



**Ohio Department of Transportation**

# GEOPAK V8i LiDAR Tools User Guide

## Using OSIP LiDAR Data in GEOPAK

**10/19/2012**

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### Introduction

This training guide will outline the procedures to create a TIN model from LAS data using a combination of GEOPAK tools and ODOT VBAs to apply a scale factor if required. The reason that the data may need to be scaled is a grid to ground issue. The OSIP LiDAR data was obtained on the grid, and if the user is attempting to line up the LiDAR data with an existing ground survey done on the ground, they will not line up without applying a scale factor. If the user is not concerned with the data lining up with an existing ground survey, i.e. getting drainage areas etc, then translating the data is not necessary. Scaling will not be required if the traditional ground survey was collected on the grid.

The LAS files that have been delivered as part of the OSIP program are binary LiDAR data files that contain quite a lot of information in them. The only information needed to generate a TIN model, is the point class and the X,Y, and Z values for each data point. For those that have not dealt with OSIP LAS data, below is a summary of the 3 classes of data that are contained in each OSIP LAS tile. Each tile measures 5,000 ft x 5,000 ft for those collected at 1ft resolution, and 2,500 ft x 2,500 ft for those collected at 6 in resolution.

Every OSIP LAS tile contains three classes of points as described below:

- “Ground” – This class represents the bare earth ground surface (*This is the class that will be used to generate an existing ground TIN model.*)
- “High Vegetation” – This class represents tall vegetation such as trees and large shrubbery along streams, etc. (*These points do not belong in an existing ground TIN model.*)
- “Default” – This class represents such things as building roofs, cars, bridge decks etc. (*These points do not belong in an existing ground TIN model.*)

In addition, this guide explains how to scale an OSIP SID image as well if required. These images can prove very useful to use in conjunction with the TIN.

*\*Note:*

If you have any questions, suggestions, or problems regarding this User Guide, please go to the following web page:

<http://www.dot.state.oh.us/Divisions/Engineering/CADDMapping/CADD/Pages/suggestions.aspx>

## Procedure Overview

- Determine project location
- Determine what LAS tile(s) encompasses the project limits
- Use GEOPAK to convert the LAS tile(s) to ASCII XYZ file(s)
- Determine if the final TIN model will need to be accurately located on the State Plane Coordinate System
  - If so a scale factor may be required. This scale factor is either provided by the surveyor or calculated, and then applied to the X and Y values of the ASCII XYZ file.
    - Determine the scale factor using GEOPAK or value provided by surveyor
    - Apply the scale factor using the ODOT VBA (ODOT\_XYZScale)
  - If not, then the ASCII XYZ file can be used as is, unscaled
- If multiple unscaled tiles are required to create the tin, an ODOT VBA (ODOT\_XYZMerge) will merge the XYZ files.
- Use the Build TIN tool from the LiDAR XYZ Tools to generate the final TIN.

## Determine Project Location and Tile(s) Needed

The first step in using the OSIP LiDAR data is to determine the location where the user wants to create a TIN model.

A DGN file has been created for users to locate the project area, and determine which tile(s) are needed to cover the project area. Below is a screen capture of what the dgn file looks like. The tile number and coverage area is shown as red squares, with the tile name in the center.



The DGN file (OSIP\_Tile\_Locations.dgn) can be downloaded from the internal CADD SharePoint Site under the “GEOPAK Shared Documents” section at the following link:

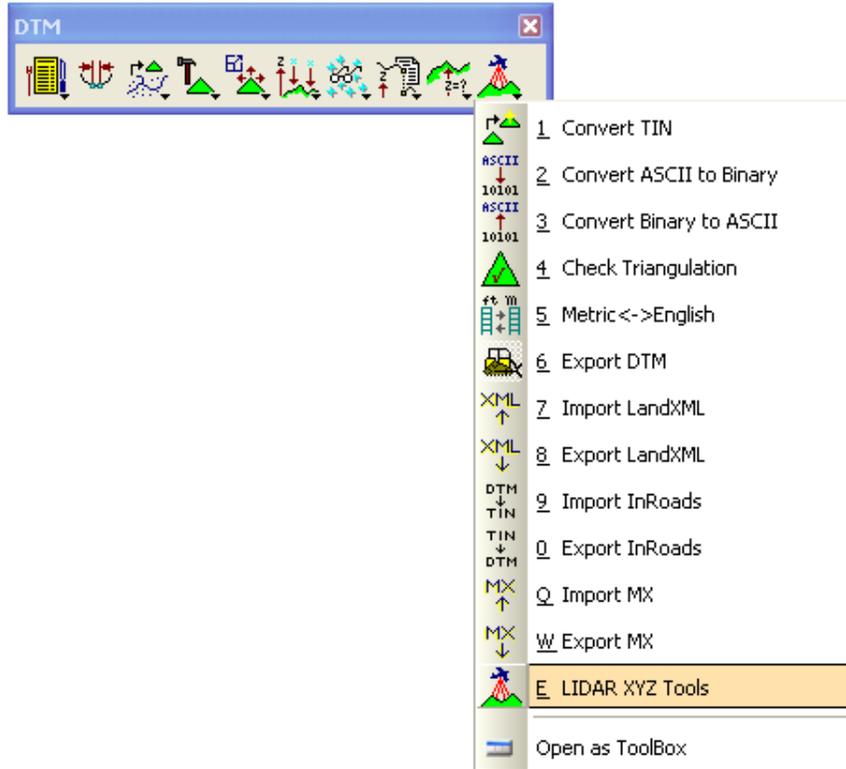
[http://www.dot.state.oh.us/Divisions/Engineering/CADDMapping/CADD/GEOPAK%20Downloads/OSIP\\_Tile\\_Locations.dgn](http://www.dot.state.oh.us/Divisions/Engineering/CADDMapping/CADD/GEOPAK%20Downloads/OSIP_Tile_Locations.dgn)



