



EXERCISE 3

FS Vertical Integration Tool

Introduction

Python programming language can be used to automate geoprocessing, editing, and data management steps to make processes run faster than if digitizing, commands, and parameters are entered in the graphical user interface manually. The Vertical Integration tool automates the processes of finding and editing sliver errors in and between two datasets.

Objectives

- Learn to use the Vertical Integration tool to find and edit a large amount of sliver errors to align one dataset to a reference dataset.

Prerequisites

- Completion of ArcMap Quick Start and ArcMap Editing Webinars or equivalent experience.
- Install Esri ArcMap 10.7.1 or higher on local computer or have access to and experience using Citrix.
- Download and unzip the data and exercises.





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In this exercise we will use a tool developed by the GTAC for the Automated Lands Program (ALP) to help align two large datasets with the potential for hundreds or thousands of corrections. The VI Tool automates many of the steps to let you discover the obvious errors, and fix them much more quickly than using manual editing tools we learned in the last two lessons. However, there is still a fair amount of decision making involved, and many of the less obvious errors will still need to be corrected manually. Before we can run the tool, we need to ensure that the map document and the data are set up correctly.

A. Prepare the Map Document

1. Launch a blank ArcMap either locally or in Citrix.

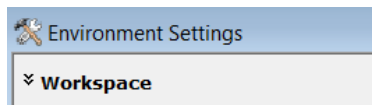


2. Click File | Open and select the following map document:

../AdvancedEditing/Lesson3/Data/CT_VI_Tool_10_3.mxd

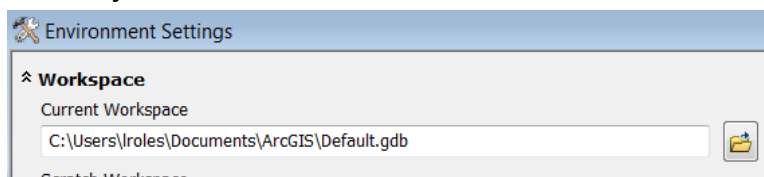
NOTE: There will be no layers in the TOC, you will add them later.

3. Set-Up your Working Directory. Click **Geoprocessing | Environments** from the drop down menus at the top of the interface.

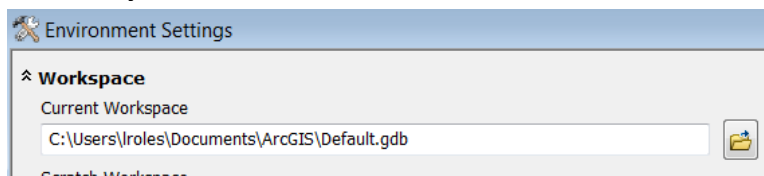


4. Expand **Workspace** to see the section's contents.

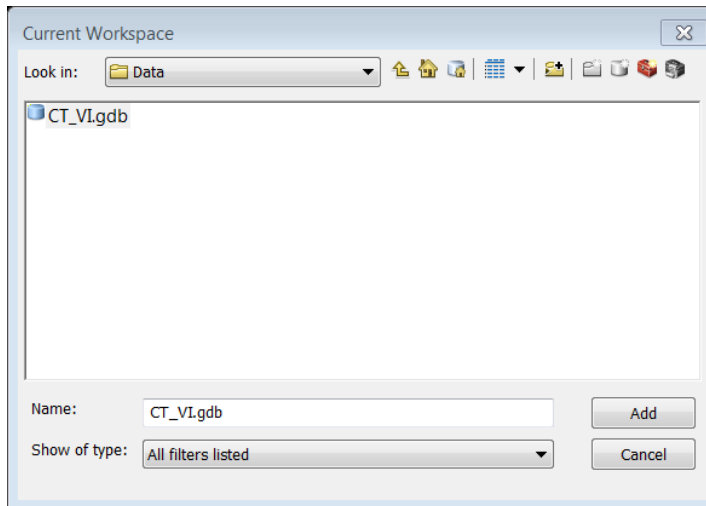
In order for the VI Tool to work the data must be in a File Geodatabase format.



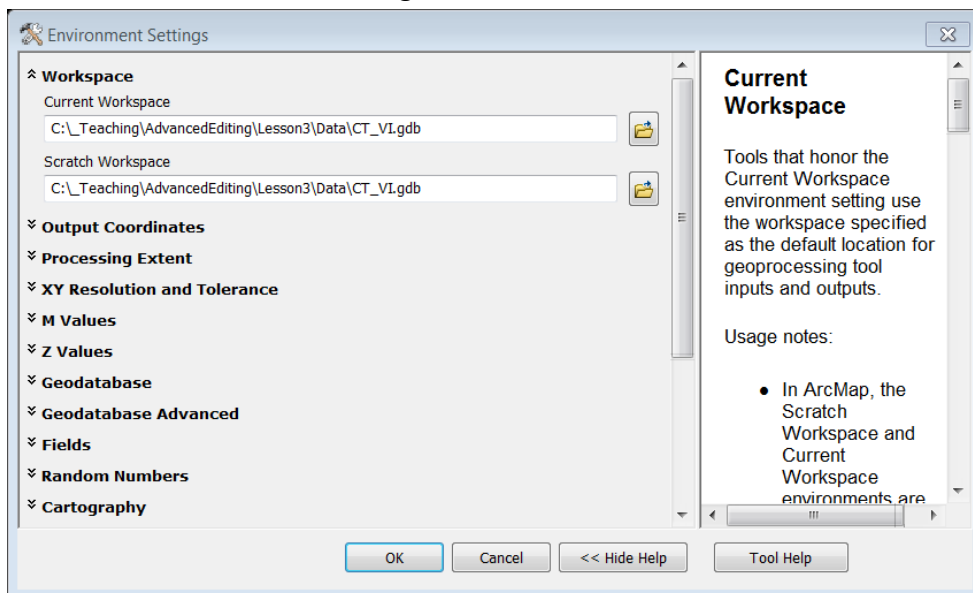
5. Click the **yellow folder** button associated with the Current Workspace.




6. Navigate to and **single-click** on the Geodatabase
../AdvancedEditing/Lesson3/Data/CT_VI.gdb then click **Add**.



7. Your workspace path should now appear in the Current Workspace input box. **Copy the path from the Current Workspace box into the Scratch Workspace box**. Then Click **OK** within the Environment Settings window to close it.

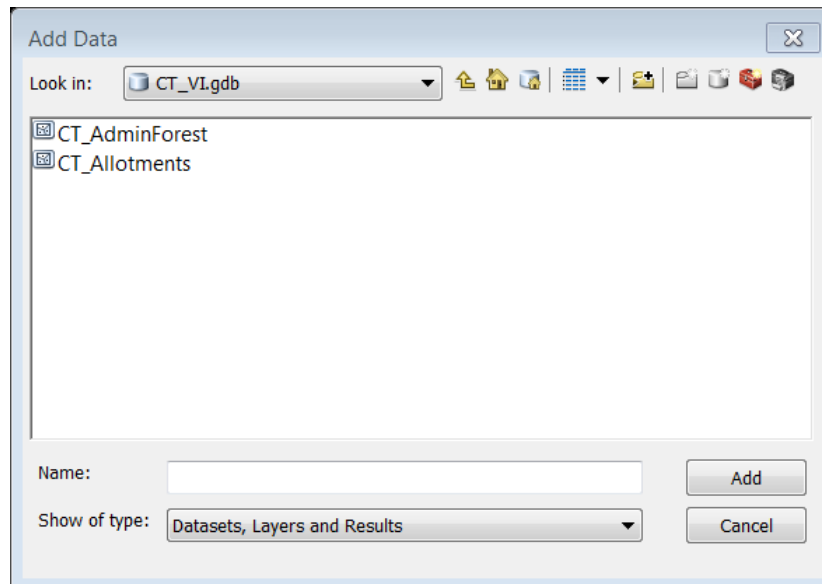


8. **Save** the map. 

