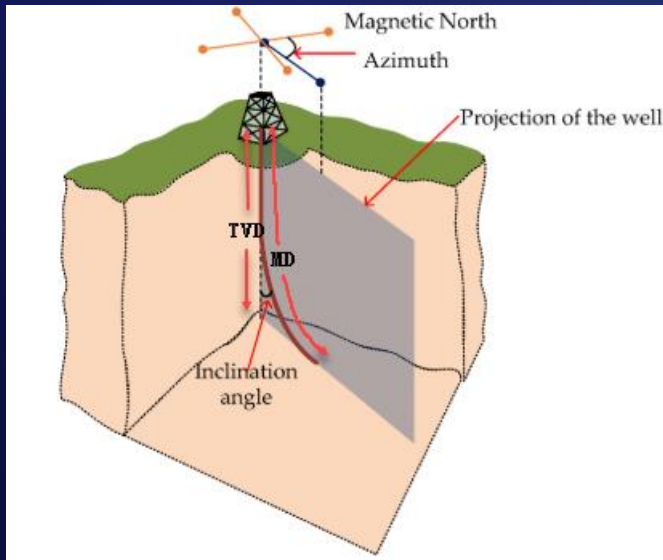
# Model Directional Wells



# Directional Wells

- Survey

- Measured Depth (MD)
- True Vertical Depth (TVD)
- Inclination
- Azimuth



**UNIVERSITY LANDS**

HOME ABOUT US OIL & GAS SURFACE & ENVIRONMENT PAYMENTS & REPORTING **WELL LIBRARY, MAPS & RESOURCES**

**WELL SEARCH** [Back to Well Search](#)

PRODUCTION SEARCH  
LEASE SEARCH  
PURCHASER LOOK UP  
MAPS  
GIS DATA  
WELL DATA APP  
OIL & GAS LEASE MAP  
SITES & INFO  
FORMS, POLICIES & PROCEDURES

### Well Detail for API 42-461-34402

<b>CBS:</b>	Upton, Block 58, Section 07	<b>Location:</b>	1975 FSL & 1930 FWL
<b>Total Depth:</b>	11547 feet	<b>Lat/Lon:</b>	31.29563637 / -101.88716668
<b>Elevation:</b>	GL 2704 feet	<b>NAD:</b>	NAD83

Map Zones (1) Documents (28) Logs (6)

Name	Type	Page	Date
Status Change University 7W 2 42-461-34402_461570.pdf	Status Change	0	8/26/2016
G-1 42-461-34402.pdf	G-1 - Gas well back pressure test, Completion or Recom	0	12/18/2003
Gyro 42-461-34402.pdf	Directional Survey	0	11/4/2003
42461344020022.tif	DRILL	1	10/18/2003
42461344020001.tif	DRILL	2	10/18/2003

Measured Depth (ft)	Incl (deg)	Drift Dir (deg.)	TVD (ft)	Course Length (ft)	Vertical Section (ft)	TOTAL Rectangular Offsets (ft)	Closure Dist (ft)	Dir. (deg.)	DLS (dg/100ft)
TIED INTO DDC GYRO SURVEY @ 11,106' MD.									
11106.00	0.60	272.90	11105.00	0.00	-51.57	51.70 N 9.00W	52.48@350.12		0.00
THE FOLLOWING ARE PATHFINDER MWD SURVEYS.									
11215.00	0.35	281.00	11214.00	109.00	-51.65	51.79 N 9.90W	52.73@349.18		0.24
11246.00	0.53	255.25	11245.00	31.00	-51.63	51.77 N 10.13W	52.76@348.93		0.85
11278.00	6.10	181.33	11276.93	32.00	-49.89	50.03 N 10.31W	51.09@348.36		18.67
11309.00	15.04	178.61	11307.38	31.00	-44.21	44.36 N 10.25W	45.53@346.99		28.88
11341.00	23.65	177.20	11337.54	32.00	-33.63	33.77 N 9.84W	35.18@343.76		26.94
11373.00	32.54	177.55	11365.74	32.00	-18.61	18.74 N 9.15W	20.85@333.96		27.79
11404.00	37.55	179.05	11391.11	31.00	-0.83	0.95 N 8.64W	8.69@276.27		16.40
11436.00	42.30	181.60	11415.65	32.00	19.70	19.58 S 8.78W	21.46@204.15		15.70
11468.00	47.66	183.18	11438.28	32.00	42.30	42.17 S 9.74W	43.28@193.00		17.11
11500.00	55.75	181.24	11458.09	32.00	67.38	67.24 S 10.68W	68.08@189.03		25.72

