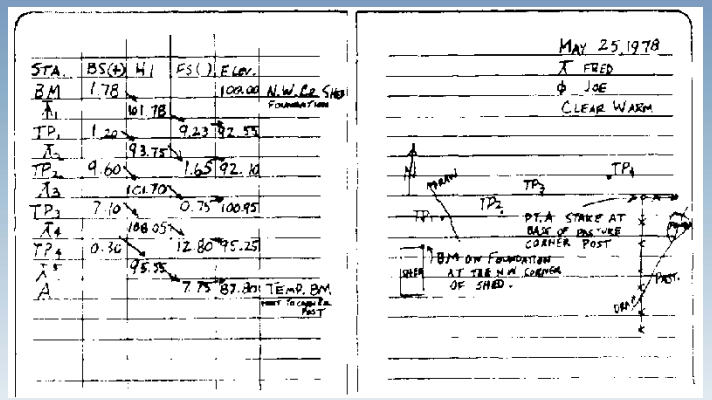
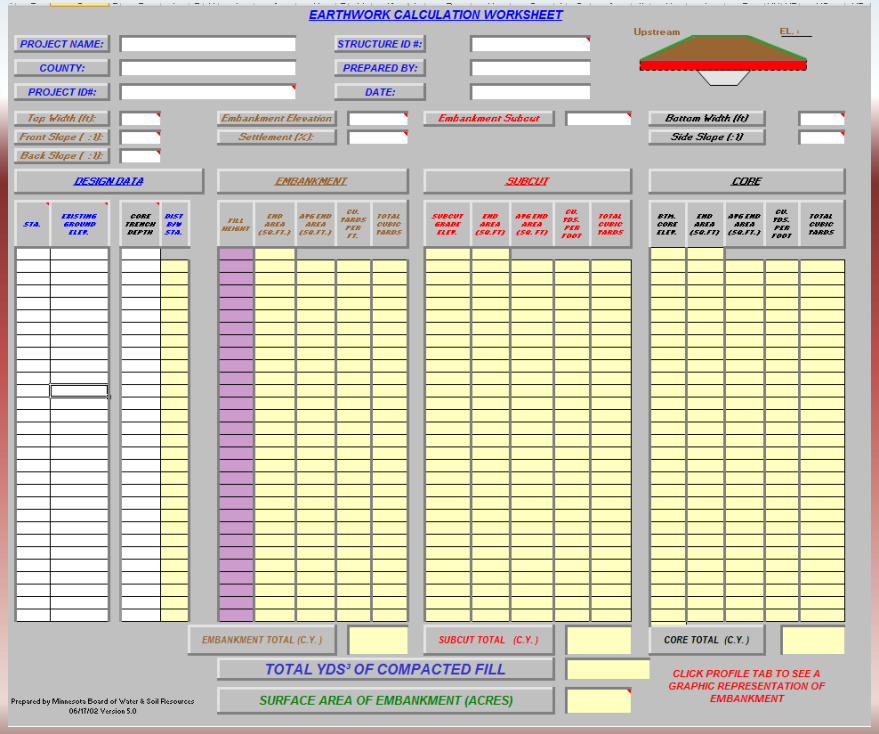
Using ArcGIS to Design Wetland Restorations

By Scott Ralston, USFWS Windom, MN

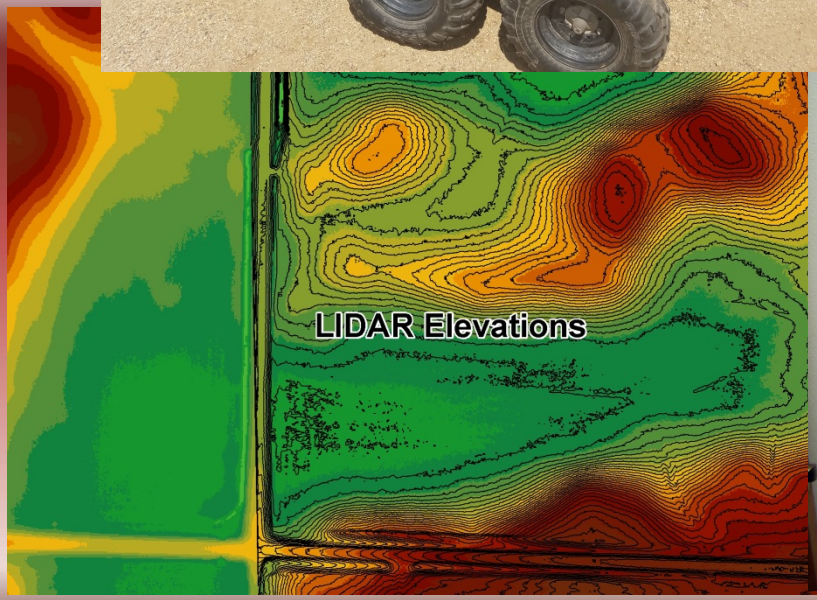
Available for Download from: SKRalston.com/USFWS/

How many still use this?





Probably use this?



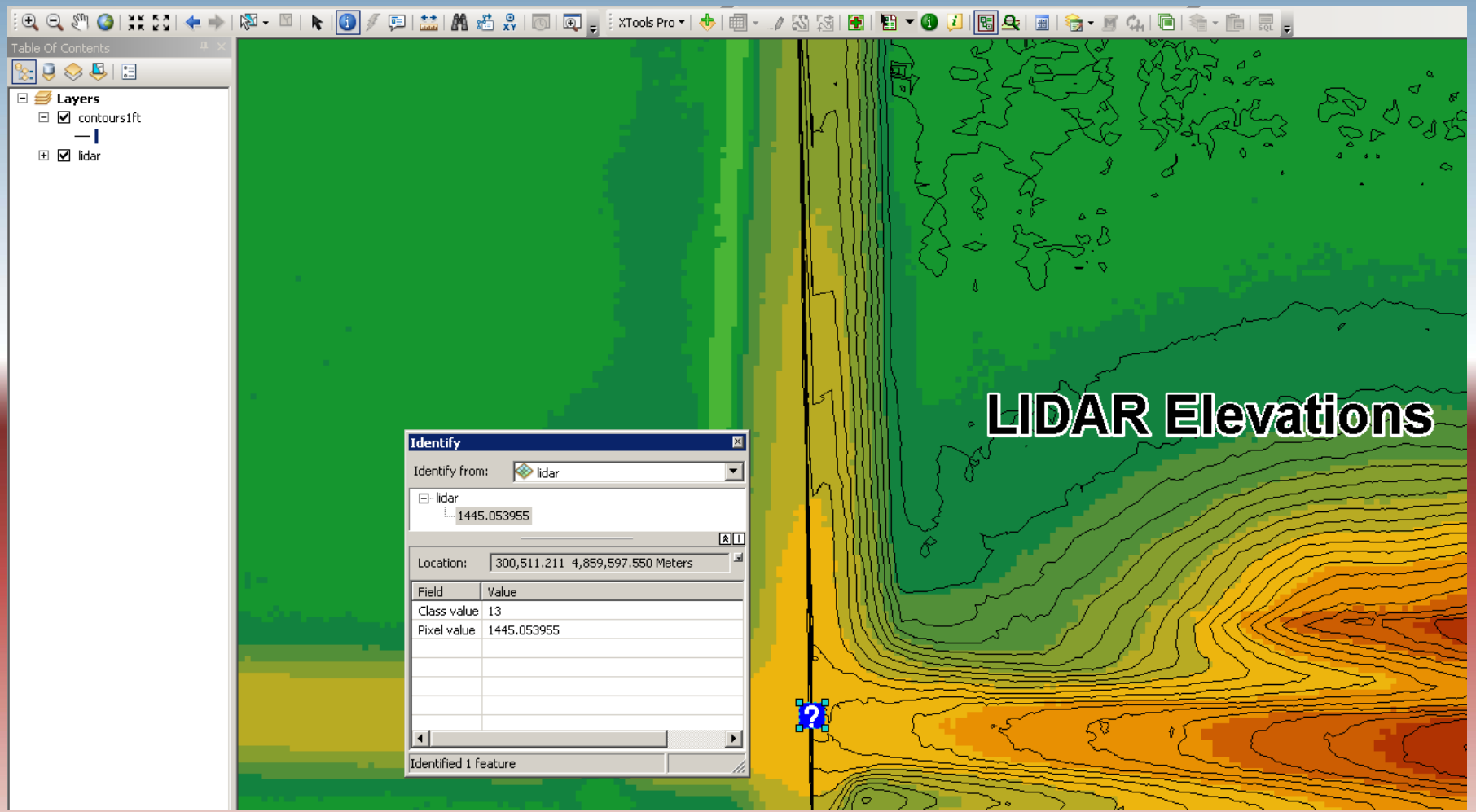
Calculation of Cut/Fill Volumes

- Complex terrain hard to accurately calculate based on station readings
- Poor volume estimates impact cost over or under estimating bid volumes
- Using digital 3D Terrain in GIS can get accurate volumes
- Fast, easy construction staking using GPS
- Potential to export to GPS guided grading in construction equipment for finish work

Need digital elevation data to make a 3-dimentional model of the landscape in GIS

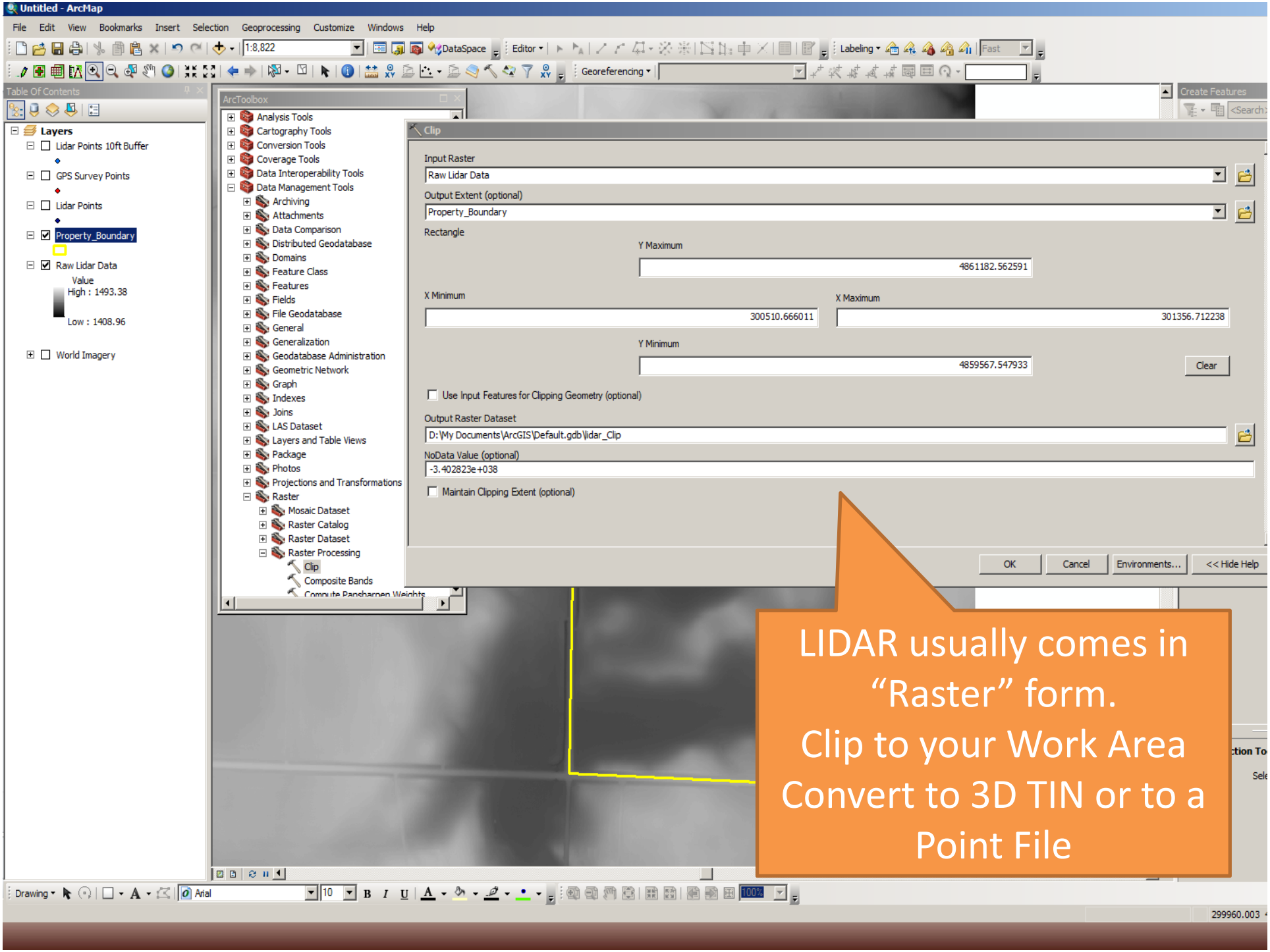
- Garbage in/Garbage out. Better quality survey data will result in more accurate calculations
- Use survey grade GPS in hand pole method or continuous topo mode on ATV
- Using laser level, tie shots to a GPS point
  - Use a Geoditic Benchmark to tie to MSL elevation
  - Or integrate with LIDAR using a common point like center of a road intersection to get MSL

