

Module 3

Objectives and Tasks

Create a Curvature Map and Intersect with a Soil Layer

- Review Slope Curvature Model
- Curvature - Region Group Step 1 Model
- Curvature - Nibble Step 2 Model
- Symbolize & Evaluate Curvature Layer
- Intersect Curvature Shapefile and Soil Layer
- Export Soil\Curvature Intersect Data Table
- Summarize Curvature by Map Units

The directory structure listed below must exist for the Curvature Models to function properly:

1. **“C:\WorkSpace\spatial\tmp”**
2. **“C:\WorkSpace\spatial\curvature”**
3. **“C:\WorkSpace\spatial\curvature\shapefile”**

Review Curvature Model

Layers & data derived from Curvature Analysis provides users with a picture of the overall slope shape -- what areas are convex, concave and linear.

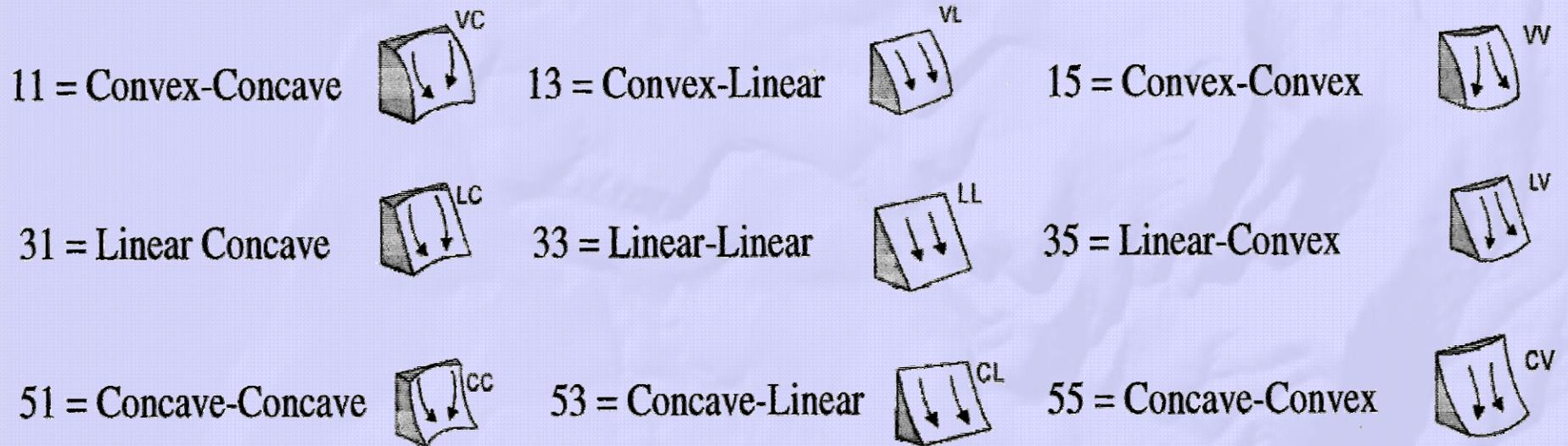
This information allows us to separate erosional and depositional surfaces; this is significant for soil genesis.

The layers created from the Curvature Model can be used to assist in pre-mapping or to adjust existing soil lines.

The intersection of curvature shapefiles and soil polygons provides statistical information on slope shape for each map unit. This could help determine map unit composition.

Review Curvature Model, cont.

The output from the Curvature Model is a grid. Each cell value is a composite of 2 values that represent slope shapes that are the perpendicular (profile) and parallel (planar) to the slope. The composite grid delineates the 9 different slope shapes.

