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State of Connecticut Department of Transportation, AEC Applications – Division of Facilities & Transit

Using LiDAR Data to Create InRoads SS2 Digital Terrain Models

The SELECTSeries Digital Design Environment

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Section 1 Introduction

1.1 Required Versions

MicroStation V8i (SELECTseries 4) - Version 08.11.09.832 InRoads V8i (SELECTseries 2) - Version 8.11.07.615

1.2 Workflow Description

This Workflow was developed for use with network drives (X-Drive) projects to instruct designers on how to retrieve 2016 LiDAR data from the online NOAA Data Access Viewer to create an **InRoads SS2 digital terrain model (DTM).** Prerequisites for using this workflow include basic MicroStation and InRoads knowledge.

1.3 File Formats

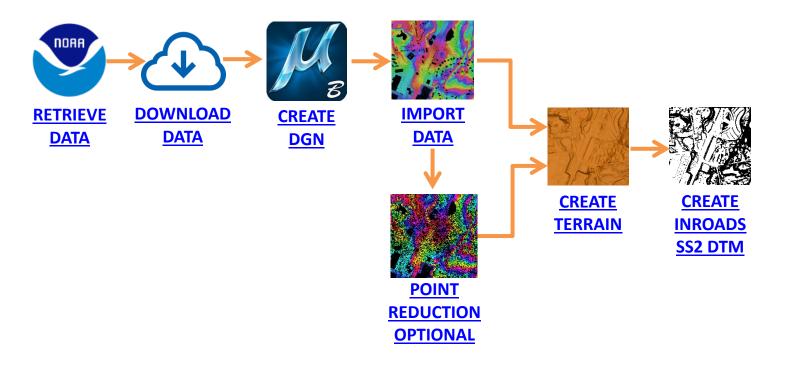
Statewide LiDAR can also be found in several locations. Keep in mind file formats found on websites might not be compatible with MicroStation V8i. Statewide LiDAR compatible with MicroStation V8i can be found in two places.

- NOAA website 2016 Flight, available at https://coast.noaa.gov/dataviewer/#/lidar/search/ Data is retrieved and downloaded from the website and then imported into a MicroStation Point Cloud POD file.
- **ProjectWise 2004 Flight**, available through the Aerial Tools Application that runs inside of MicroStation and gets attached as a MicroStation Point Cloud POD file.

Known Locations of Connecticut LiDAR Data

	Combatable with MicroStation V8i
ProjectWise	
Statewide 2004	
5 FT Point Clouds	YES 💙
NOAA Website	
2016 CRCOG LiDAR: Connecticut	
Statewide Points – ASCII X,Y,Z Pts	YES 💙
2016 CRCOG LiDAR: Connecticut	NO 🗙
Statewide Points - LAS	NO 🦘
2016 CRCOG LiDAR: Connecticut	NO 🗙
Statewide Points - LAZ	NO 🔨
UCONN/CT ECO	
Statewide 2016	NO 🗙
DEM	
Statewide 2016	NO 🗙
LAS	

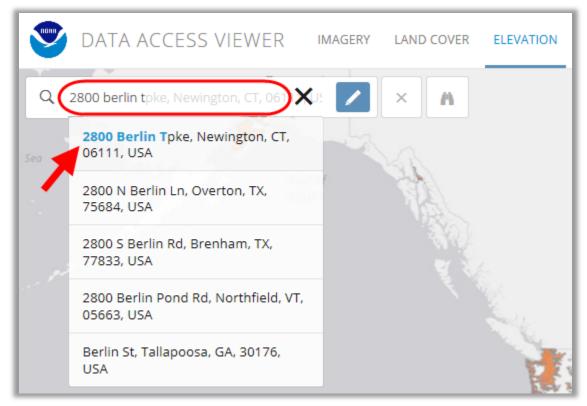
1.4 Flow Chart



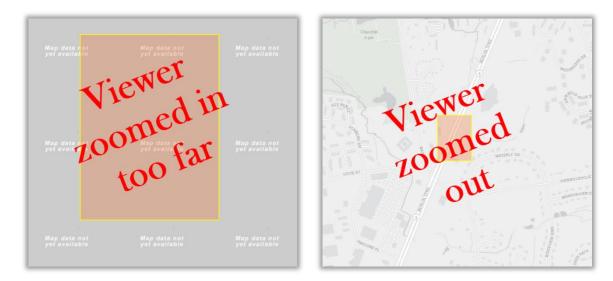
Section 2 LiDAR Data Retrieval

2.1 Retrieving LiDAR Data from NOAA

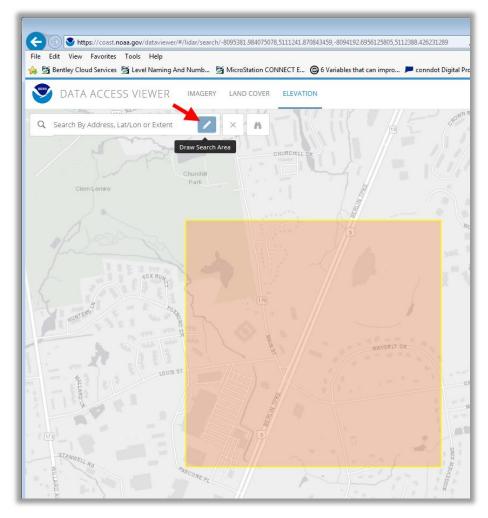
1. Go to the NOAA Data Access Viewer and search for your location. https://coast.noaa.gov/dataviewer/#/lidar/search/



2. After entering a location or address the viewer may make the map zoomed in too far, you may need to zoom out a bit to see the map information.



3. Click the **Draw Search Area** icon. Click and drag from left to right to create a selection area. The area should be shaded.



4. To select a data set, click the **Cart** icon next to the *2016 CRCOG Lidar: Connecticut Statewide* data set title. The cart icon in the upper right should update and show the number of items added.



