Creating Watershed Delineations and Digital Elevation Models For Five Water Supply WATERSHEDS FROM LiDAR Data In The Cape Breton Regional Municipality, Nova Scotia

Cape Breton Municipality Water Utilizes

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Course: Remote Sensing Term Project

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Overview

The organization/Municipality of whom this project was completed for is the Cape Breton Regional Municipality Water Utility. The project was to be completed using LiDAR data to update the water supply area watershed boundaries found within the Cape Breton Regional Municipality. The nature of this project was to update watershed boundaries, create Digital Elevation Models (DEM), and create watershed delineations for each watershed.

The following sections will walk you, the reader, through the process of importing XYZ data, exporting the XYZ data as Grid files (to make for opening the workspace files faster), exporting the Elevation models to a file of which ArcMap can read, the creation of watershed delineations. Exporting the watershed delineations as a shapefile to work within ArcMap, Filling holes within the data using the TerraScan software, and finally comparing the new water supply area watershed boundaries with the original boundaries.

Figure 1, seen below shows the location of the water supply area watersheds are location in Nova Scotia and more specifically, where they are located within Cape Breton Regional Municipality.

Figure 1: Key Map of Study Area

Importing XYZ into Global Mapper

The way that XYZ data was imported into Global Mapper for this project is what this section will be talking about first. The first step after opening Global Mapper is to click on File and then go to Open Data File(s). The first window that will pop up is where you select your XYZ files that you wish to bring into Global Mapper. Once you click open, the next window that pops up is where you can select the import options. For this project, the only thing that was changed was the Import Type and that was changed to Elevation Grid from 3D Point Data, and make sure to have the Use Selected Options for All ASCII Files check box checked before you hit the okay button. The following window that will pop up will be where you set the grid creation options. In the case of this project the Vertical Units were set to Meters, the Grid Method was changed to Binning (Minimum Value – DTM), and the Manually Specify the Grid Spacing to Use, One was used as the file units. Then the last thing to change before clicking the okay button is to move the slider bar all the way to Loose. Then once you click okay the loading process will begin, but another window will pop up and that window will ask you to set the Projection for the files being loaded. The setting for this window are the following; the projection was set to UTM, the Zone was set to 20 (66˚W -60˚W – Northern Hemisphere), the Datum was set to NAD83, the Planar Units and the Elevation Units were set to Meters. Finally, make sure the Use Selected Projection for all Selected Files check box is checked before clicking okay. Please note that not all the data is in zone 20, so when you go to import that data the zone needs to be changed from zone 20 to zone 21.

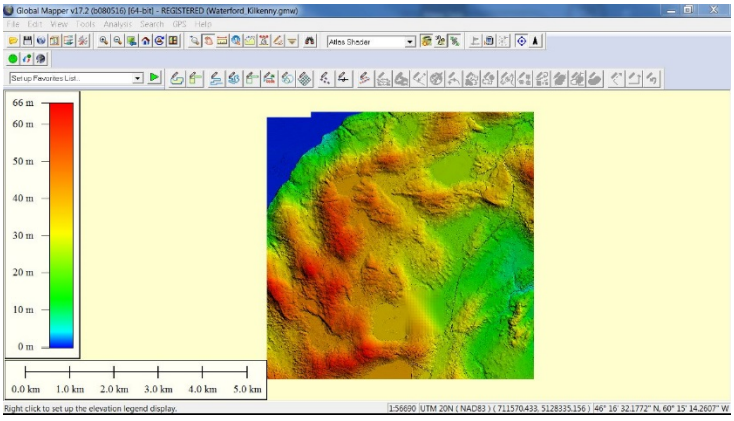


Figure 2: After importing XYZ Data

Figure 2, which you can see to the left, is showing Waterford and Kilkenny water supply area watersheds after the XYZ data has been loaded into Global Mapper using the above settings.

Exporting XYZ as Grid Files

This section is all about exporting the XYZ data files to Grid files. The main reason for converting the XYZ files to Grid files is to make the process of opening a Global Mapper workspace faster than using the XYZ data. Once you have completed the process of bringing in the XYZ data into Global Mapper (the pervious section), you can then being the process of Batch Converting your XYZ data.

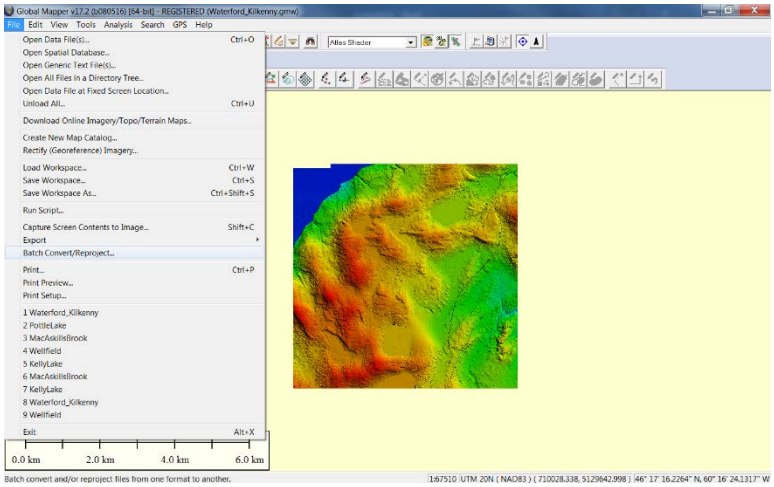


Figure 3: First Step in Converting XYZ Data to Grid Files

The way that the files are batch converted, you first select the Batch Convert/Reproject found under the File drop down menu. Figure three, seen below, shows you the reader what this first step looks like when using Global Mapper 17 (64-bit).

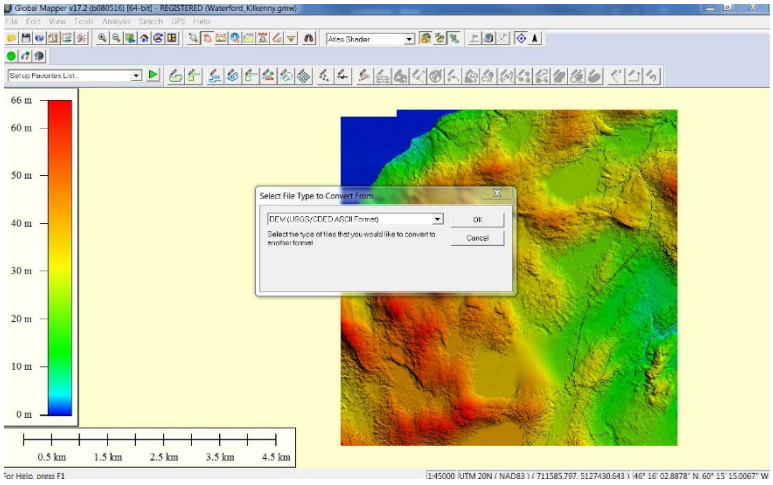


Figure 4: Select File Type to Convert From Window

The following window that appears will be asking you to select a file type to want to convert your data from; in this case, the file type that was selected was DEM (USGS/COED ASCII Format), an example of this window could be seen in Figure 4 to the right. Then once your file type has been selected, the next window that pops up is asking you to select the file type of which you wish to convert your data too.