Using LIDAR Elevation at a road intersection to tie to laser level surveys



Need digital elevation data

- Use LIDAR Elevations
  - Download LIDAR for your state/county etc.
  - Most LIDAR is accurate within 6 inches or less for hard surfaces like crop ground, upland grasslands, particularly good on roads.
  - Does not penetrate water or heavy thick vegetation like trees or cattail
  - Can easily develop hybrid maps using LIDAR for upland areas and fill in low wet areas with survey data.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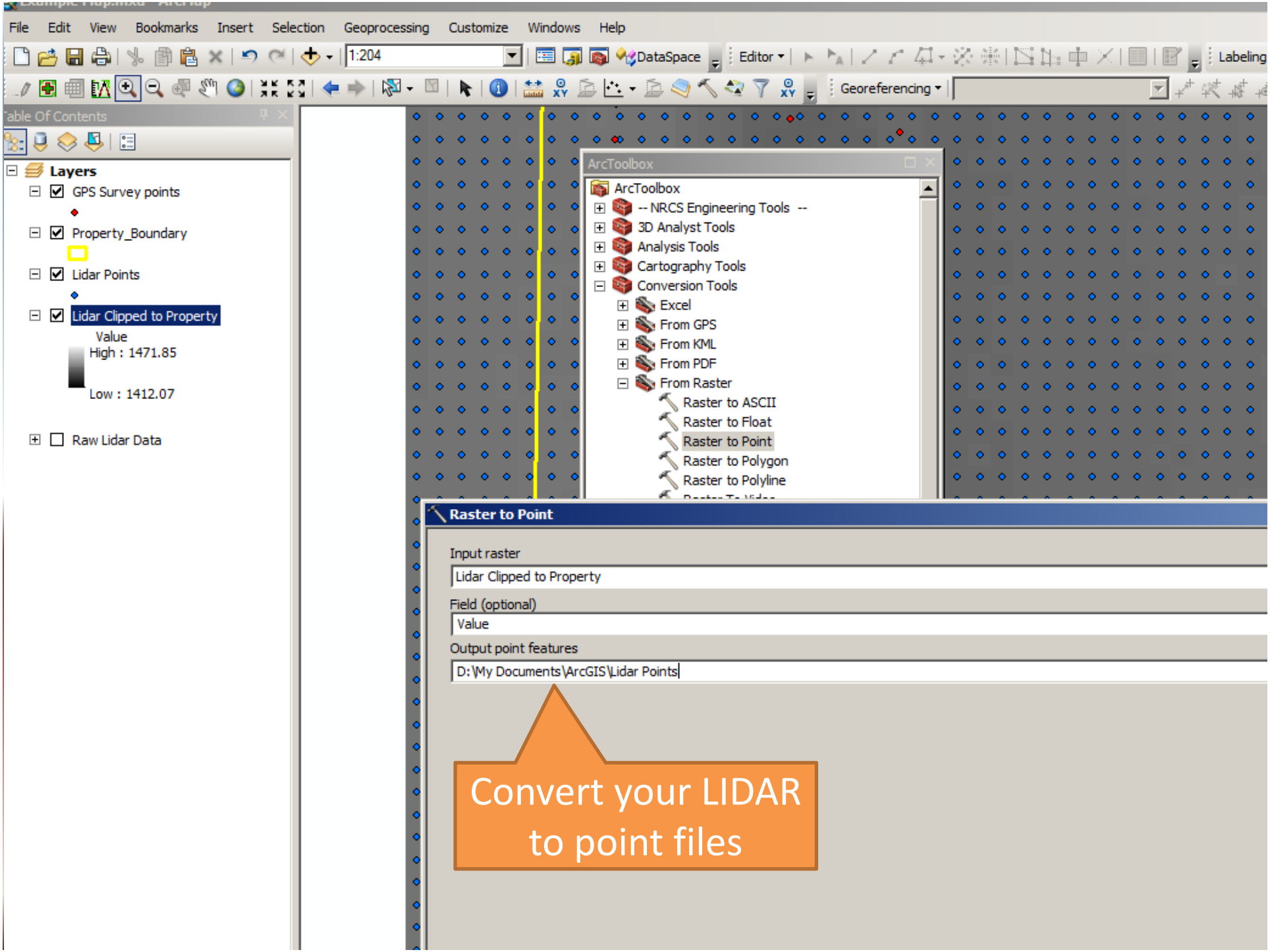
Raster
Mosaic Dataset
Raster Catalog
Raster Dataset
Raster Processing
Clip
Composite Bands
Clip
Input Raster
Raw Lidar Data
Output Extent (optional)
Property_Boundary
Rectangle
Y Maximum
4861182.562591
X Minimum
300510.666011
X Maximum
301356.712238
Y Minimum
4859567.547933
Clear
Use Input Features for Clipping Geometry (optional)
Output Raster Dataset
D:\My Documents\ArcGIS\Default.gdb\lidar_Clip
NoData Value (optional)
-3.402823e+038
Maintain Clipping Extent (optional)
OK
Cancel
Environments...
<< Hide Help
LIDAR usually comes in "Raster" form.
Clip to your Work Area
Convert to 3D TIN or to a Point File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Cartography Tools
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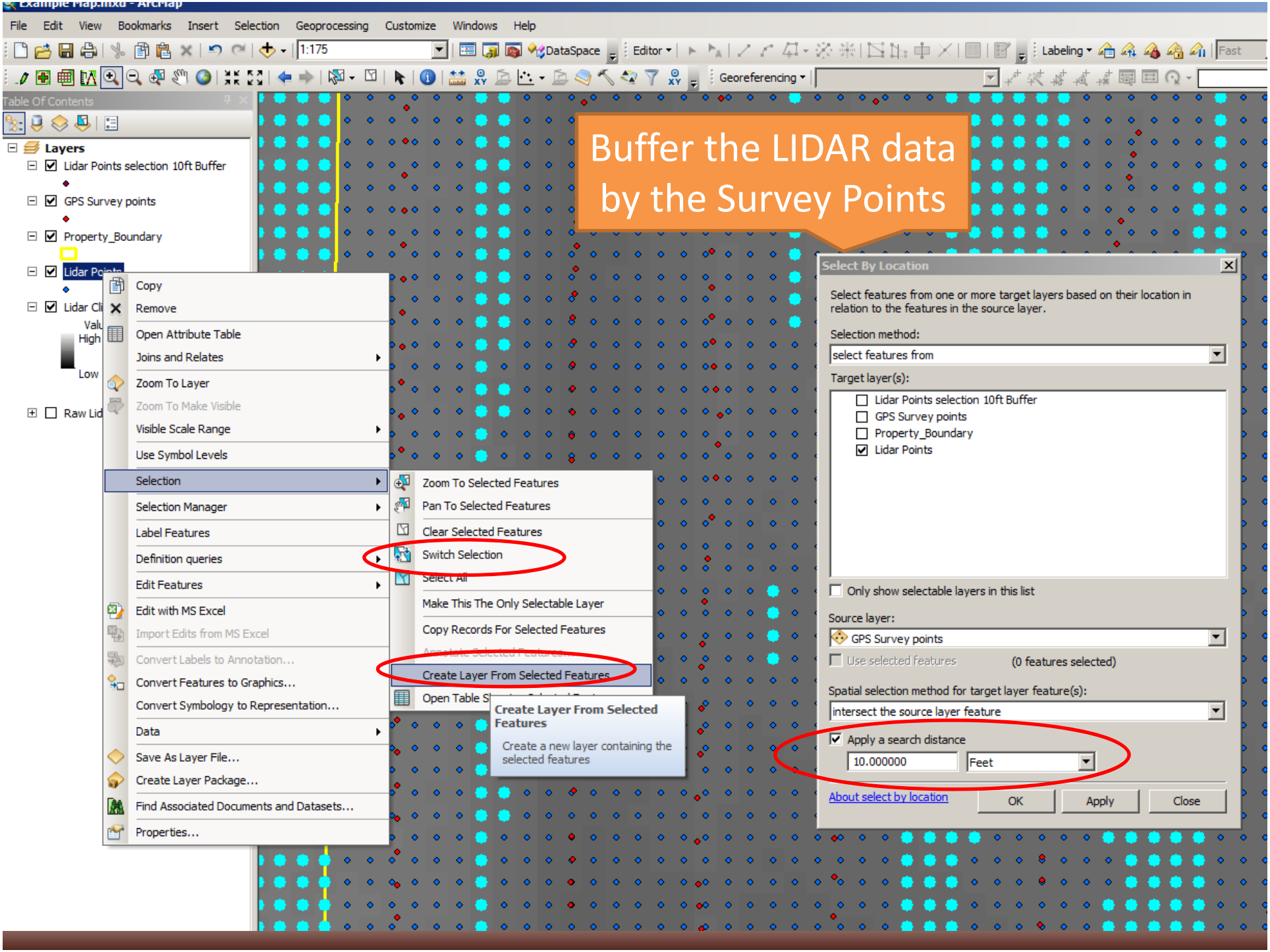
Excel
From GPS
From KML
From PDF
From Raster
Raster to ASCII
Raster to Float
Raster to Point
Raster to Polygon
Raster to Polyline
Raster to Point
Input raster
Lidar Clipped to Property
Field (optional)
Value
Output point features
D:\My Documents\ArcGIS\Lidar Points
Convert your LIDAR to point files