5. Click on the **shopping cart icon**. The MY CART page should appear, the data source you selected should be shown. Click **Next**.



+ https://coast.noaa.gov/dataviewer/#/li	dar/search/_8005381 084 0		- • ×
File Edit View Favorites Tools Help Sile Sile Eentley Cloud Services Sile Level Naming And I			
	MY CART		×
Items in Your Cart - 1			
Lidar ×			
2016 CRCOG Lidar: Connecticut Statewide - 1			
Clear Cart			
Feedback Return to Vie	wer	Nex	t
			🔍 95% 🔻 🔐

6. The next page shows projection options. Set the *Projection, Datum and Unit fields* to those matching your survey ground file, if you do not have a survey file select NAD83 and NAVD88. Set the Output Options:

Output Product: Point

Output Format: Points – ASCII X,Y,Z Pts. then Click Next.

NOTE: If your survey is Horizontal Datum NAD27 and Vertical Datum NAVD88 extra steps will need to be completed in MicroStation as this is not an option on the NOAA website as it is a rare occurrence. In this case select the Vertical Datum NGVD29 and see AEC Applications for help with the vertical transformation.

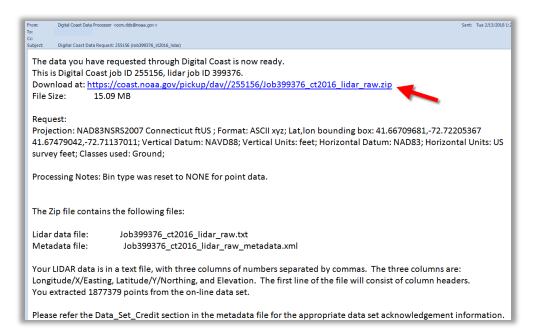
	MY CAR	Т			
Provision Your Data					Help
2016 CRCOG Lidar: Connecticut Statewide - 1	Lidar				
	Projection & Datum Options:				
	Projection:		Zone:		
	State Plane 1983	\checkmark	Zone 0600 Connecticut		~
	Horizontal Datum:		Horizontal Units:		
	NAD83	~	U.S. Feet		~
	Vertical Datum:	What's this?	Vertical Units:		
	NAVD88	~	Feet		~
	Output Options:				
	Output Product:		Output Format:		
	Point		Points - ASCII X,Y,Z Pts		\checkmark
	Data Options:				
	Use Advanced Options	What's this?			
	Data Classes:	What's this?			
	Ground All				
	 Add Intensity Images Reset 				
Feedback Return to Viewer				Previous	Next

- 7. On the next page enter your state email address. Click Next.
- 8. Review your selections and if correct, click Submit.
- 9. Take note of the *order number* provided on the confirmation page and make a note for the location, this will make it easier to sort out emails received later with the data links.

MY CART	\times
Success Your request has been sucessfully submitted for processing.	
Your order number is 255156 . You will receive an email at my.name.@ct.gov when your order has been processed, with a link to retrieve the data.	
If you have questions about your request, contact us at ocm.dds@noaa.gov	

2.2 Downloading and Saving the LiDAR Data Set

 The first email you receive from Digital Coast is a confirmation of the data request. No action needs to be taken with this email. The *second email* contains the *download link* (keep in mind this link will eventually expire) for the data. Click the link in the email and save the zip file to your project. The third email you receive also contains links to the same data in the second email. This email can be ignored. Emails may take a few minutes to receive; your wait time will be longer for larger data sets.



2. After clicking the link, Select Save as. Browse to your project folder and the appropriate subfolder for your unit. Click Save.

	Save As	
Internet Explorer	Q ↓ Libraries → Documents → Documents → NOAA	- 4 Search NOAA
What do you want to do with	Organize 🔻 New folder	8== - @
Job399376_ct2016_lidar_raw.zip? Size: 15.0 MB	★ Favorites ■ Desktop	Documents libr Arrange by: Folder -
From: coast.noaa.gov	🙀 Downloads 🎽 PAC	Name
 Open The file won't be saved automatically. 	Sa Recent Places	No items match your search.
→ Save	Documents	
Save as	Documents	<)
Cancel	File name: Job399376_ct2016_lidar_raw.zip Save as type: Compressed (zipped) Folder (*.zip)	• •
	Hide Folders	Save Cancel

- 3. In window explorer select the zip file, right click and *choose* **Extract All**. The files will extract into a folder and contain a .txt file(s) and an .xml file.
- 4. Erase the zip file once the files are extracted, once the files are unzipped the zip version is not needed.

Section 3 Point Clouds

In this section you will create a 3D MicroStation file used for the LiDAR data import. This DGN file will be used to pull the liDAR data in to a Point Cloud MicroStation POD file.

3.1 Creating a 3D DGN File

- 1. Open MicroStation through accounting. Do not use an existing file that has elements already in it, this could slow the processing up when an InRoads DTM is getting created and displayed.
- 2. Create a brand new 3D MicroStation file using the correct seed file. Select the 3D geospatial seed file that matches your datum from the following path *W:\Workspace\Standards\seed\Geospatial*

Follow the prompts to name and open the new file.