The second method is to click and hold the *Utilities* fly out button on the *DTM Toolbox*



Select the *LIDAR XYZ Tools* at the bottom of the fly out



Once the user has determined what tile(s) will be needed, each one needs to be converted from an LAS file to an ASCII XYZ file using the *LIDAR XYZ Tools*. This is done in two steps for each individual LAS file;

1. Use the **Convert LAS to Binary** tool in GEOPAK to convert LAS file(s) to Binary XYZ file(s).
2. Use the **Convert XYZ – ASCII/Binary** tool in GEOPAK to convert Binary XYZ file(s) to ASCII XYZ file(s).

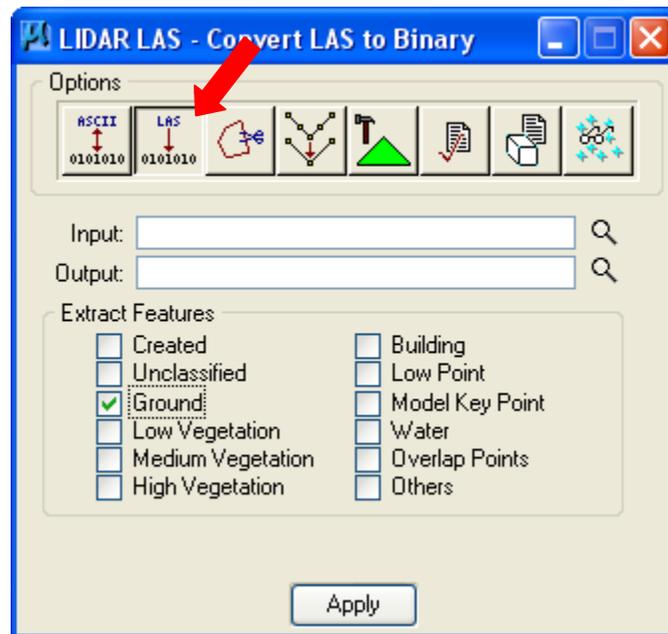
The output files generated in these steps, and in all subsequent steps, are to be saved in the project directory. The two steps to generate an ASCII XYZ file are shown below.

### Convert LAS to Binary Tool

The second button is the **Convert LAS to Binary** tool. To use this tool the user selects an LAS file as the input, and defines the Binary XYZ file to be created in the project directory as the output.

This tool reads the LAS file, which is not useable outside of this particular tool, and converts it to a Binary XYZ file. This tool is used to convert each LAS file to a Binary XYZ file, one at a time. The tool does not support the conversion of multiple LAS files.

Checking the **Ground** field will only extract the “Ground” feature class from the LAS file, which is the only one to be used when creating an existing ground TIN model. If no selection is checked prior to clicking **Apply**, the process will appear to run very quickly and complete with no error, however no XYZ file will be output to the defined directory.