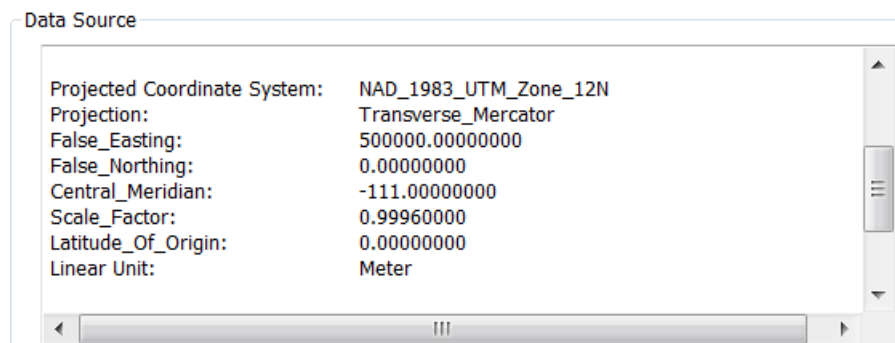
B. Load & Explore Data

1. Click the **Add Data** button. Navigate to **../AdvancedEditing/Lesson3/Data/CT_VI.gdb**, select the two feature classes, **CT_AdminForest** and **CT_Allotments**, then click the **Add**

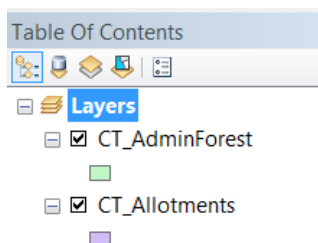
button.



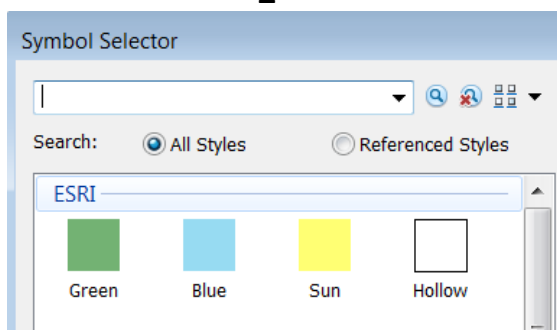
2. Always check to make sure that both layers have the same spatial reference. Double click each layer to **open the Layer Properties window and click the Source tab**. *You will see that they are both in the UTM NAD83 Zone 12 projection. If they were different, you would have to use the Project tool make them the same.*



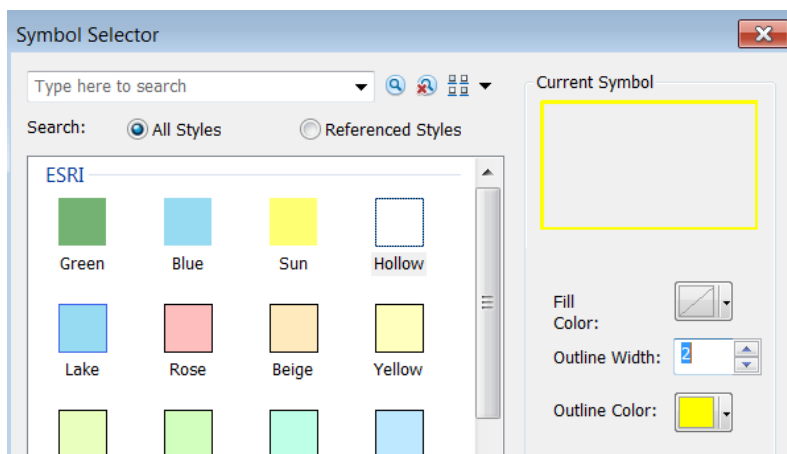
3. If needed, select and drag the **CT_AdminForest** layer to the **top of the TOC**. *Remember that you need to be in the List by Drawing Order view in the TOC to move layers.*



4. **Double click the CT_AdminForest color block to open the Symbol Selector window.**




5. **Select the Hollow symbol, change the color to Solar Yellow and the Outline width to 2. Click the OK button.**

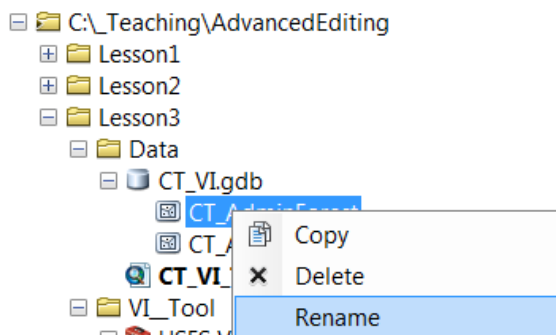


For the purposes of matching the outer boundary of the layer to be updated (LTBU) layer (CT_Allotments) to the reference layer (CT_AdminForest) it is recommended that you position the reference boundary layer above the LTBU as you explore the data set. Also, set the reference layer to Hollow and set a high contrasting outline color like red or yellow so that you can more easily see the misalignments. You can change or leave symbology associated with LTBU as the default.

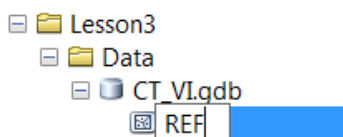
6. **Click on the Bookmark menu** and **explore all the Sliver bookmarks** one at a time. You should notice the layer boundaries do not match and need to be aligned. Feel free to explore the data more, although by after the first two Exercises you have a pretty good idea of the spatial errors between the two layers.

7. **Click the Zoom to Full Extent** button  once you finish exploring the data so that both layers are visible in their full extent in the data view.

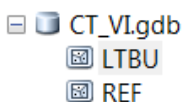
8. Before the VI Tool can run we must rename the feature classes to match the variable names in the scripts. **In the ArcCatalog window, right click on the CT_AdminForest feature class and select Rename from the Context Menu.**



9. **Change the name to “REF”.** The REF layer is the reference layer that has the most accurate boundary.



10. Repeat the procedure and **rename the CT_Allotments feature class to “LTBU”**. LTBU stands for “layer to be updated.” *This layer has a less accurate boundary and we want it to match the REF layer.*



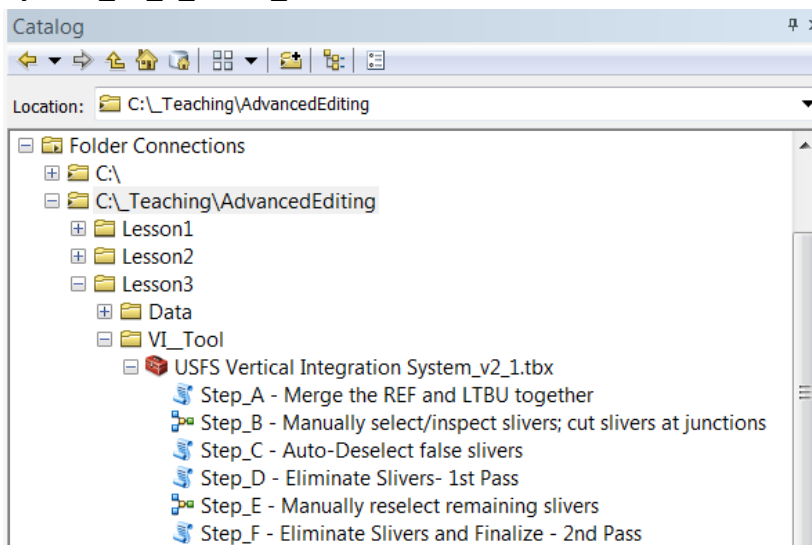
11. Since the data is already in the TOC, ArcMap will leave the original names as the alias. If you want, you can change the layer names to LBTU and REF, but it is not necessary.