🥂 Select Seed Fil	le - \\DOT-SDCEN(507V\CTDOT_Wor	kspace\$\Works	space\St	andards\seed\(Geospatial\	×
Look in:	<u>]]</u> Geospatial		•	G 💋	F 📂 🛄 🔻	3	è.
Recent Places Desktop Libraries Computer	Name D_Poly_27F D_Poly_27W D_Poly_83F D_Poly_83F D_Geospatia D_Geospatia D_Geospatia D_Geospatia	I.dgn F.dgn I.dgn al_27FT.dgn al_27M.dgn al_83FT.dgn	Date modifie 1/30/2018 10: 1/30/2018 10: 1/30/2018 10: 1/30/2018 11: 1/30/2018 11: 2/2/2018 1:01 1/30/2018 11:	55 AM 56 AM 57 AM 57 AM 14 AM 14 AM	Type DGN File DGN File DGN File DGN File DGN File DGN File DGN File	Size 31 KB 31 KB 55 KB 31 KB 38 KB 38 KB 38 KB 38 KB	
Network	File name: Files of type:	3D_Geospatial_83 MicroStation DGN	-		•	Open Cancel	

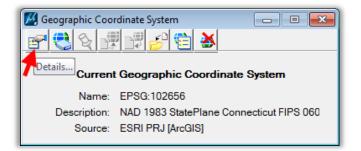
3. On the MicroStation main menu select *Tools > Geographic > Select Geographic Coordinate System*. On the Geographic Coordinate system tool box select **Edit Reprojection Settings**.

💹 Geographic Coo	rdinate System 📃 🗉 🗾					
🚰 😍 🖉	P 🖓 🎒 🚵					
Current	Current Geographic Edit Reprojection Settings					
Name:	EPSG:102656					
Description:	NAD 1983 StatePlane Connecticut FIPS 060					
Source:	ESRI PRJ [ArcGIS]					
oource.						

4. On the Reprojection Settings dialog box set *Reproject Elevations* to **Yes** on both the Reference and Active Model tabs.

🔀 Reprojection Settings	🔀 Reprojection Settings
Reference Active Model	Reference Active Model
Reprojection Settings	Reprojection Settings
Stroke Tolerance 0.1	Stroke Tolerance 0.1
Reproject Cell components ir If Spatially Large	Reproject Cell components ir If Spatially Large
Reproject Multiline Text com If Spatially Large	Reproject Multiline Text com If Spatially Large
Rotate Cells Yes	Rotate Cells Yes
Scale Cells Yes	Scale Cells Yes
Rotate Text Elements Yes	Rotate Text Elements Yes
Scale Text Elements Yes	Scale Text Elements Yes
Stroke Arcs to Line Strings If Spatially Large	Stroke Arcs to Line Strings If Spatially Large
Stroke Ellipses to Line String: If Spatially Large	Stroke Ellipses to Line String: If Spatially Large
Stroke Curves to Line Strings If Spatially Large	Stroke Curves to Line Strings If Spatially Large
Reproject Elevations Yes	Reproject Elevations Yes
Add Points If Needed No	Add Points If Needed No
Ok Cancel	Ok Cancel

- 5. If you downloaded a 1983 State Plane data set with NAD83 horizontal information and chose a vertical datum of NGVD29 (rather than the typical NAVD88) you will need to adjust the Vertical Datum setting in MicroStation before importing the points.
 - A. On the MicroStation main menu select *Tools >Geographic > Select Geographic Coordinate System.* On the Geographic Coordinate sytem tool box select **Details**.



B. On the Geoghraphical Coordinate System Properties dialog box change the Vertical Datum to *National Geodetic Vertical Datum of 1929* and select **OK**.

📕 Geographic Coordinate System Pro	operties 🗖 🗉 🖾
Coordinate System	*
Datum	*
Ellipsoid	*
Coordinate System Modifiers	*
-	
Vertical Datum	National Geodetic Vertical Datum of 1929 🗨
Vertical Datum Local Transform Type	

- C. On the Geographic Coordinate System Changed dialog box select **Reproject the Data to the new Geographic Coordinate System** and select **OK**.
- D. On the MicroStation main menu select *File > Save Settings*.

3.2 Creating Point Clouds from LiDAR Data

1. In MicroStation select the **Point Clouds** Icon.



2. The Point Clouds dialog will appear, Click the Attach button.

Point (Clouds (0 of 0 listed	l)
<u>F</u> ile <u>E</u>	dit <u>V</u> iew <u>S</u> ettin	gs <u>U</u> tilities
ŧ∎ - I	E 🔕 🙈 🖉) 💮 💽 🚳
File Nam	ne Attach	Descript
	rittden	

3. Windows Explorer dialog box will appear, browse to select the text files that were downloaded from the NOAA site. Change the Files of Type: to ASCII Files (*.txt) and select one or many files at once and click **Open**.

Look in:		TDOT_Projects\$\999_IRSS2_TE	-ST\Survey\Oxford\Job39782	9_ct2 💌
()	Name		Date modified	Туре
Recent Places	0000	_41073_41_12_raw.txt _41073_41_14_raw.txt	2/5/2018 3:15 PM 2/5/2018 3:15 PM	Text Docu Text Docu
	job397829		2/5/2018 3:15 PM 2/5/2018 3:15 PM	Text Docu Text Docu
Desktop	job397829	_41073_43_12_raw.txt	2/5/2018 3:15 PM	Text Docu
	0000	_41073_43_14_raw.txt _41073_43_16_raw.txt	2/5/2018 3:15 PM 2/5/2018 3:15 PM	Text Docu Text Docu
Libraries	0000	_41073_43_18_raw.txt _41073_45_12_raw.txt	2/5/2018 3:16 PM 2/5/2018 3:16 PM	Text Docu Text Docu
	0000	_41073_45_14_raw.txt 41073_45_16_raw.txt	2/5/2018 3:16 PM 2/5/2018 3:16 PM	Text Docu Text Docu
Computer	0000	_41073_45_18_raw.txt	2/5/2018 3:16 PM	Text Docu
Network	•			Þ
	File name: Files of type:	ob 397829 41073 45 18 ra	aw.tod	Open Cancel
	riles of type:	ASUIT Hies (".bd)		Cancel

4. A dialog for converting ASCII will open, make sure the columns are set to x, y, z as shown below and make sure the geometry units are set to *survey_feet* if the job is in english and *Meters* if the job is in metric. Click **OK**.