The following window that will pop up will be a window similar to Figure 5 (see below). This window is the main Batch Convert window; this window is asking you to choose the XYZ data files you wish to convert. In this window, you will see Add Loaded Files button located at the bottom left hand corner of the window, by clicking this button it will automatically add all the files that have been loaded into the Global Mapper workspace to the Source Files window within the Batch Convert window. The next thing that was done within this window is select a destination for the converted files. For this project Specify, output directory was selected and then an output folder was chosen. Under the File Names section, Use Source file Name was chosen the name of the lake or brook was added to the end of each file name.

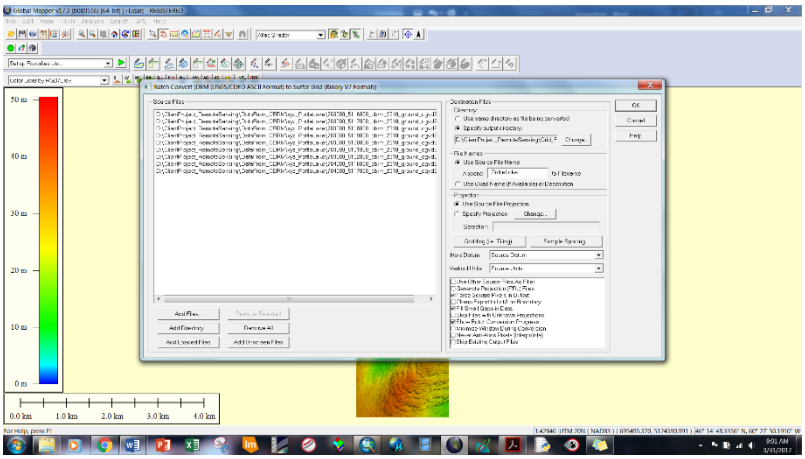


Figure 5: Main Batch Convert Window

The following two windows are similar to the process completed when first bringing in the XYZ data. Once you click the okay button within the Batch Convert window, the next window that will pop up will be the Generic ASCII Text File Import Options and you select the same settings as before: Elevation Grid from 3D Point Data and make sure that the Use Selected Options for All Files is selected.

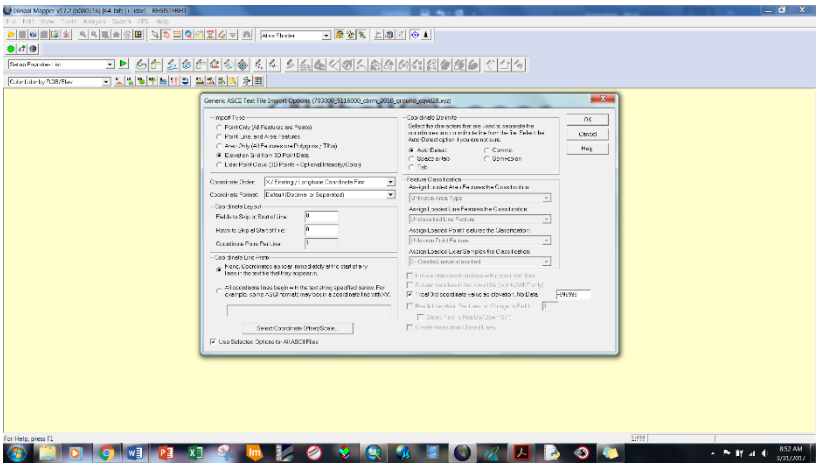


Figure 6: Import Options Window

The final window with this process is the Elevation Grid

Creation Options. Again, this window is the same as the very first process done for this project, along with the same parameters. The window looks something like this with all the correct parameters input, see Figure 7 (below).

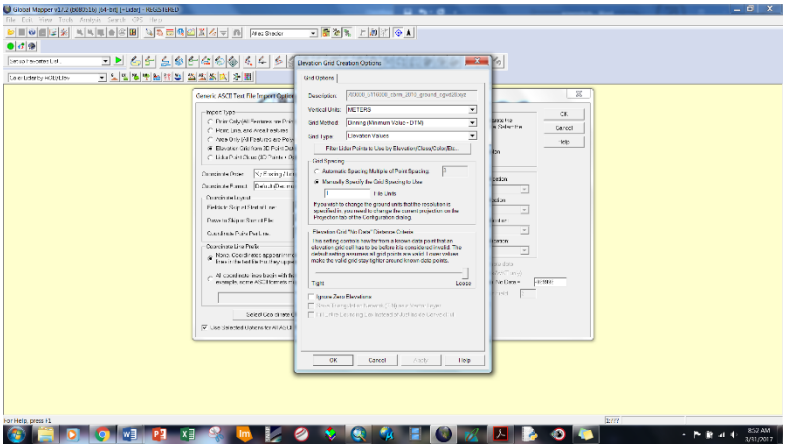


Figure 7: Elevation Grid Creation Options

Exporting Elevation Models

This section is all about exporting the DEMs so they can be used in ArcMap. The way that this process is completed is it all starts with selecting the Export Elevation Grid Format, which can be found by selecting File and then Export. Once, the selection has been made the first window that will pop up will be asking you to select an export format and in this case Surfer Grid (Binary v7 Format) was used. Then the following window will be asking you to input the parameters you wish to use. For this project, there were only two parameters that were changed and those were the Vertical Units, which was set to METERS. Then the second parameter was the Interpolate to Fill Small Gaps in Data box was checked, this was checked so that all the small gaps in the data would be filled. Then once you have the parameters you wish to use and click okay, the following window will be asking you to select a folder of where you wish to place you export and what you wish to name your export. Then once you hit the okay button, the export will begin.