# Model Directional Wells with 3D polylines

0	0	0	0	
1759	1758.866247	19.25542989	4.358123434	
1855	1854.865048	19.63354843	4.194107586	
1950	1949.863239	19.64339677	3.622168219	
2045	2044.860924	19.75840855	3.001620136	
2140	2139.859116	20.10326205	2.546098468	
2235	2234.857307	20.44454008	2.088671684	
3569	3568.586593	9.281400842	11.34070178	
3664	3663.567635	7.957176464	12.69268009	
3728	3727.555841	7.257446716	13.70133636	
3791	3759.19547	6.82133648	14.1557537	
3791	3790.530269	5.786036043	14.19776291	
3823	3822.457151	3.763798346	13.50999958	
3855	3854.288718	0.772497097	12.21045511	
3886	3884.961477	3.425335395	10.6765785	
3918	3916.376521	9.254297807	8.958778794	
3950	3947.523479	16.38489473	7.259248038	
3982	3978.455653	24.47781309	5.98411697	
4013	4008.185088	33.19644368	4.965232324	
4045	4038.419589	43.57888259	3.619313345	
4077	4068.087105	55.43333249	1.850507144	
4109	4097.144631	68.64834999	0.341128409	
4140	4124.611662	82.79014936	2.8787785	

```
import arcpy
import os

filePath = r"C:\Shared\Subsurface\UC2018\DirectionalSurvey.txt"

file = open(filePath, "r")

lateralfc = r"C:\Shared\Subsurface\UC2018\Data.gdb\Lateral"

XStart = 2114464.393702
YStart = 10315414.494273

array = arcpy.Array()
point = arcpy.Point()

for line in file:
    M, Z, NS, EW = line.split()
    point.Z = float(Z) * -1
    point.X = XStart + float(EW)
    point.Y = YStart + float(NS)
    point.M = float(M)
    array.add(point)

cursor = arcpy.da.InsertCursor(lateralfc, ["SHAPE@"])
line = arcpy.Polyline(array, None, True)
cursor.insertRow([line])
del cursor

array.removeAll()

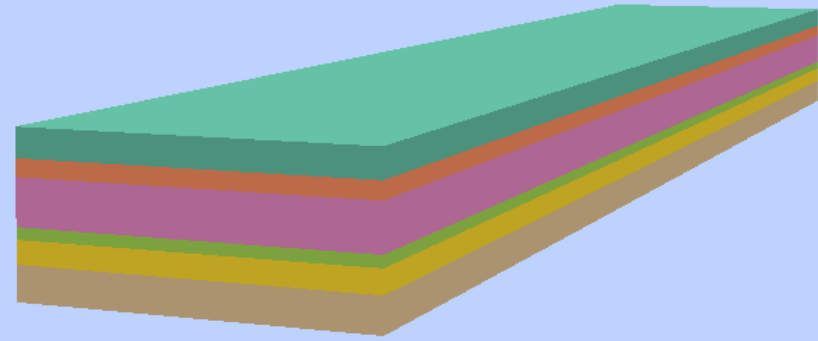
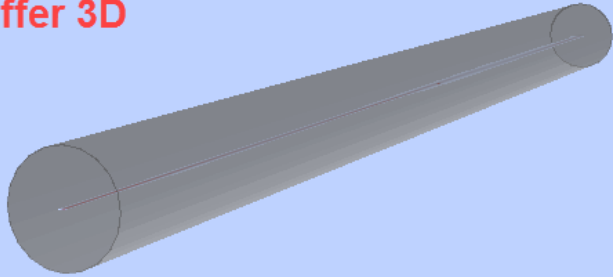
file.close()
```





Calculate Volume

## Buffer 3D



Geoprocessing

← Add Z Information

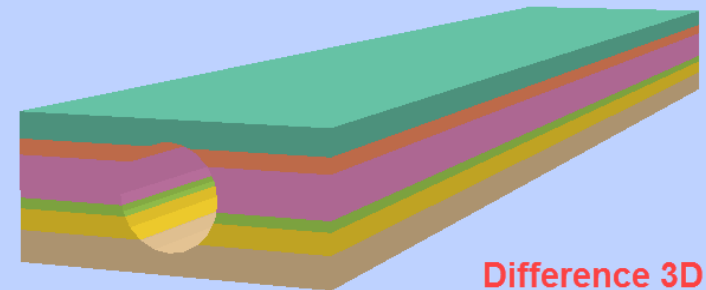
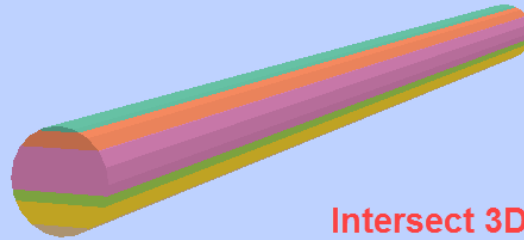
Parameters | Environments

Input Features  
Intersect\_mp

\* Output Property  
 Lowest Z  
 Highest Z  
 Average Z  
 Surface Area  
 Volume  
 Lowest Slope  
 Highest Slope  
 Average Slope

OBJECTID	Shape	Name	Volume
1	MultiPatch A		203.580354
2	MultiPatch B		1493.97974
3	MultiPatch C		5922.449044
4	MultiPatch D		5922.449044
5	MultiPatch E		1486.024207
6	MultiPatch F		2437.399569
7	MultiPatch G		602.092299

## Intersect 3D



## Difference 3D

ArcNews Fall 2017

### 3D GIS Simplifies Management of Oil and Gas Leases in West Texas

*With ArcGIS Pro, Analysts Can Easily View Extent of Leased Land Plus Depth of Mineral Deposits*