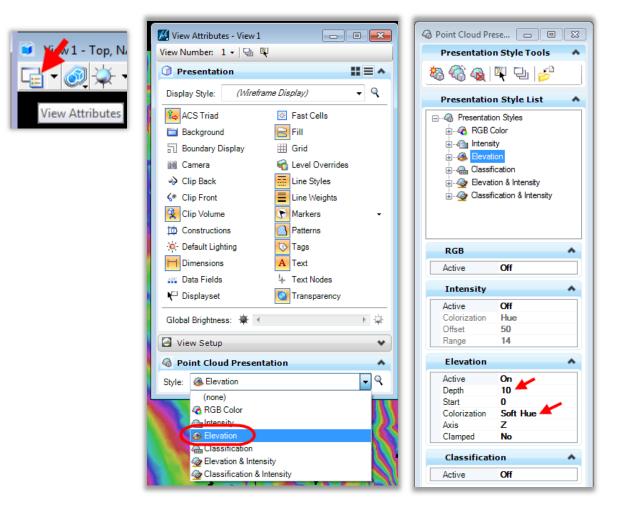
Point X	-	Point Y	-	Point Z
4973	74.84	2166	92.92	600.35
497374.79		216695.07		600.97
49737	74.77	2166	97.26	601.66
4973	74.48	2167	12.78	605.80
49737	74.44	2167	15.12	606.29
49737	74.39	2167	17.23	607.08
49737	74.13	2167	32.64	611.34
Action		^	Options	
Attach	Yes		Geometry Unit RGB Unit Intensity Unit Normalize Intensitie Compression Spatial Filtering Spatial Spacing	Survey_Feet 0 to 255 (byte) s Yes Aerial LIDAR data 0.050 (50m Disabled 0.00100
Geographic Info	rmation	*		
Reproject	No			
Source GeoCS	<none></none>			
Name				

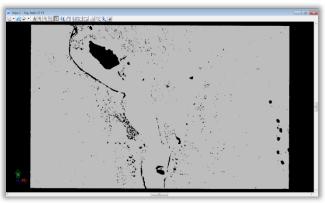
- 5. The save dialog will appear, save the file as a .pod file.
- 6. Click Fit View to see the points.

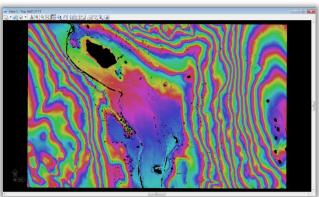
3.3 Point Cloud Display

- 1. Select the View Attributes icon on your View window.
- 2. For Point Cloud Presentation select *Elevation*.
- 3. To change the display click on the Magnifying Icon under Point Cloud Presentation. Select the desired look under *Depth* and *Colorization* and click **Save Settings**.

Tip: You can also set this from the Point Clouds dialog, choose *Settings > Presentation* and select Elevation. Right click to apply to open views.







Section 4 Point Reduction Methods

MicroStation can handle displaying very large Point Cloud POD files but InRoads SS2 cannot necessarily handle this amount of data. The points in the 2016 LiDAR are very close together so you may experience issues when trying to create or view an InRoads SS2 Surface created from the POD files that have not been reduced. When creating a surface from the LiDAR data a triangle is created to every point. For large data sets you will need to reduce the points in order to create the needed surfaces. InRoads support does not explicitly set a maximum size, so it is really just a function of the amount of free memory on the machine, and the amount of memory that the OS allocates to the program.

AEC Applications ran trials and suggests getting the number of points down to approximately 2 million in order to have a workable InRoads SS2 DTM. If the file you originally downloaded from NOAA is about 20 MB or less, skip to <u>Section 5</u>. If you have a very large area which contains multiple point clouds or the file from NOAA was larger than 20 MB the .pod file will need to be reduced. To be able to create and view the graphics of an InRoads DTM the point cloud needs to be reduced to about 2 million points.

This workflow shows two methods to reduce the amount of points before creating an InRoads SS2 DTM.

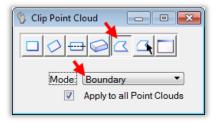
- 1. Point Cloud Export Tool
 - Reducing the Area of the point cloud
 - Reducing the Density of the point cloud
- 2. InRoads Data Acquisition Tool
 - Filtering the data on import

4.1 Reducing the Area and Density of POD Files

A point Cloud can be clipped and the density of the points can be filtered down. This reduction will need to be done on large data sets in order to have a manageable size DTM.

4.1.1 Area Reduction

 First we will work on reducing the area of the POD files. Review the point clouds and place a boundary around the needed area. In the Point Clouds dialog box select *Edit > Clip*, Select *Boundary* Mode and the desired placement method and follow the prompts to clip the point cloud. This only clips out the display of the points. The points still exist in the point cloud, they are just hidden. To remove the points the point cloud will need to be exported and saved as a new file.



- 2. Highlight all the point clouds files and select File > Export. In the Export Point Cloud box set the following: Format = Pointools POD (*.pod) Region Filter = Clip Density = 100 Click OK.
- Export Point Cloud

 Options

 Format
 Pointools POD (*.pod)

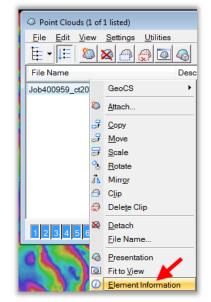
 Region Filter
 Density
 100

 Geographic Information

 Geocoding
 Take GeoCS F Input Point Cloud

 OK
 Cancel
- 3. When the next box appears select your project folder and rename the clipped POD file. Click Save.
- 4. Open the Point Clouds dialog box and select the newly created POD file. To see how many points are in the point cloud right click on the highlighted files in the point cloud window and select *Element Information* from the dropdown.
- 5. In the element information pane look at the metadata section, the number of points should be listed.