Creation of Watershed Delineations

One main tool was used through the process of creating the watershed. That tool is found within the Global Mapper software itself. That tool can be found under the Analysis tab and the tool is called Generate Watersheds. There is a couple things that were done before running this tool; the first thing was to bring in the original boundary, which was gathered from CBRM, into Global Mapper through the Open files option under the Files tab. Then the second thing that was completed before running the watershed tool was to place a pour point. This single point was placed where it was believed to be a watercourse. Then by using the identify tool within Global Mapper, the point was selected and then the Generate Watershed tool was opened and the correct parameters were input into the tool and then the tool was ran.

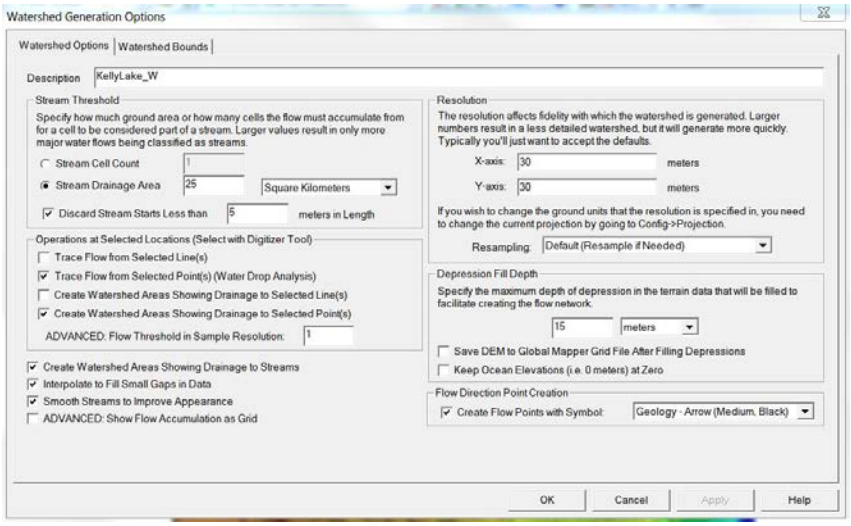


Figure 8: Generating Watershed Tool

The following image, Figure 8, shows what the tool looks like with all the parameters that were used throughout the process of completing this project. The Stream drainage area was based on the square kilometers that the boundary covered (each boundary had a different square kilometer number). Then with the pour point selected, the Trace Flow from Selected Point box was checked. The reason the X and Y axis number is so high is due to the lower the number that you put into this section the longer that it will take for the tool to generate the watershed. The final output after running the tool with the above parameters it will give you an output that shows the watercourses, one large watershed, and points (which can't really be seen within Global Mapper, but once you export them (which is shown in the following section) you will be able to see them in ArcMap).

Exporting Watershed Delineations as Shapefiles

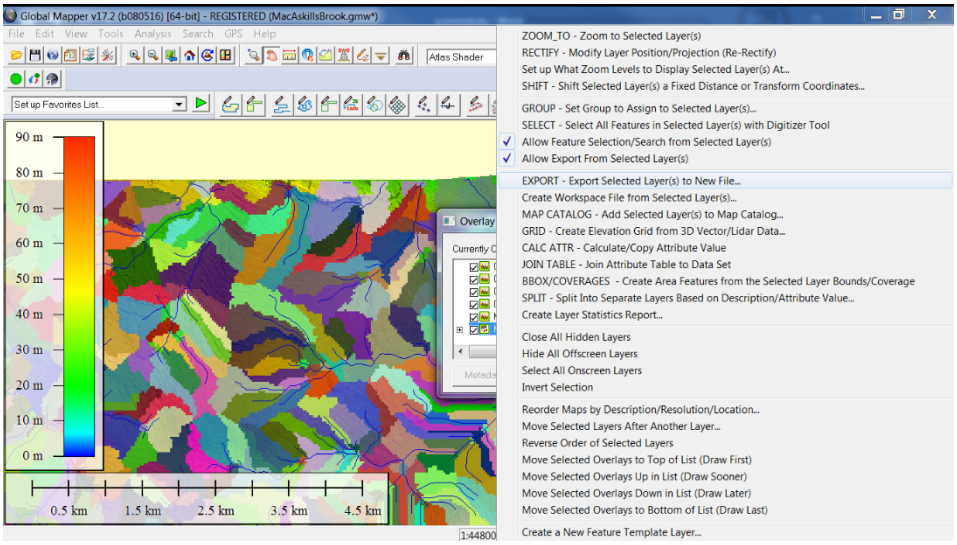


Figure 9: Exporting Watershed Layers to New Files

The way that the exporting of the watersheds works is you open the Overlay Control Center, find the watershed overlay (it should be named after the lake or brook with the word watershed tagged on the end of it. Once you have located that overlay, right click on that overlay and then click EXPORT – Export Selected Layer(s) to New Files option. Figure 9, seen below, shows you the reader what that step looks like. The following window that appears once you click the export-selected layers to new files is asking what format you wish to export these layers as, for the project the Client asked the watershed delineations be shapefiles. Therefore, the files format that was chosen was shapefiles and then the next window that pops up is the Shapefile export options, within this window it allows you to select which features you wish to export, which folder you would like them to export to and what you would like to name them. The window looks something like this, as seen in Figure 10, this figure has all the information filled out and it is ready for the exporting to begin.

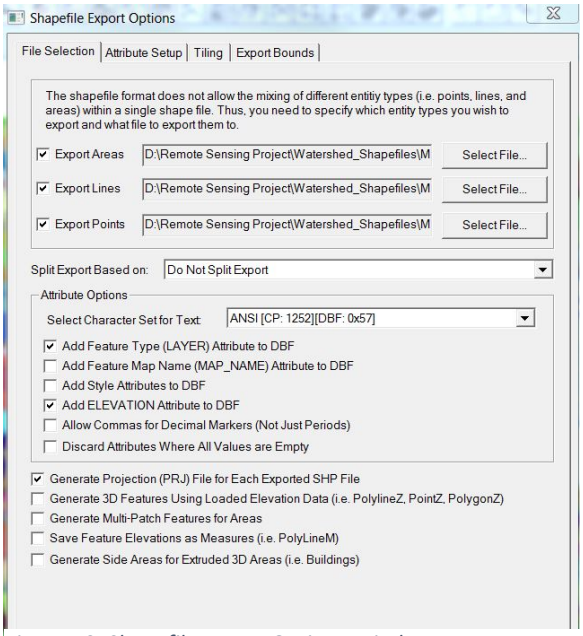


Figure 10: Shapefile Export Options Window

Filling Holes within Data in TerraScan

The following section is all about filling the holes found within the data. This process was done within TerraScan (Bentley Map Enterprise). The first step after you have created a workspace for the specific lake or brook that you are working with is to open the TerraScan main window and bring in just to tiles that are surrounding the missing tile. The way to bring the points into TerraScan is to go File-Read Points, within the TerraScan main window. Then a window pops up asking you to select the tiles around the missing tile, please note that you need to select XYZ files that surround the missing tile because TerraScan does not read the gird file format. Then the next window that pops up will be asking you to Load Points, nothing within this window was changed. Once you click okay, at the bottom of the window, the point will be loaded into the main window of the software. When the points are first loaded into the software they look something like you see in Figure 12, only they are classified as Default and are white in colour. The next step in the process is to classify the points as ground points. This process also completed within the TerraScan window, under the Classify tab - under the Routine drop down menu select Ground. The window pops up looks something like Figure 11 see below. There was nothing changed within this window, so just click okay at the bottom of the window. Once this tool has run, the colour of the points will change to an orange white colour; in Figure 12 (as seen on the following page), this is what the points should look like once the above process has been completed.