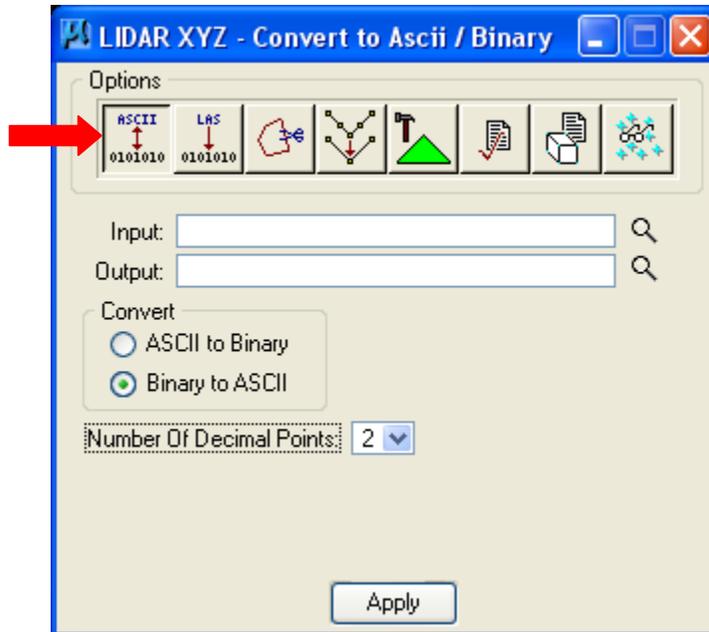


*\*Note: Depending on how many LAS tiles are needed to cover the project area, naming of the output files can get confusing. It is recommended that the user give careful thought when choosing file names for this tool and all subsequent tools. For example there is no difference in the file extension between an ASCII and Binary XYZ file, so the user may want to define this difference when choosing a name, (i.e. include “ASCII” or “Binary” in the file name). It is also a good idea to keep the tile name in the file name as well. (For example; N1985490\_Binary.xyz)*

### Convert XYZ – ASCII/Binary Tool

This tool reads a Binary XYZ file, and converts it to an ASCII XYZ file. For the purposes of this guide, this tool is used to convert each Binary XYZ file that was created in the **Convert LAS to Binary** tool previously. It can also be used to convert an ASCII XYZ file to a Binary file, which is not needed for the process outlined in this guide.

The first button is the **Convert XYZ – ASCII/Binary** tool. This tool is used to convert the previously created Binary XYZ file(s) as the input, and defines the ASCII XYZ file to be created in the project directory as the output. As in the last tool, each XYZ file must be converted one at a time, as the tool does not support the conversion of multiple XYZ files.



### Grid to Ground Scaling

One thing that many users have noticed when working with the OSIP LiDAR data, is that when a TIN is built and visualized on screen, it may not line up with a State Plane Coordinates basemap. The horizontal shift in location is a result of Grid to Ground coordinate differences. Ground surveys are generally done on the Ground, while the OSIP LiDAR data was obtained on the Grid. As a result of this difference, a scale factor needs to be applied to each LiDAR point to properly locate the final resulting TIN model on the State Plane Coordinate System, i.e. the Ground.

*\*Note: In order for the scaling process detailed following to work properly, the existing ground survey that the user is attempting to align the LiDAR data with, MUST have been surveyed and placed using State Plane Coordinates. If an assumed coordinate system was used, this process WILL NOT work.*

As mentioned in the introduction, there will be times that the user wants to have the TIN model located properly horizontally on an existing ground survey. There will also be times that the user is not concerned with the location of the TIN model, such as if they only need to obtain drainage areas, or observe general drainage patterns that do not have to be accurately aligned with a basemap.

For the times that the user does not need the TIN accurately located, the TIN model can be built directly without any sort of horizontal translation. For projects where the user does want to horizontally translate the TIN to line up with a specific project, a series of steps will have to be performed on the data in order to do so. The following details the procedure to horizontally translate the data into its proper location.

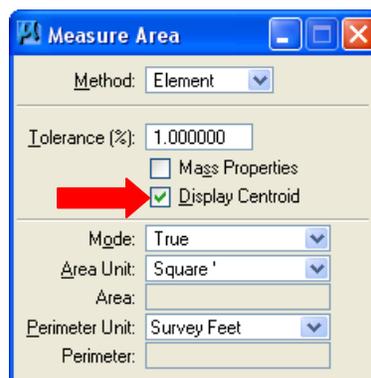
### Obtaining the Scale Factor

A scale factor is required to translate the LiDAR data into its correct position. This scale factor can be obtained one of two ways; either provided by the surveyor of the ground survey or obtained using the following process in GEOPAK.