Metadata	^
Name Number of Cloude	Job400959_ct2016_lidar
Number of Points	3,261,629
Enamels E Lower Bound	486277.866,221397.910
 	490371.330,225185.824



4.1.2 Density Reduction

- 1. To further reduce the size of the point cloud we will also need to reduce the density. In the Point Cloud window select *File > Export*.
- 2. The Point Cloud Export window will appear, set the format to .pod, and select a lower density or enter a lower density into the density field. To determine which density to input, perform the following calculation: 2,000,000/ number of points in your point cloud = ?. Convert the resulting decimal to %. Select the closest density setting to this number, or type in this density.

In this Example the point cloud has 3,261,629 points. 2,000,000 / 3,261,629 = .61 = 61% Select 60 from the density dropdown or enter 61 into the field

Export Point Cloud	X
Options	*
Format	Pointools POD (*.pod)
Density	60
Geographic	Information
Geocoding Take GeoCS	Fror Input Point Cloud
	OK Cancel

- 3. Click **OK** in the Export Point Cloud Window.
- 4. The save dialog will appear. Save the file as a .pod file and name it to indicate the amount reduced.
- 5. In the Point Cloud dialog box attach the new POD file and compare. Make sure you are happy with the density of the new POD file. The key is to flush out as many points as necessary but still maintain the same basic contour lines.

When you are satisfied detach all the unneeded POD files.

- 6. Check to see how many points the reduced point cloud contains. Open the Point Clouds dialog box and select the newly created POD file. To see how many points are in the point cloud right click on the highlighted files in the point cloud window and select *Element Information* from the dropdown.
- 7. In the element information pane look at the metadata section, the number of points should be listed. If you are satisfied with the size move on to <u>Section 5</u>.

4.2 Data Acquisition

4.2.1 Filter Descriptions

InRoads SS2 has a tool located on the Task Menu called Data Acquisition. This tool is used to bridge the transition on Point Cloud Data to InRoads DTM creation. This tool also has point reduction tools. Follow the steps in <u>Section 5</u> to use Data Acquisition to further reduce the data.

The **Tile Filter** uses an algorithm that divides the LIDAR data set into tiles. A best fit plane is calculated for each tile, and LIDAR points are removed if they fall within the user set Z tolerance to the plane.

The **TIN Filter** first separates the LIDAR points into tiles with a maximum of 2 million points and then repetitively triangulates each tile, filtering out points. The TIN Filter algorithm filters out the points if they fall within the user set Z tolerance of the triangle planes.

No Filter – No filtering is applied

Z Tolerance - common to both algorithms and is basically the variation in the Z coordinate that the surface is allowed to move during the filtering process. Typically for the first invocation of the filtering function, the Z tolerance should be set from 0.5 to 1.0 for imperial data sets and from 0.25 to 0.5 for metric data sets. Depending on the outcome and the desired result, the Z tolerance can be varied up or down.

Max. Tile Points - specifies that a tile will not be subdivided if it has less than this number of points. Typically this is set to five.

Point Clouds Surface	
Accept	
Filters	
Filter Option	Tolerances
Tile Filter	Z Tolerance: 1.000
Tin Filter	O Coarse
No Filter	◎ Fine
	V Reinsert Points
Point Features Before Filter:	3261629
Point Features After Filter:	137210
Reduction %:	95.7932064008506
Filter	

Max. Tile Divisions - the allowable level of recursion allowed and is the number of time the initial tiling set can be subdivided. Typically this is set to five.

Start Tile Length – The LIDAR data set is initially divided into tiles of this size, prior to recursion to the minimum tile points. The setting of this parameter requires some knowledge of the distance between the LIDAR points, which requires an inspection of the LIDAR points in MicroStation to determine. Typically set this to 10 times the distance between the LIDAR points.

Course Filter (TIN option only) - Filter more points with some blurring of ridges and valleys

Fine Filter (TIN option only) - Filters fewer points with less blurring of ridges and valleys Points

Before Filter/Points After Filter/Reduction % - Display of the number of points before and after filtering, plus the percentage reduction of points from before and after.

4.2.2 BENTLEY SUGGESTED SETTINGS FOR POD FILE IMPORT

In the Create Terrain From Point Cloud dialogue box

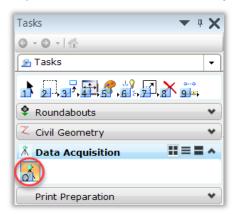
- Always use the "Tin Filter".
- Input the "Z" Tolerance.
- Always use the "Coarse" option.
- Always use "Reinsert Points" option.

Point Clouds Surface		×	Point Clouds Surface		-X
Accept Filters Filter Option Tile Filter Tin Filter No Filter	Tolerances Z Tolerance: .5 Coarse Fine Reinsert Points		Accept Filters Filter Option Tile Filter Tile Filter Tin Filter No Filter	Tolerances Z Tolerance: 1.000 Coarse Fine Reinsert Points	
Point Features Before Filter: Point Features After Filter: Reduction %: Filter	332002		Point Features Before Filter: Point Features After Filter: Reduction %: Filter		

Section 5 InRoads Surface Tools

5.1 Using Data Acquisition

1. Select the point cloud in the point cloud window. In the Tasks toolbar in MicroStation go to *Data Acquisition* and click the **Data Acquisition** tool.



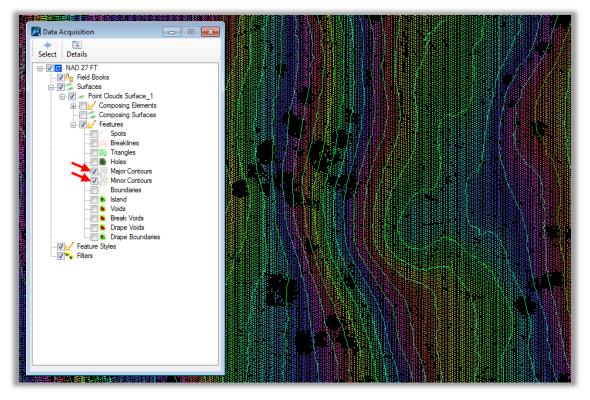
2. The Data Acquisition toolbox should appear, right click on the surface fields and select *Create Surface... > Import from Point Clouds*.

