Exercise 8 – Creating a Land Cover Layer with Topology Rules

Session Objectives: At the conclusion of this session, you will be able to:

- ❑ Delineate & attribute a simple land cover map
- ❑ Create a Topology feature class and add rules
- ❑ Validate the topology
- ❑ Fix topological errors in a feature class

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Revision: Gabriel DeAlessio (May 2010)

Revision: Eric Kelchlin (December 2013)

Software: ArcGIS 10, SP5

Directory Path: CSP7200\Exercise8

GDB: Execise8.gdb

Imagery: Aerial_2009.sid

MXD: Exerc8.mxd

SECTION 1 – Heads-up Digitizing in ArcMap 10

Digitizing landscape features from aerial photos or satellite imagery represents the most basic technique of mapping vegetation. Sometimes this level of detail is all you need, or in most cases, all you can afford giving time and budget constraints. This technique works best for general land cover features such as forest, grassland, agriculture and developed land. Small plant communities or species of interest that are poorly defined in the imagery can be captured with a GPS unit on the ground and added to the map later on.

All data are located in CSP7200\Exercise8, unless otherwise stated.

TASK 1 – Add a Domain and New Field

1. Launch ArcMap and open the **Exec8.mxd**.

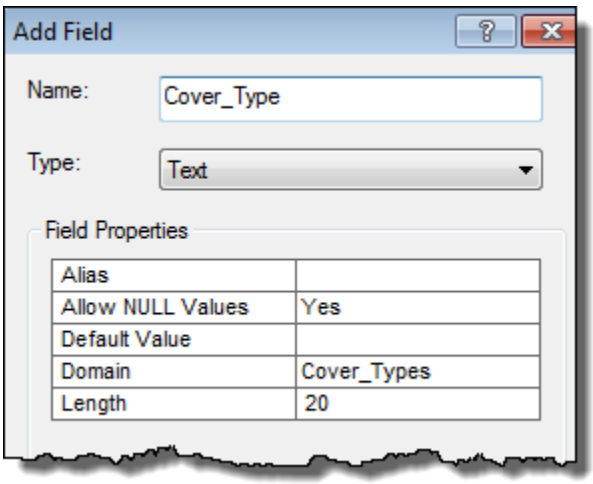
2. To make attributing polygons easier, let's add a **Cover_Type** field and a domain to generate a simple drop-down list.

   - First, create a new domain. Open ArcCatalog on the sidebar and right-click on the **Exercise8.gdb**. Select Properties and the Domains tab.

   - Name the new domain **Cover_Types** and add a description.

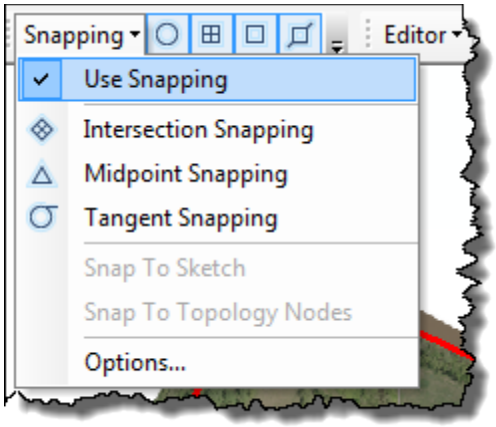
   - Change the Field Type to Text and add the following cover types in both the Code and Description fields: <u>Forest, Field, Developed and Water</u>.

   - Open the **Land_Cover** attribute table and create the new **Cover_Type** text field. Give the field a text length of 20 and assign the domain we just created to the domain field.



TASK 2 – Set Editing Preferences and begin Editing

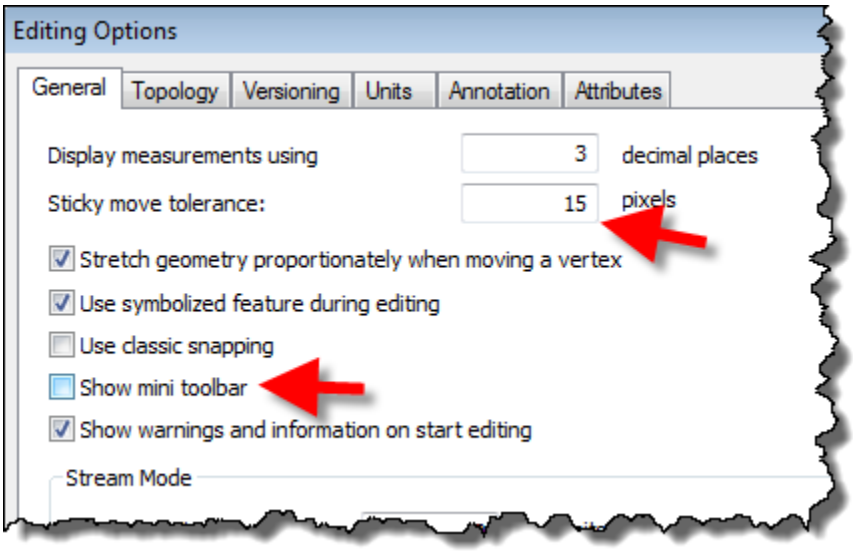
1. From the **Editor** Toolbar, select Snapping > Snapping Toolbar. Dock the new toolbar.