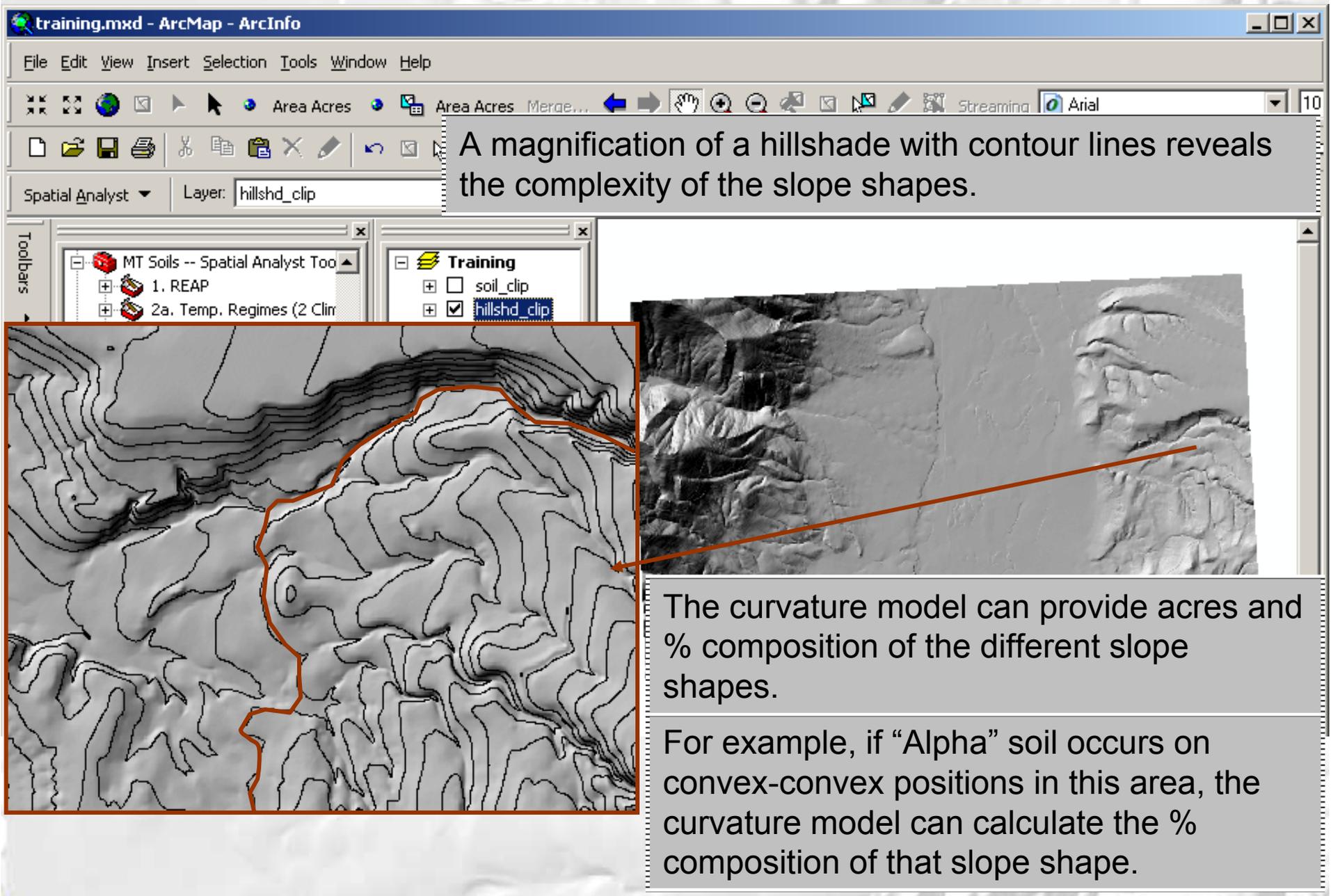


The first number represents values from the profile grid (up slope) and the second number represents the values from the planar grid (across slope).

Profile grid (upslope): 1 = Convex 3 = Linear 5 = Concave

Planar grid (across slope): 1 = Concave 3 = Linear 5 = Convex

Review Curvature Model, cont.



The screenshot shows the ArcMap interface with a map titled "training.mxd". The map displays a hillshade with contour lines. A red line highlights a specific area on the map. A magnified view of this area is shown in the bottom right, revealing the complex curvature of the terrain. The interface includes a menu bar (File, Edit, View, Insert, Selection, Tools, Window, Help), a toolbar with various navigation and analysis tools, and a layer list on the left. The layer list shows "hillshd_clip" selected under the "Training" folder. The text "A magnification of a hillshade with contour lines reveals the complexity of the slope shapes." is overlaid on the map area.

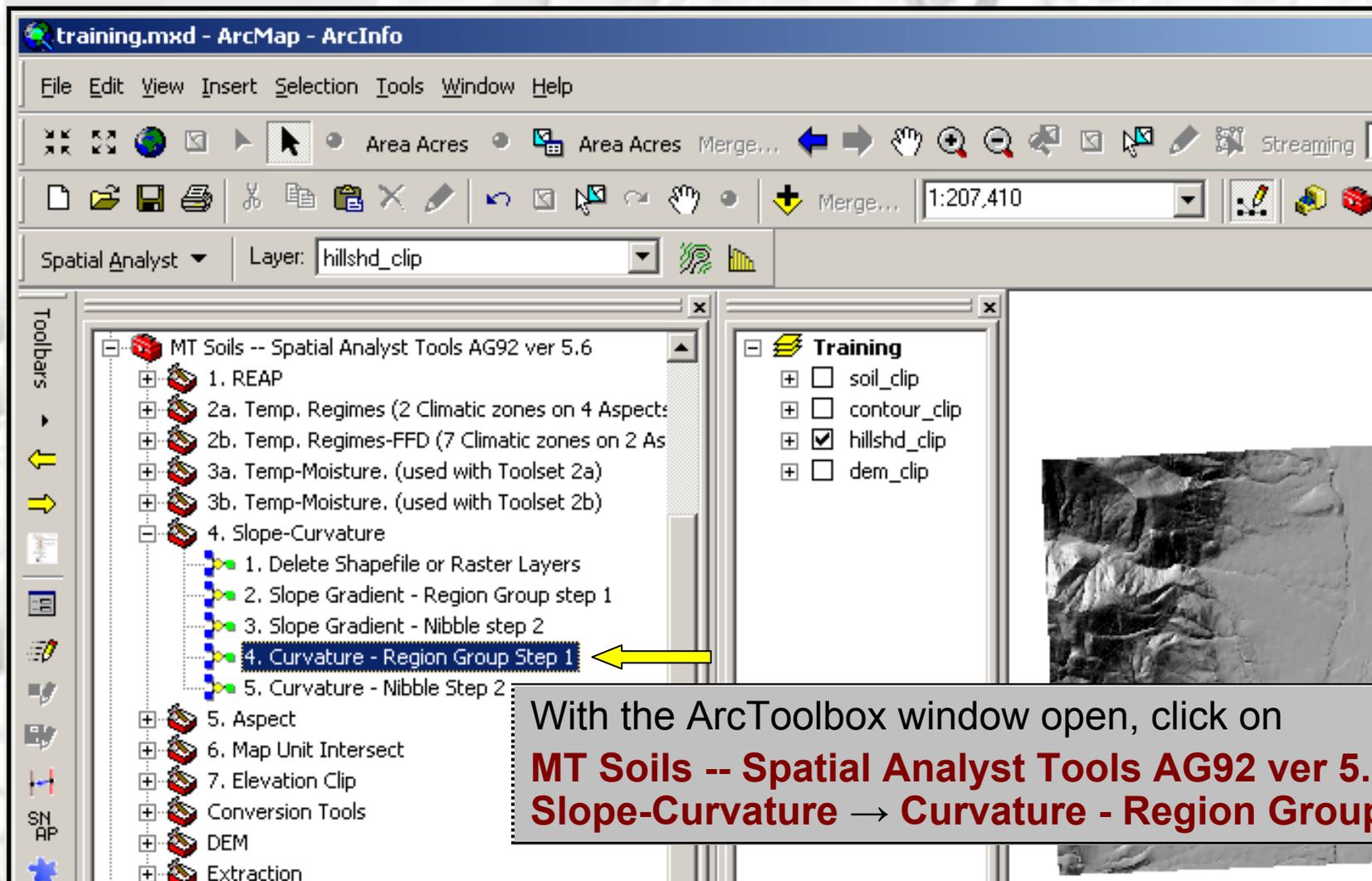
A magnification of a hillshade with contour lines reveals the complexity of the slope shapes.

The curvature model can provide acres and % composition of the different slope shapes.

For example, if "Alpha" soil occurs on convex-convex positions in this area, the curvature model can calculate the % composition of that slope shape.

Curvature - Region Group Step 1

In this exercise, an elevation raster (“*dem_clip*”) is used to produce a curvature (slope shape) raster.