M Data Acquisition	
+ E Select Details	
Feature Create Surface >	Empty Surface
Filters	From Field Book
	From Field Book Selection Set
	Import External Surface 🛛 🗾 🕨
	Import From Point Clouds

 The Point Clouds Surface box will appear. If you did your reduction in the Point Clouds dialog box select *No Filter* and click Accept. If you still need to do a reduction select the desired Filter Option, *Tile Fitler* or *Tin Filter* and enter in the tolerances. Select the Filter botton to test the reducion, when you are happy with the results click Accept.

Point Clouds Surface		—
Accept Filters		
Filter Option	Tolerances	
Tile Filter	Z Tolerance:	0.2
Tin Filter	Max. Tile Points:	5
No Filter	Max. Tile Divisions:	1
	Start Tile Length:	10.000
Point Features Before Filter:	3261629	
Point Features After Filter:	1646537	
Reduction %:	49.5179555982609	
Filter		

4. In the Data Acquisition box browse to your *newly created surface > Features*, expand the list check the *Major Contours* and *Minor Contours*. Spot check the countours againist the point cloud.



5.2 Creating an InRoads DTM

5. Right click the point cloud surface and go to *Export to... > InRoads DTM*.

📕 Data Acquisition	- • ×	C	
↔ (Ξ Select Details		2	
NAD 27 FT NAD 27 FT Field Books Surfaces Point Clouds Sur	tron 1		
Composing Composing Composing Composing Features Feature Styles Filters	Create Graphics Vertical Exaggeration Clip by Polygon Append External Surface Merge External Surface		
	Export to		GEOPAK TIN
	Delete		InRoads DTM 🦰
			MX modelfile
			LandXML
			DTED file 🕨 🕨

6. A Save As dialog will appear, **Save** the DTM.

Organize Vew folder						1
Data (D:) GGS CSurveys (DOT-SDCENG01V) (F:) GGS Data (L:) Intersection Magic (M:) CTDOT/Workspace8 (\\DOT-SDCENG01V) (P:) GGS HWYS (DOT-SDCENG01V) (P:) Traeng (\\DOT-SDCENG01V) (Q:) GGS HWYS (DOT-SDCENG01V) (Q:) Traung (\\DOT-SDCENG01V) (Q:) CGS Traend Files (S:) TRU Maps (T:) E NG Workspaces - DOT-SDCENG07V (W:)	•	Name Completed_Mainline.dtm Completed_Superelevation.dtm Trinal_dtm Final_dtm Mainline.dtm Conford_surface.dtm Superelevation.dtm	Date modified 1/31/2011 11:51 A 1/31/2011 11:51 A 5/4/2016 5:16 PM 5/3/2016 5:16 PM 1/5/2018 12:40 PM 1/31/2018 10:14 A 5/3/2016 12:38 PM	DTM File DTM File DTM File DTM File	Size 260 KB 93 KB 286 KB 1,929 KB 1,514 KB 1,514 KB 1,2804 KB 1,884 KB	
CTDOT_Projects (DOT-SDCENG07V) (X:) Network File name: oxford surface.dtm Save as type: InRoads DTM file (*.dtm)	11 T					

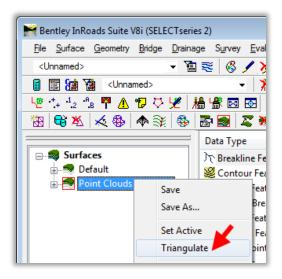
7. Before moving to the next step, exit MicroStation completely to clear the memory on the computer.

5.3 Displaying InRoads DTM Graphics

1. Open MicroStation through accounting and open and/or create a new design file, using one of the seed files below.

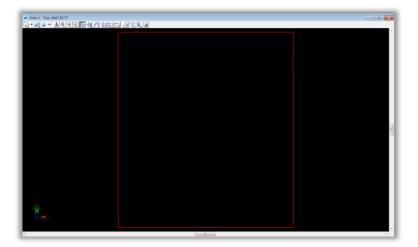
W:\Workspace\Standards\seed\CT_Design_3D_V8i.dgn W:\Workspace\Standards\seed\CT_Design_3D_V8i.dgn

- 2. Activate InRoads Suite.
- 3. Open the DTM that was created. Right click on the surface and select *Triangulate*.

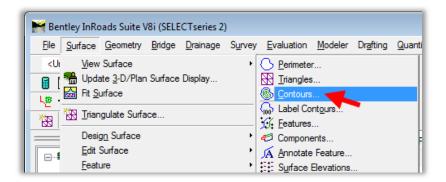


4. On the InRoads dialog box go to Surface > View Surface > Perimeter. On the View Perimeter dialog box load the Survey Preference, select the LiDAR surface and click Apply. Fit View and the perimeter will appear in your MicroStation view window.

Bentley InRoads Suite V8i (SELECTseries 2)		View Perimeter	x
File Surface Geometry Bridge Drainage Surve	y <u>E</u> valuation <u>M</u> odeler Dr <u>a</u> fting <u>Q</u> uant	Surface: Point Clouds Surface 👻	Apply
<u< td=""> View Surface Image: Constraint of the stress of the stress</u<>		Symbology:	Close Preferences Help
Desi <u>gn</u> Surface ► Edit Surface ►	D: Features Image: Components Annotate Feature Image: Surface Elevations	Object Name Perimeter	BYL



5. To view contours, navigate to *Surface > View Surface > Contours*.



 On the View Contours dialog box click the Preferences... button. Select the Survey preference and click Load, then click Close. Before displaying the contours settings consider making adjustments to the display settings.