Buffer the LIDAR data by the Survey Points
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High
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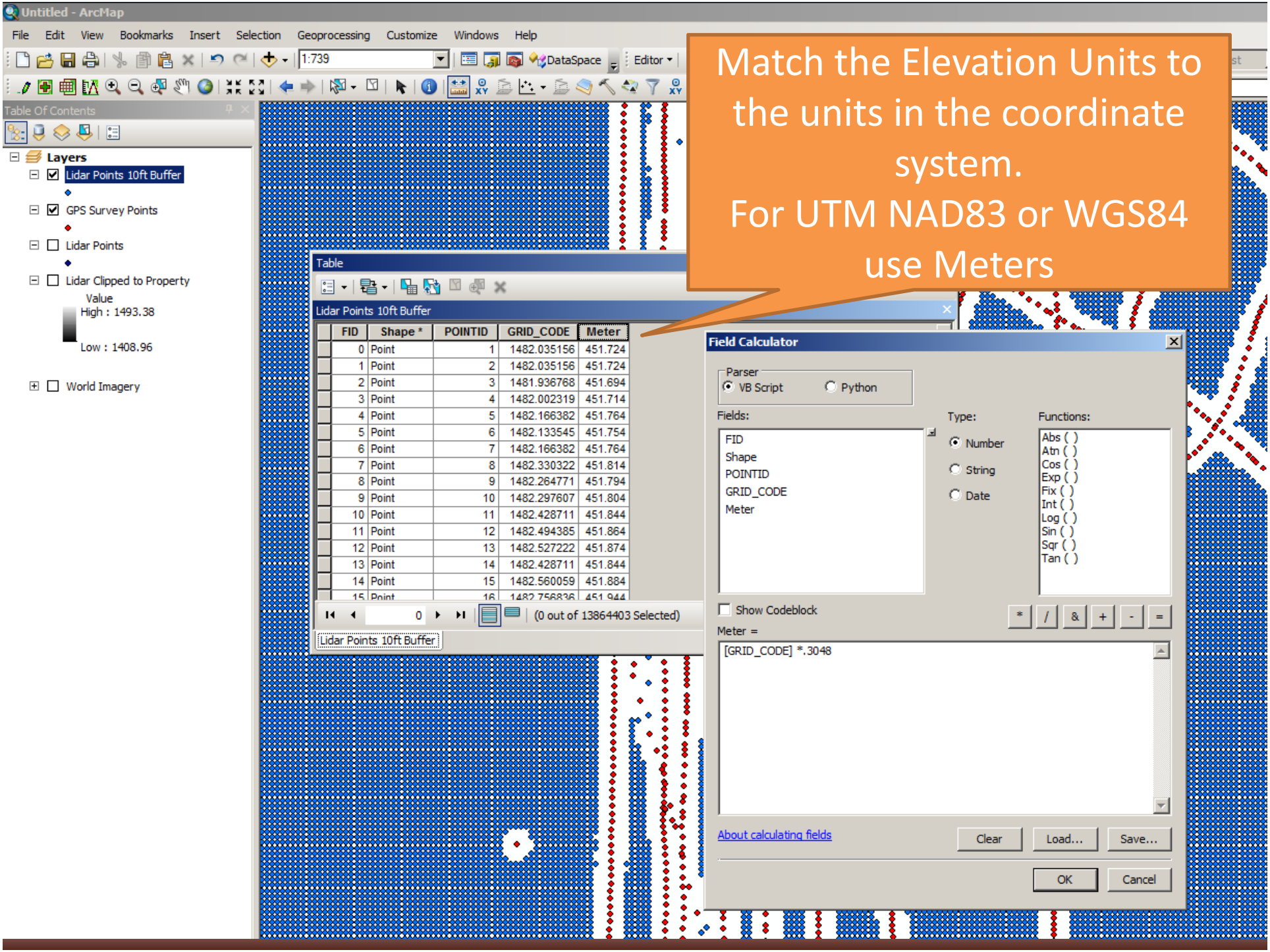
Copy
Remove
Open Attribute Table
Joins and Relates
Zoom To Layer
Zoom To Make Visible
Visible Scale Range
Use Symbol Levels
Selection
Selection Manager
Label Features
Definition queries
Edit Features
Edit with MS Excel
Import Edits from MS Excel
Convert Labels to Annotation...
Convert Features to Graphics...
Convert Symbology to Representation...
Data
Save As Layer File...
Create Layer Package...
Find Associated Documents and Datasets...
Properties...
Zoom To Selected Features
Pan To Selected Features
Clear Selected Features
Switch Selection
Select All
Make This The Only Selectable Layer
Copy Records For Selected Features
Create Layer From Selected Features
Open Table
Create Layer From Selected Features
Create a new layer containing the selected features
Select By Location
Select features from one or more target layers based on their location in relation to the features in the source layer.
Selection method:
select features from
Target layer(s):
Lidar Points selection 10ft Buffer
GPS Survey points
Property_Boundary
Lidar Points
Only show selectable layers in this list
Source layer:
GPS Survey points
Use selected features
(0 features selected)
Spatial selection method for target layer feature(s):
intersect the source layer feature
Apply a search distance
10.000000
Feet
About select by location
OK
Apply
Close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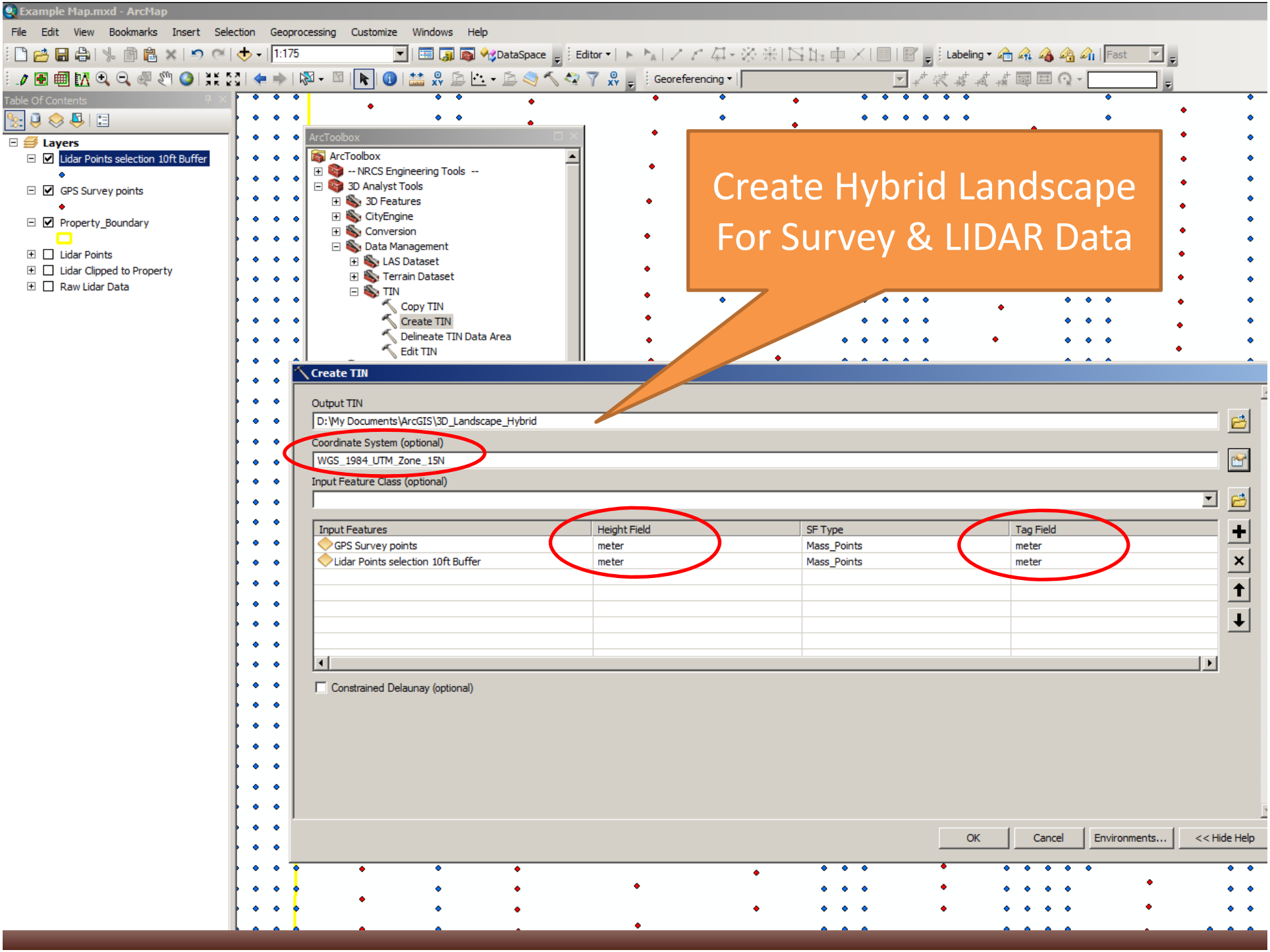
High : 1493.38
Low : 1408.96
World Imagery
Match the Elevation Units to the units in the coordinate system.
For UTM NAD83 or WGS84 use Meters
Table
Lidar Points 10ft Buffer
FID Shape * POINTID GRID_CODE Meter
0 Point 1 1482.035156 451.724
1 Point 2 1482.035156 451.724
2 Point 3 1481.936768 451.694
3 Point 4 1482.002319 451.714
4 Point 5 1482.166382 451.764
5 Point 6 1482.133545 451.754
6 Point 7 1482.166382 451.764
7 Point 8 1482.330322 451.814
8 Point 9 1482.264771 451.794
9 Point 10 1482.297607 451.804
10 Point 11 1482.428711 451.844
11 Point 12 1482.494385 451.864
12 Point 13 1482.527222 451.874
13 Point 14 1482.428711 451.844
14 Point 15 1482.560059 451.884
(0 out of 13864403 Selected)
Lidar Points 10ft Buffer
Field Calculator
Parser
VB Script
Python
Fields:
FID
Shape
POINTID
GRID_CODE
Meter
Type:
Number
String
Date
Functions:
Abs ( )
Atn ( )
Cos ( )
Exp ( )
Fix ( )
Int ( )
Log ( )
Sin ( )
Sqr ( )
Tan ( )
Show Codeblock
* / & + - =
Meter =
[GRID_CODE] *.3048
About calculating fields
Clear
Load...
Save...
OK
Cancel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CityEngine
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LAS Dataset
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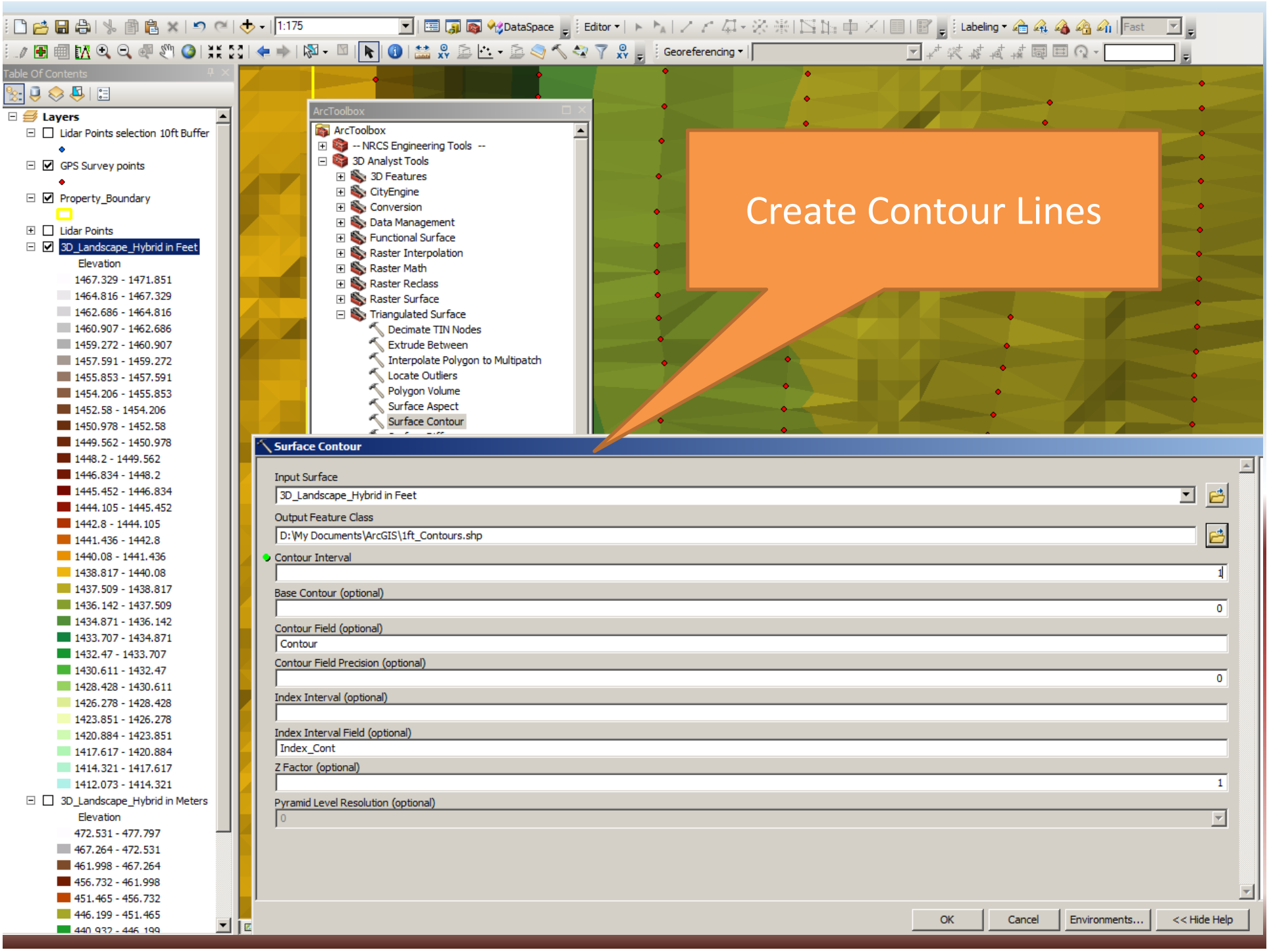
TIN
Copy TIN
Create TIN
Delineate TIN Data Area
Edit TIN
Create Hybrid Landscape
For Survey & LIDAR Data
Create TIN
Output TIN
D:\My Documents\ArcGIS\3D_Landscape_Hybrid
Coordinate System (optional)
WGS_1984_UTM_Zone_15N
Input Feature Class (optional)
Input Features
Height Field
SF Type
Tag Field
GPS Survey points
meter
Mass_Points
meter
Lidar Points selection 10ft Buffer
meter
Mass_Points
meter
Constrained Delaunay (optional)
OK
Cancel
Environments...
<< Hide Help