C. Explore the Vertical Integration Tool

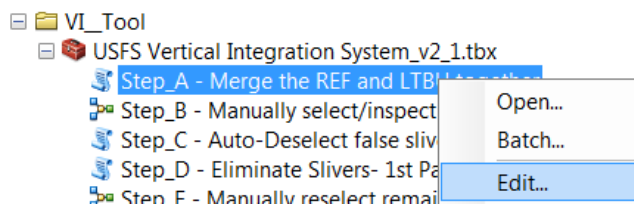
Note: You do not have to be a Python expert to run the VI Tool, but it helps to take a look at the commands so that you know what to expect as the output. ArcPy runs ArcMap tools and processes, but runs them command line instead of having to manually fill in the GUI window. Running multiple tools through python has many advantages such as: it allows you to run many commands in a certain order much more quickly; allows you to document your process; and allows you to run the processes over and over in the exact same way.

1. Open the ArcCatalog Window and expand the VI Tool toolbox:

..\AdvancedEditing\Lesson3\Data\VI__Tool\USFS Vertical Integration System_v2_1_Arc10_1.tbx



2. Investigate the Python Script. **Right Click on Step A and select Edit.**



3. This will open up a text editor for the script called ScriptA.py. You do not need to know the python coding language to **read through and see that there are ArcMap tools commands** listed after every “arcpy.”


```

StepA.py - Notepad
File Edit Format View Help
Result_Step_A = "Result_Step_A"

arcpy.env.XYTolerance = ".001 Meters"
if arcpy.GetParameter(3) == 1:
    arcpy.env.overwriteOutput = 1
else:
    arcpy.env.overwriteOutput = 0

arcpy.Select_analysis(LTBU, "LTBU_Select")
arcpy.Select_analysis(REF, "REF_Select")
arcpy.AddField_management("LTBU_Select", "x_mb_x", "LONG")
arcpy.CalculateField_management("LTBU_Select", "x_mb_x", "

arcpy.MakeFeatureLayer_management(REF, "REF_LAYER")
arcpy.SelectLayerByLocation_management("REF_LAYER", "INT")
arcpy.Union_analysis("LTBU_Select;REF_LAYER", "REF_LTBU_
arcpy.MultipartToSinglepart_management("REF_LTBU_Union")
  
```

- For example if you **look through the code** you will see the following highlighted functions that call up ArcGIS tools and processes you may have used before within the ArcMap the GUI window:

```

arcpy.Select_analysis
arcpy.MakeFeatureLayer_management
arcpy.Union_analysis
arcpy.MultipartToSinglepart_management
arcpy.AddField_management
arcpy.CalculateField_management
arcpy.SpatialJoin_analysis
  
```

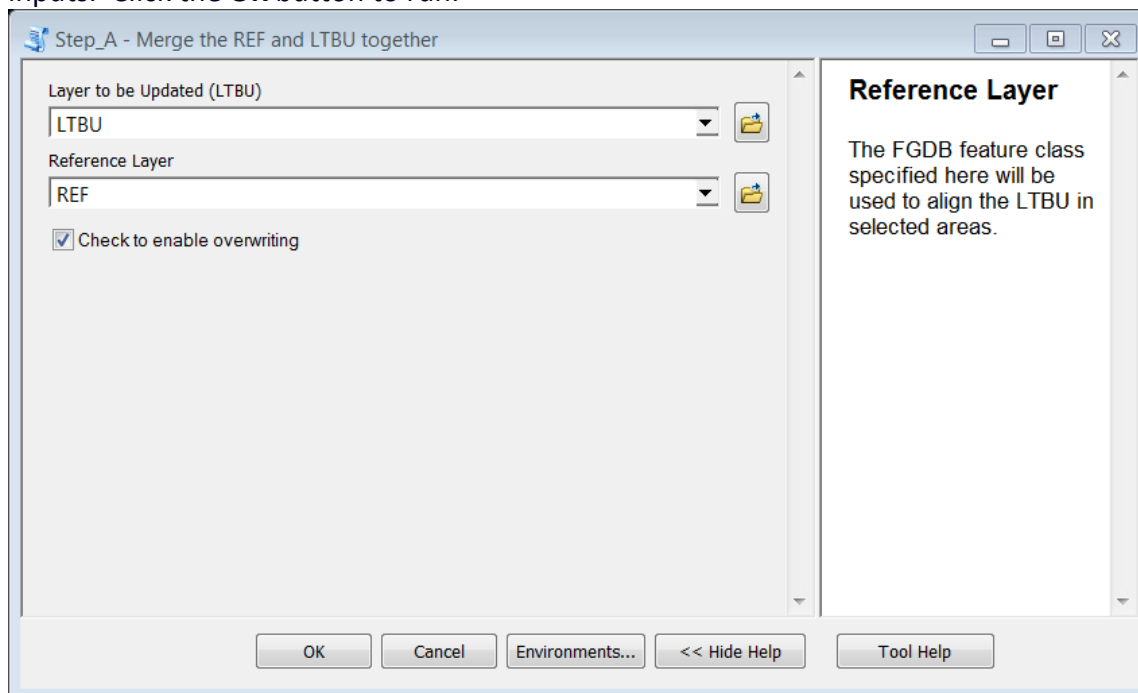
- Click **File | Exit** and close the script without making or saving any edits.
- You are welcome to explore the code in the other VI Tool scripts using this method.** However, this class isn't about learning python, it is learning to use the VI Tool to automate large dataset alignment projects.

D. Run Step A - Merge the REF and LTBU together

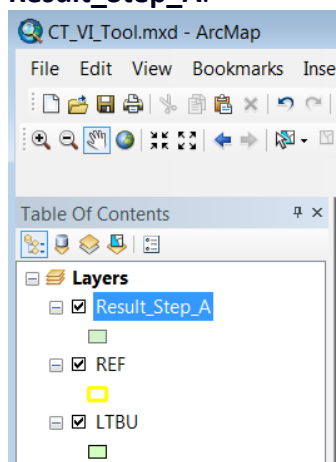
Step_A uses the Union tool to combine the reference layer (REF) and layer to be updated (LTBU) together and then creates a singlepart layer. Note that, if the size of the layers are very large the Union tool can be inconsistent so check the results carefully to ensure that the output is what you expected. If not, run the step again. Step A also creates a "ThinRating" field to measure the likelihood that a polygon in the result is a sliver based on its shape. You will use this fields along with the

SHAPE_Area field in the next step to manually select which features to correct in Step C.

1. **Double click the Step_A tool** in the Catalog window to run it.
2. **Place the REF Layer and the LTBU Layer in their respective locations** within the tool inputs. Click the **OK** button to run.



3. After the tool is done you will **notice a new layer added to the TOC called Result_Step_A.**



4. **Right click the Result_Step_A layer and Open Attribute Table. Scroll all the way to the right** side of the table to see that the script joined the attributes of both the the REF and the LTBU, plus added several other fields. You will use the ThinRating field with the SHAPE_Area field to help you find probable sliver polygons.