Kiew Contours				
Main Advanced	Labels			
Surface:	Point Cl	ouds Surface	▼ H	elp
Fence Mode:	Ignore		-	
Interval:	1.000			
Minors per Major:	4		-	
Symbology:				
Object		Name		
Major Contours		INDCON		BYL
Minor Contours		INTCON		BYL
Major Labels		INDCON		BYL
Minor Labels		Default		BYL
Major Depressio	n Co	Default		BYL
Minor Depressio	Minor Depression Co			BYL
Apply Preferences Close				

- If you have a very large DTM you may need to adjust the contour settings to be able to veiw the contours. Click through each tab on the View Contours dialog box and adjust as needed. Adjusting one or many settings will help speed up the display and minimize crashing. Main Tab
 - Increase the the contour internal and decrease the Minors per Major
 - Turn off the Label display

Advanced

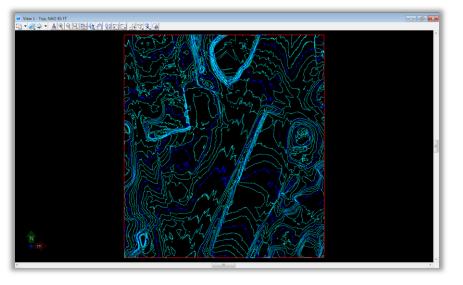
• Turn off Smoth

Labels

- Increase the text label spacing
- uncheck the clipping box for labels

🖬 View Contours	View Contours	View Contours
Main Advanced Labels	Main Advanced Labels	Main Advanced Labels
Surface: Point Clouds Surface Help	Display As: Linestring	Help
Fence Mode:	Elevation	Major Labels
Interval: 1.000	High 754.327	Precision:
Minors per Major: 4	Low 306.728	Orientation: Automatic Suffix:
Symbology:	Thin Tolerance: 286~28'44.0"	Spacing: 10
Object Name	Minimum Area: 0.00	Minor Labels
Major Contours INDCON BYL	Clip Minor Contours on Steep Slopes	Precision: 0 Prefix:
Minor Contours INTCON BYL	Maximum Slope: 100.00%	Orientation: Automatic - Suffix:
Major Labels INDCON BYL	Draw Depressions Counterclockwise	Spacing: 20
May Depression Co Default BYL	Smooth	
Minor Depression Co Default BYL	Attach Tag	Clipping
Apply Preferences Close	Apply Preferences Close	Apply Preferences Close

6. Select the desired suface settings and click Apply. The contours will apear in your window.



Section 6 Appendix

6.1 More about Point Clouds

A point cloud is a data file which can include a large number of points on the surface of an object. A point cloud is a set of vertices in a 3D coordinate system and these vertices are defined the by X, Y and Z coordinates. Point clouds are usually created by 3D scanners. These devices measure a large number of points on the surface of an object and output a point cloud as a data file (*.POD). The point cloud represents the visible surface of the object that has been scanned or digitized. Point clouds are used for many purposes, especially to confirm measurements between the DGN model and the real world.

Point Clouds (4 of 4 listed)						• X	
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File Name	Description	4	ھ	ł	Ĵ		٦
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CT_5ft_0410720544_3.pod		100	\checkmark	\checkmark	\checkmark		
CT_5ft_0410720544_5.pod		100	\checkmark	\checkmark	\checkmark		
CT_5ft_0410720544_6.pod		100	\checkmark	\checkmark	\checkmark		
12345678 2 1	L						

The Point Clouds tools allow you to import, control, visualize and manipulate point cloud images. You can import a point cloud into a DGN and use it as a visual reference. The Point Cloud dialog (File > Point Clouds), along with the Point Cloud toolbox (Tools > Point Cloud), lets you control all aspects of attaching and manipulating point cloud image files. A point cloud is treated as any standard element and can be part of a model or level. MicroStation Point Clouds are POD files, this format allows you to work with huge point clouds with great performance.

You can open multiple point cloud files simultaneously. Also, you can batch convert multiple point clouds files either to one POD file, convert the data to ASCII format or create a terrain model.



6.2 When and Why Should Points be Reduced

MicroStation can handle displaying very large Point Clouds POD files but InRoads SS2 cannot necessarily handle this amount of data. The 2016 LiDAR has points very close together. You may experience issues when trying to create an InRoads SS2 Surface from the POD files as the DTM cannot handle the same amount of data points as a point cloud. When creating a surface from the LiDAR data a triangle is created to every point. For large data sets you may need to reduce the points in order to create the needed surfaces.

When creating surfaces from point cloud data it is important to answer the following questions:

- What is the data being used for?
- How large of an area will be used?
- Is the area very flat, or very hilly?

How you answer these questions will affect how the data is manipulated. What the data is being used for is the most important of these questions, because it is directly affected by the level of detail in the data. If the LiDAR is being used as a starting place to determine sightlines, or large drainage calculations such as time of concentration, a less detailed surface is probably fine. If the surface is being used to figure out drainage issues on a small scale such as catch basin placement, the LiDAR surface may need to be fairly detailed. The size of the area is also important, for example, a very large area will need to have the number of points reduced to be able to create a DTM, however if the area is very flat, reducing the number of points too much could cause the contours to not show up properly or not be clearly representative of the area. In this case the area would need to be broken up and have multiple DTMs made to keep the level of detail of the surface, while keeping the file size manageable. A large hilly area may not be as affected by a reduction of points because the contours can still be interpolated properly. **All data acquired through this process should only be used for preliminary designs**.

The example below shows an area with a drainage channel and how reducing the points can cause the resulting contours to become somewhat misleading if not looked at carefully.