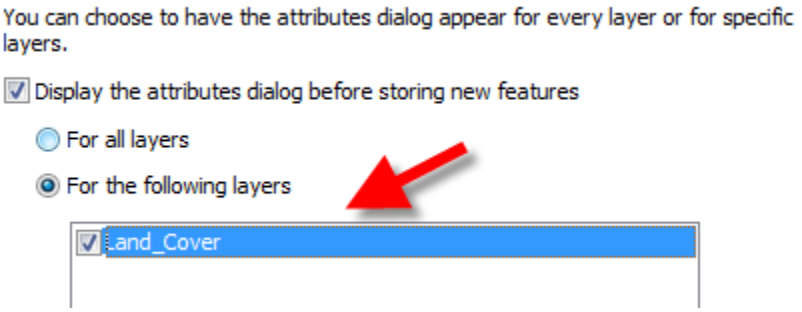
2. From the Snapping Toolbar select Options and ensure the Snapping Tolerance is set to 10 units. Also, make sure to enable Use Snapping by selecting it.

3. From the Editor Toolbar, select Options and ensure that the Sticky move tolerance is set to 15-20 pixels to avoid accidental polygon moves.

   - Also, uncheck the Show mini toolbar box to hide a really annoying tool.



4. Click on the Attributes tab and have the attribute dialog pop-up after each polygon is created.



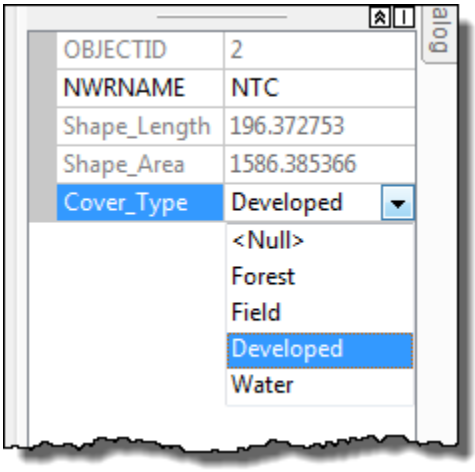
5. Start an editing session from the Editor Toolbar. The objective is to create polygons that are perfectly aligned so there are no gaps, dangles or overlaps. To do this you start from a single polygon, like we have here, and digitize new smaller polygons using the Cut Polygon Tool.

   - First select the single large polygon using the Edit Tool .
   - Zoom into the area you want to work-on using the mouse scroll wheel.
   - Select the Cut Polygon Tool from the Editor Toolbar. In order to make a cut you use one of two strategies:

     i. Start cutting the smaller polygon <u>outside</u> the boundary of the larger selected polygon and then double-clicking <u>outside</u> again to complete.

     ii. Overlap the polygon on itself to finish the cut. This works great for smaller land cover features that are "islands" within the large selected polygon.

6. Assign the polygon a cover type by first selecting the polygon with the Edit Tool , then click the Attribute Tool and select the cover type from our domain that we created earlier.



7. Repeat these processes for a few more polygons to get the idea. If you make a mistake remember that the Undue Tool is a lifesaver!

8. Stop Editing and Save Edits.

SECTION 3 – Heads-up Digitizing with Topology

TASK 1 - Establish Topology Rules

The land cover layer you just built was created without topology rules and as a result, the layer has no topological integrity. In layman's terms; the polygons may or may not border each other correctly.

In this part of the exercise, we will use the LC_Premade feature class, one that has common errors that sometimes occur when editing. Some polygons overlap their neighbors, while others don't come close enough and leave gaps. We're going to apply the following topological rules (i.e., relationships) in the geodatabase to clean-up the mess:

Rule 1 A polygon cannot exist in the space as another polygon or overlap;

Rule 2 All polygon boundaries are contiguous and there are no gaps between polygons; and

Rule 3 **LC_Premade** feature class must cover the **Boundary** feature class.