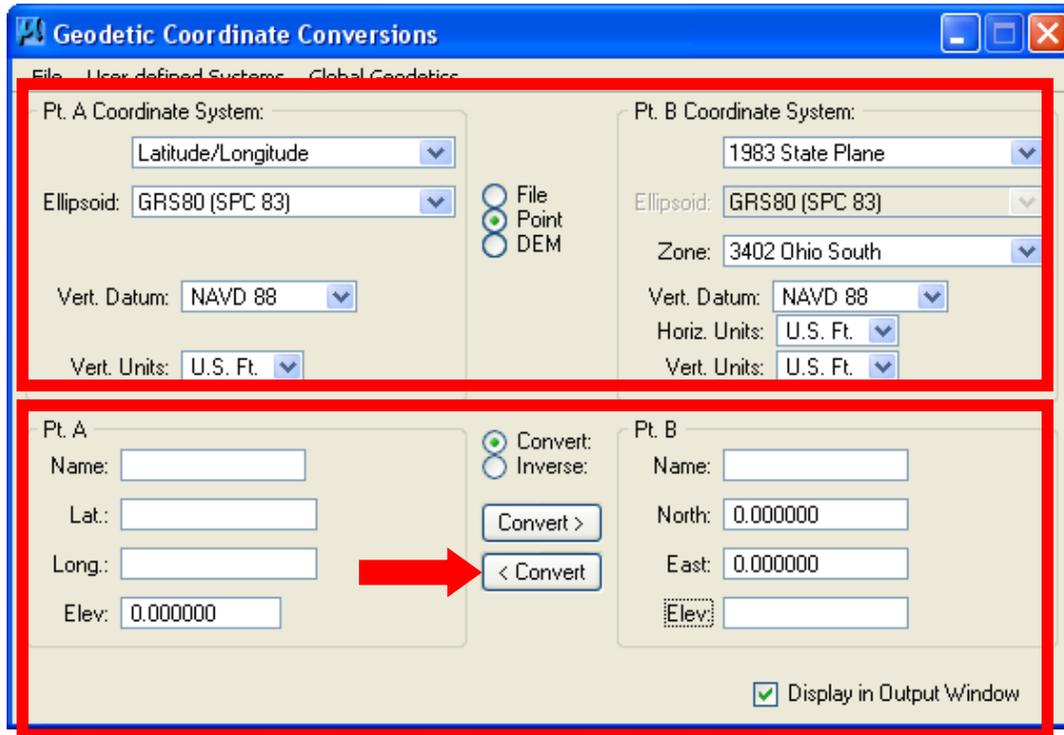
In GEOPAK Survey V8i, Bentley has incorporated new tools to better enable the user to switch and convert coordinate systems. However at the present time, the tool needed to obtain the scale factor is not functioning properly in V8i yet, and Bentley is aware of this. As a workaround the user is able to load a GEOPAK XM MDL while in GEOPAK V8i. This MDL is the tool that will be used to obtain the scale factor, if it is not provided by the surveyor.

The basic procedure is as follows;

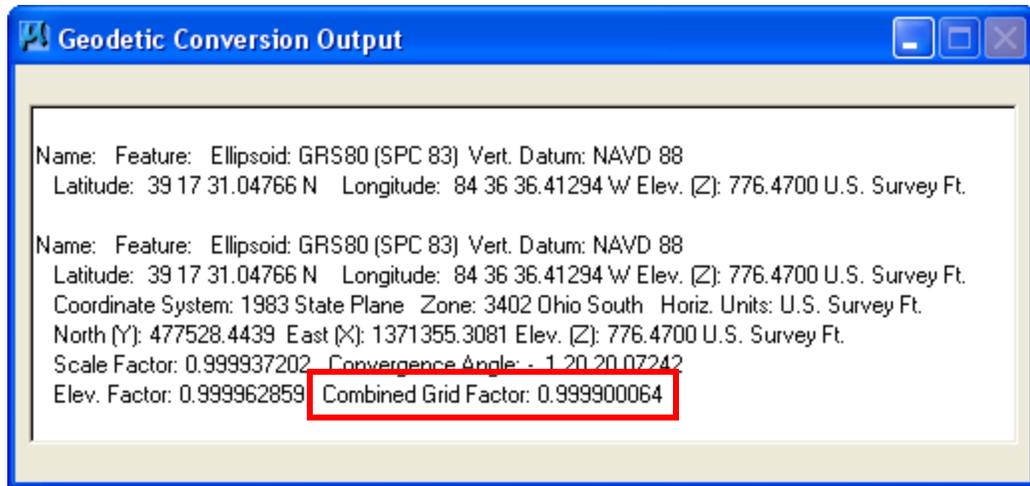
- Draw a closed shape that accurately and completely encloses every aspect of the project area. (Most times the survey Tin Hull, if available, will serve as this shape very well)
- Use MicroStation to locate the centroid of the project area shape.
  - Once the closed shape enclosing the project area has been created, use the MicroStation tool **Measure Area** with “Display Centroid” toggled on. This will place a transient element at the centroid of the shape. The transient element is snappable, but not editable in any other way. Once the DGN file is closed the element will be deleted from the file.



- Use the XM MDL in V8i, to obtain the Combined Grid Factor for the project area based on the centroid.
  - Load the following MDL *C:\Program Files\Bentley\geopak\V8.11\bin\geod.ma* by clicking **Utilities>MDL Applications** (*GEOPAK Must be activated*)
  - Once the MDL loads, configure the “Pt A Coordinate System” and “ Pt B Coordinate System” portions of the dialogue box as follows.....



- Toggle on “Point” in the upper portion of the dialogue box.
- Toggle on “Convert” in the lower portion of the dialogue box.
- Fill in the “North, East, and Elev” values (The elevation field can be left blank if the elevation is not available. The conversion will still work.) on the right for “Pt B” with the data for the centroid of the project area. The “Name” field can be left blank. Populate the “North” and “East” values with the X and Y coordinates of the centroid obtained from MicroStation AccuDraw. Toggle on “Display in Output Window” as well.
- Clicking on the lower “< Convert” button will convert the values input for “Pt B” to the new values for “Pt A” on the left. A new text box will appear with the conversion output data. This box contains the Combined Grid Factor, as shown below.