Figure 1 - Image of the Drainage channel



Figure 2 - Overlay of Survey Data on drainage channel

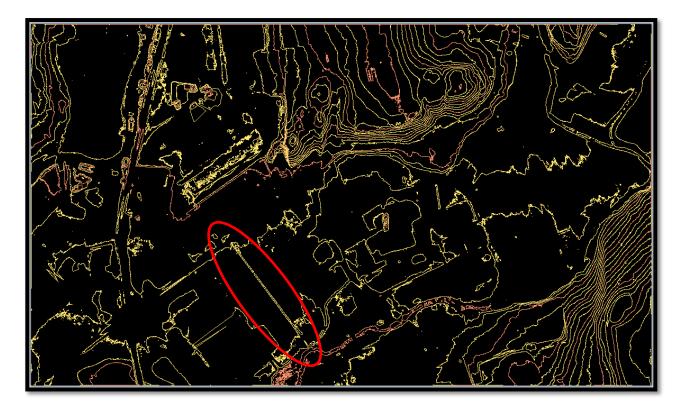


Figure 3 - Contours from surface with no reduction in points - channel is distinguishable

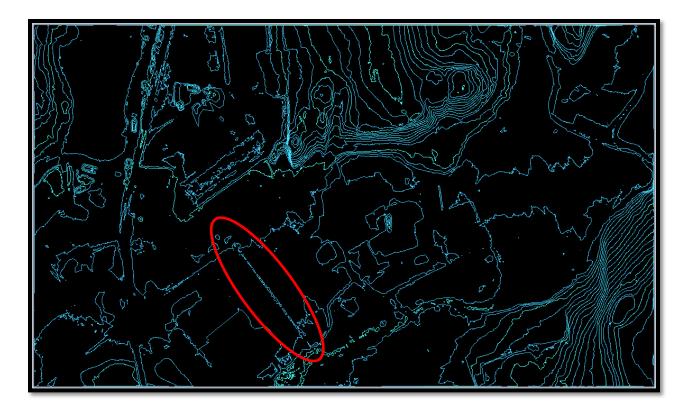


Figure 4 - Contours from surface with 90% reduction in points - channel is still distinguishable



Figure 5 - Contours from surface with 99% Reduction in points - channel is not distinguishable

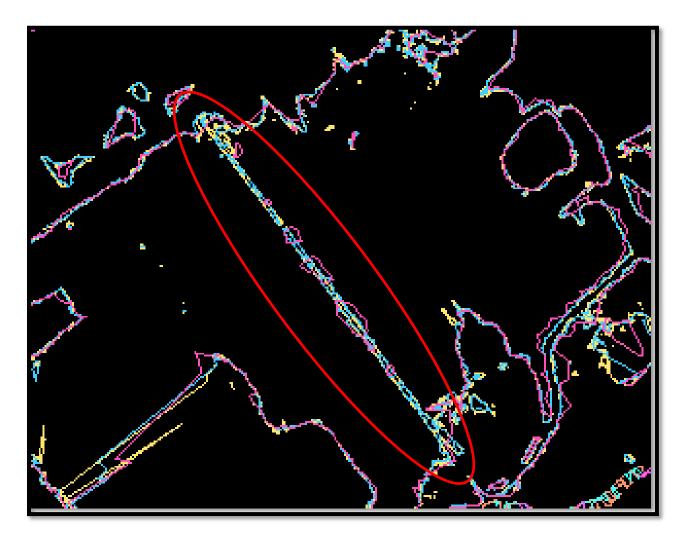


Figure 6 - Zoomed in section with all contours overlaid on one another.

The opposite can also be true; sometimes too many points can be detrimental. The example below shows a section of Bradley Airport, the first surface is not reduced, the second surface is reduced by 99%. Too many points in this case, makes the slight dips in this very flat area appear to be craters in the surface when just looking at the contours. The second surface is more useful in this instance by getting rid of the extraneous points that give the impression of high and low points.

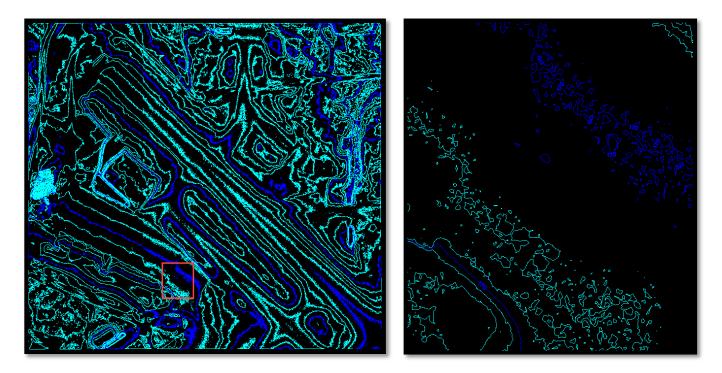


Figure 7 - Unreduced Surface with Zoom in of Contours

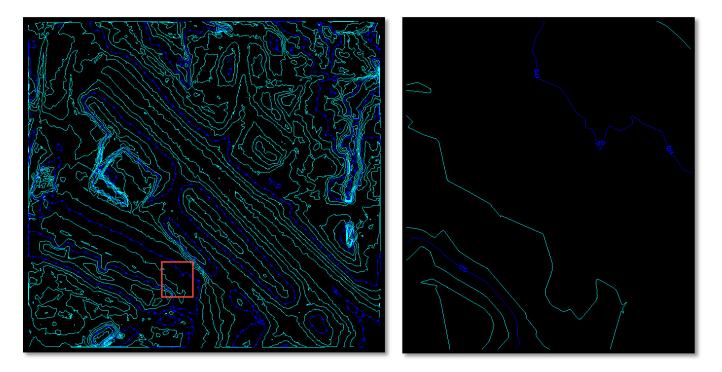


Figure 8 - Surface with Points Reduced 99% with Zoom in of Contours