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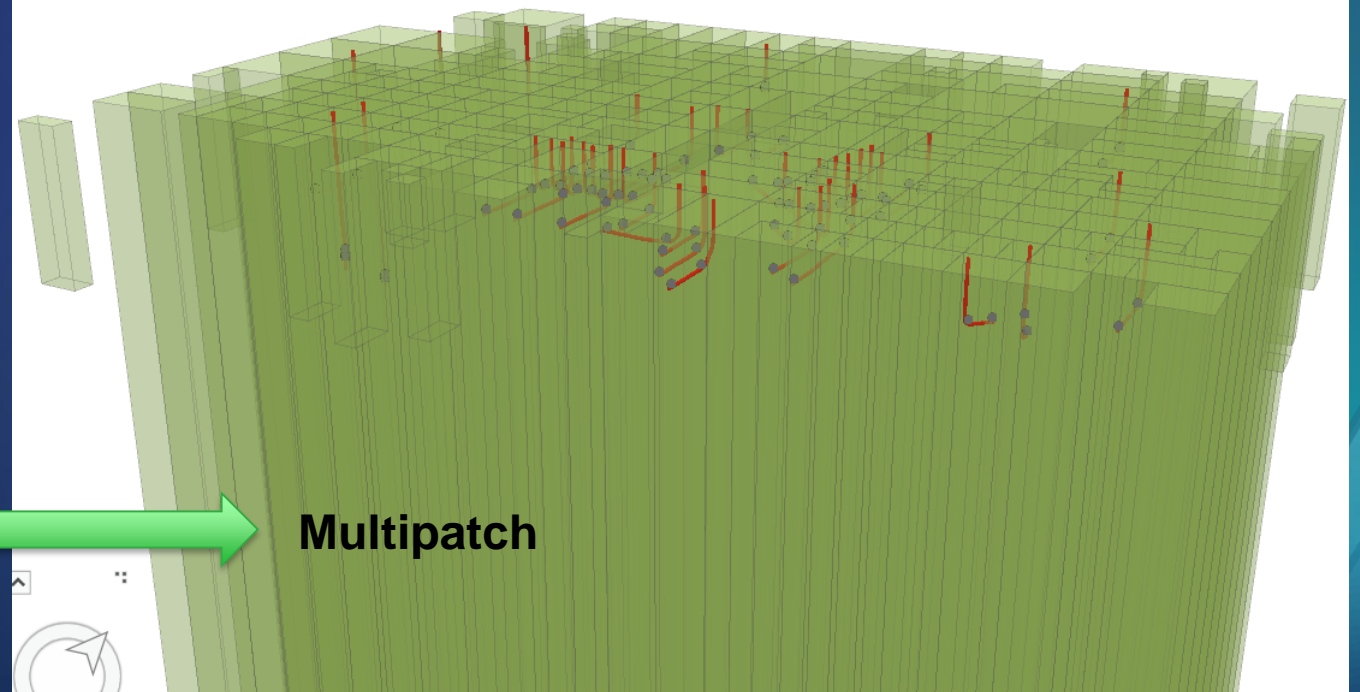
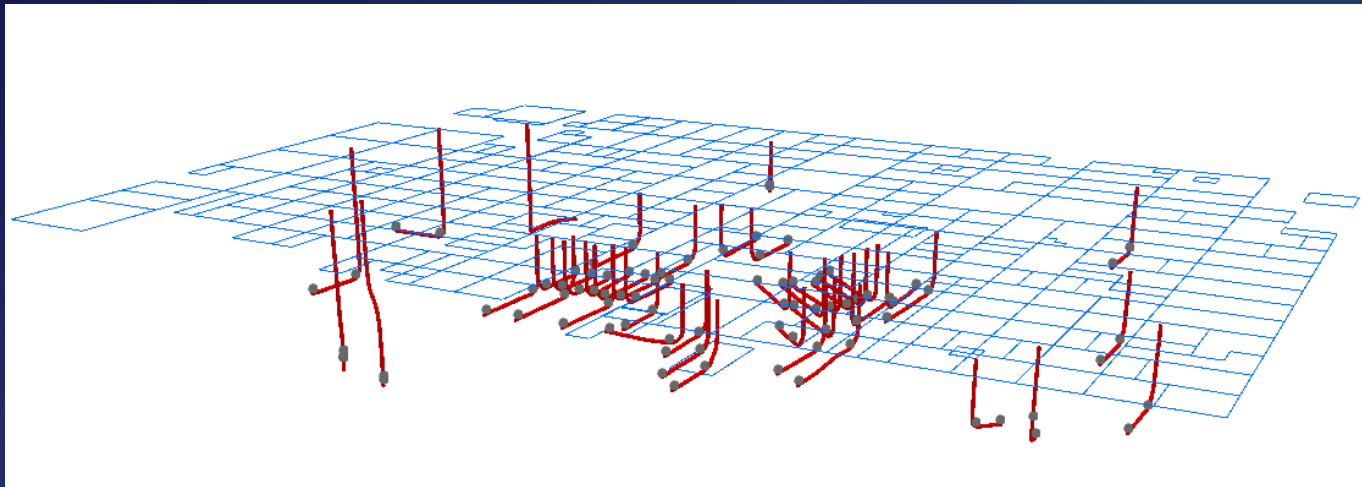
University Lands manages the surface and mineral interests of 2.1 million acres of land across 19 counties in west Texas. Its revenue goes to the Permanent University Fund (PUF), one of the largest university endowments in the United States, that benefits operational and capital improvements for both the University of Texas and Texas A&M University systems.