The screenshot shows the ArcMap interface with the following components:

- Training Window:** Lists layers: soil_clip, contour_clip, hillshd_clip, and dem_clip.
- ArcToolbox Window:** Shows a tree structure under "MT Soils -- Spatial Analyst Tools AG92 ver 5.6". The path "4. Curvature - Region Group Step 1" is highlighted with a blue selection box and a yellow arrow pointing to it.
- Main Map Area:** Displays a grayscale hillshade map of a terrain.

With the ArcToolbox window open, click on
MT Soils -- Spatial Analyst Tools AG92 ver 5.6 →
Slope-Curvature → **Curvature - Region Group Step 1**

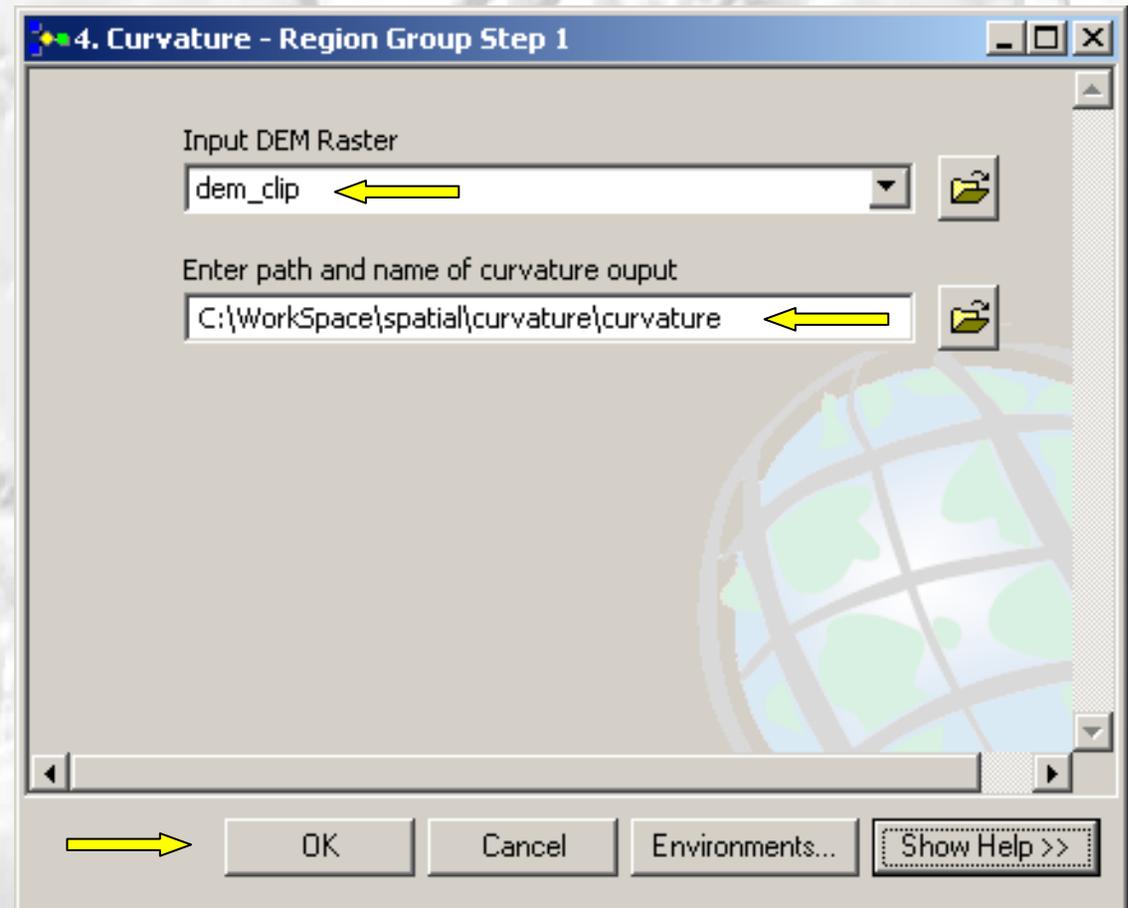
Curvature - Region Group Step 1, cont.

In the **Curvature - Region Group Step 1** dialog box:

Select a DEM for the **Input DEM Raster** field.

Under the **Enter path and name of curvature output** field, the user can choose their own file name and location or accept the default value.

Click "**OK**" to run the model.