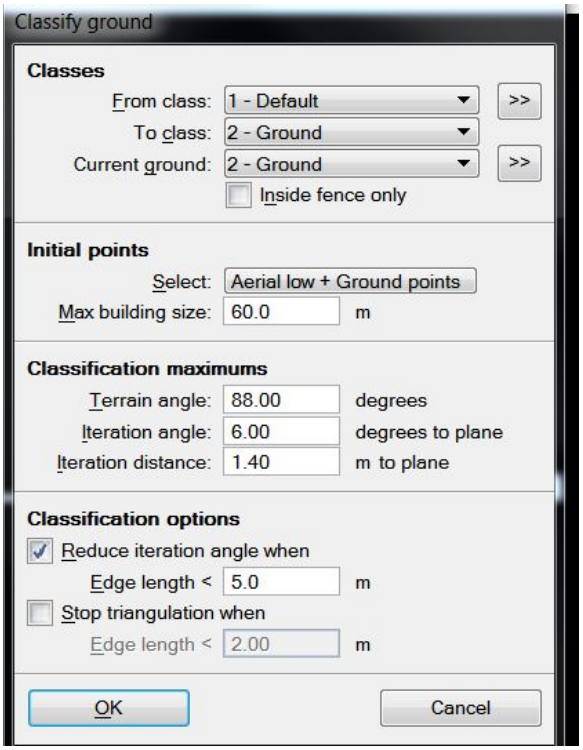


Figure 11: Ground Classify Tool

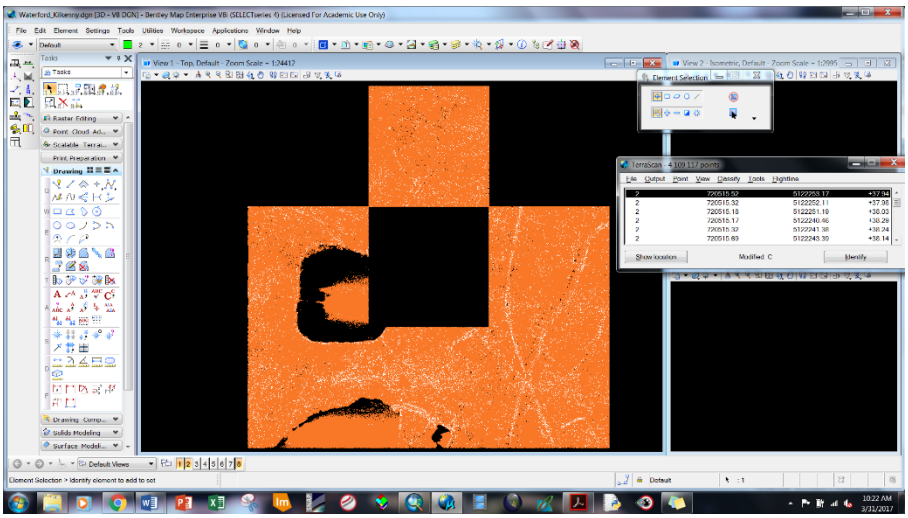


Figure 12: After the Ground Classify Tool Has Been run

The following steps are the process of filling the holes within the data. The first step is to draw a rectangle that just slightly larger than the hole in the data, as seen in Figure 13. The following step is to Export the lattice model, this tool can be found under the Output dropdown menu. Once this tool was selected, a window pops up that looks like Figure 14. Within this window, as seen in Figure 14, you select Ground as the class; lowest hit z as the Value. You want to export the whole area. Then where it says File format you need to select Xyz text to match the rest of the XYZ data files. The final thing that needs to be put into this window is the Grid spacing and the Fill gaps upto parameters, with these two parameters it is a lot of trial and error, it is recommended to start with low numbers and slowly increase the numbers after you see the output. Every time you click okay to run the Export lattice tool another window will pop up

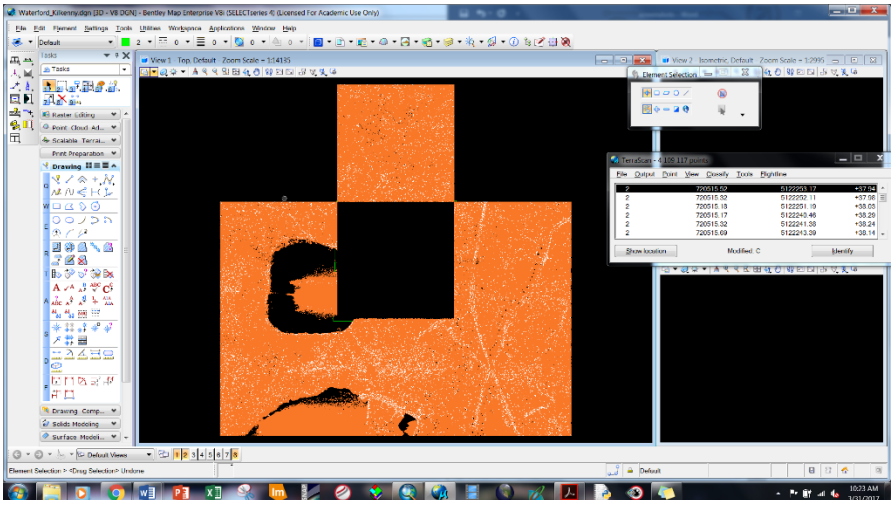
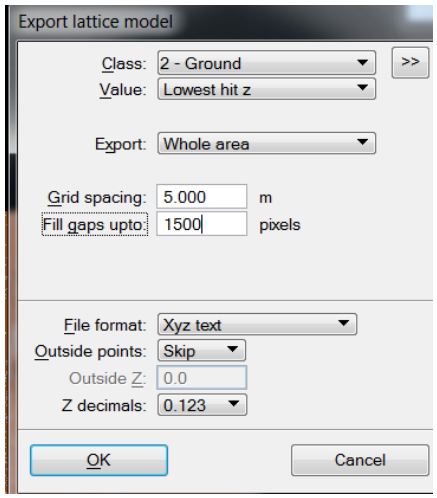


Figure 13: Adding a Rectangle to fill the hole



asking you select a folder of where you wish to place the exported file and also asking you what you wish to name the exported file. Once you find the correct numbers that cover the whole area where is the hole is the data is located it will look something like Figure 15, as seen below.