Table

Result_Step_A

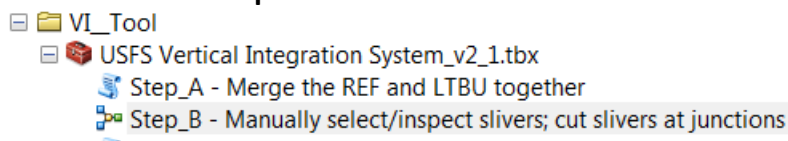
	ORIG_FID	x_mb_id_x	x_mb_ratio_x	ThinRating	NumAdj	SHAPE_Length	SHAPE_Area
	1	1	0.349492	HIGH	1	4533.39031	7941.047076
	2	2	0.010599	HIGH	1	1517.332548	3018.235476
	2	3	0.001303	HIGH	1	4295.928945	2641.133124
	2	4	0.012379	HIGH	1	4841.315625	48333.639681
	3	5	0.006186	HIGH	1	821.569445	519.723911
	3	6	0.01219	HIGH	1	3558.524257	20250.886678
	4	7	0.004785	HIGH	1	5595.488102	22113.722387

If you plan to use this tool on your own data, ensure you have properly set your workspace to the file geodatabase containing both the reference layer (REF) and layer to be updated (LTBU) before running this step. You may want to set the geoprocessing XY tolerance in the environment setting to be an appropriate value (example: ".05 meters", so slivers under that width are not expressed). Also, make sure you have taken the steps to properly prepare your data by removing all subtypes. For this training, the settings are correct.

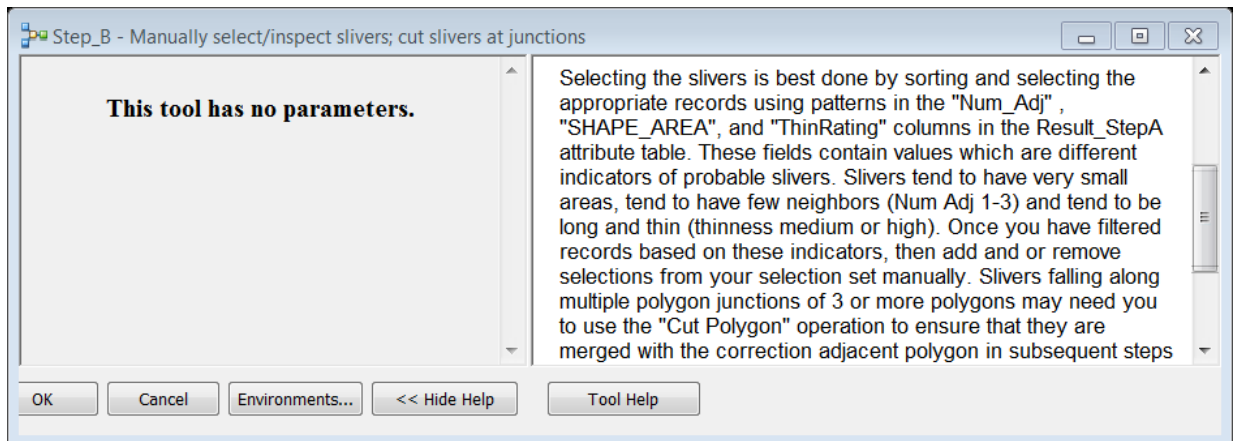
E. Complete Step B - Manually select/inspect slivers; cut slivers at junctions

Step B is a non-functional placeholder for a **critical manual step** that requires the user to select those records that are considered to be "slivers" so the errors can be corrected. Slivers tend to have very small areas, and/or tend to be long and thin (thinness MEDIUM or HIGH). The selection set created in this step is a key part of the system and you should select your set of vertical integration errors (or slivers) very carefully so the system can remove them in the next steps.

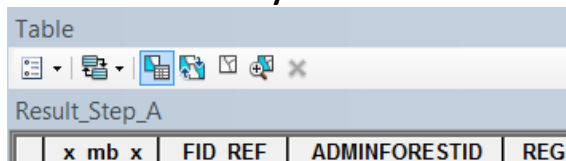
1. **Double click on Step B** in the VI Toolbox.



- A window will open up with no parameters, just instructions for how to best select slivers. **Read the instructions.**

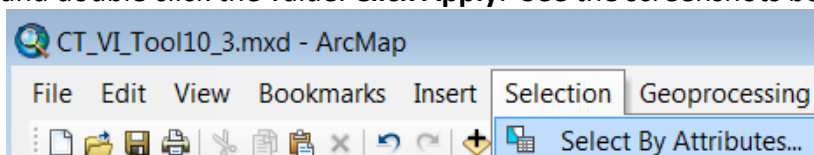


- Click on the **Select by Attributes** button in the Result_Step_A table.



If this was a real project with real data, you would have to decide the SHAPE_Area value and ThinRating you will use for selecting features to be corrected by the next script; and at what level you should check each feature individually before running the script. The idea is not to have important a land management features deleted by accident. For this project we are going to play the role of a Range Manager who knows that there are no important land units less than 25 acres (100,000 m2), and so we will let the script fix all features less than 100,000 m2.

- To start, let's select all records with a **SHAPE_area less than 100,000 m2, or a ThinRating of HIGH**. Open up the Select by Attributes window and Double click on the Field, Single click on the operator, and either type the value or check Get Unique Value and double click the value. **Click Apply**. See the screenshots below.



Select by Attributes

Enter a WHERE clause to select records in the table window.

Method: Create a new selection

Attributes: x_mb_ratio_x, ThinRating, NumAdj, SHAPE_Length, SHAPE_Area

Operators: =, <>, Like, >, >=, And, <, <=, Or, %, (), Not, Is, In, Null

Values: 'HIGH', 'LOW', 'MEDIUM'

Get Unique Values Go To:

SELECT * FROM Result_Step_A WHERE:
SHAPE_Area <100000 OR ThinRating = 'HIGH'

Buttons: Clear, Verify, Help, Load..., Save..., Apply, Close

5. **Browse through the Attribute Table** to see information about some of the records that were selected. **Notice that about three-quarters of the polygons were selected.** Due to the nature of the Union process, your numbers may not be exactly the same, but they should be close.

Table

Result_Step_A

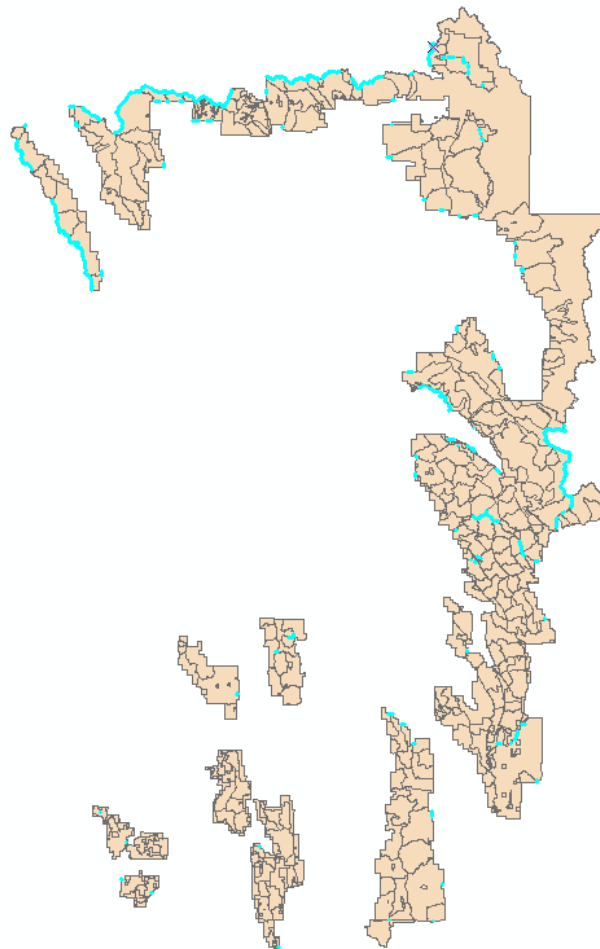
	OBJECTID_12 *	SHAPE *	FID_LTB_U_Select	OBJECTID_1	OBJECTID_2	OBJECTID_3
▶	1	Polygon	15	188	188	1
	2	Polygon	15	188	188	1
	3	Polygon	18	165	165	1
	4	Polygon	63	150	150	1
	5	Polygon	66	32	32	
	6	Polygon	68	34	34	