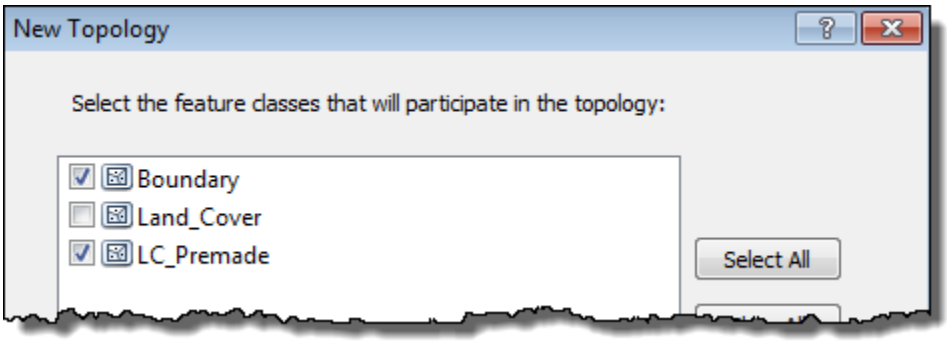
1. Close ArcMap and open ArcCatalog.

2. To make a new topology, simple browse to the **Exercise8.gdb**. Right-click on the **NCTC** feature dataset, select **New** and choose **Topology**.

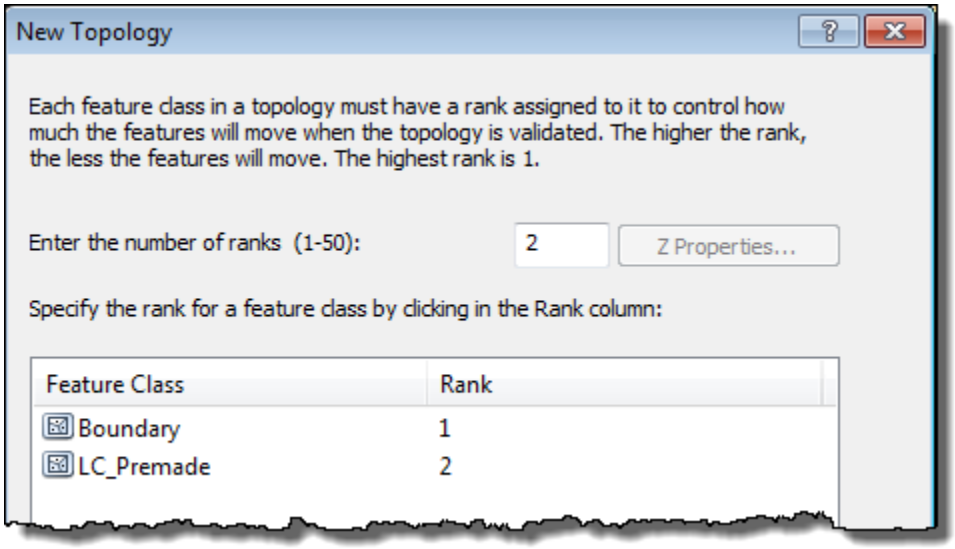
3. A **New Topology** dialog appears. Read the overview information. Click Next.

4. Name the new topology **Landcover_Topology**. Accept the default tolerances. Click Next.

5. Select **Boundary** and **LC_Premade** to participate in the topology. Click Next.



6. Enter the number of ranks to be **2**. Then, change the rank values as shown below. Click Next.

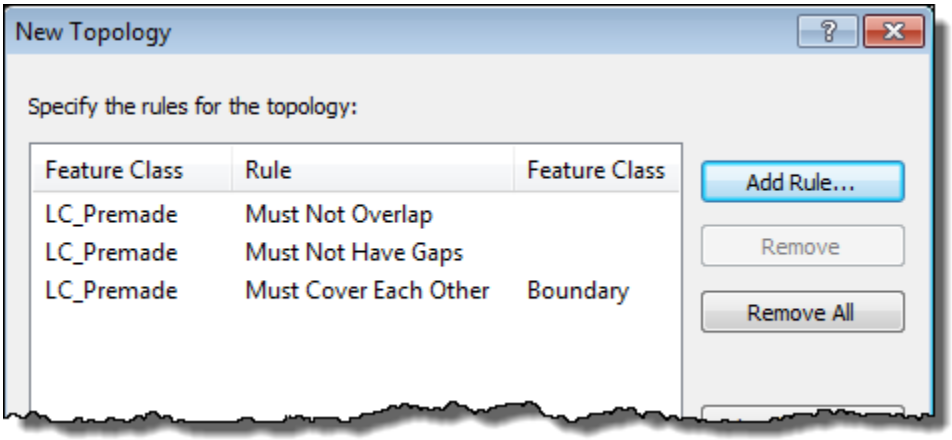


<u>What does this ranking mean?</u> Feature classes of a lower rank will be snapped to feature classes of a higher rank. So, in this example, the landcover layer will be adjusted to the boundary layer. The boundary is ranked the highest because we want to minimize any adjustment of this feature.

7. Select **Boundary** and **LC_Premade** to participate in the topology. Click Next.

8. Use the

button to add the following 3 rules:



9. Click OK when finished adding the topology rules. A summary appears in the New Topology dialog. Click Finish.

10. Choose **NO** when asked to validate the topology. We will validate the topology and fix any errors using ArcMap in the next section.