Figure 14: Export Lattice Model Window

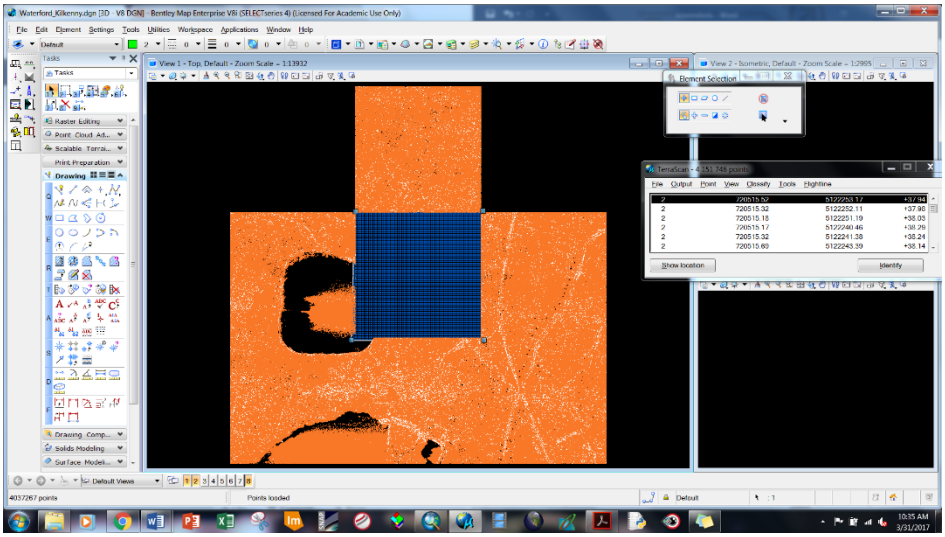


Figure 15: Final Output of filling the hole within the data all done within TerraScan

Comparing New Boundaries to Original Boundaries

The following images/figures are showing the comparison between the original boundaries that Cape Breton Regional Municipality digitized from a 1:10,000 photograph and the boundaries that have ben created using the LiDAR data. Within each image/Figure you will see a yellow polygon that is the boundary created by CBRM and the red polygon is the boundary that was created using the above process.