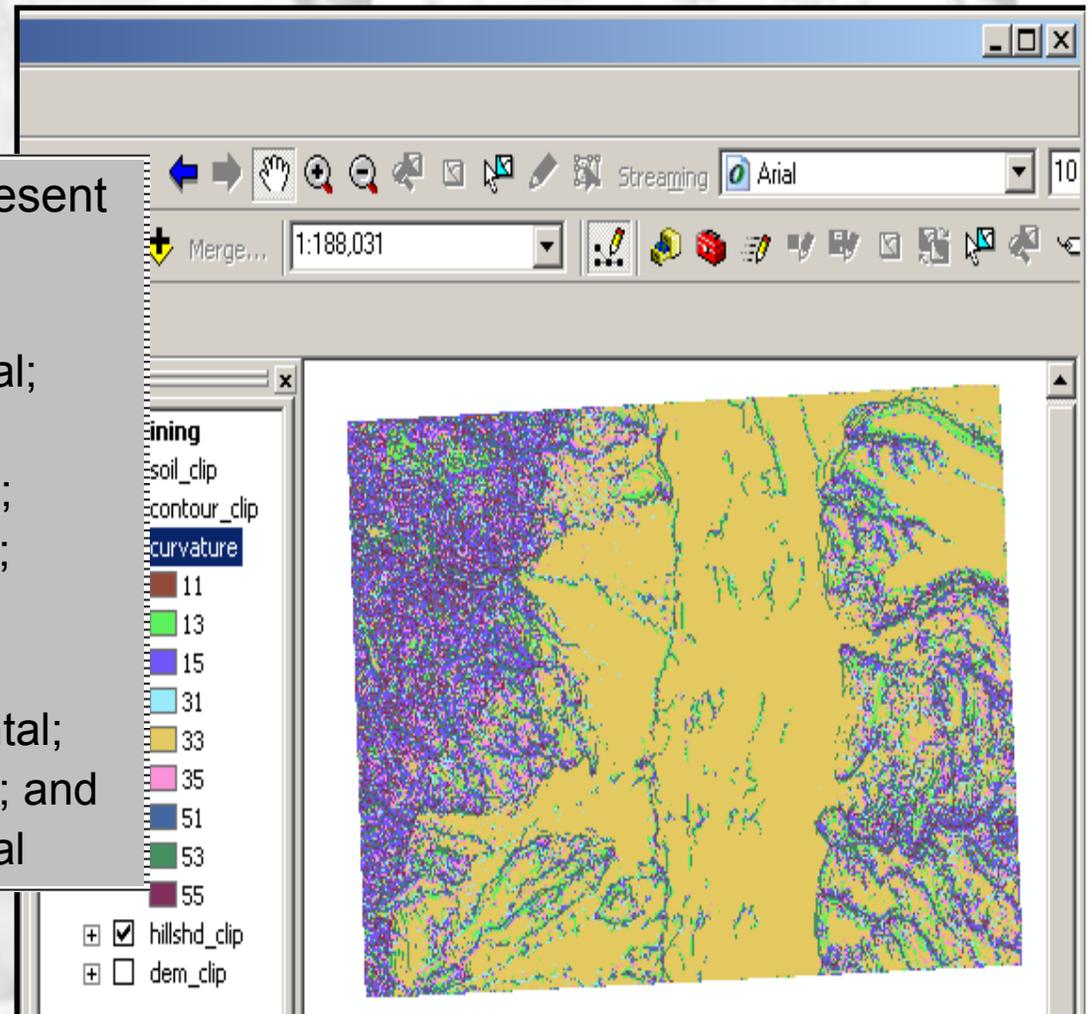


Curvature - Region Group Step 1, cont.

After running the “Curvature - Region Group Step 1” model, a curvature raster is automatically added to the project. This raster will include many small curvature delineations.

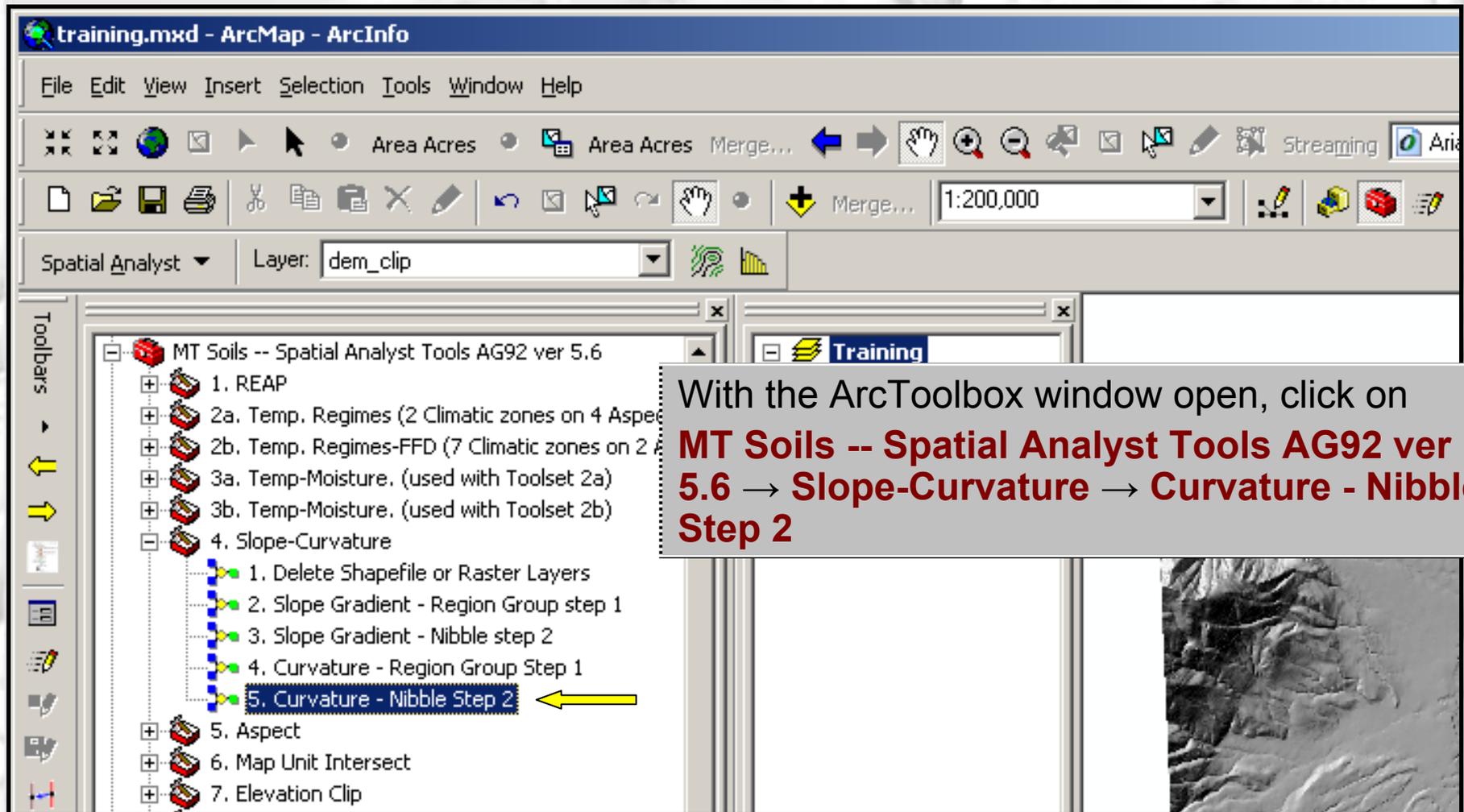
The values from curvature raster represent the following slope shapes:

- 11** = Convex vertical, Concave horizontal;
- 13** = Convex vertical, Linear horizontal;
- 15** = Convex vertical, Convex horizontal;
- 31** = Linear vertical, Concave horizontal;
- 33** = Linear vertical, Linear horizontal;
- 35** = Linear vertical, Convex horizontal;
- 51** = Concave vertical, Concave horizontal;
- 53** = Concave vertical, Linear horizontal; and
- 55** = Concave vertical, Convex horizontal



Curvature - Nibble Step 2

The “Curvature – Nibble Step 2” model creates a curvature raster and shapefile. The nibble function reduces the number of very small slope delineations. This process will allow for faster processing times when intersecting these outputs with a soil layer.