Navigation: 1 (3778 out of 4274 Selected)

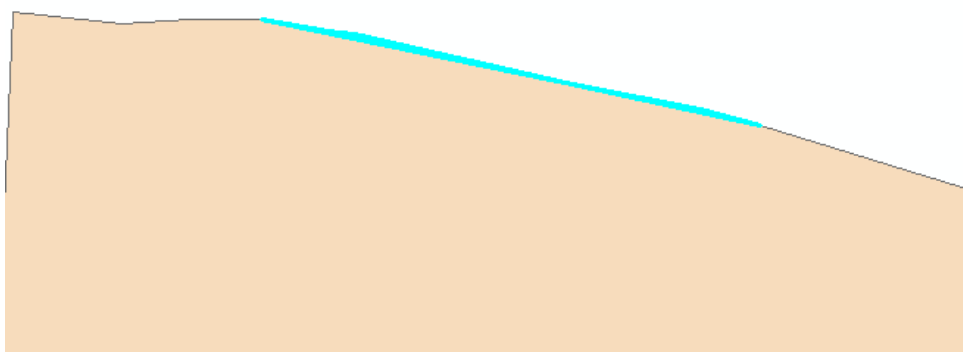
Result_Step_A

6. Turn off the other Layers in the TOC and leave only the Result_Step_A Click on the **Zoom to Full Extent** button in the Standard Toolbar to get a spatial idea of the selected slivers.

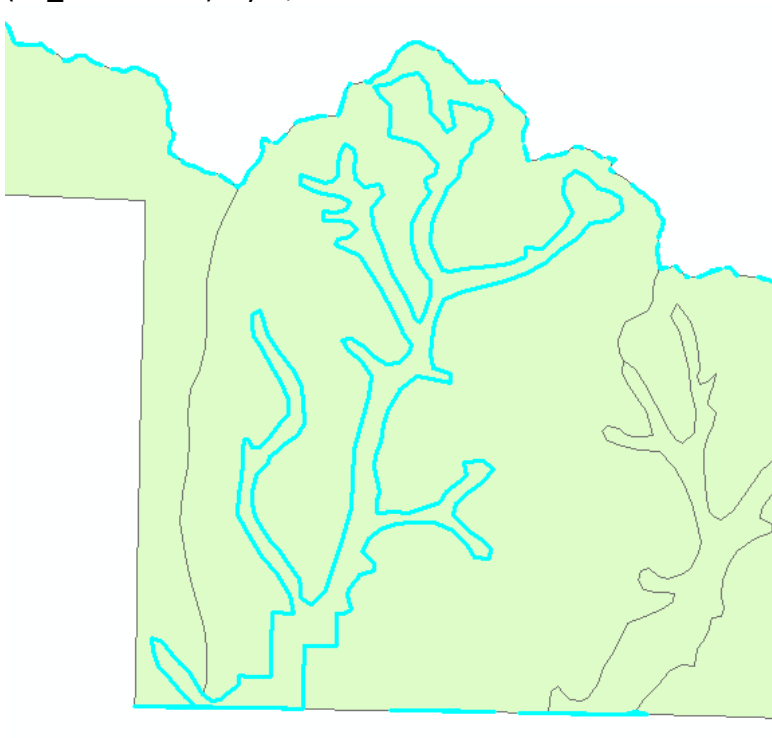
Most selections seem to be around the edges, but there are a few we will want to zoom in to look at more closely.



7. Click on the **Bookmarks menu** and **select the bookmark named Sliver**. This is what we would expect most of the true slivers to look like - long and thin and on the edge of both layers. These are the areas we want the tool to fix. If you want you can select the other Sliver bookmarks to see if they are selected.



8. Click on the Bookmarks menu and **select the bookmark named “High thin rating not a sliver”**. This appears to be a buffer around a stream that should remain in the LTBU (CT_Allotments) layer, therefore we want to remove it from the selection set.




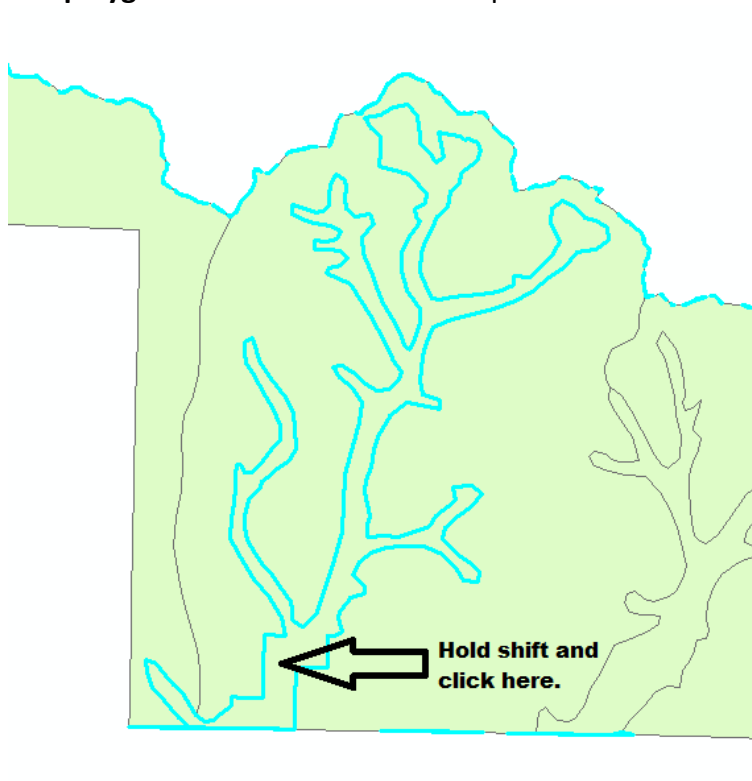
able

result_Step_A

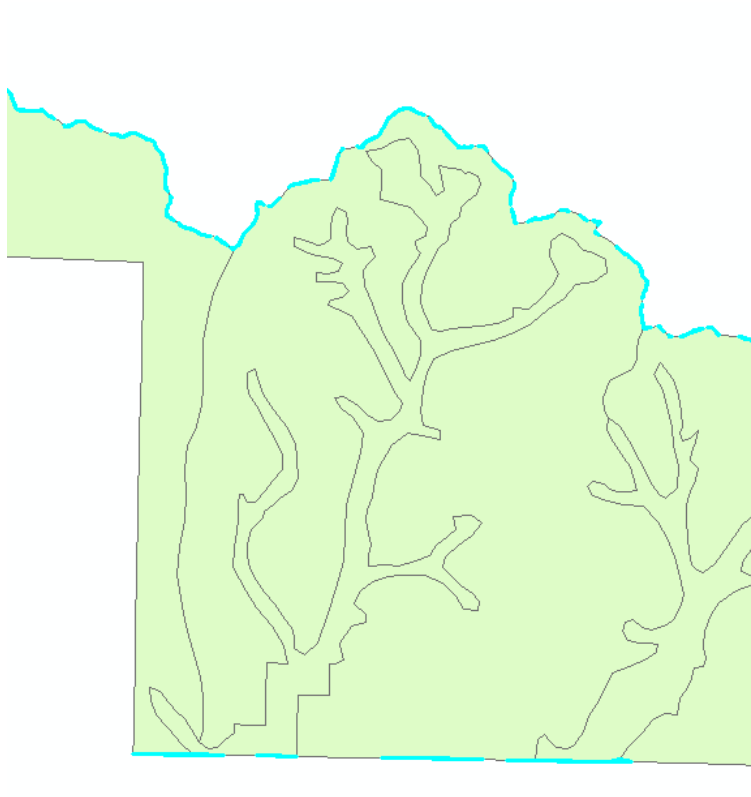
ALLOT_TYPE	ALLOT_KIND	SHORT_NUMB	FULL_NAME
Active Allotment	C&H	116	Middle Creek C&H

Knowing your data and doing a thorough check is a critical step in this process! Otherwise you will end up deleting legitimate data. On a real project, you could spend hours ensuring that the selection set is correct. For this class we are giving you a delineation for the sake of time.