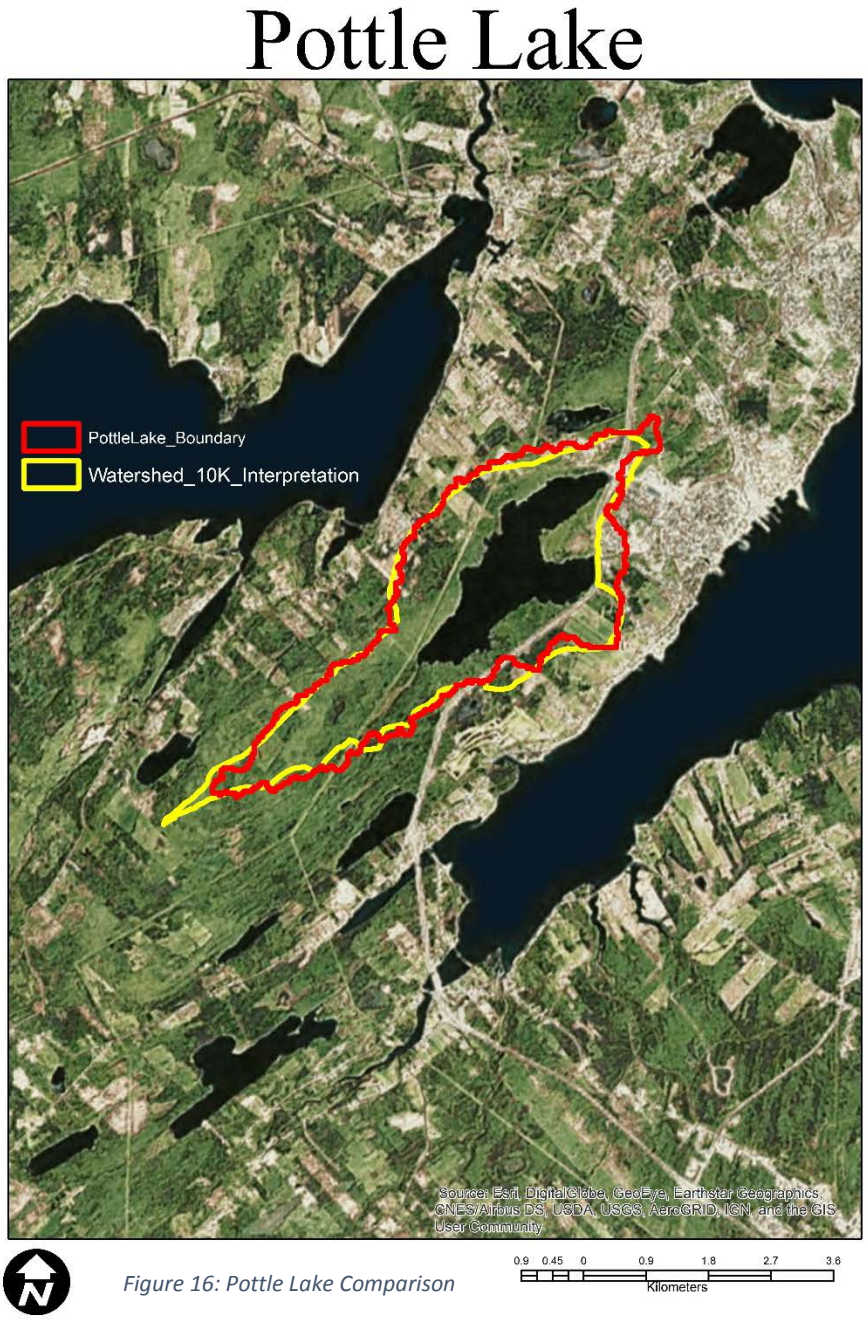


Figure 16: Pottle Lake Comparison

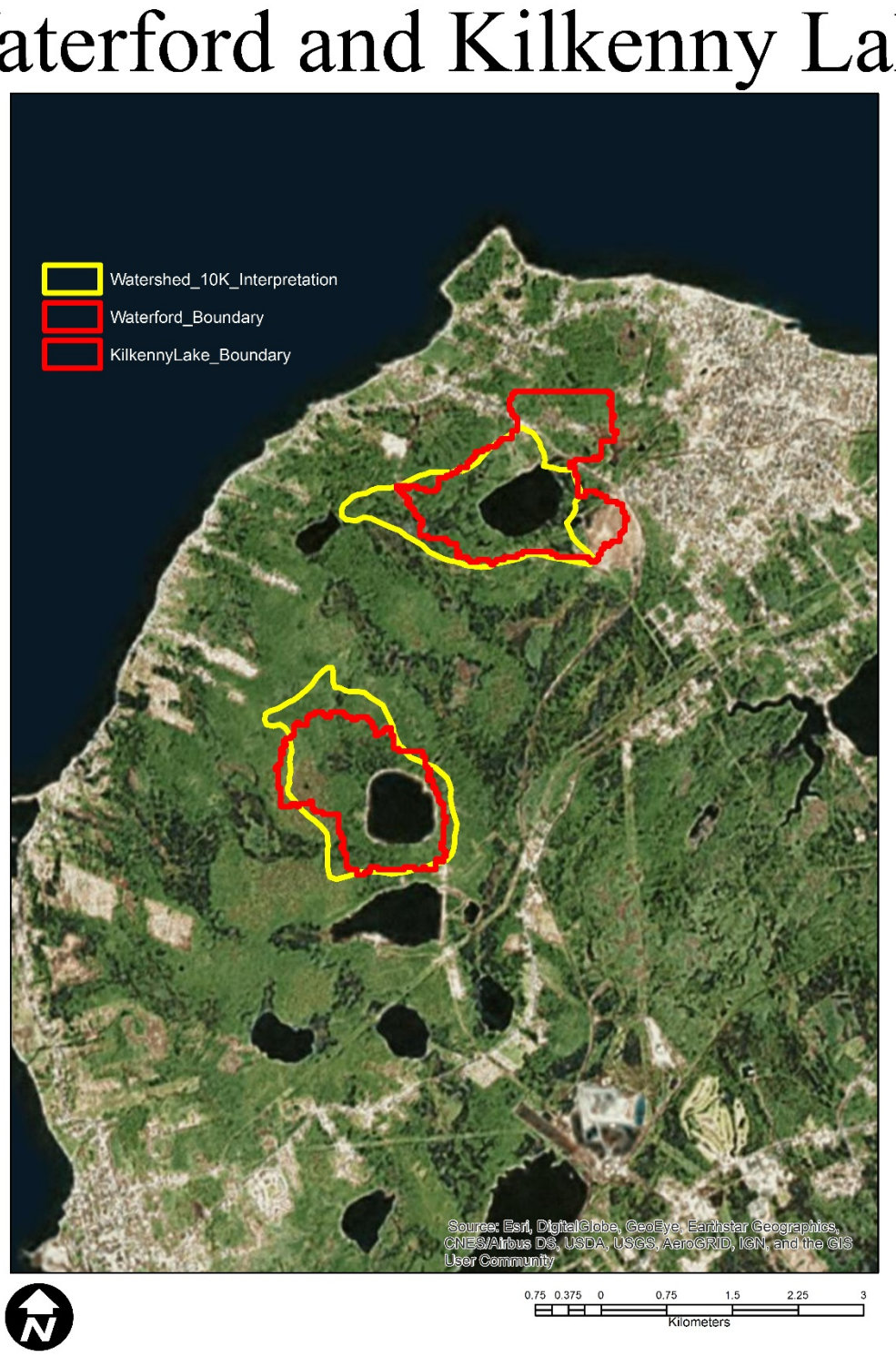


Figure 17: Waterford and Kilkenny Lake Comparison

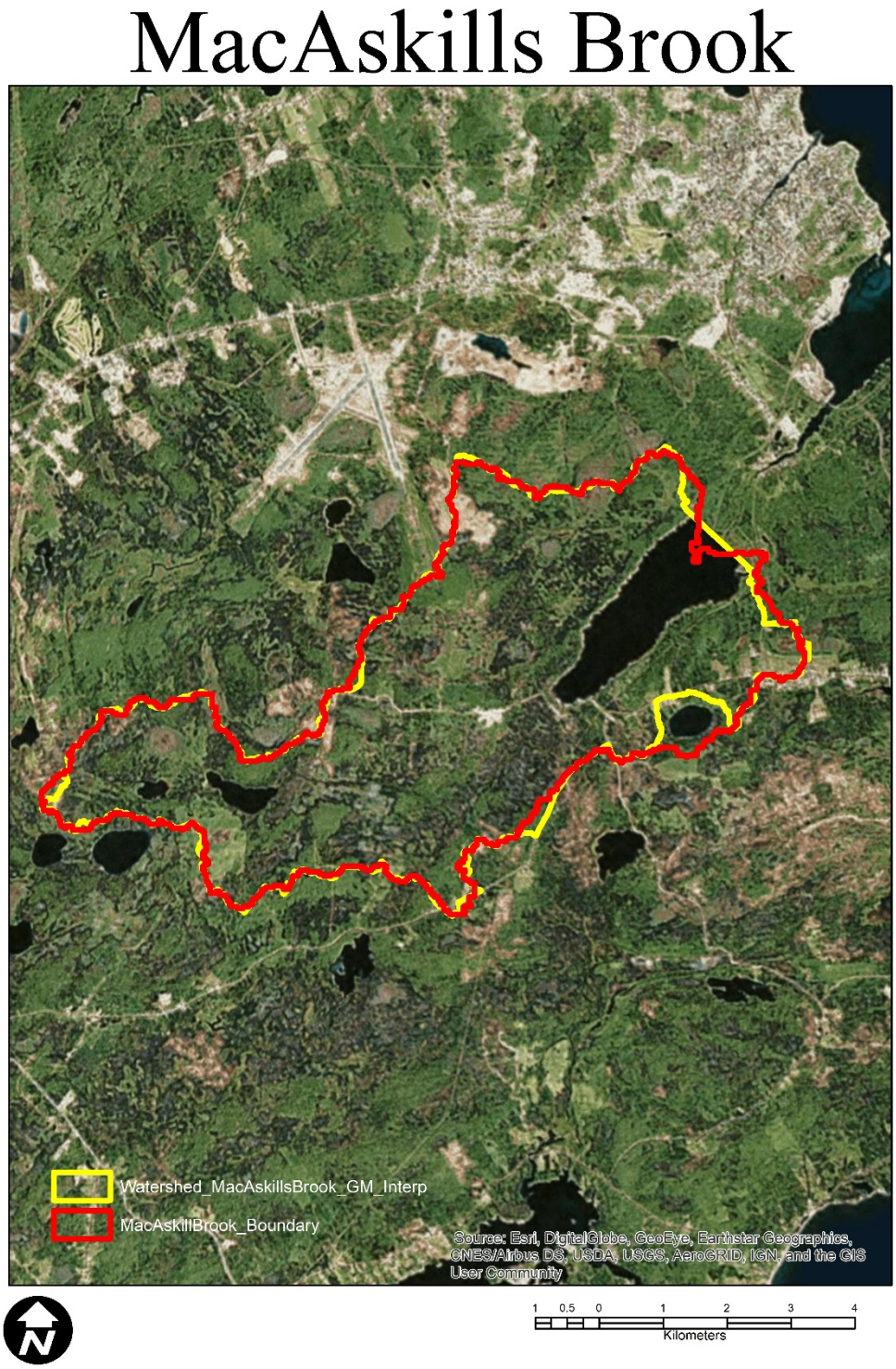


Figure 18: MacAskills Brook Comparison

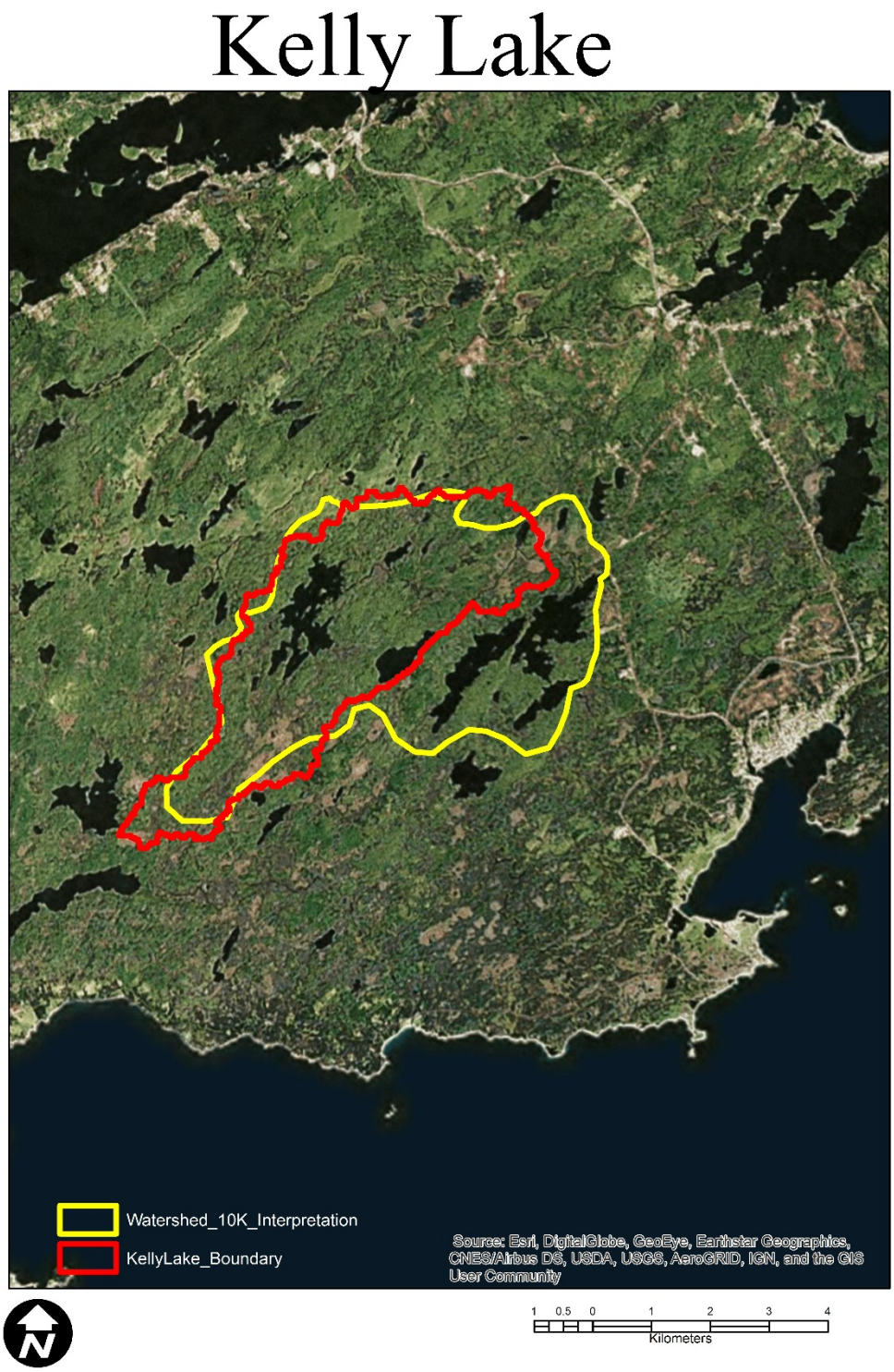


Figure 19: Kelly Lake Comparison

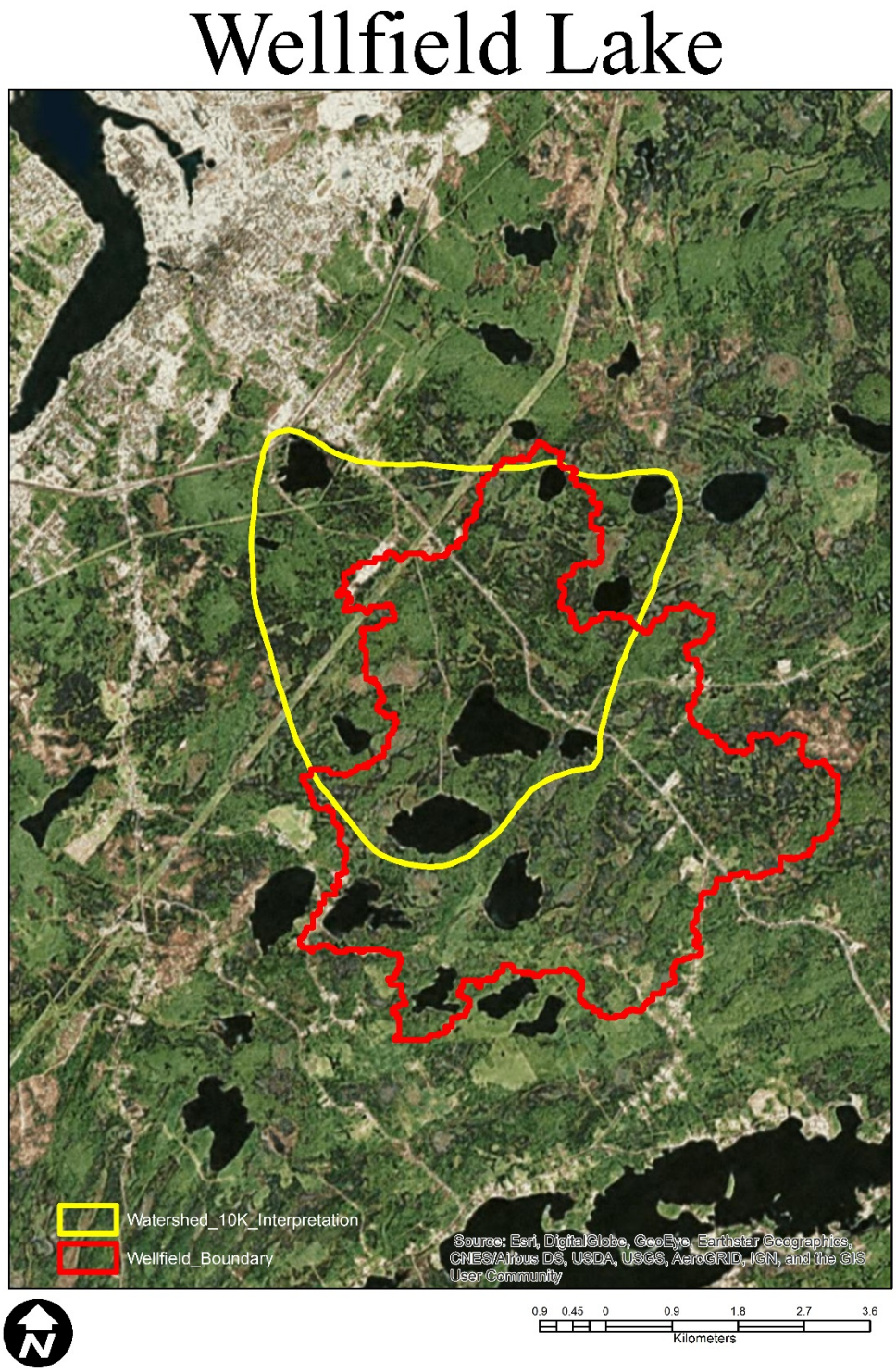


Figure 20: Wellfield Lake Comparison

Appendices

List of Data Used

The data that was used for this project are as follows. The first set of data that was used for the completion of this project was the XYZ data, which then created the Digital Elevation Models (DEMs) for each water supply area watershed. The XYZ data was also exported to create the Grid files. The watershed shapefiles were created through an automated process that can be found within the Global Mapper software. The missing tiles were created within Bentley Map Enterprise (TerraScan) along with the surrounding data. The water supply area watershed boundaries were created within ArcMap using the editor tool and looking at the DEM for that watershed.

Data Organization

The subfolders within the **Client Project Remote** Sensing folder are the following. **Boundaries Shapefiles**, **Client Workflow Report**, **Data from CBRM**, **Final Presentation**, **Global Mapper**, **Grid Files**, **Missing Tiles**, **New DEMs**, **TerraScan**, **Watershed Shapefiles** and finally my working MXD. Within the **Boundaries Shapefiles** folder, the reader will find a boundary for each individual water supply area watershed and a New Watershed Boundaries shapefile, which contains all the boundaries in one shapefile and can be classified by using the WatershedN field. This field contains the name of each individual water supply area watershed