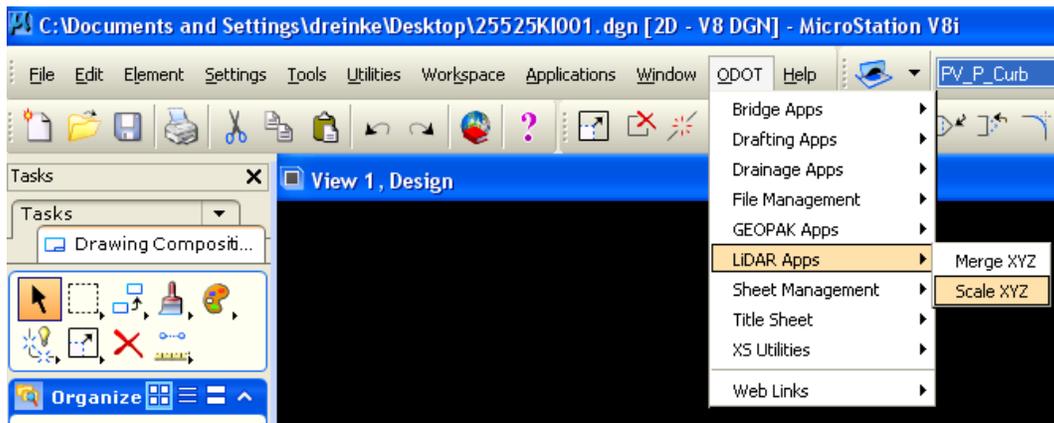


- Taking the inverse of the Combined Grid Factor will result in the final scale factor to be applied to each LiDAR point's X and Y values, which will properly locate the LiDAR data horizontally. This final scale factor will be applied using a custom ODOT VBA in MicroStation.

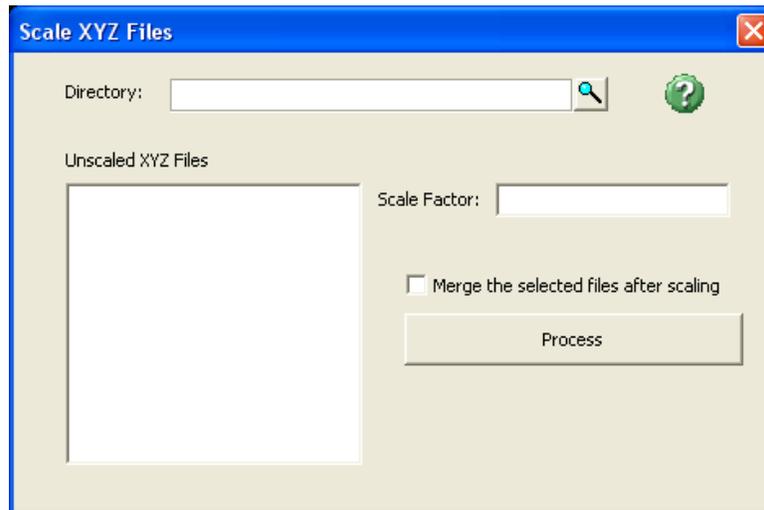
### Using the ODOT VBA (ODOT\_XYZScale) to Apply Scale Factor

As mentioned previously, taking the inverse of the Combined Grid Factor will yield the final scale factor to be applied to the LiDAR data (X, Y, and Z values) to properly locate the surface on the ground survey.

To open the Scaling application, use the ODOT pulldown as shown below.



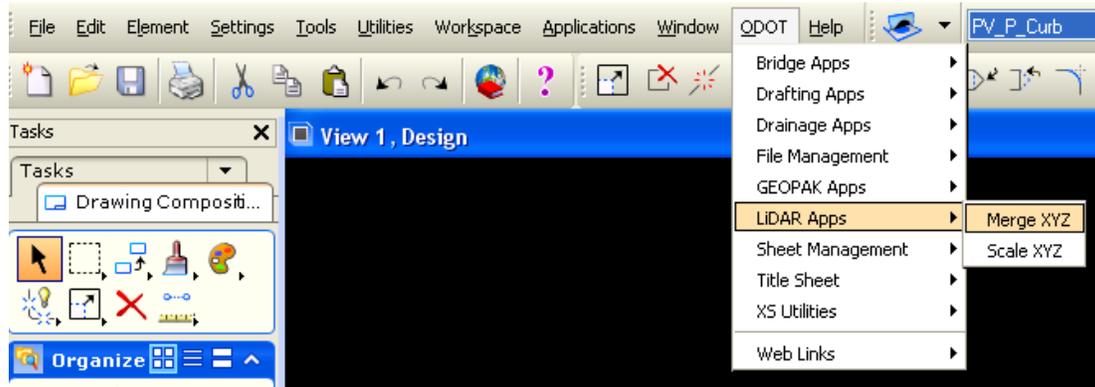
The scaling application will open as shown below. The green “?” button will open the help document, which describes in detail how the application operates.