Create Contour Lines
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1464.816 - 1467.329
1462.686 - 1464.816
1460.907 - 1462.686
1459.272 - 1460.907
1457.591 - 1459.272
1455.853 - 1457.591
1454.206 - 1455.853
1452.58 - 1454.206
1450.978 - 1452.58
1449.562 - 1450.978
1448.2 - 1449.562
1446.834 - 1448.2
1445.452 - 1446.834
1444.105 - 1445.452
1442.8 - 1444.105
1441.436 - 1442.8
1440.08 - 1441.436
1438.817 - 1440.08
1437.509 - 1438.817
1436.142 - 1437.509
1434.871 - 1436.142
1433.707 - 1434.871
1432.47 - 1433.707
1430.611 - 1432.47
1428.428 - 1430.611
1426.278 - 1428.428
1423.851 - 1426.278
1420.884 - 1423.851
1417.617 - 1420.884
1414.321 - 1417.617
1412.073 - 1414.321
3D_Landscape_Hybrid in Meters
Elevation
472.531 - 477.797
467.264 - 472.531
461.998 - 467.264
456.732 - 461.998
451.465 - 456.732
446.199 - 451.465
440.932 - 446.199
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ArcToolbox
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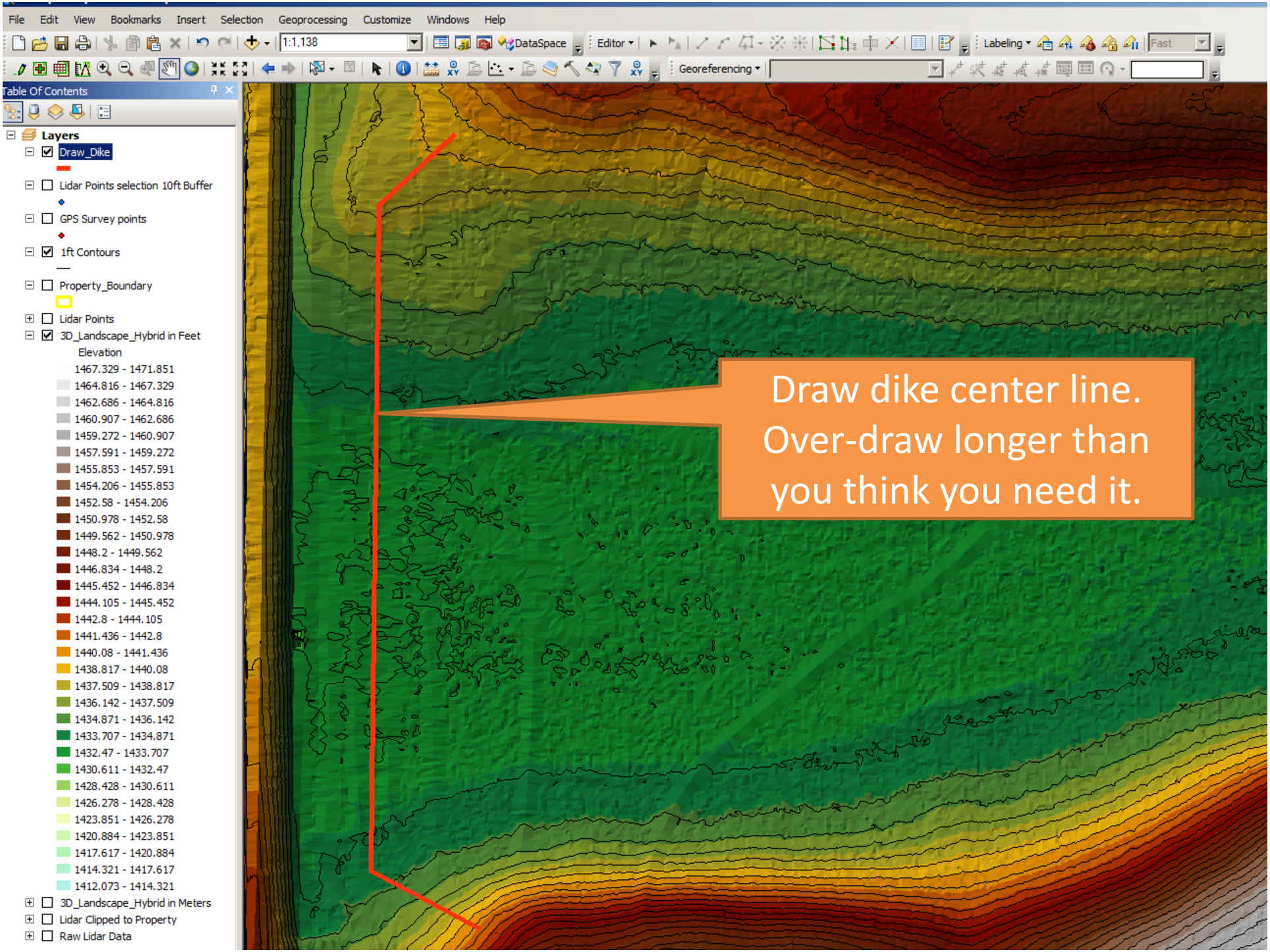
Raster Interpolation
Raster Math
Raster Reclass
Raster Surface
Triangulated Surface
Decimate TIN Nodes
Extrude Between
Interpolate Polygon to Multipatch
Locate Outliers
Polygon Volume
Surface Aspect
Surface Contour
Surface Contour
Input Surface
3D_Landscape_Hybrid in Feet
Output Feature Class
D:\My Documents\ArcGIS\1ft_Contours.shp
Contour Interval
1
Base Contour (optional)
0
Contour Field (optional)
Contour
Contour Field Precision (optional)
0
Index Interval (optional)
Index Interval Field (optional)
Index_Cont
Z Factor (optional)
1
Pyramid Level Resolution (optional)
0
OK
Cancel
Environments...
<< Hide Help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1450.978 - 1452.58
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1442.8 - 1444.105
1441.436 - 1442.8
1440.08 - 1441.436
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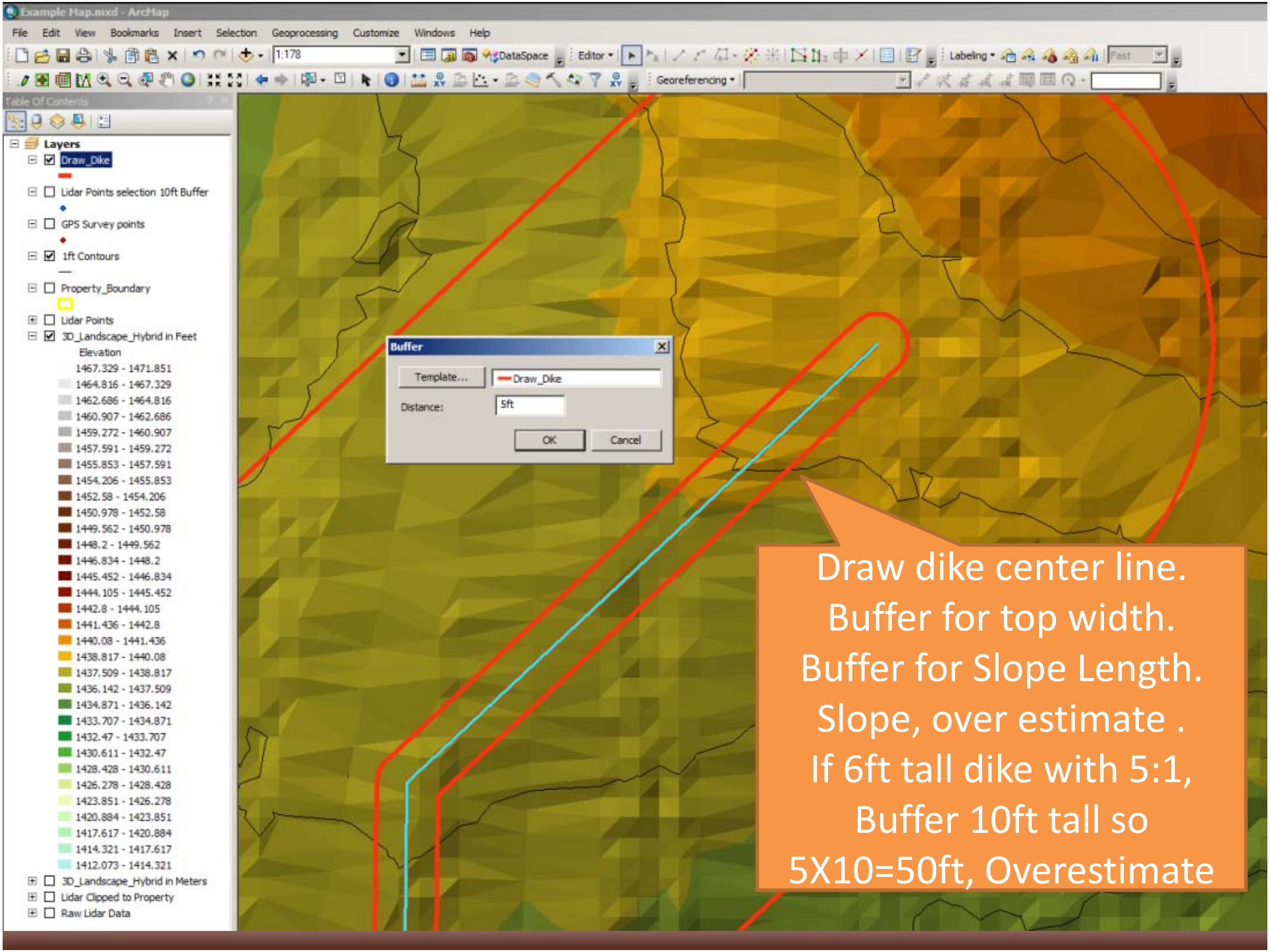
1428.428 - 1430.611
1426.278 - 1428.428
1423.851 - 1426.278
1420.884 - 1423.851
1417.617 - 1420.884
1414.321 - 1417.617
1412.073 - 1414.321
3D_Landscape_Hybrid in Meters
Lidar Clipped to Property
Raw Lidar Data
Draw dike center line.
Over-draw longer than
you think you need it.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1460.907 - 1462.686
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1457.591 - 1459.272
1455.853 - 1457.591
1454.206 - 1455.853
1452.58 - 1454.206
1450.978 - 1452.58
1449.562 - 1450.978
1448.2 - 1449.562
1446.834 - 1448.2
1445.452 - 1446.834
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1440.08 - 1441.436
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1437.509 - 1438.817
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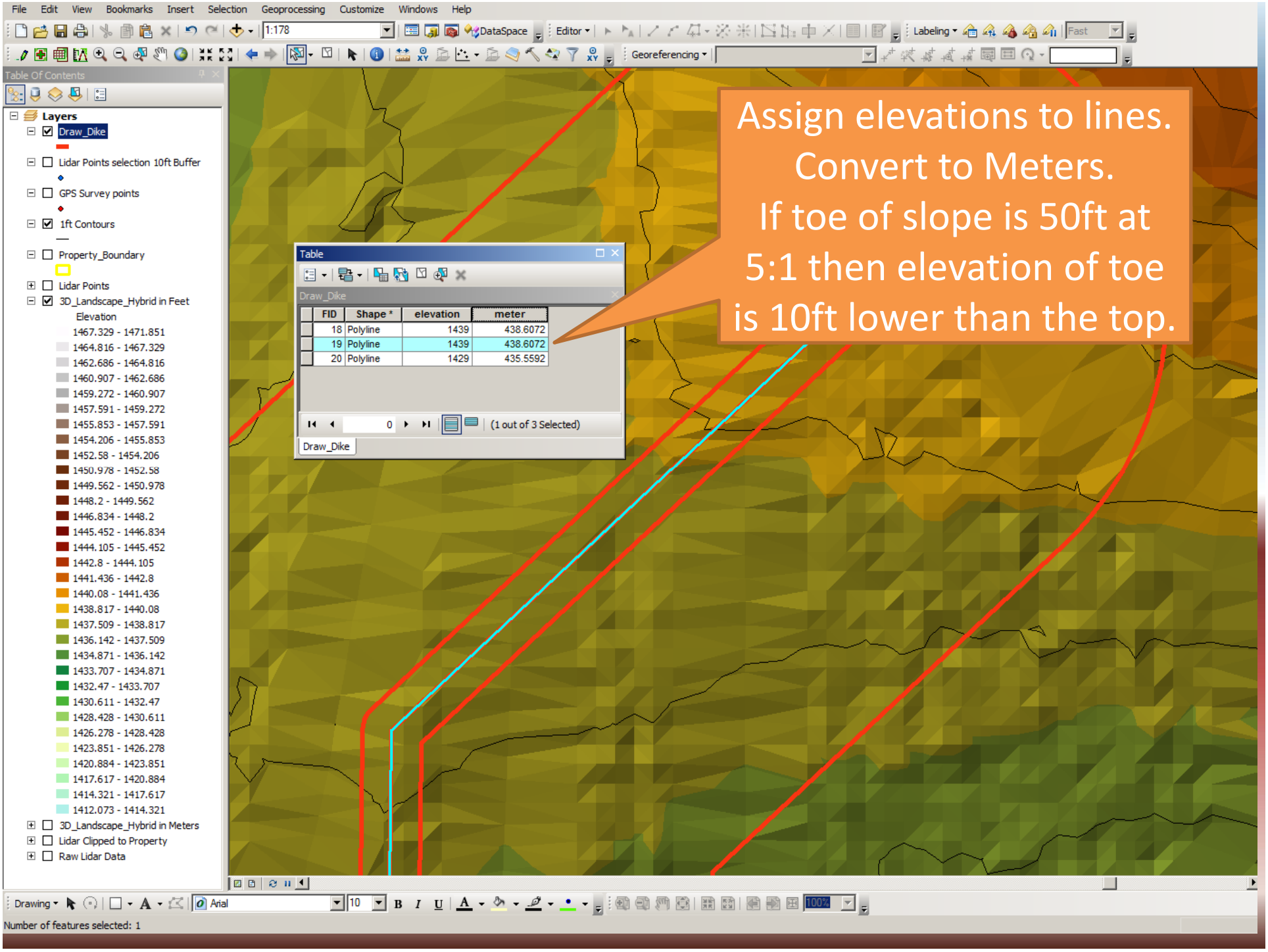
1433.707 - 1434.871
1432.47 - 1433.707
1430.611 - 1432.47
1428.428 - 1430.611
1426.278 - 1428.428
1423.851 - 1426.278
1420.884 - 1423.851
1417.617 - 1420.884
1414.321 - 1417.617
1412.073 - 1414.321
3D_Landscape_Hybrid in Meters
Lidar Clipped to Property
Raw Lidar Data
Buffer
Template...
Draw_Dike
Distance:
5ft
OK
Cancel
Draw dike center line.
Buffer for top width.
Buffer for Slope Length.
Slope, over estimate .
If 6ft tall dike with 5:1,
Buffer 10ft tall so
5X10=50ft, Overestimate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1464.816 - 1467.329
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1460.907 - 1462.686
1459.272 - 1460.907
1457.591 - 1459.272
1455.853 - 1457.591
1454.206 - 1455.853
1452.58 - 1454.206
1450.978 - 1452.58
1449.562 - 1450.978
1448.2 - 1449.562
1446.834 - 1448.2
1445.452 - 1446.834
1444.105 - 1445.452
1442.8 - 1444.105
1441.436 - 1442.8
1440.08 - 1441.436
1438.817 - 1440.08
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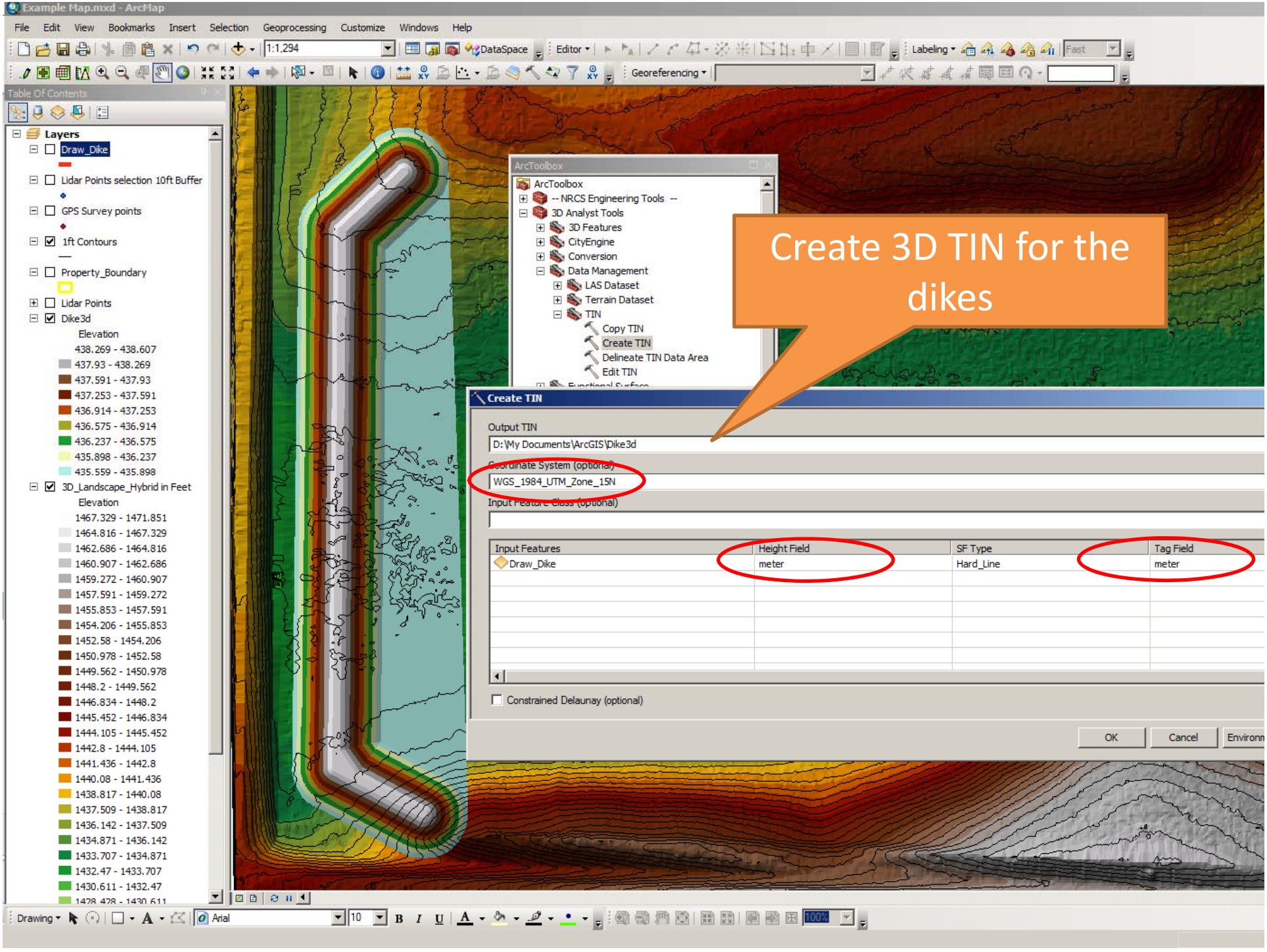
1428.428 - 1430.611
1426.278 - 1428.428
1423.851 - 1426.278
1420.884 - 1423.851
1417.617 - 1420.884
1414.321 - 1417.617
1412.073 - 1414.321
3D_Landscape_Hybrid in Meters
Lidar Clipped to Property
Raw Lidar Data
Table
Draw_Dike
FID Shape * elevation meter
18 Polyline 1439 438.6072
19 Polyline 1439 438.6072
20 Polyline 1429 435.5592
(1 out of 3 Selected)
Draw_Dike
Assign elevations to lines.
Convert to Meters.
If toe of slope is 50ft at 5:1 then elevation of toe is 10ft lower than the top.
Number of features selected: 1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Dike3d
Elevation
438.269 - 438.607
437.93 - 438.269
437.591 - 437.93
437.253 - 437.591
436.914 - 437.253
436.575 - 436.914
436.237 - 436.575
435.898 - 436.237
435.559 - 435.898
3D_Landscape_Hybrid in Feet
Elevation
1467.329 - 1471.851
1464.816 - 1467.329
1462.686 - 1464.816
1460.907 - 1462.686
1459.272 - 1460.907
1457.591 - 1459.272
1455.853 - 1457.591
1454.206 - 1455.853
1452.58 - 1454.206
1450.978 - 1452.58
1449.562 - 1450.978
1448.2 - 1449.562
1446.834 - 1448.2
1445.452 - 1446.834
1444.105 - 1445.452
1442.8 - 1444.105
1441.436 - 1442.8
1440.08 - 1441.436
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1437.509 - 1438.817
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1430.611 - 1432.47
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ArcToolbox
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TIN
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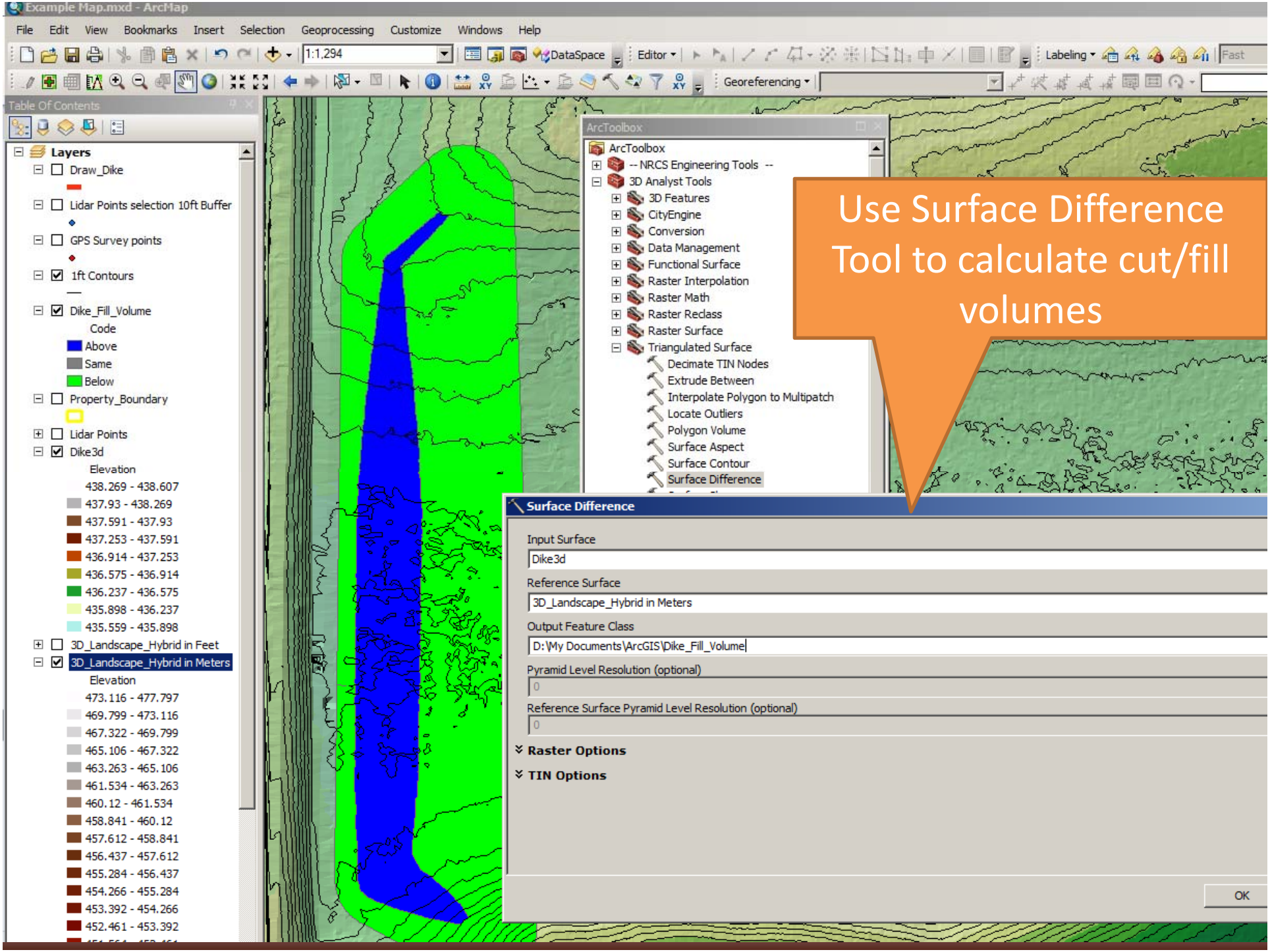
Create TIN
Delineate TIN Data Area
Edit TIN
Create 3D TIN for the dikes
Create TIN
Output TIN
D:\My Documents\ArcGIS\Dike3d
Coordinate System (optional)
WGS_1984_UTM_Zone_15N
Input Feature Class (optional)
Input Features
Height Field
SF Type
Tag Field
Draw_Dike
meter
Hard_Line
meter
Constrained Delaunay (optional)
OK
Cancel
Drawing
Arial
10
100%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Same
Below
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Dike3d
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437.93 - 438.269
437.591 - 437.93
437.253 - 437.591
436.914 - 437.253
436.575 - 436.914
436.237 - 436.575
435.898 - 436.237
435.559 - 435.898
3D_Landscape_Hybrid in Feet
3D_Landscape_Hybrid in Meters
Elevation
473.116 - 477.797
469.799 - 473.116
467.322 - 469.799
465.106 - 467.322
463.263 - 465.106
461.534 - 463.263
460.12 - 461.534
458.841 - 460.12
457.612 - 458.841
456.437 - 457.612
455.284 - 456.437
454.266 - 455.284
453.392 - 454.266
452.461 - 453.392
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ArcToolbox
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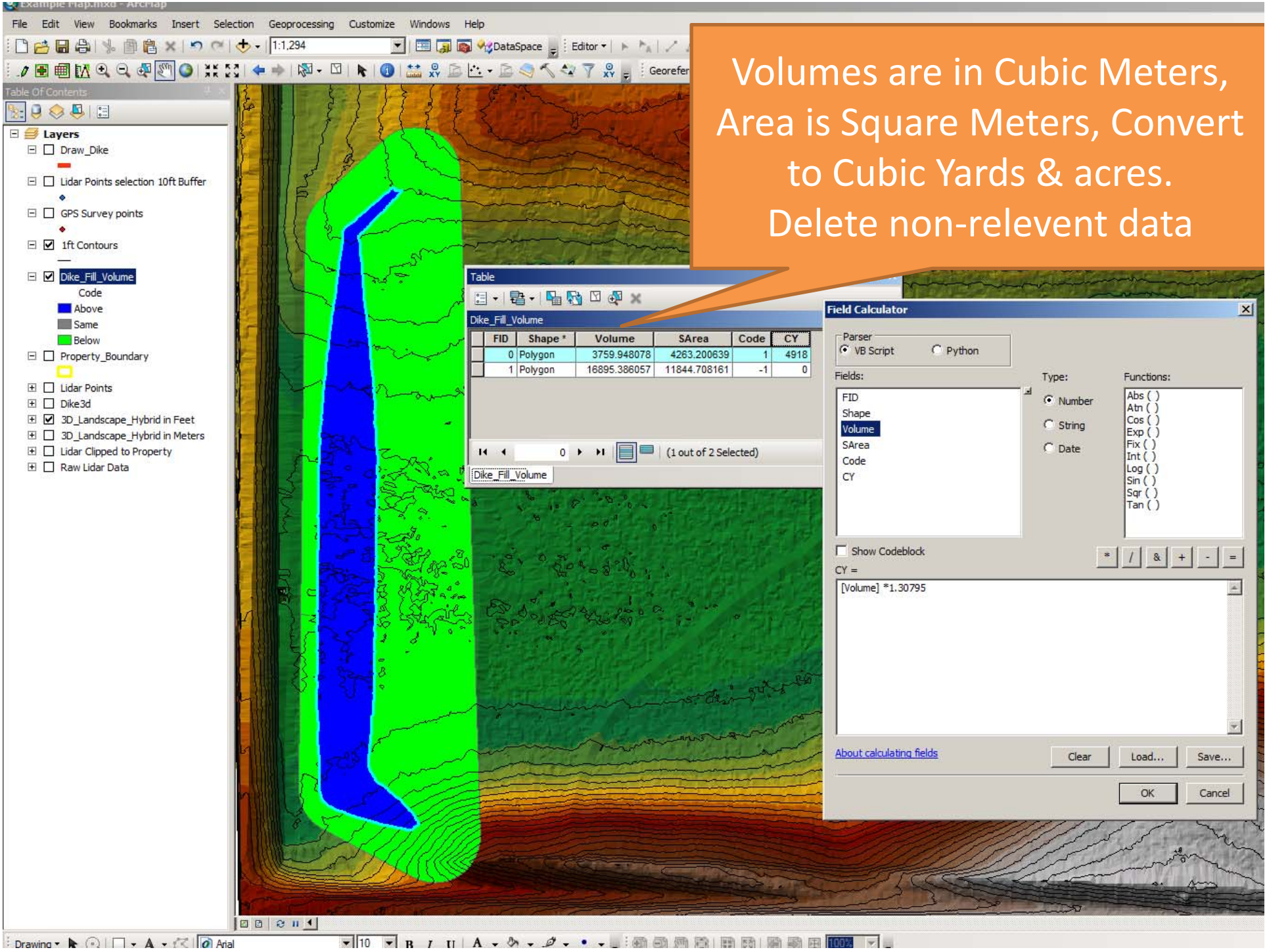
Raster Interpolation
Raster Math
Raster Reclass
Raster Surface
Triangulated Surface
Decimate TIN Nodes
Extrude Between
Interpolate Polygon to Multipatch
Locate Outliers
Polygon Volume
Surface Aspect
Surface Contour
Surface Difference
Use Surface Difference Tool to calculate cut/fill volumes
Surface Difference
Input Surface
Dike3d
Reference Surface
3D_Landscape_Hybrid in Meters
Output Feature Class
D:\My Documents\ArcGIS\Dike_Fill_Volume
Pyramid Level Resolution (optional)
0
Reference Surface Pyramid Level Resolution (optional)
0
Raster Options
TIN Options
OK