Why did we select these topology rules?

Must Not Overlap – Requires that the interior of polygons in the feature class not overlap. The polygons can share edges or vertices. This rule is used when an area cannot belong to two or more polygons. It is useful for modeling administrative boundaries, such as ZIP Codes or voting districts, and mutually exclusive area classifications, such as land cover or landform type.

Must not have gaps – This rule requires that there are no voids within a single polygon or between adjacent polygons. All polygons must form a continuous surface. An error will always exist on the perimeter of the surface. You can either ignore this error or mark it as an exception. Use this rule on data that must completely cover an area. For example, soil polygons cannot include gaps or form voids—they must cover an entire area.

Must Cover Each Other – Requires that the polygons of one feature class must share all of their area with the polygons of another feature class. Polygons may share edges or vertices. Any area defined in either feature class that is not shared with the other is an error. This rule is used when two systems of classification are used for the same geographic area, and any given point defined in one system must also be defined in the other. One such case occurs with nested hierarchical datasets, such as census blocks and block groups or small watersheds and large drainage basins. The rule can also be applied to nonhierarchically related polygon feature classes, such as soil type and slope class.

For complete listing of rules and fixes, open the ArcGIS help and look up topology rules.

TASK 2 – Validate Topology & Must Cover Each Other Errors

1. Close ArcCatalog and return to ArcMap.

2. Add the topology to the map. Click **Add Data** and browse to the topology.

   - When prompted, click **Yes** to add all associated feature classes.

3. Zoom to Full Extent if the entire boundary is not visible. It's time to validate to see to see if and where errors exist within the feature classes.

4. Right-click in the top menu section of ArcMap and check the box next to Topology to load the toolbar.

5. Start an editing session.

6. Click the **Validate Entire Topology** button.

7. Click **Yes** when asked if you are really sure you want to validate the full extent. Yikes, look at all that red!

8. Click the **Error Inspector** tool. This tool allows you to manage and interact with the topology errors on your map. You can search for violations of specific topology rules or for exceptions (errors that you mark as acceptable). You can also choose whether to inspect the currently visible extent or the entire topology.

9. Click the **Search Now** button. You should find 21 errors total.

Error Inspector

Show: <Errors from all rules> 21 errors Search Now Errors Except

Rule Type	Class 1	Class 2	Shape	Feature 1	Feature 2	Exception
Must Not Have Gaps	LC_Premade		Polyline	0	0	False
Must Not Have Gaps	LC_Premade		Polyline	0	0	False
Must Not Have Gaps	LC_Premade		Polyline	0	0	False
Must Not Have Gaps	LC_Premade		Polyline	0	0	False
Must Not Have Gaps	LC_Premade		Polyline	0	0	False
Must Not Have Gaps	LC_Premade		Polyline	0	0	False
Must Not Have Gaps	LC_Premade		Polyline	0	0	False

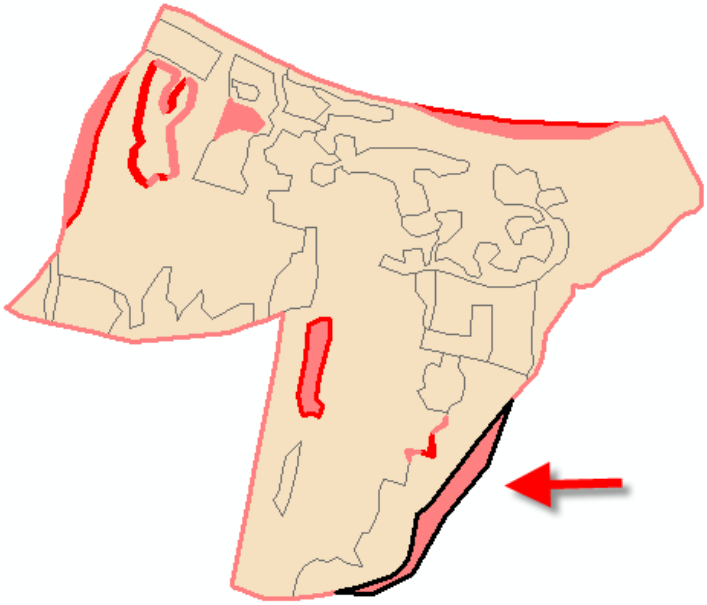
10. Click on Down Arrow and Select **Must Cover Each Other.** Click **Search Now**.