- Click on the **Select Features tool**  to activate. Then **hold down the Shift key and click this polygon to unselect it** so the script doesn't remove it.








10. The data view should look similar to this. All the outer slivers remain selected, but the allotment polygon is unselected.



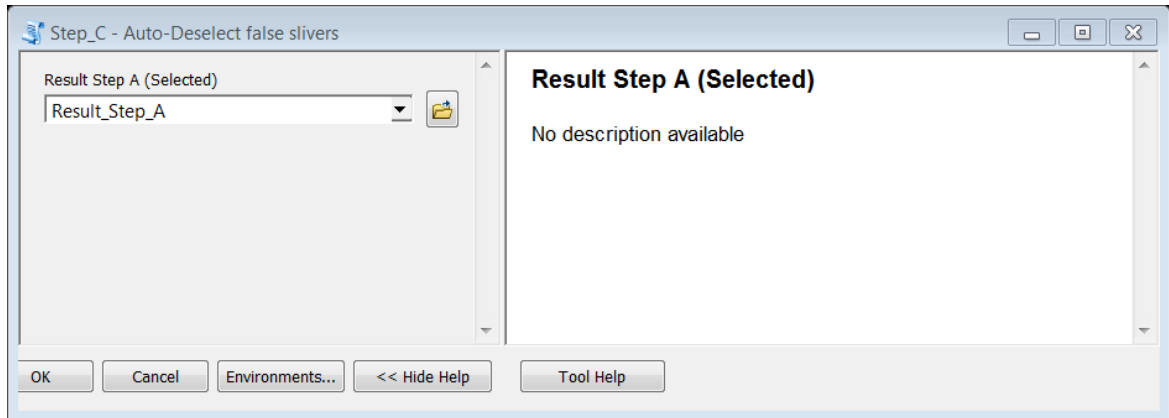
F. Run Step C - Auto Deselect False Slivers

Step_C accepts the selection made on the result from Step_A and removes from it features with boundaries that do not touch both the Reference layer and the Layer to be Updated. These features are not true slivers in that they were not formed as a result of discrepancies between the two layers.

1. **Double click Step C** to run the script.

-  VI_Tool
 -  USFS Vertical Integration System_v2_1.tbx
 -  Step_A - Merge the REF and LTBU together
 -  Step_B - Manually select/inspect slivers; cut slivers at junctions
 -  Step_C - Auto-Deselect false slivers

- Click the dropdown in the Step C window and select the Result_Step_A layer. Click OK.



- When the script is done **examine the Result_Step_A table**, it may have a few less features selected, however in this case the selection number is the same.

Table

Result_Step_A

	OBJECTID_12 *	SHAPE *	FID_LTBU_Select	OBJECTID_1	OBJECTID_2	OBJECTID_3
1	1	Polygon	15	188	188	1
2	2	Polygon	15	188	188	1
3	3	Polygon	18	165	165	1
4	4	Polygon	63	150	150	1
5	5	Polygon	66	32	32	1
6	6	Polygon	68	34	34	1

1 (3777 out of 4274 Selected)

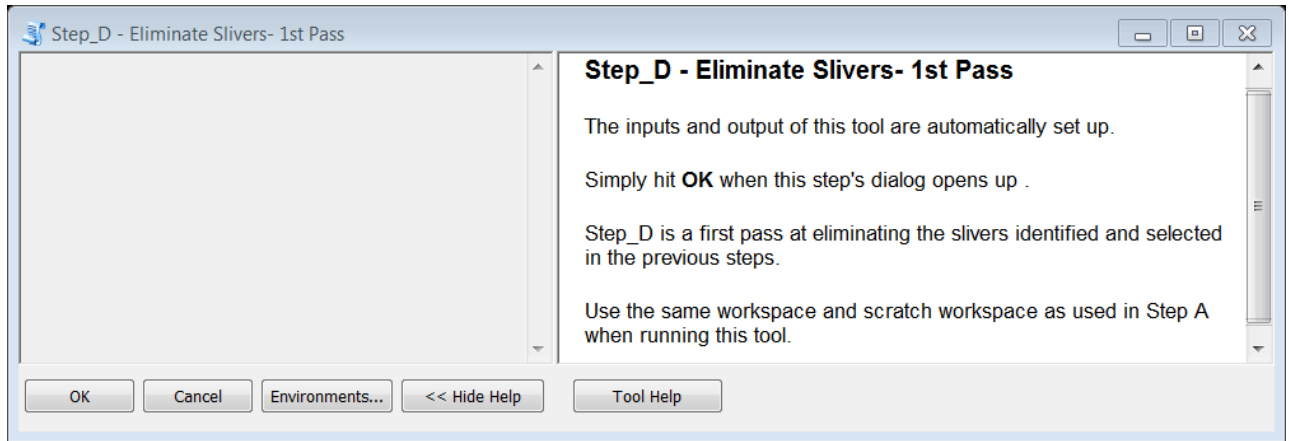
Result_Step_A

G. Run Step D – Eliminate Slivers First Pass

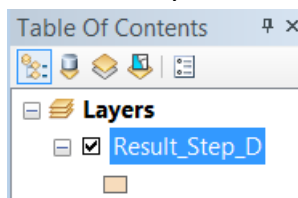
- Double click Step D** in the VI Toolbox to run the script.

- VI_Tool
 - USFS Vertical Integration System_v2_1.tbx
 - Step_A - Merge the REF and LTBU together
 - Step_B - Manually select/inspect slivers; cut slivers at junctions
 - Step_C - Auto-Deselect false slivers
 - Step_D - Eliminate Slivers- 1st Pass

- Notice that the parameters are already set for this tool, so just **click OK** to run.



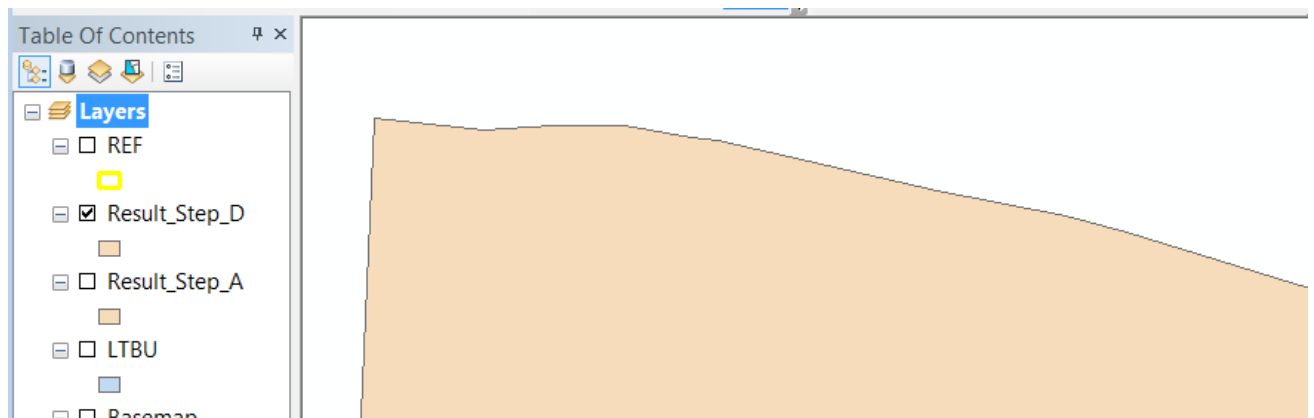
- Step D may take a few minutes to run.** When it is completed the new layer will automatically be added to the TOC.