Volumes are in Cubic Meters, Area is Square Meters, Convert to Cubic Yards & acres.
Delete non-relevent data
File Edit View Bookmarks Insert Selection Geoprocessing Customize Windows Help
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Below
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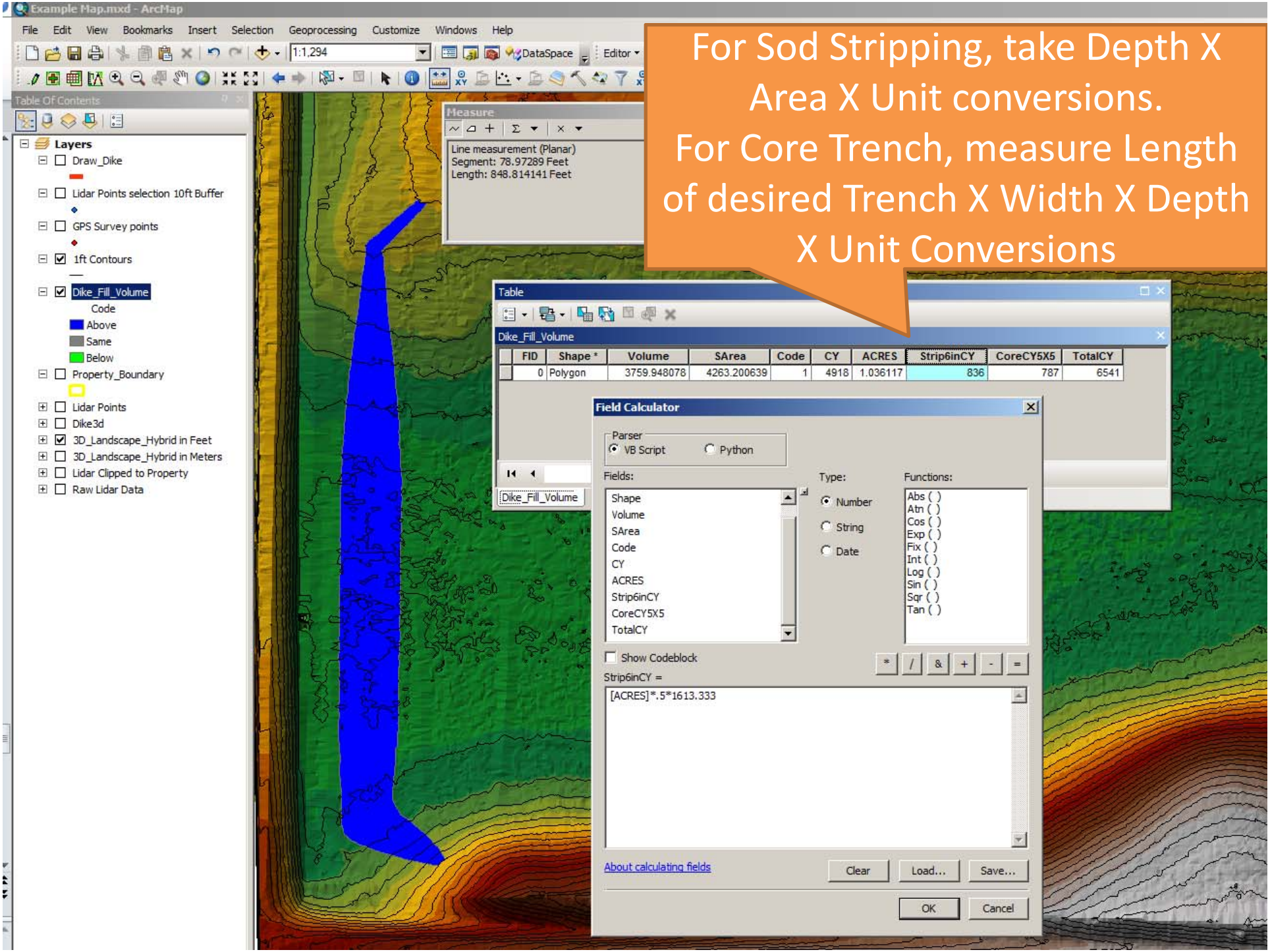
Lidar Points
Dike3d
3D_Landscape_Hybrid in Feet
3D_Landscape_Hybrid in Meters
Lidar Clipped to Property
Raw Lidar Data
Table
Dike_Fill_Volume
FID Shape * Volume SArea Code CY
0 Polygon 3759.948078 4263.200639 1 4918
1 Polygon 16895.386057 11844.708161 -1 0
(1 out of 2 Selected)
Field Calculator
Parser
VB Script
Python
Fields:
FID
Shape
Volume
SArea
Code
CY
Type:
Number
String
Date
Functions:
Abs ( )
Atn ( )
Cos ( )
Exp ( )
Fix ( )
Int ( )
Log ( )
Sin ( )
Sqr ( )
Tan ( )
Show Codeblock
CY =
[Volume] *1.30795
About calculating fields
Clear
Load...
Save...
OK
Cancel