The screenshot displays the ArcMap interface. The title bar reads "training.mxd - ArcMap - ArcInfo". The menu bar includes File, Edit, View, Insert, Selection, Tools, Window, and Help. The toolbar contains various navigation and analysis tools. The Spatial Analyst toolbar is active, showing the "Layer: dem_clip" dropdown. The ArcToolbox window is open, displaying a list of tools under "MT Soils -- Spatial Analyst Tools AG92 ver 5.6". The tool "5. Curvature - Nibble Step 2" is highlighted with a blue selection box and a yellow arrow pointing to it. A text box overlay on the right side of the screenshot provides instructions: "With the ArcToolbox window open, click on **MT Soils -- Spatial Analyst Tools AG92 ver 5.6** → **Slope-Curvature** → **Curvature - Nibble Step 2**".

training.mxd - ArcMap - ArcInfo

File Edit View Insert Selection Tools Window Help

Area Acres Merge... 1:200,000

Spatial Analyst Layer: dem_clip

Toolbars

MT Soils -- Spatial Analyst Tools AG92 ver 5.6

- 1. REAP
- 2a. Temp. Regimes (2 Climatic zones on 4 Aspects)
- 2b. Temp. Regimes-FFD (7 Climatic zones on 2 Aspects)
- 3a. Temp-Moisture. (used with Toolset 2a)
- 3b. Temp-Moisture. (used with Toolset 2b)
- 4. Slope-Curvature
 - 1. Delete Shapefile or Raster Layers
 - 2. Slope Gradient - Region Group step 1
 - 3. Slope Gradient - Nibble step 2
 - 4. Curvature - Region Group Step 1
 - 5. Curvature - Nibble Step 2
- 5. Aspect
- 6. Map Unit Intersect
- 7. Elevation Clip

With the ArcToolbox window open, click on **MT Soils -- Spatial Analyst Tools AG92 ver 5.6** → **Slope-Curvature** → **Curvature - Nibble Step 2**

Curvature - Nibble Step 2, cont.

All data entries for this model have been pre-populated with default values. Click **OK** if changes are not required.

In the **Curvature - Nibble Step 2** dialog box:

The curvature raster created in step 1 is automatically loaded into the **Input curvature raster** field.

The **Size of generalization** determines the degree of filtering or generalization that will occur. A value of 5 represents about 1/8 of an acre for a 10 meter DEM. Values greater than 5 are not recommended. If filtering is not wanted, accept the default value of 0.

A default value for the generalized curvature raster has been entered into the **Name of generalized curvature raster** field.

A default value for the curvature shapefile has been entered into the **Directory and name of curvature shapefile** field.

5. Curvature - Nibble Step 2

Input curvature raster
C:\Workspace\spatial\curvature\curvature

Size of generalization
0

Name of generalized curvature raster
C:\WorkSpace\spatial\curvature\curve_gen

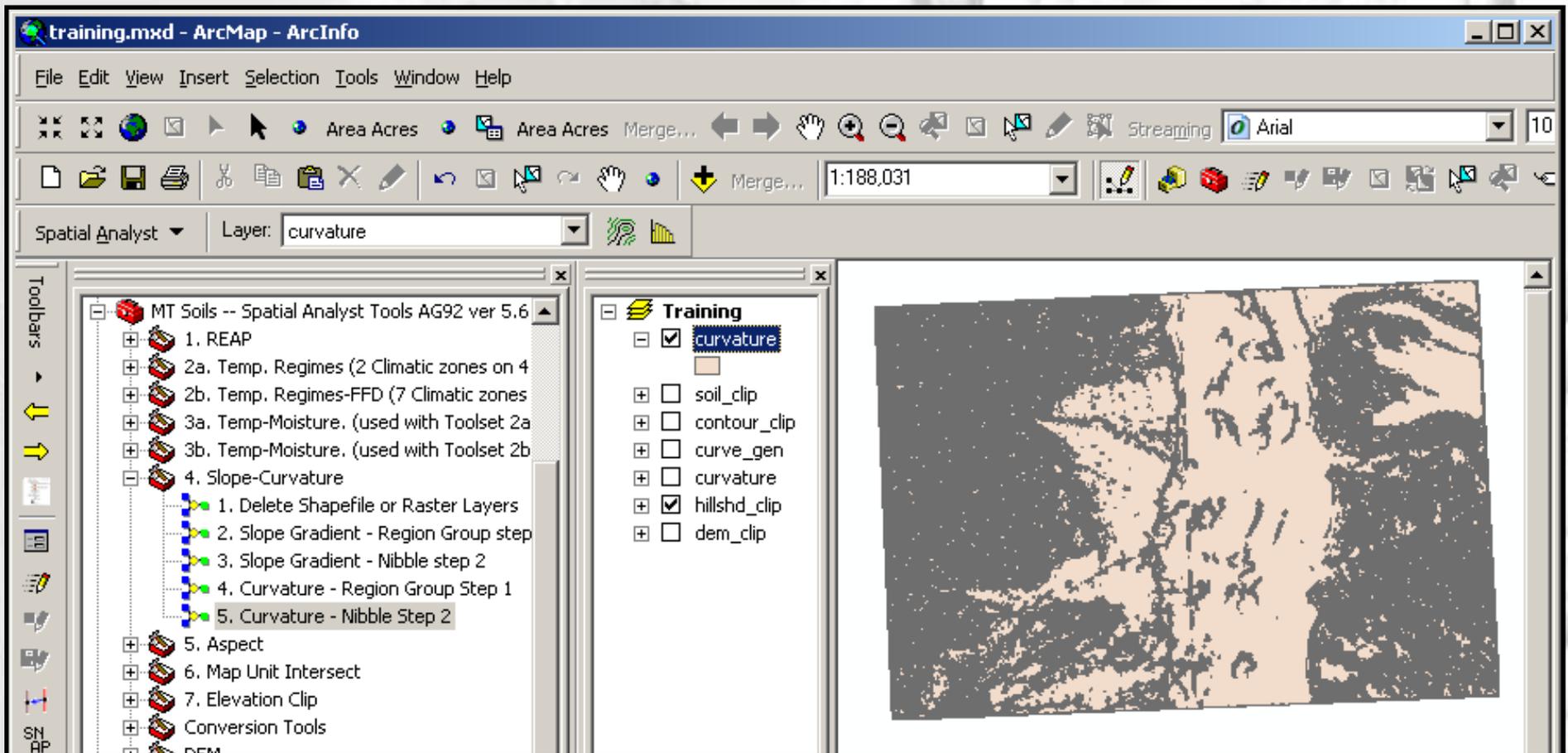
Directory and file name of curvature shapefile
C:\WorkSpace\spatial\curvature\shapefile\curvature.shp