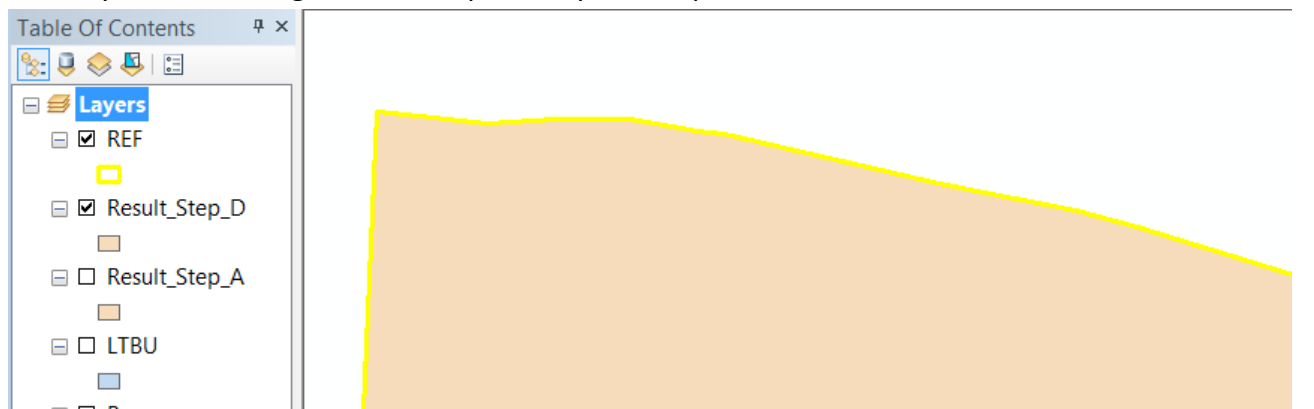
- Right click and **Open Attribute Table for Result_Step_D layer**. Notice that over three quarters of the slivers have been removed.

OBJECTID_12 *	SHAPE *	FID_LTBUS_Select	OBJECTID_1	OBJECTID_2	OBJECTID_12
1	Polygon	270	165	165	<Null>
2	Polygon	326	39	39	<Null>
3	Polygon	374	88	88	<Null>
4	Polygon	383	97	97	<Null>
5	Polygon	392	106	106	<Null>
6	Polygon	392	106	106	<Null>

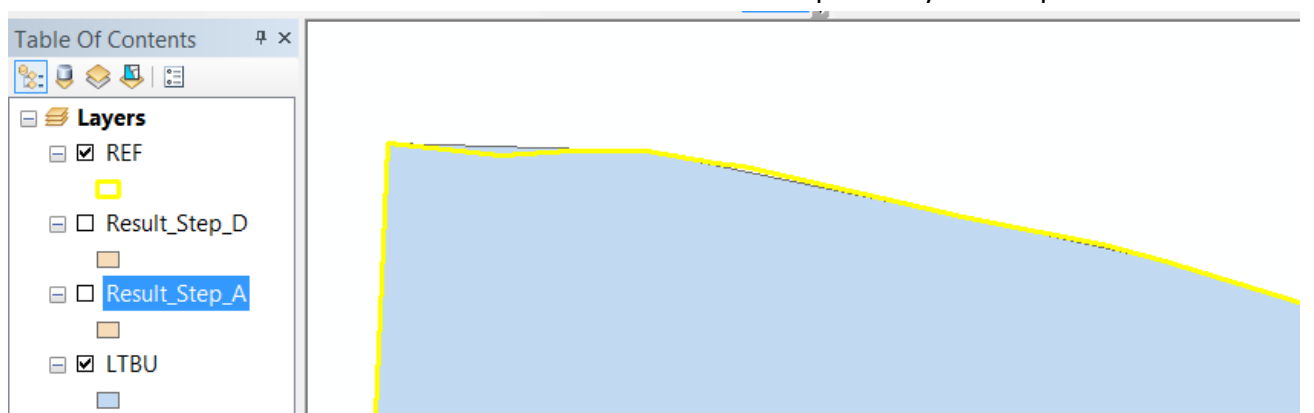
- Uncheck all layers in the TOC except the Result_Step_D layer**, so that it is the only one to draw. **Click on the Bookmarks menu and select Sliver**. Notice that the sliver has been removed.



6. **Move the REF layer up to the top of the TOC and turn it on.** Notice that the Result_Step_D is aligned with the reference layer in this area. This alignment was one of many automatic alignments completed by the script.



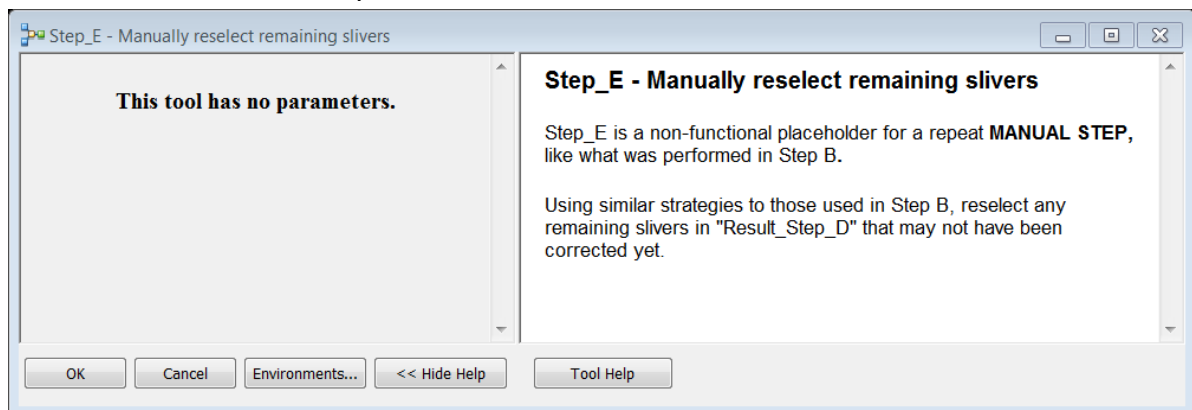
7. **Turn off the Result_Step_D and turn on the LTBU,** to see the update. Feel free to zoom around the data to see other automatic sliver corrections completed by the script.




H. Complete Step E - Manually reselect remaining slivers

For whatever reason, Step D will miss some of the slivers so the process needs to be repeated. Step_E is a non-functional placeholder for a repeat **manual step**, like what was performed in Step B. Using similar strategies to those used in Step B, reselect any remaining slivers in "Result_Step_D" that may not have been corrected yet.

1. In the Catalog window, **double click on the Step E** script to open the window. Notice that this is another placeholder step requiring you to manually select any other slivers that have not been edited yet.



2. If necessary, open the attribute table for the Result_Step_D layer. Click on the **Select by Attribute** button . **Select SHAPE_Area < 100,000 m2.** See screenshot below.

Select by Attributes

Enter a WHERE clause to select records in the table window.