11. Click on the first error in the Error Inspector. Notice how the identified error turns black on the map.

Error Inspector

Show: LC_Premade - Must Cover Each Other - Boundary 9 errors Search Now Errors Exceptions

Rule Type	Class 1	Class 2	Shape	Feature 1	Feature 2	Exception
Must Cover Each Other	LC_Premade	Boundary	Polygon	4	0	False
Must Cover Each Other	LC_Premade	Boundary	Polygon	0	1	False
Must Cover Each Other	LC_Premade	Boundary	Polygon	0	1	False
Must Cover Each Other	LC_Premade	Boundary	Polygon	0	1	False
Must Cover Each Other	LC_Premade	Boundary	Polygon	0	1	False
Must Cover Each Other	LC_Premade	Boundary	Polygon	0	1	False
Must Cover Each Other	LC_Premade	Boundary	Polygon	0	1	False
Must Cover Each Other	LC_Premade	Boundary	Polygon	0	1	False
Must Cover Each Other	LC_Premade	Boundary	Polygon	13	0	False



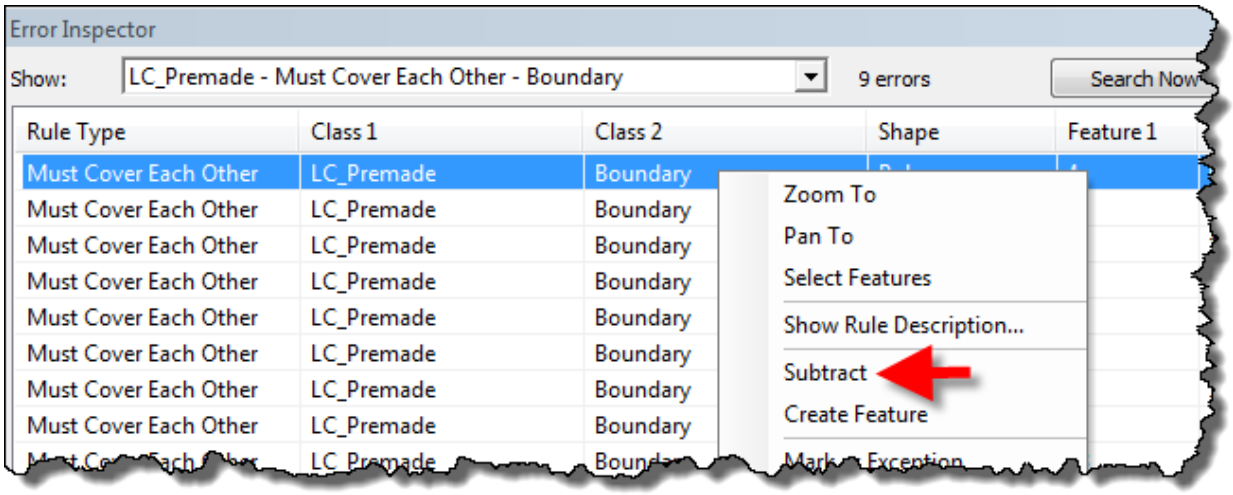
12. Close inspection reveals that the polygon lies outside the NCTC Boundary.

    To fix errors identified by the **Must Be Covered By Feature Class Of** rule we two options:

    Subtract: removes the overlapping portion of each feature that is causing the error so the boundary of each feature from both feature classes is the same.

    Create Feature: creates a new polygon feature out of the portion of the overlap from the existing polygon so the boundary of each feature from both feature classes is the same.

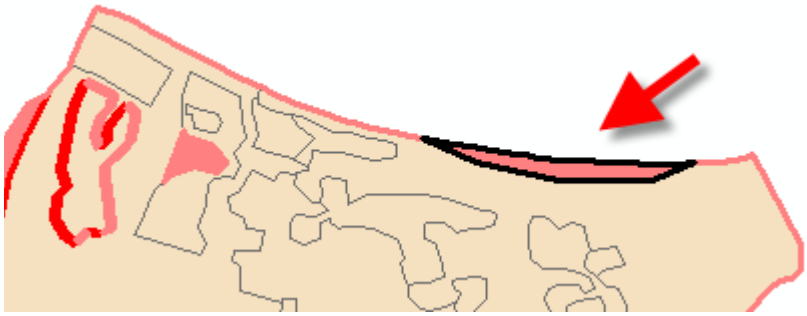
13. With this error selected, **Right click** on the selected line inside the dialog and select **Subtract**. This will remove this area completely from the **LC_Premade** layer (reshaping the layer's boundary). **Do not** use **Create Feature** as this fix will modify the NCTC Boundary, which we know is correct and don't want to change.



- Now let's **Validate Entire Topology** again to make sure we fixed the problem.

14. Another way to correct topology is to use the **Fix Topology Error Tool** . Activate the tool on the toolbar by **left clicking** on it.