Example Map.mxd - ArcMap
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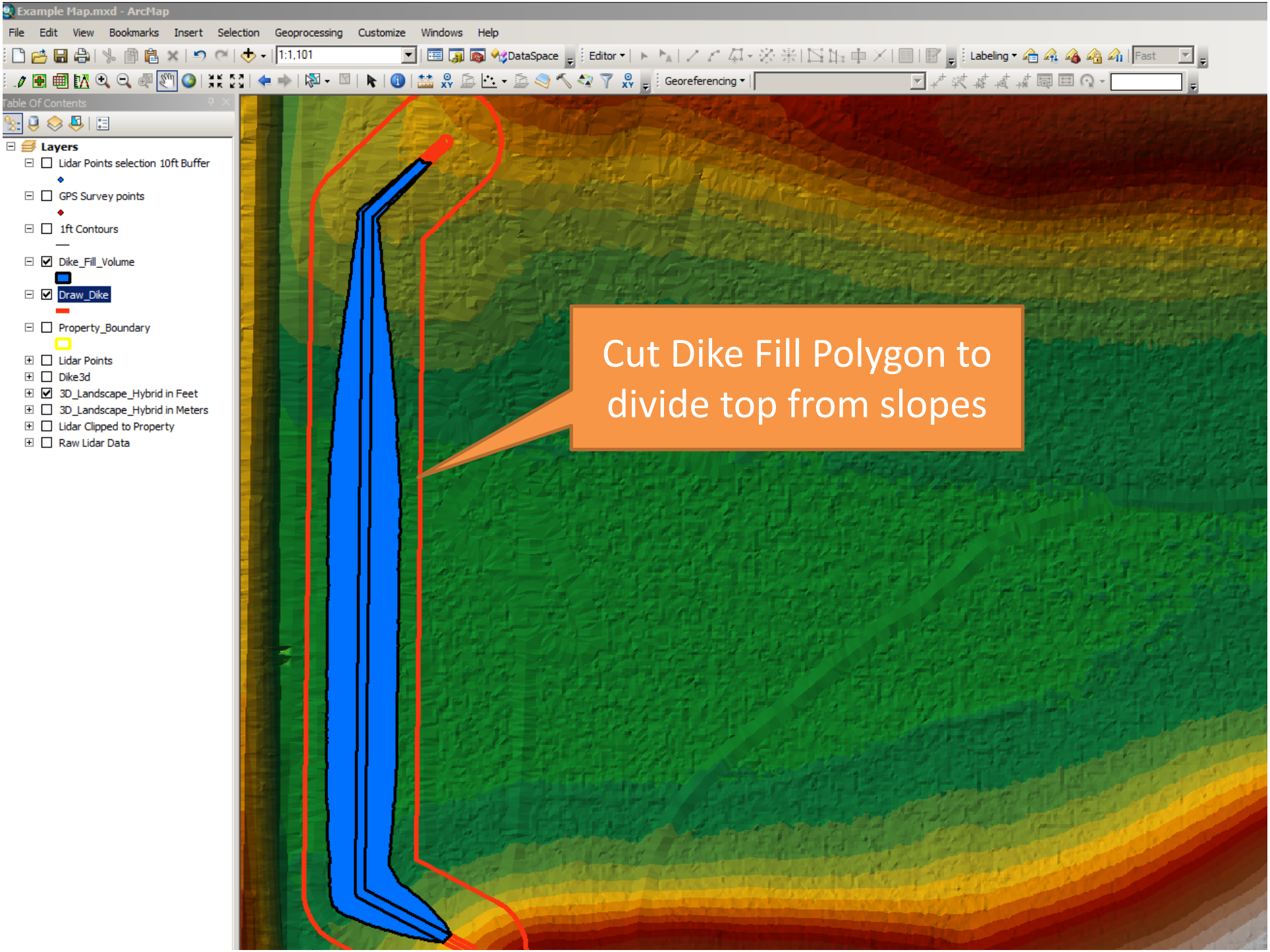
3D_Landscape_Hybrid in Meters
Lidar Clipped to Property
Raw Lidar Data
Measure
Line measurement (Planar)
Segment: 78.97289 Feet
Length: 848.814141 Feet
For Sod Stripping, take Depth X Area X Unit conversions.
For Core Trench, measure Length of desired Trench X Width X Depth X Unit Conversions
Table
Dike_Fill_Volume
FID Shape * Volume SArea Code CY ACRES Strip6inCY CoreCY5X5 TotalCY
0 Polygon 3759.948078 4263.200639 1 4918 1.036117 836 787 6541
Field Calculator
Parser
VB Script
Python
Fields:
Shape
Volume
SArea
Code
CY
ACRES
Strip6inCY
CoreCY5X5
TotalCY
Type:
Number
String
Date
Functions:
Abs ( )
Atn ( )
Cos ( )
Exp ( )
Fix ( )
Int ( )
Log ( )
Sin ( )
Sqr ( )
Tan ( )
Show Codeblock
* / & + - =
Strip6inCY =
[ACRES]*.5*1613.333
About calculating fields
Clear
Load...
Save...
OK
Cancel