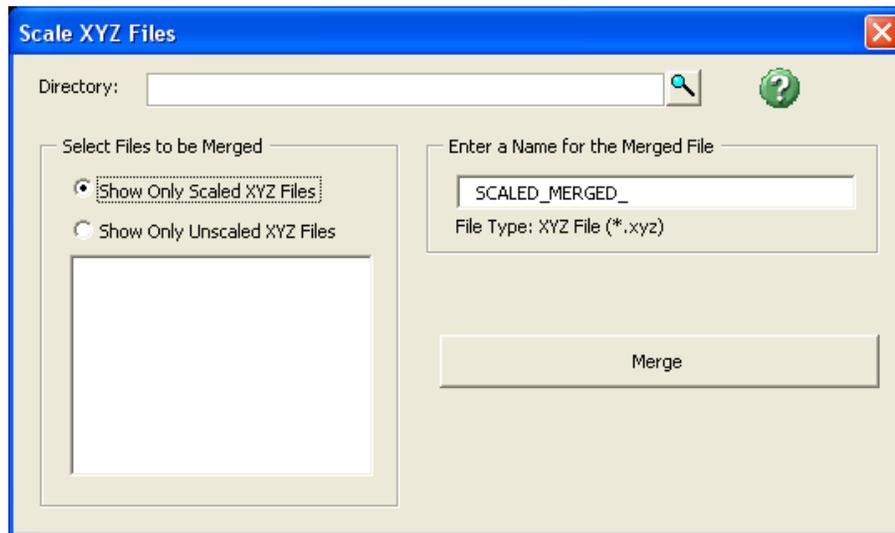
The basic function of this tool is to scale a single XYZ file, or multiple files, and save a new scaled XYZ file. If you are scaling multiple XYZ files the user has the option to merge the files into one scaled XYZ file. If the file(s) are only scaled, the original file names will be retained with “SCALED” prepended to the file(s) name(s), and saved in the same directory as the file(s) being scaled. If the files are to be scaled and merged, the user will be prompted to specify a new file name with “SCALED\_MERGED” prepended to the files names, and saved in the same directory as the files being scaled and merged.

**Merge Multiple Scaled or Unscaled XYZ Files**

An ODOT VBA was created to merge multiple XYZ files into one XYZ file for use in creating a TIN file from multiple tiles of LiDAR data. The name of the VBA is ODOT\_XYZMerge, and can be accessed from the ODOT pulldown as shown below.



The merge application will open as shown below. The green “?” button will open the help document, which describes in detail how the application operates.



The basic function of this tool is to merge multiple scaled or unscaled XYZ files, and save a new merged XYZ file. The user must first define the directory where the unmerged XYZ files reside. Next choose to show either the scaled or unscaled XYZ files only. The scaled files are recognized by the file name prefix “Scaled”, and the unscaled files are recognized by the file name prefix “Unscaled”. Next the XYZ files to be merged should be selected. The “Ctrl” or “Shift” keys can be used to select multiple XYZ files. Next a file name needs to be defined. Finally the Merge button will commence the process of merging the files. The merged file will be saved in the same directory as the source files.

### Build TIN from the LiDAR XYZ Tools

The final step in creating a TIN model is using the **Build Triangles** tool to create a TIN from the previously generated DAT file. There are two different methods of building a TIN based on what data you have available. One method uses a DAT file as the source data, the other uses an XYZ file as the source data.

We will first discuss the **Build Triangles** method using a DAT file as the source data.

The **Build Triangles** tool can be accessed two different ways. The first is to click on the **Menu Bar** button on the **DTM Toolbox**