OK Cancel Environments... Show Help >>

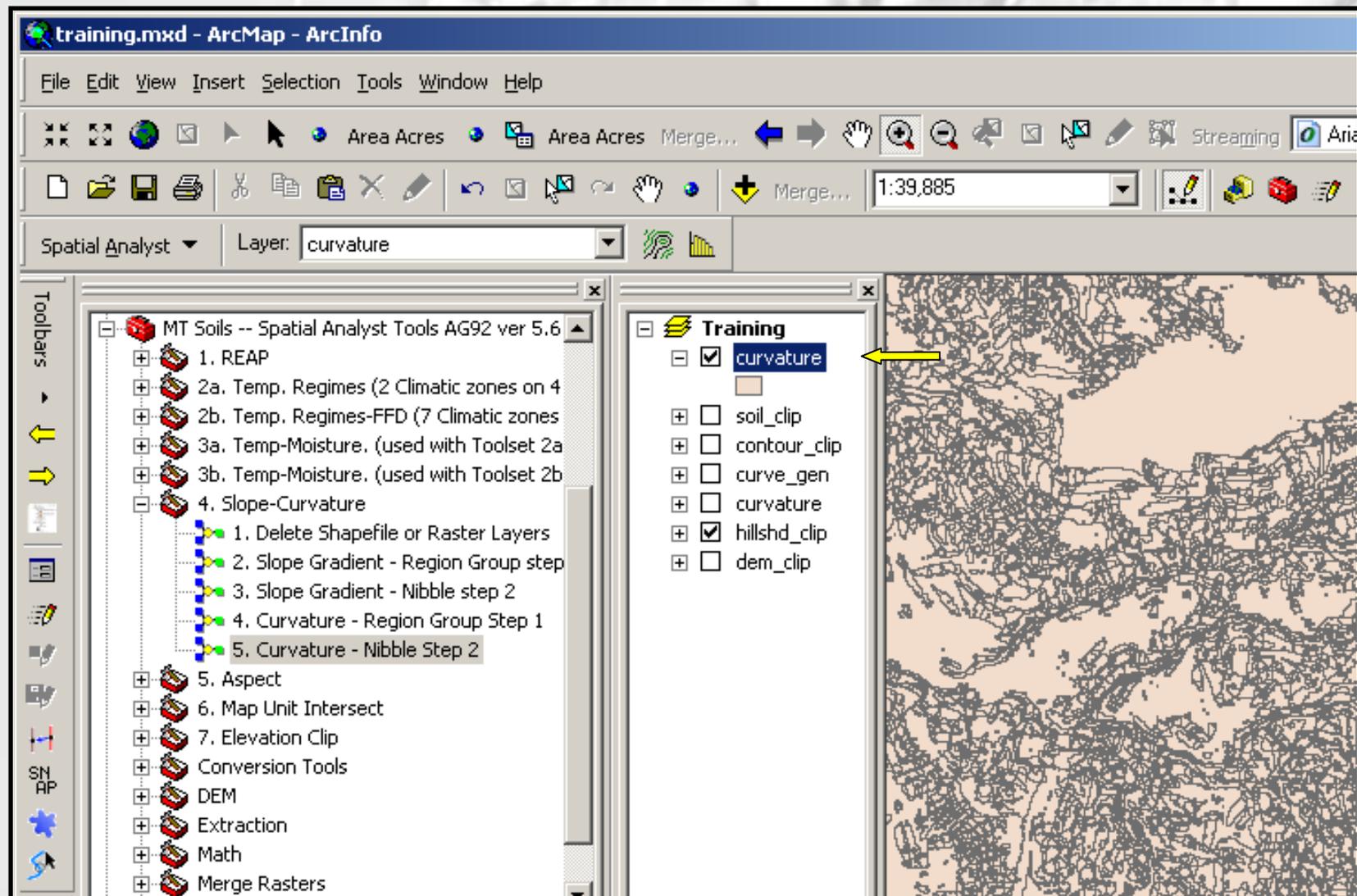
Click **OK** to run the model

Curvature - Nibble Step 2, cont.

After running the “Curvature - Nibble Step 2” model, a curvature raster (curve_gen) and a shapefile (curvature) are automatically added to the project.