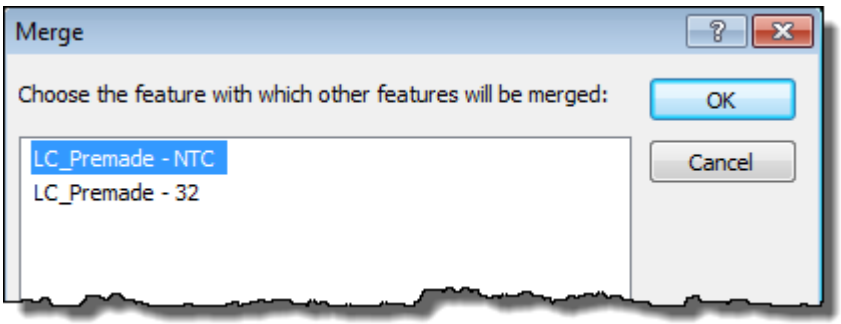
    - With the tool active, select the error in the northeast.



15. Looking closely will reveal that there is a gap in the landcover between the NCTC Boundary and the existing landcover polygons. To correct, we need to **right click** and select **Create Feature** to add in a polygon.

    - Once the feature is added, open the **Attribute** tool. You will notice that it lacks any attribute data. You can code it individually or choose to merge it to an adjacent feature.

    - **Select** both the new polygon and the Forest polygon to the south. Then in the **Editor Menu**, select **Merge**. Be sure to select the feature with attributes to Merge to rather than the new one to retain those attributes!



    - Now let's **Validate Entire Topology** again to make sure we fixed the problem.

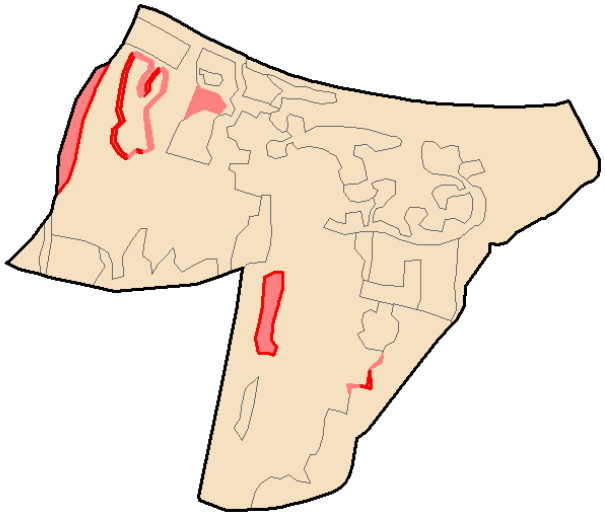
    - Notice this error is gone now. Leave the remaining errors for now, we'll fix them later.

TASK 3 – Must Not Have Gaps

In this section we'll examine the MUST NOT HAVE GAPS errors. This is one of the few rules that will ALWAYS generate an error. This is because you will always have an 'end' to your polygons extents, and therefore a 'gap' where they do not touch another. We will start by marking this error as an exception

Must Not Have Gaps	This rule requires that there are no voids within a single polygon or between adjacent polygons. All polygons must form a continuous surface. **An error will always exist on the perimeter of the surface.** You can either ignore this error or mark it as an exception. Use this rule on data that must completely cover an area. For example, soil polygons cannot include gaps or form voids—they must cover an entire area.

1. Click on the **Fix Topology Error Tool** and click on the boundary so that it has a black outline.



- Click the **Error Inspector** button. Notice there is only one error shown. Since this one error will always show up when we inspect, let's make it an exception so it won't appear again. That way, only the errors we are concerned with will be displayed.

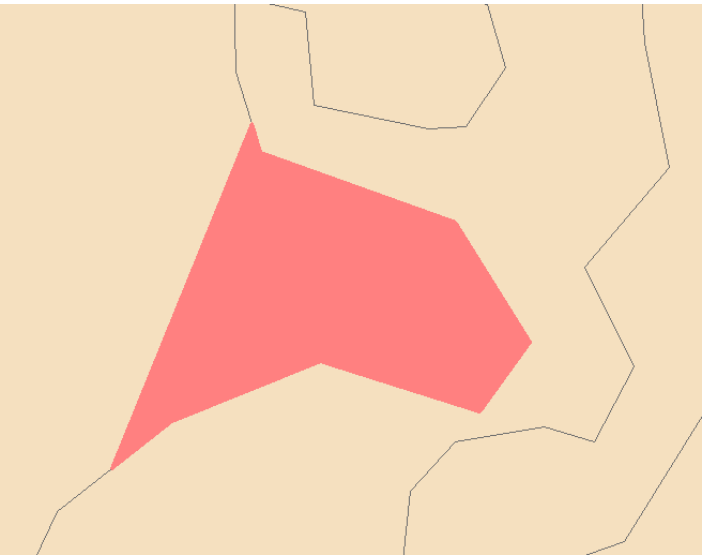
- Right click on the error in the Error Inspector dialog and choose **Mark as Exception**.