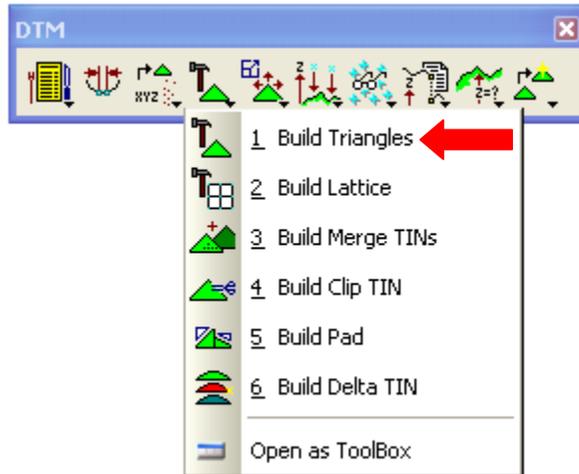


The **DTM Menu** tool bar will open up; click **Build>Triangles**

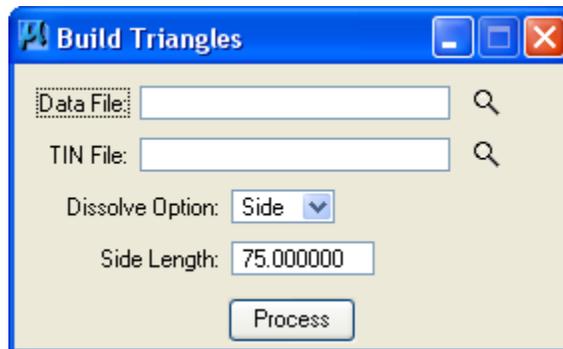
The second is to click and hold the **Build** fly out button on the **DTM Toolbox**



Select the **Build Triangles** at the top of the fly out



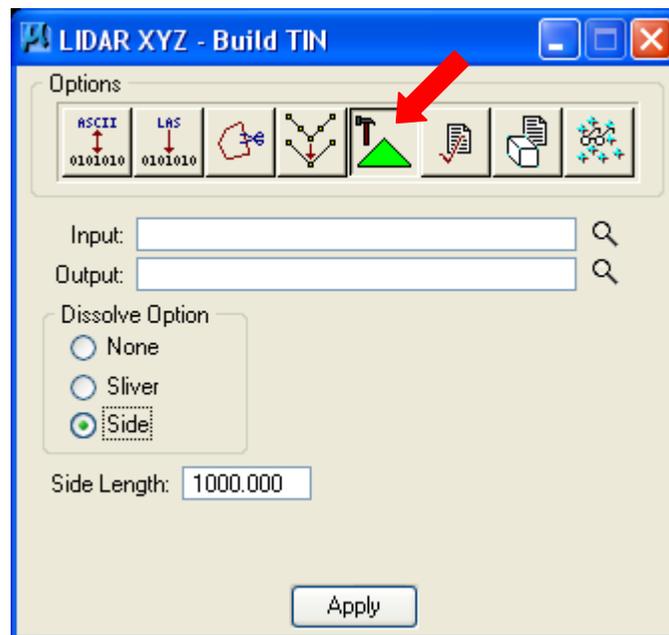
- The Build Triangles tool is a fairly straightforward tool. Choose the final DAT file as the “Data File” and then define the “TIN File” to be created. The “Dissolve Option” is up to the user to choose the option that works best for the situation. Since the tiles are square in shape, the “Dissolve Option” really won’t affect the TIN model much, except for at the extreme edges.



- Click “Process” to build TIN.

Next we will discuss the **Build TIN** method using an XYZ file as the source data.

The Build TIN tool can be accessed via the LiDAR XYZ Tools as shown below.



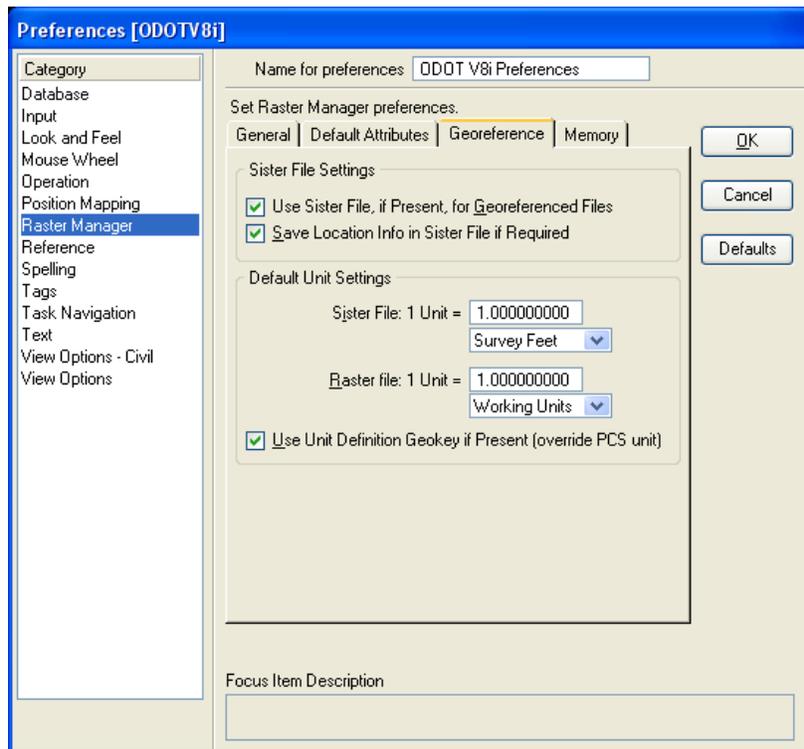
- The Build TIN tool works much the same as the previously described Build Triangles tool, with the only differences being an XYZ file needs to be defined as the input file, and clicking Apply rather than Process initiates the creation of the TIN file.