Since 1923, oil and gas production have been key sources of income for the PUF. University Lands leases its land to companies for oil and gas development and retains royalty interest in production. To ensure that companies' drilling operations were staying inside the boundaries of their leases and that University Lands was receiving accurate royalty payments, analysts from the land and regulatory departments needed to be able to quickly identify oil and gas wells traversing through leases and view perforations (oil and gas extraction points) along that trajectory.

# Manage Mineral Leases

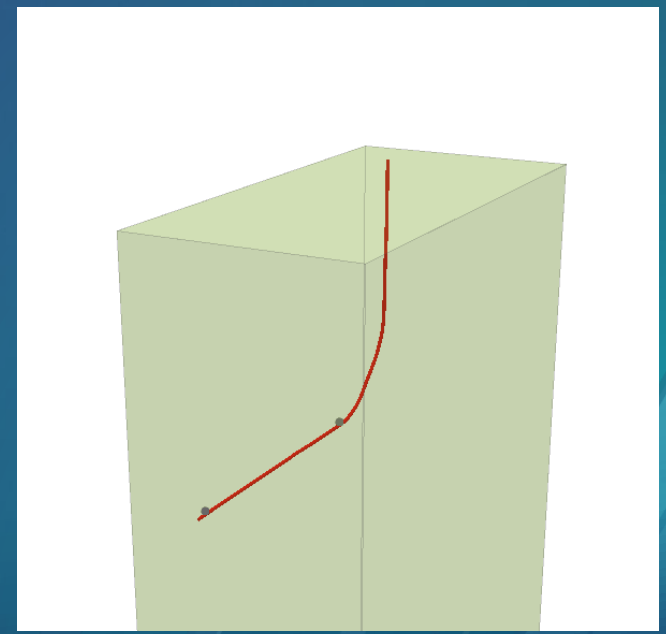
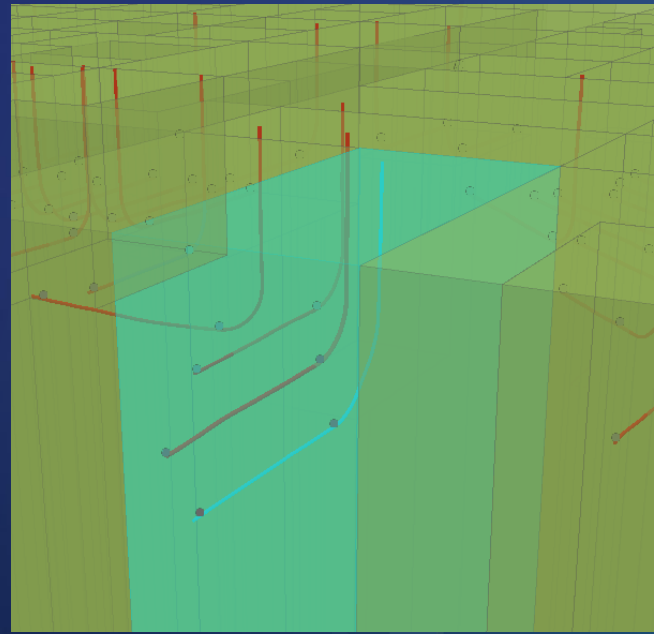
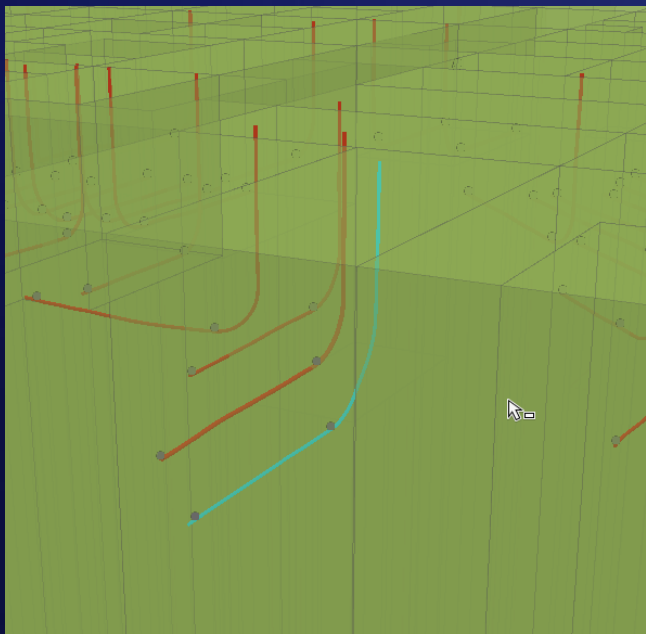
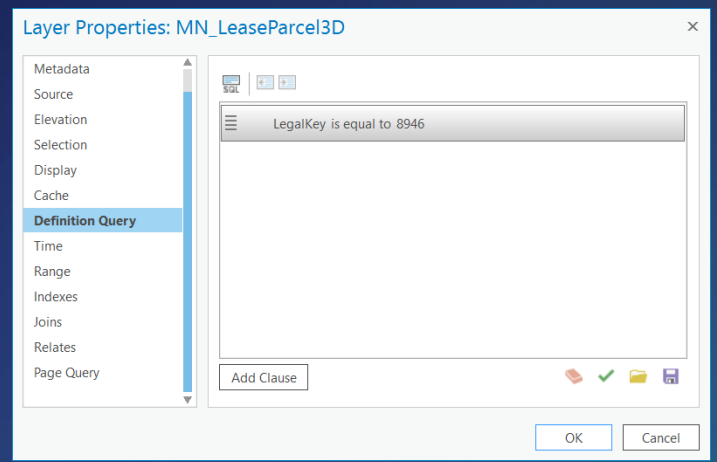
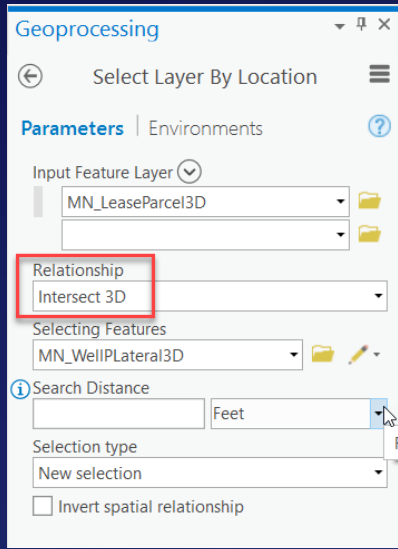
- **University Lands**