- **Validate the Entire Topology** again to make sure we fixed the problem.

- Close the **Error Inspector** dialog.

Tip: If you need to go back to the error you marked as an exception, in the Error Inspector check Exceptions and click Search Now. Notice if you Right click on the Exception you can choose Mark as Error.

2. Let's look at actual errors now. Zoom into the error as shown below.



- Click the **Error Inspector** button.
- Click the **Search Now** button to quickly find this error.
- Select the error in the Error inspector dialog. The polygon should have a black outline.
- To fix this error – Right click and select **Create Feature**, which will create a new polygon feature within **LC_Premade** (getting rid of the gap). If you had multiple errors and use selected them all and used the Create Feature fix, the result will be one polygon feature per gap. So, be careful.

3. Open the Attribute table and Attribute the new polygon to Developed.

OBJECTID	35
NWRNAME	<Null>
Classification	Developed
Acreage	
Shape_Length	459.507047
Shape_Area	8962.922456

4. **Validate the Entire Topology** again to make sure we have fixed the problem.

TIP: After any polygon editing session; including the subtracting and creating and merging we just did, remember your Acreages are no longer accurate! ALWAYS recalculate your Acreages after editing shapes.

TASK 4 – Must Not Have Overlap

In this section, we will zoom-in to an area where polygons are overlapping. Since a land cover can only have 1 attribute per location, these are errors that need to be corrected. Overlapping polygons also lead to double counting of acreages.

1. Zoom to full extents .

2. Click the **Error Inspector** button. Click **Search Now**.

3. Select the "**Must Not Have Overlap**" error to identify the error on the map.

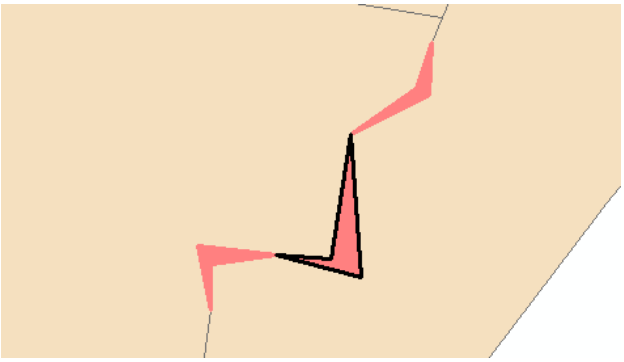
   To fix errors identified by the **Must Not Have Overlap** rule we have **3** options within the error inspector:

   Subtract: removes the overlapping portion from each feature and leaves a gap or void in its place. This fix can be applied to one or more selected Must Be Covered By Feature Class Of errors.

   Merge: adds the portion of overlap from one feature and subtracts it from the others that are violating the rule. You need to pick the feature that receives the portion of overlap in the Merge dialog box that pops up. This fix can be applied to one Must Not Overlap error only.

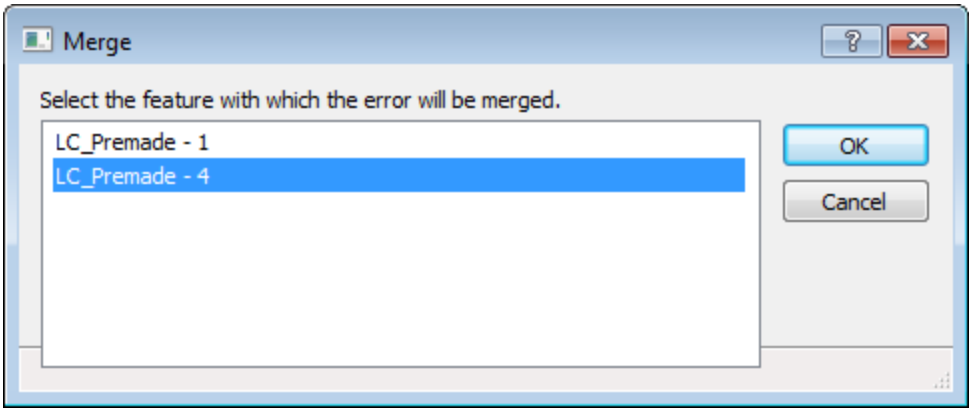
   Create Feature: creates a new polygon feature out of the error shape and removes the portion of overlap from each of the features. The fix can be applied to one or more selected Must Be Covered By Feature Class Of errors.