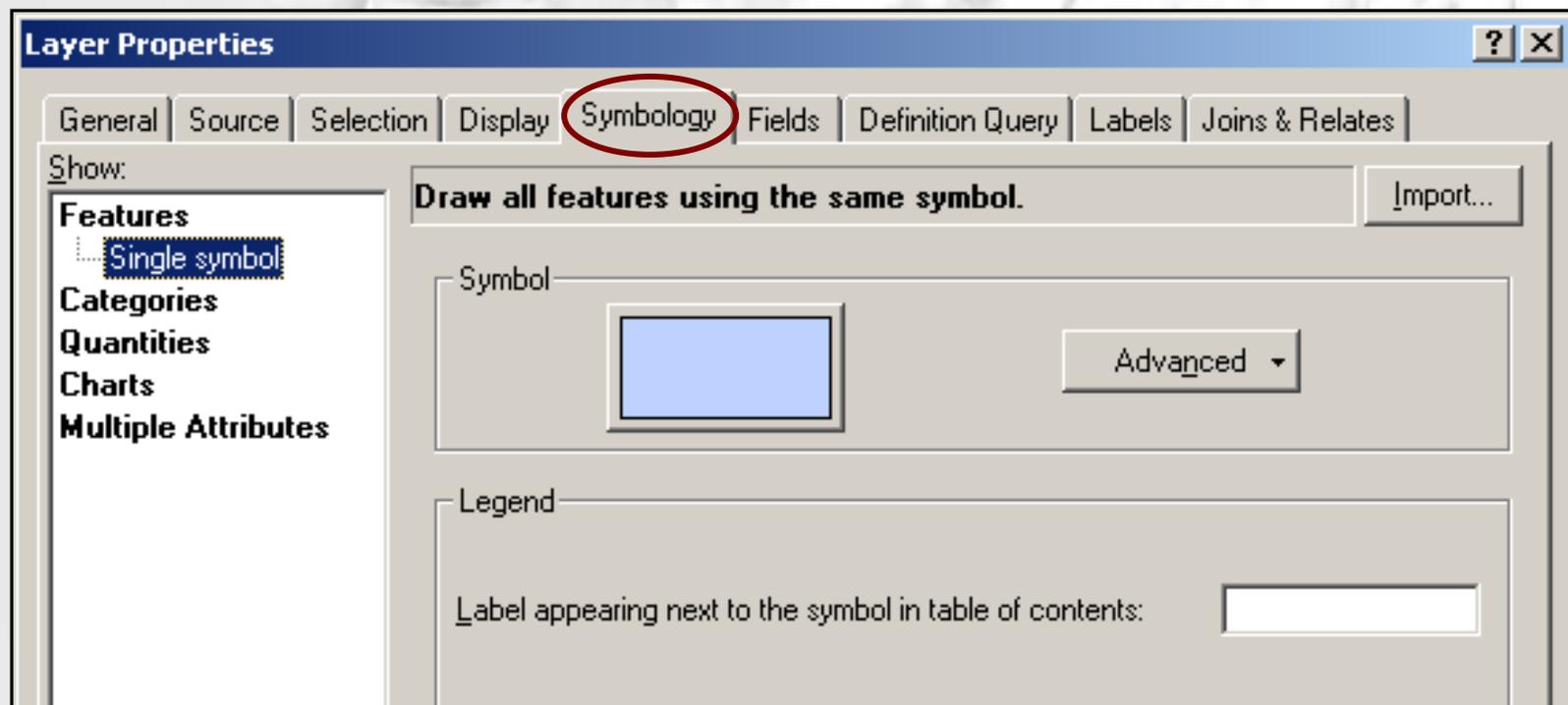
Symbolize & Evaluate Curvature Layer



In the **Data Frame** window, double-click on the curvature shapefile that was created by the “**Curvature - Nibble Step 2**” model. This will open the properties window.

Symbolize & Evaluate Curvature Layer, Cont.

Click on the “**Symbology**” tab in the **Layers Properties** window



Symbolize & Evaluate Curvature Layer, Cont.

In the Layers Properties window under the **Symbology** tab:

The screenshot shows the 'Layer Properties' dialog box with the 'Symbology' tab selected. The 'Value Field' is set to 'curvature' and the 'Color Ramp' is set to a sequential color ramp. The 'Add All Values' button is highlighted with a yellow arrow.

Layer Properties

General | Source | Selection | Display | Symbology | Fields | Definition Query | Labels | Joins & Relates

Show:

Features

Categories

Unique values

Unique values, many I

ools in a

ates

Draw categories using unique values of one field. Import...

Value Field: curvature

Color Ramp

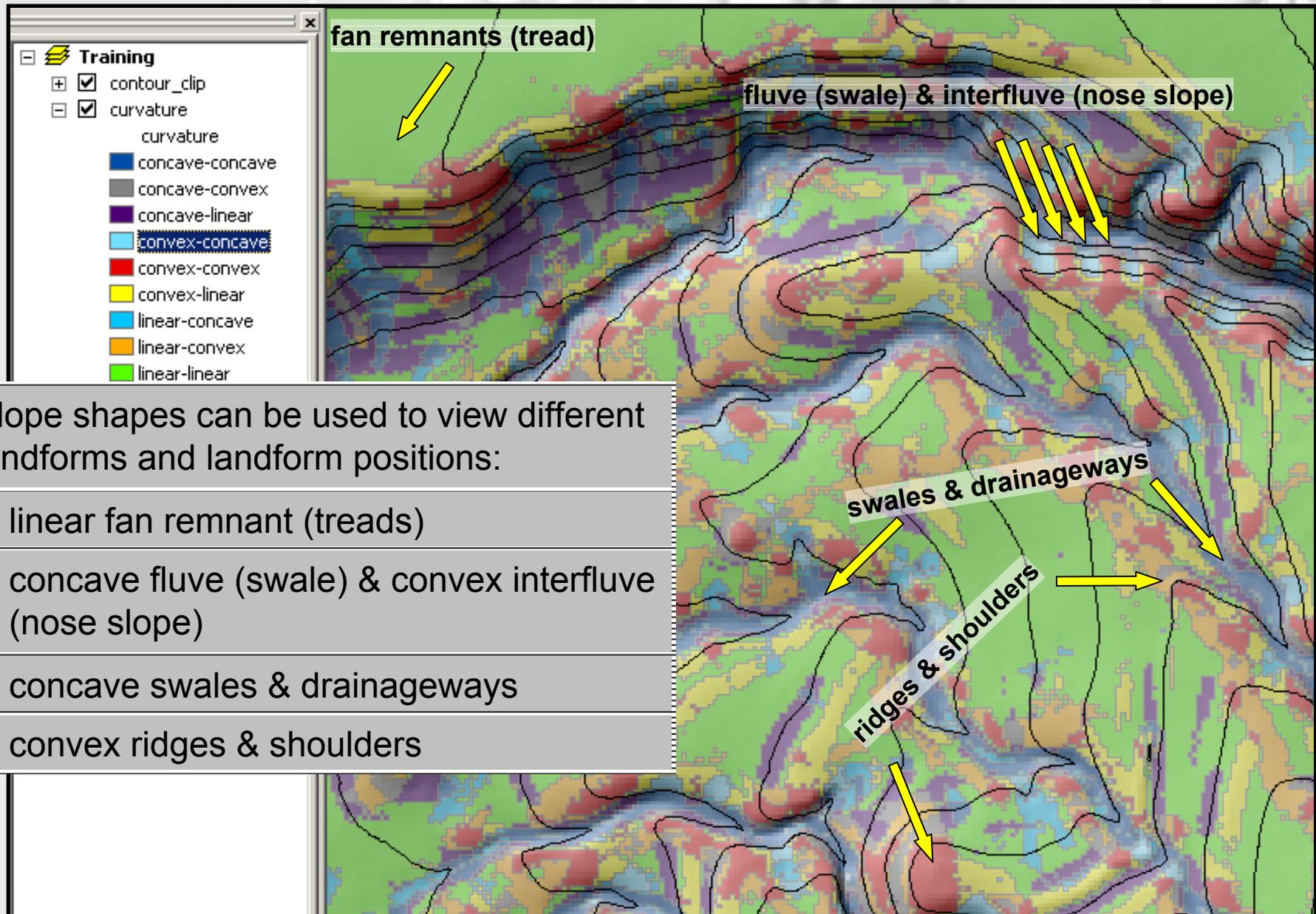
Symbol	Value	Label	Count
<input type="checkbox"/>	<all other values>	<all other values>	
<Heading>			
	concave-concave		
	concave-convex		
	concave-linear		
	convex-concave		
	convex-convex		
	convex-linear		
	linear-concave		
	linear-convex		
	linear-linear		

Add All Values | Add Values... | Remove | Remove All | Advanced

OK | Cancel | Apply

- Click on **Categories** → **Unique values**.
- Select "*curvature*" for the **Value Field**.
- Uncheck the **<all other values>** box.
- Click on the **Add All Values** button.
- Click "**OK**".