- 2.1 million acres primarily in west Texas
- Revenue supports University of Texas and Texas A&M University systems
- Examine if the companies' drilling operations were staying inside the boundaries of their leases



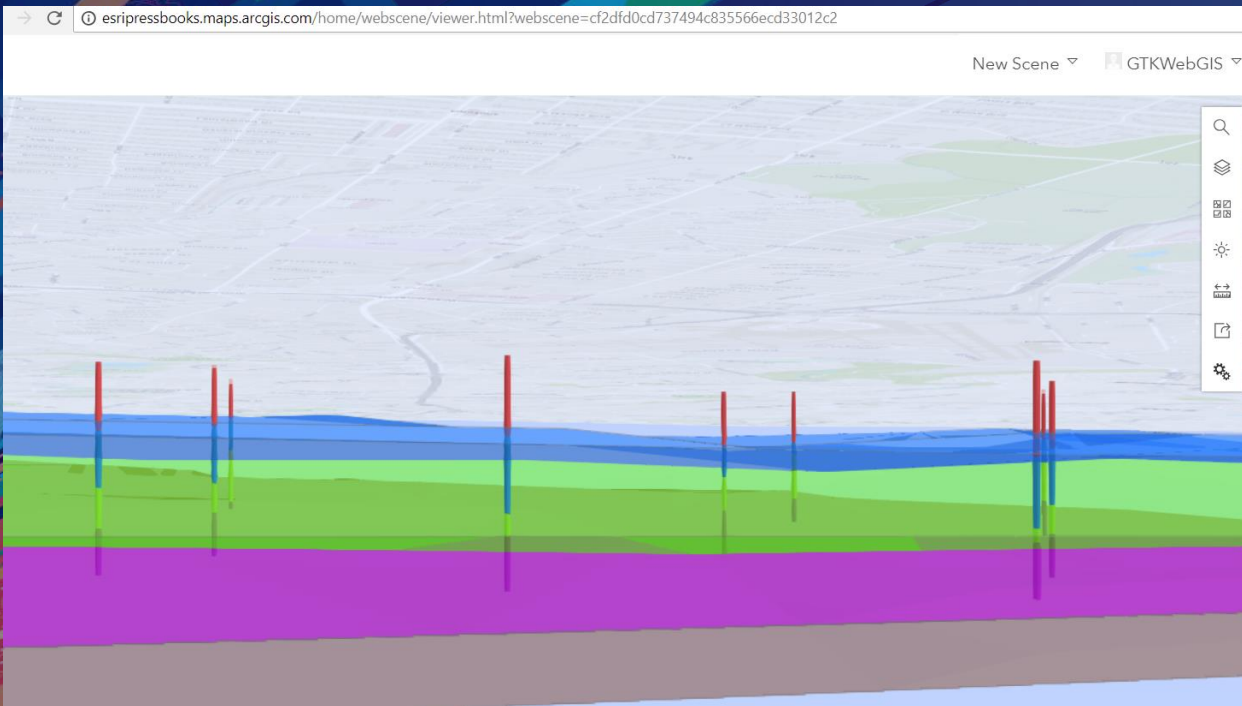
**Multipatch**





Data provided by University Lands

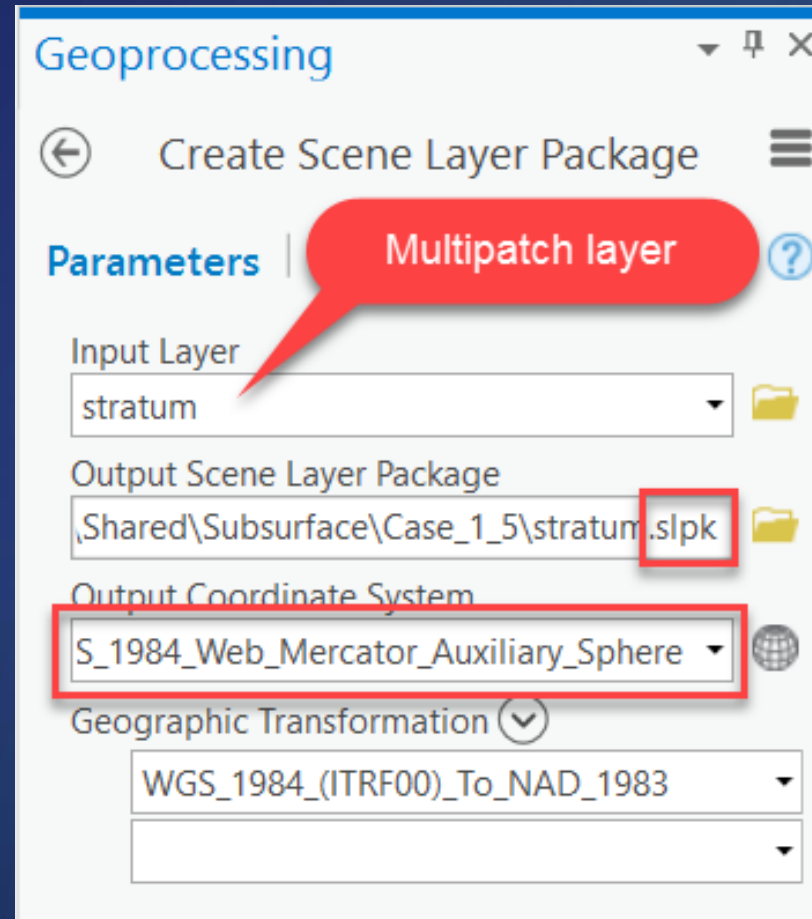




Share at ArcGIS Online

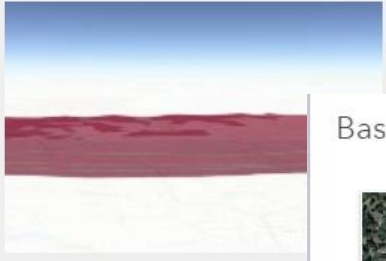
# Sharing

- Scene layer package
  - Create Scene Layer Package



# ArcGIS Online Local Scene

**Properties**

Thumbnail 

Title

Summary

Tags  [Add tag\(s\)](#)

Background Color

Clip to Extent

[Update To Current View](#)

**Basemap**


Imagery Imagery Hybrid


Streets Topographic





Navigation Streets (Night)