name. Within the **Client Workflow Report** folder there is a subfolder called **Comparison Maps**, within this folder there are five images that are showing the comparison between the original boundaries and the boundaries that were created using the LiDAR data. There are for other files fund within the main **Client Workflow Report** folder one being this very report, the PDF for this report, an image of a tool that was used during the creation of this project and finally the word document that contains the screen shots following the processes that were used throughout the completion of this project. The next folder is the **Data from CBRM** folder, within this folder there are several more folders. They are CBRM DEM, xyz Kelly Lake, xyz MacAskills Brook, xyz Pottle Lake, xyz Waterford and Kilkenny, xyz Wellfield, CBRM Data Access file, and then the zip folders for the first

six folders (from CBRM DEM to xyz Wellfield). Within the **CBRM DEM** folder, the reader will find DEM files for each water supply area watershed that were created by CBRM. The next six folders (xyz Kelly Lake to xyz Wellfield) all contain the XYZ data that was needed to create the new DEMs and the watersheds. The Access file contains a bunch of information about the lakes or brooks. The next folder is the **Final Presentation** folder; within this folder, the reader can find two more folders (Importing and TerraScan) along with screenshots of each watershed and a PowerPoint presentation. In the Importing and TerraScan folders, there are screenshots that can be seen above in the throughout the report. The screenshots of each watershed can also be found in the **Comparing New Boundaries to Original Boundaries** section above. The PowerPoint presentation is the same one that was presented to the