Example Map.mxd - ArcMap
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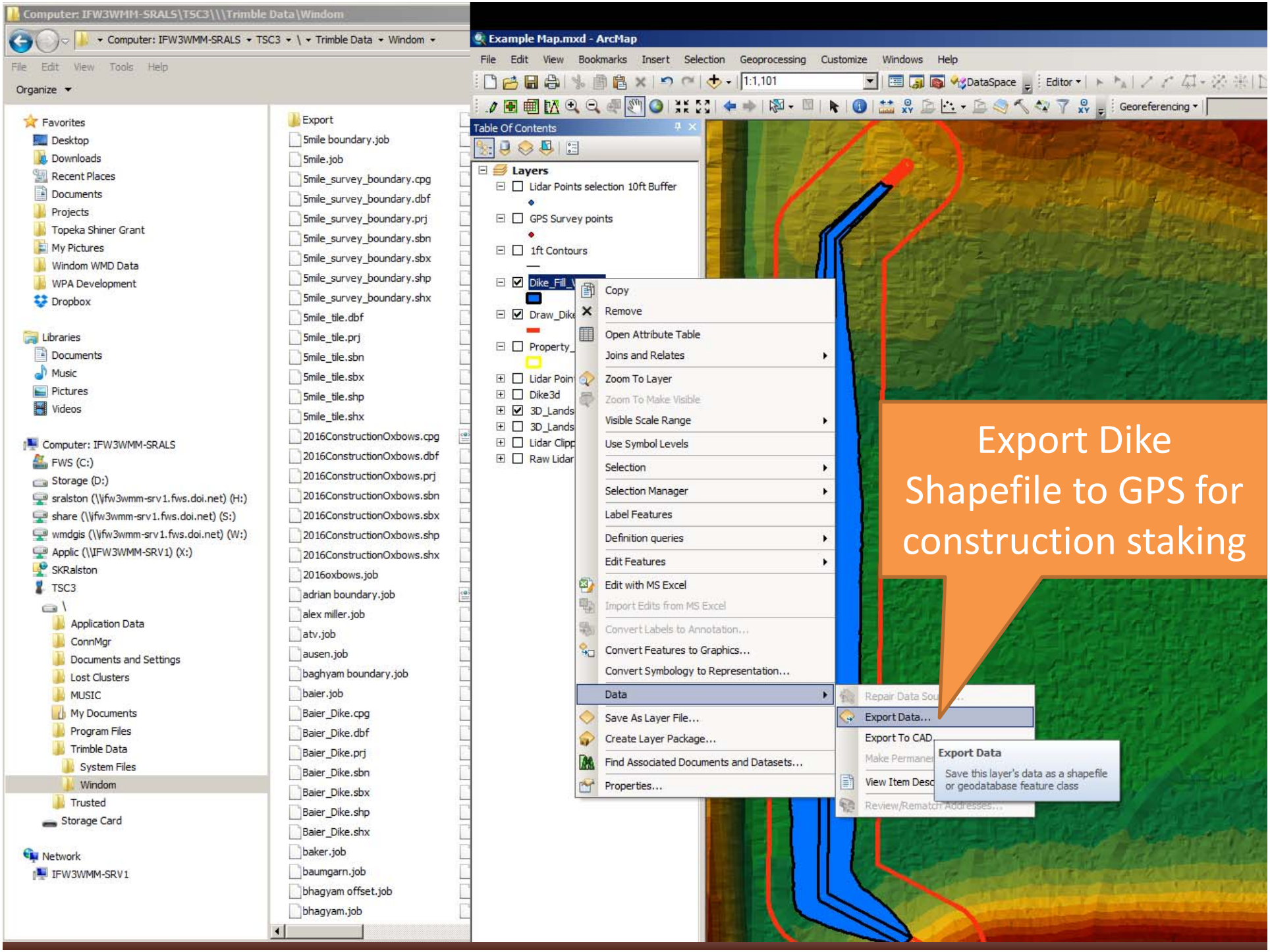
3D_Landscape_Hybrid in Meters
Lidar Clipped to Property
Raw Lidar Data
Cut Dike Fill Polygon to divide top from slopes