Ground Transparency

0 25 50 75 100

Stratum - stratum2 

 Scene Layer by GTKWebGIS

	1	1
	2	1
	3	1
	Other	

 Color

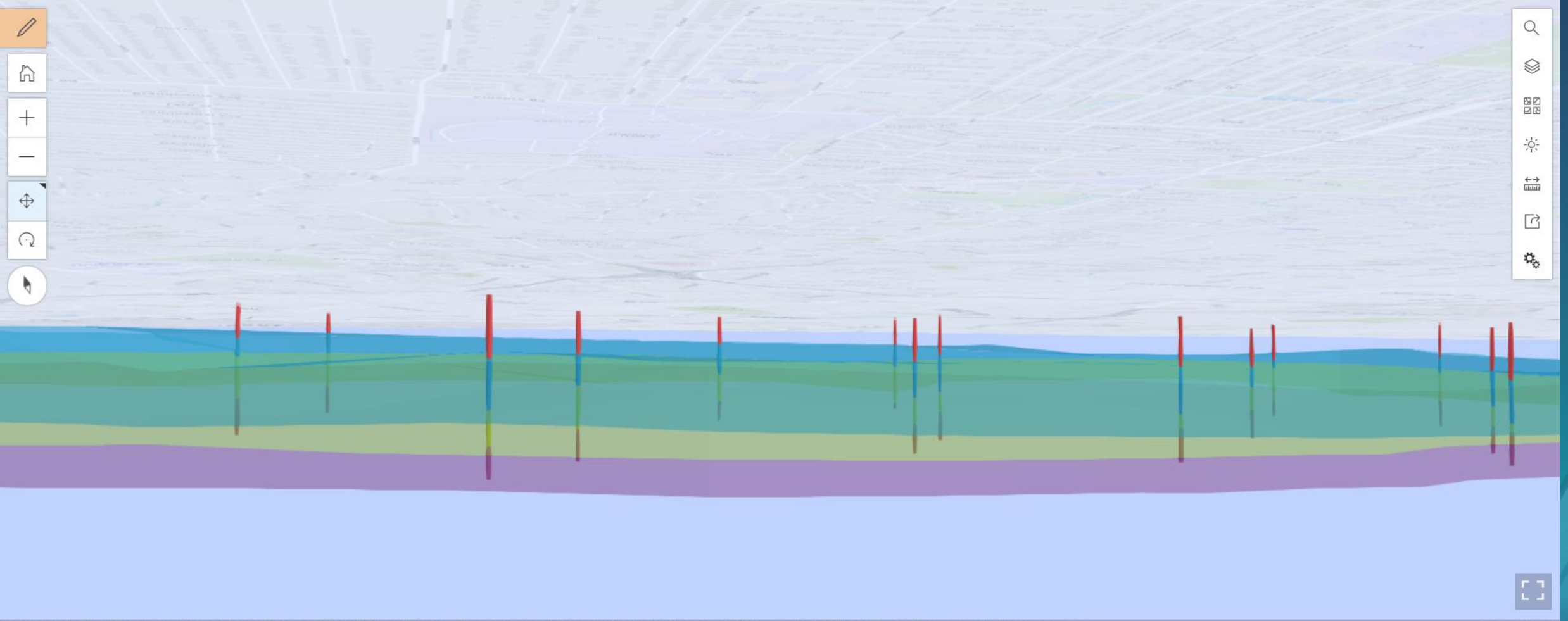
**Elevation Mode**

Absolute height