rest of the Remote Sensing class and the instructors. In the Global Mapper folder is where the reader can find the workspace for each water supply area watershed. Then within the **Grid Files** folder there are five subfolders, one for each water supply area watershed, that contain the grid files, that have been batch converted from the xyz data. The **Missing Tiles** folder contains the XYZ files that are missing from the data. The **New DEMs** folder contains the new DEMs that were created by using the XYZ data. The files that can be found within the **TerraScan** folder is the two Bentley Map Enterprise workspaces that were used to create the missing tiles. Finally, within the **Watershed Shapefiles** folder there are five subfolders one for each water supply area watersheds, within these folders there are three shapefiles one shapefile for the area features, one shapefile for the line features, and one shapefile for the point features. These shapefiles were exported from Global Mapper after running the watershed delineation tool. Then the ArcMap document this is where the comparison between the new water supply area watershed boundaries and the original boundaries is done, this document also contains all the newly created DEMs, the line shapefiles for each water supply area watershed, and the original boundaries that were created by CBRM.

Software Used

The software packages that were used in completing this project are as follows. The software Global Mapper was used to do a majority of the processing. In the first four sections of this report were done within Global Mapper. Then filling the holes within the data was done within Bentley Map Enterprise (TerraScan). Then everything was brought into ArcMap to make sure that everything is meeting the requirements.