Method : Create a new selection

x_mb_ratio_x
ThinRating
NumAdj
SHAPE_Length
SHAPE_Area

= < > Like
> > = And
< < = Or
_ % () Not
Is In Null Get Unique Values Go To:

SELECT * FROM Result_Step_A WHERE:
SHAPE_Area <100000

- Look in the **Result_Step_D** table to see the selected features. It appears there are around 170 slivers less than 100,000 m2 that need to be removed.

Table

Result_Step_D

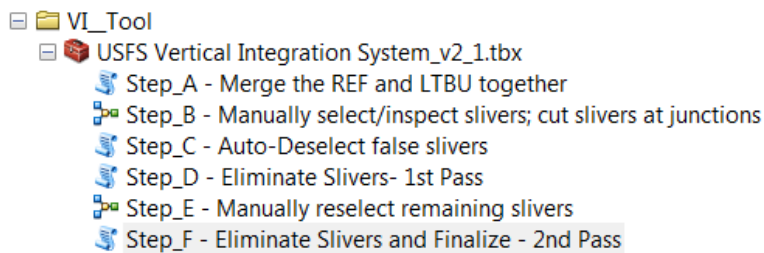
	OBJECTID_12 *	SHAPE *	FID_LTBU_Select	OBJECTID_1	OBJECTID_2	OBJECTID_3
	15	Polygon	-1	0	0	
	16	Polygon	-1	0	0	
	34	Polygon	-1	0	0	
	40	Polygon	-1	0	0	
	125	Polygon	-1	0	0	
	137	Polygon	-1	0	0	

(172 out of 670 Selected)

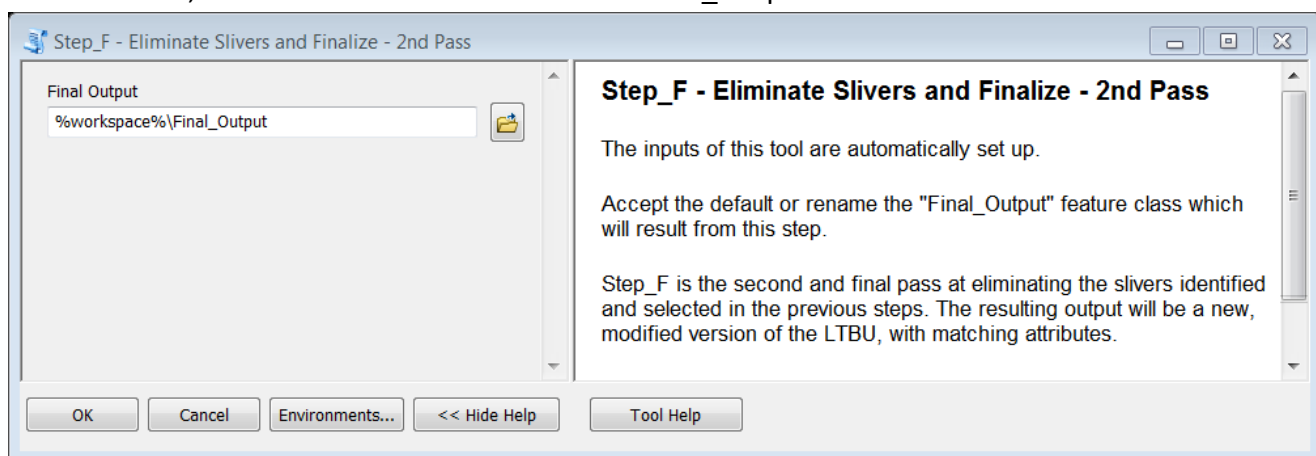
Result_Step_D

I. Run Step F - Eliminate Slivers and Finalize - 2nd Pass

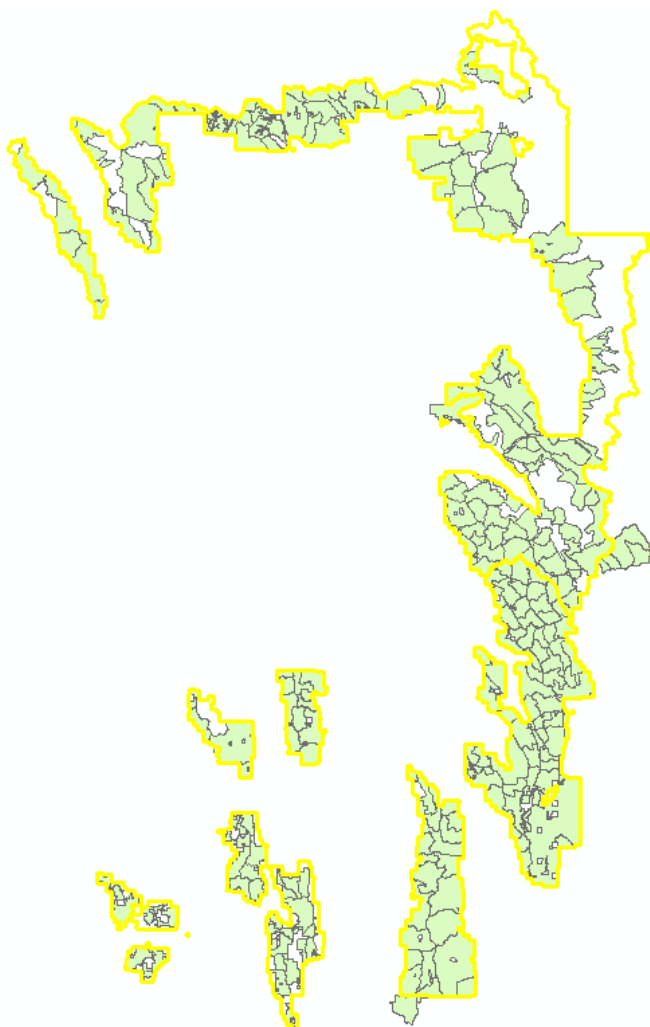
1. In the Catalog Window, **double click the Step F script.**



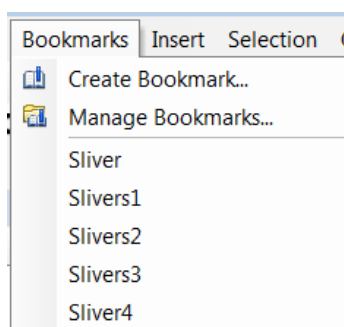
2. In the Step F window it will automatically save to the Workspace you set in the Environments, and it will name the feature class Final_Output. **Click OK** to run the tool.



3. When the script is finished it will add the Final_Output layer to the TOC. **Move the REF layer to the top of the TOC and look at the results.**



4. **Zoom in to all the sliver bookmarks** to make sure they have been fixed.



5. **Open the Attribute Table for the Final_Output layer** to see the results.
There should be around 252 features in the layer. That is because Step F not only

removes the selected sliver features, it also removes all the features from the Result_Step_D that were in the REF boundary but were not in the LTBU.

Table

Final_Output

	OBJECTID_12 *	SHAPE *	OBJECTID_1	OBJECTID_2	OBJECTID	CN	
▶	1	Polygon	152	152	<Null>	10182.010515	5
	2	Polygon	153	153	<Null>	10176.010515	5
	3	Polygon	154	154	<Null>	10177.010515	5
	4	Polygon	155	155	<Null>	10264.010515	2
	5	Polygon	156	156	<Null>	10179.010515	5
	6	Polygon	157	157	<Null>	10259.010515	2

1 (0 out of 252 Selected)

Final_Output

- If this was your own project, you would want to be very familiar with the data and spend a good amount of time looking for potential errors needing a manual fix. You may want to individually inspect all the features below your management thresholds to make sure the script doesn't delete real management areas.

Congratulations, you have completed this Exercise!