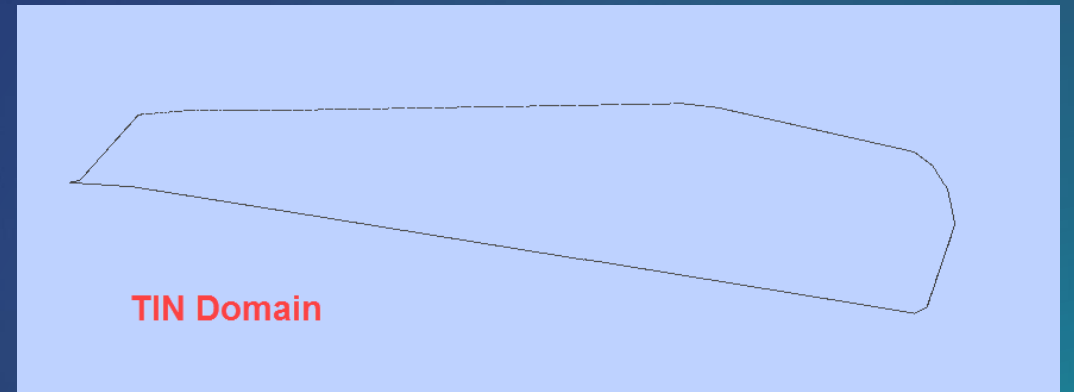
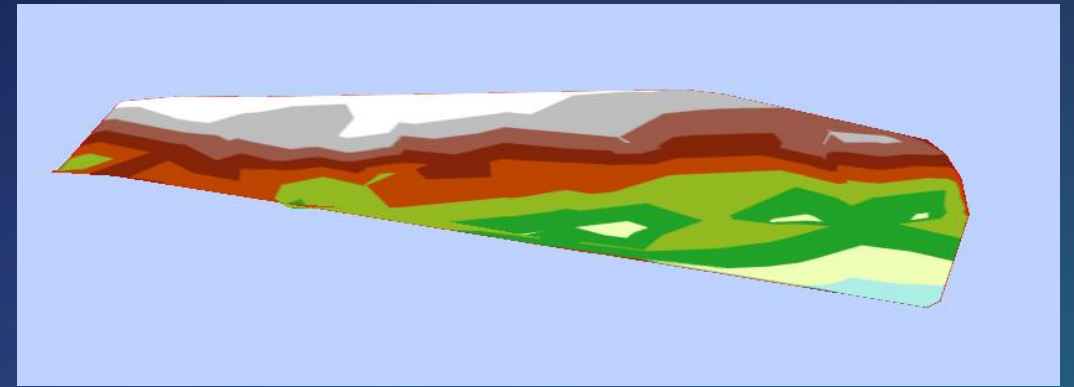
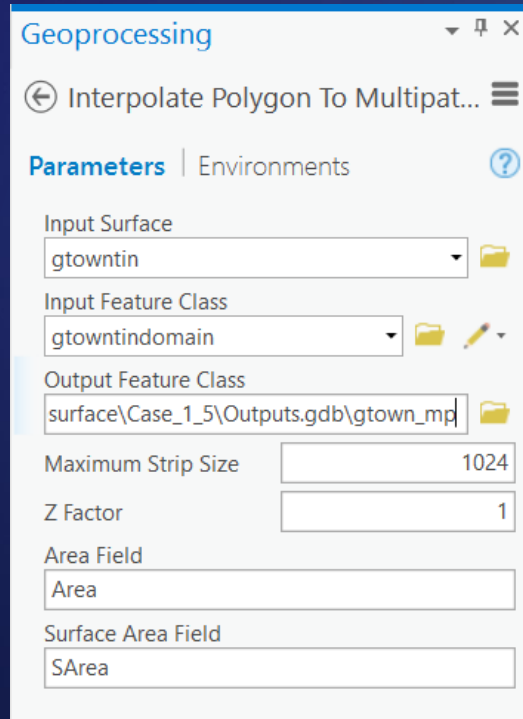
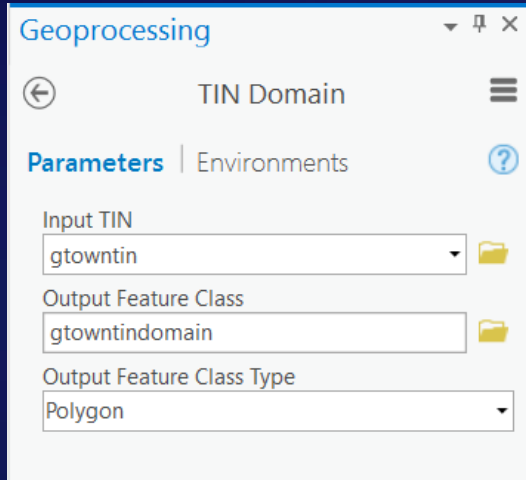
Offset  meters