4. Select the error highlighted below using the **Fix Topology Error Tool**



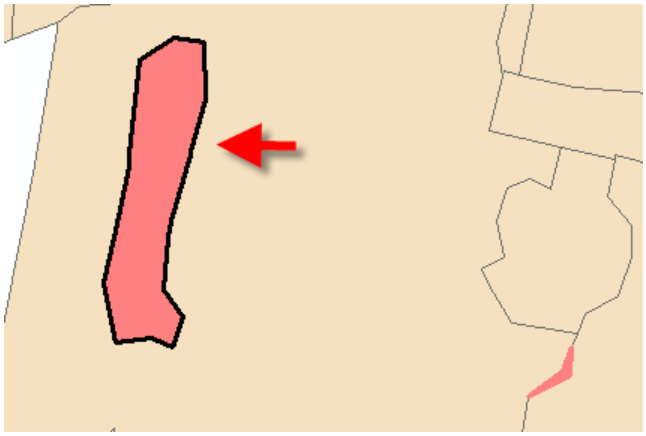
- Right click on the topology and select **Merge.** **Do Not** use Create Feature (which will make new polygons) or Subtract (which will create slivers in the LC_Premade feature class).

- Based on the underlying land cover, select the second feature on the list and click **OK**.



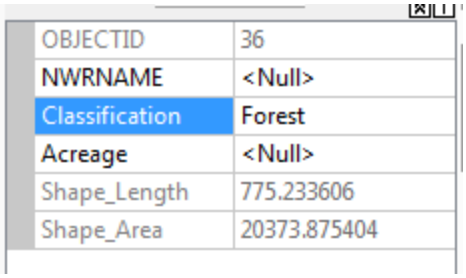
- **Validate the Entire Topology** again to make sure we fixed the problem.

5. Next, select the large overlapping error as shown below. We need to make sure only 1 polygon exists.

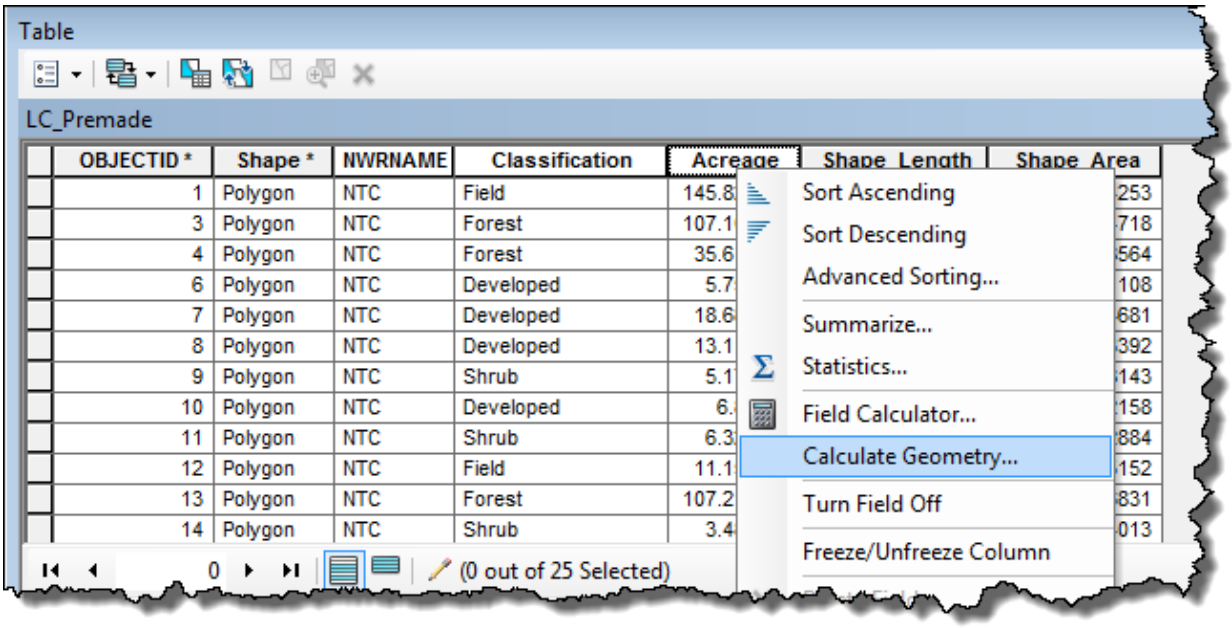


- **Right click** and choose **Create Feature**. This forces 2 simultaneous actions: 1) it subtracts the shape from the underlying polygon and 2) it creates a new feature in the same location.

- Identify on the new feature. You will notice the attribute has been lost since the Create Feature removes the existing and replaces it with a new polygon. You can attribute the new polygon to Forest.



OBJECTID	36
NWRNAME	<Null>
Classification	Forest
Acreage	<Null>
Shape_Length	775.233606
Shape_Area	20373.875404

- **Validate the Entire Topology** again to make sure we fixed the problem.
- Stop editing and save edits.

6. <u>If time permits:</u> Using the skills learned in this exercise; restart editing and continue fixing any remaining topological errors. Remember to right-click on the Acreage field and Calculate the Geometry to generate the correct acres. It's not automatic.