## Attach OSIP Imagery in MicroStation

When attaching OSIP Imagery files (SID format), it can be either attached directly with no scaling or the image can be scaled in order to align with scaled TIN data.

The OSIP imagery was delivered with accompanying sister files (SDW format) which are located in the same directory as the SID imagery. When attaching a SID image the sister file, which is used by MicroStation to properly locate the image based on the grid, should be applied. The settings for this are described below.

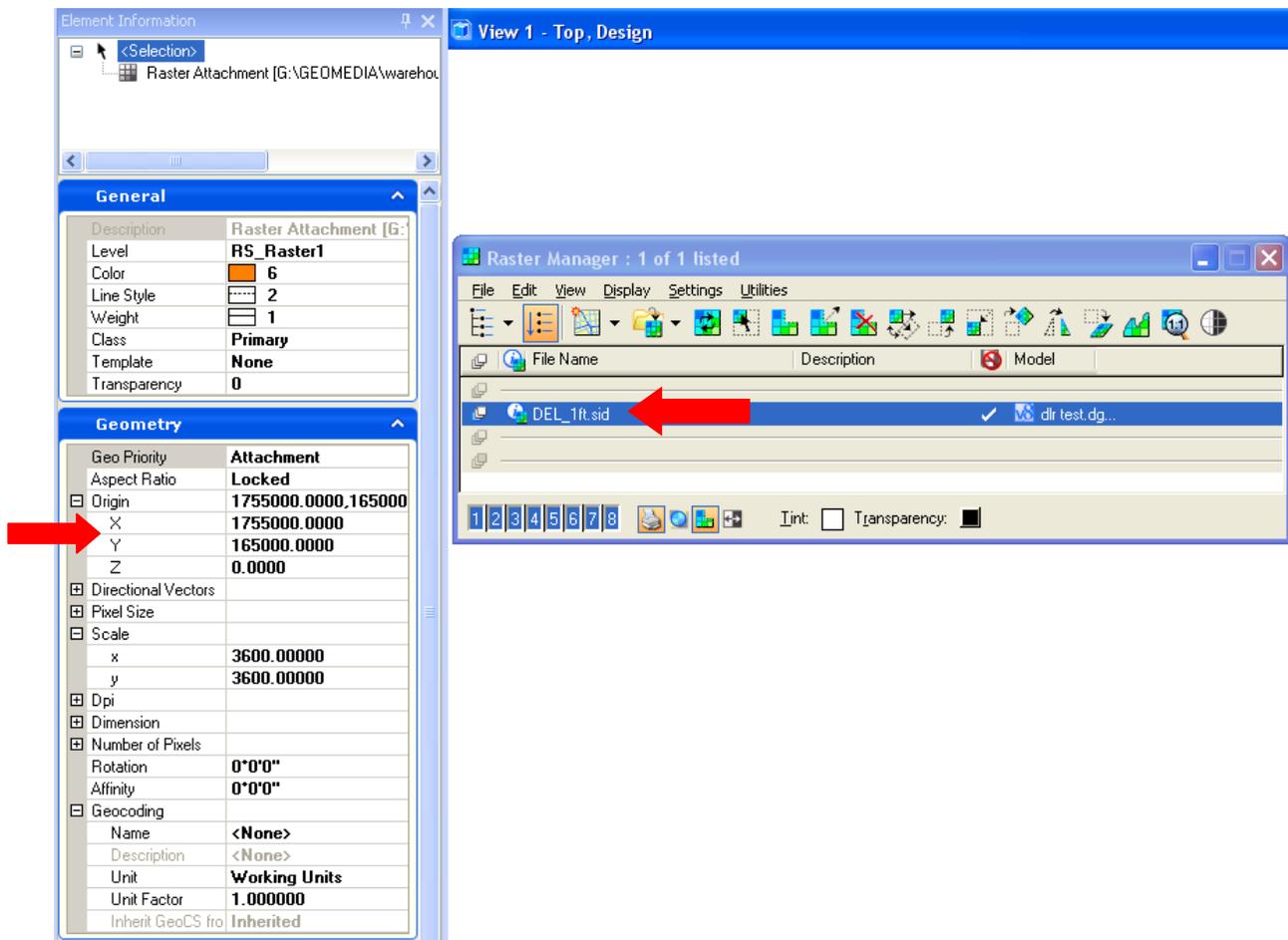
Make sure that the following preferences are set as shown below by accessing the Workspace Preferences from the pull downs **Workspace>Preferences**.



Should the image need to be scaled to appear in the correct ground location, the same scale factor that was used to build the TIN can be applied to the image origin in MicroStation.

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Double clicking the attached raster image from the “Raster Manager” will open the “Element Information” box as shown below.



To scale the image location, the X and Y origin values need to be multiplied by the scale factor. This will move the attached raster image to the proper location. The values that appear initially are populated automatically by the sister file which was used per the preferences set previously.