**Transparency**

0% 50% 100%



# Convert TIN to Multipatch



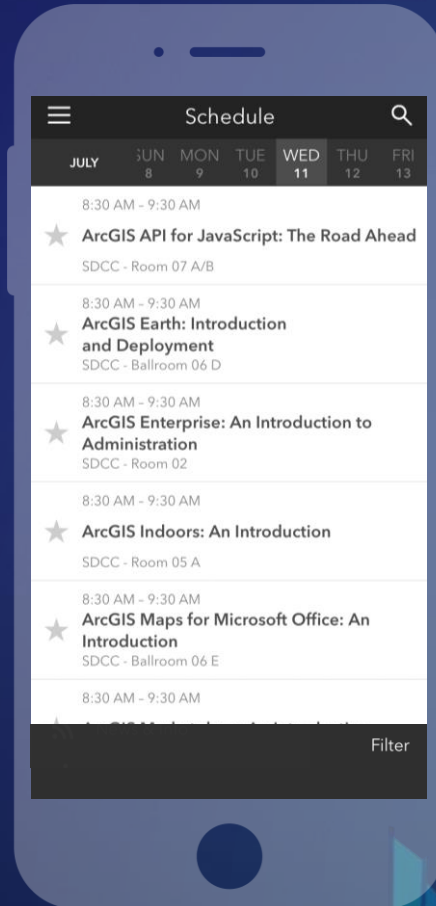


# Please Take Our Survey on the App

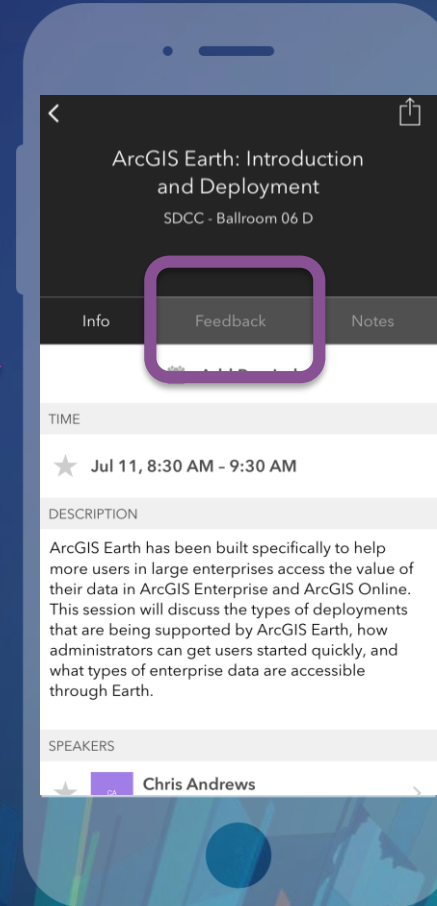
Download the Esri Events app and find your event



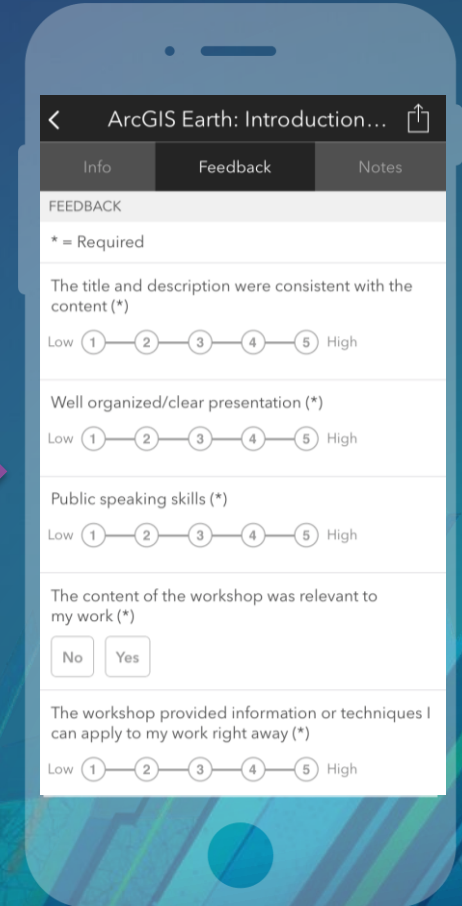
Select the session you attended



Scroll down to find the feedback section



Complete answers and select "Submit"





**esri**

**THE  
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OF  
WHERE**