Computer: IFW3WMM-SRALS\TSC3\\\Trimble Data\Windom
Computer: IFW3WMM-SRALS ▸ TSC3 ▸ \ ▸ Trimble Data ▸ Windom
File Edit View Tools Help
Organize
Favorites
Desktop
Downloads
Recent Places
Documents
Projects
Topeka Shiner Grant
My Pictures
Windom WMD Data
WPA Development
Dropbox
Libraries
Documents
Music
Pictures
Videos
Computer: IFW3WMM-SRALS
FWS (C:)
Storage (D:)
sralston (\\ifw3wmm-srv1.fws.doi.net) (H:)
share (\\ifw3wmm-srv1.fws.doi.net) (S:)
wmdgis (\\ifw3wmm-srv1.fws.doi.net) (W:)
Applic (\\IFW3WMM-SRV1) (X:)
SKRalston
TSC3
\
Application Data
ConnMgr
Documents and Settings
Lost Clusters
MUSIC
My Documents
Program Files
Trimble Data
System Files
Windom
Trusted
Storage Card
Network
IFW3WMM-SRV1
Export
5mile boundary.job
5mile.job
5mile_survey_boundary.cpg
5mile_survey_boundary.dbf
5mile_survey_boundary.prj
5mile_survey_boundary.sbn
5mile_survey_boundary.sbx
5mile_survey_boundary.shp
5mile_survey_boundary.shx
5mile_tile.dbf
5mile_tile.prj
5mile_tile.sbn
5mile_tile.sbx
5mile_tile.shp
5mile_tile.shx
2016ConstructionOxbows.cpg
2016ConstructionOxbows.dbf
2016ConstructionOxbows.prj
2016ConstructionOxbows.sbn
2016ConstructionOxbows.sbx
2016ConstructionOxbows.shp
2016ConstructionOxbows.shx
2016oxbows.job
adrian boundary.job
alex miller.job
atv.job
ausen.job
baghyam boundary.job
baier.job
Baier_Dike.cpg
Baier_Dike.dbf
Baier_Dike.prj
Baier_Dike.sbn
Baier_Dike.sbx
Baier_Dike.shp
Baier_Dike.shx
baker.job
baumgarn.job
bhagyam offset.job
bhagyam.job
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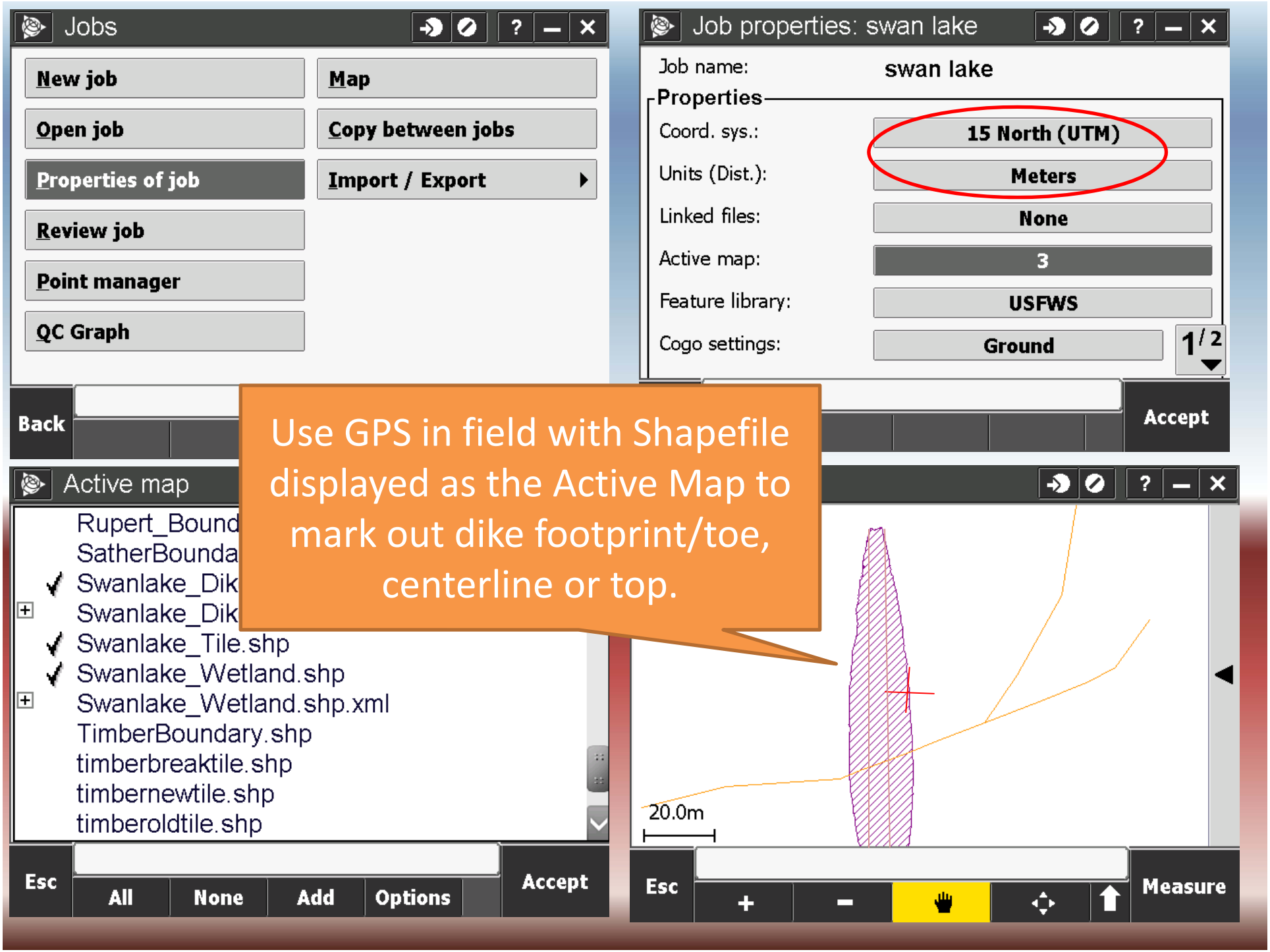
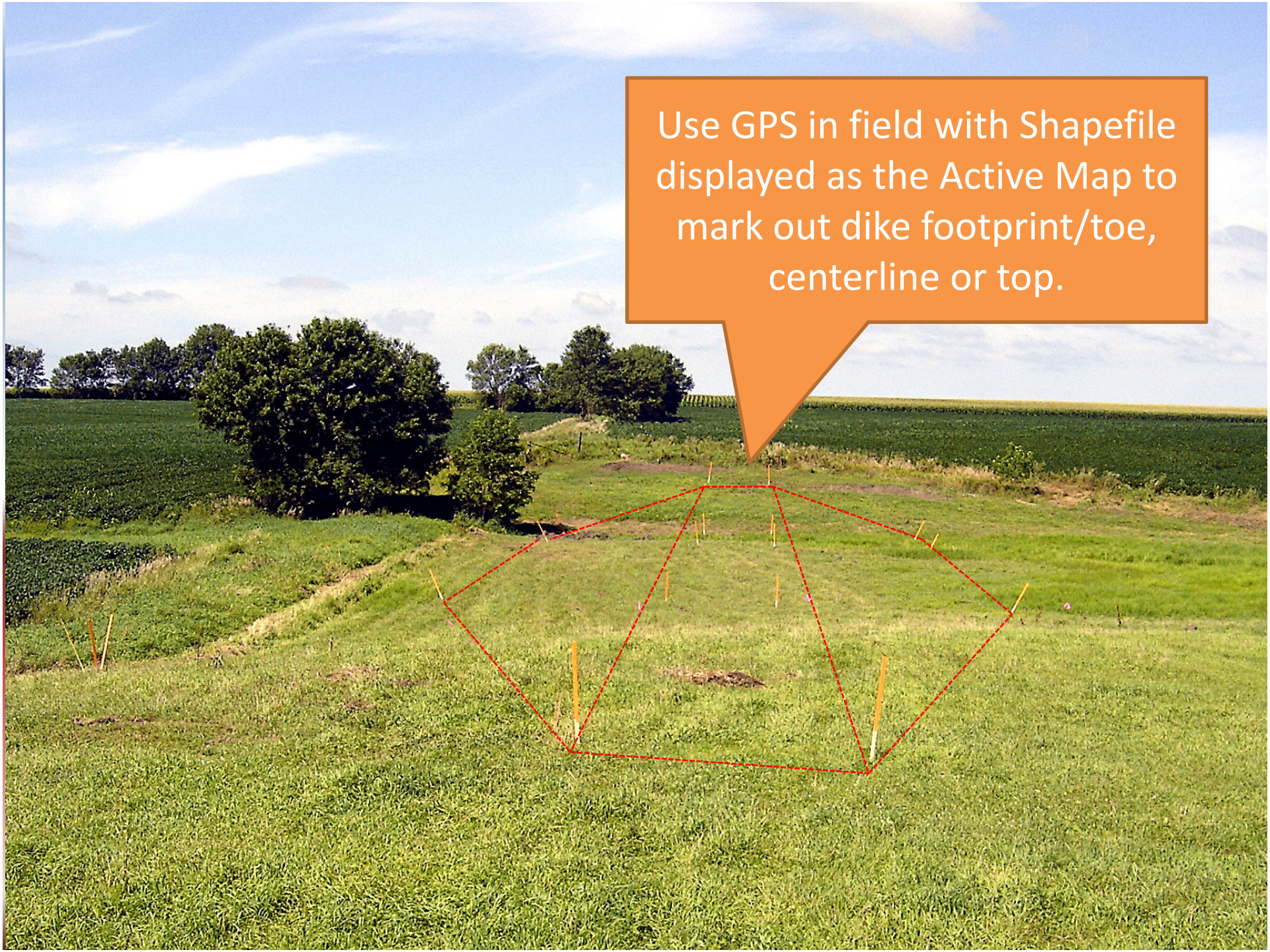
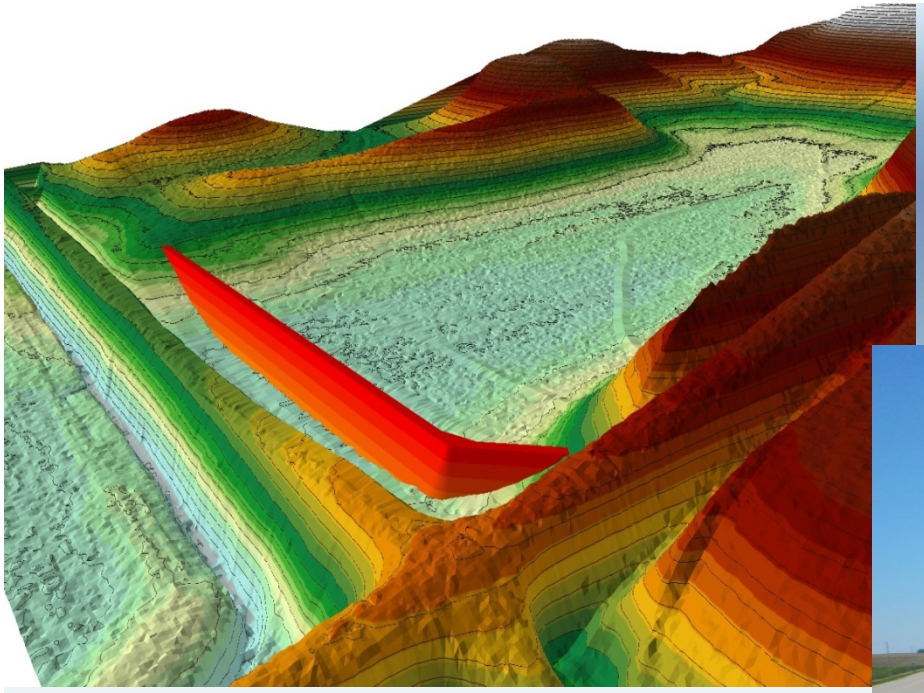
3D_Lands
3D_Lands
Lidar Clipp
Raw Lidar
Copy
Remove
Open Attribute Table
Joins and Relates
Zoom To Layer
Zoom To Make Visible
Visible Scale Range
Use Symbol Levels
Selection
Selection Manager
Label Features
Definition queries
Edit Features
Edit with MS Excel
Import Edits from MS Excel
Convert Labels to Annotation...
Convert Features to Graphics...
Convert Symbology to Representation...
Data
Save As Layer File...
Create Layer Package...
Find Associated Documents and Datasets...
Properties...
Repair Data Source...
Export Data...
Export To CAD...
Make Permanent...
View Item Description...
Review/Rematch Addresses...
Export Data
Save this layer's data as a shapefile or geodatabase feature class
Export Dike Shapefile to GPS for construction staking


Jobs
New job
Map
Open job
Copy between jobs
Properties of job
Import / Export
Review job
Point manager
QC Graph
Back
Job properties: swan lake
Job name:
swan lake
Properties
Coord. sys.:
15 North (UTM)
Units (Dist.):
Meters
Linked files:
None
Active map:
3
Feature library:
USFWS
Cogo settings:
Ground
1/2
Accept
Use GPS in field with Shapefile displayed as the Active Map to mark out dike footprint/toe, centerline or top.
Active map
Rupert_Bound
SatherBounda
Swanlake_Dik
Swanlake_Dik
Swanlake_Tile.shp
Swanlake_Wetland.shp
Swanlake_Wetland.shp.xml
TimberBoundary.shp
timberbreaktile.shp
timbernewtile.shp
timberoldtile.shp
Esc
All
None
Add
Options
Accept
20.0m
Esc
Measure


Use GPS in field with Shapefile displayed as the Active Map to mark out dike footprint/toe, centerline or top.



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Thank

You!