Symbolize & Evaluate Curvature Layer, Cont.



Slope shapes can be used to view different landforms and landform positions:

- linear fan remnant (treads)
- concave fluve (swale) & convex interfluve (nose slope)
- concave swales & drainageways
- convex ridges & shoulders

Intersect Curvature Shapefile and Soil Layer

The **Curvature-Mapunit Intersect** model is used to intersect a curvature shapefile with a soil layer. The model also dissolves polygons based on inputs (“MUSYM” and “Curvature”).

Note: If the output from this model is used in an Excel worksheet, the dissolve process is needed to reduce the number of records (Excel can only have up to 65,536 rows).

The screenshot shows the ArcMap interface with the Spatial Analyst toolbox open. The toolbox contains a folder named "MT Soils -- Spatial Analyst Tools AG92 ver 5.6" which is expanded to show several tools. The tool "3. Curvature-Mapunit Intersect" is highlighted with a yellow arrow. To the right of the toolbox is a legend for the "Training" workspace, which lists various curvature and soil layer combinations with corresponding color swatches. The map view on the right shows a topographic map with contour lines and a color-coded overlay representing the intersection of curvature and soil layers.

training.mxd - ArcMap - ArcInfo

File Edit View Insert Selection Tools Window Help

Area Acres Area Acres Merge...

Spatial Analyst Layer: cur

Open the **MT Soils -- Spatial Analyst Tools AG92 ver 5.6** toolbox → **Map Unit Intersect** → **Curvature-Mapunit Intersect**

Toolbars

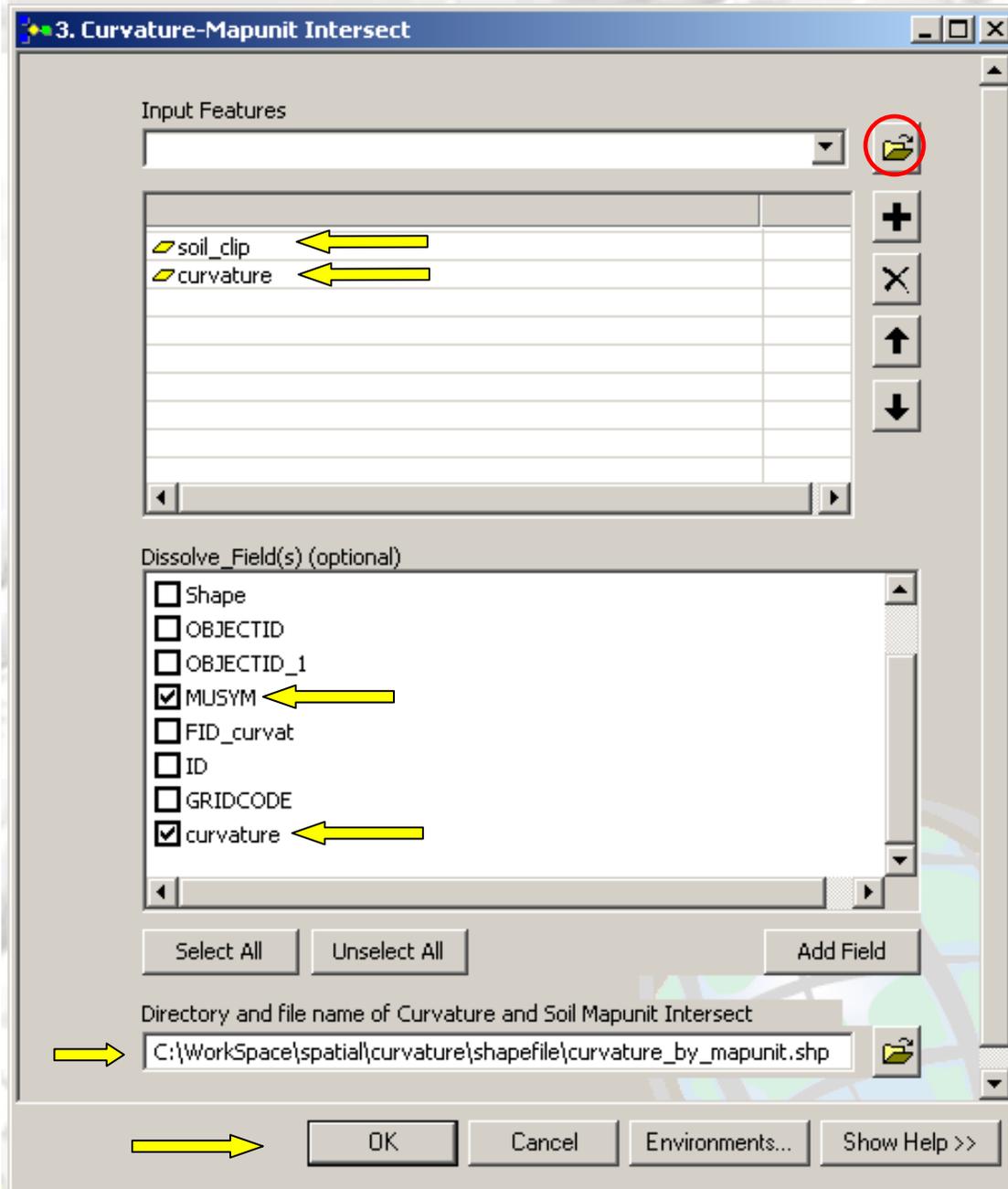
MT Soils -- Spatial Analyst Tools AG92 ver 5.6

- 1. REAP
- 2a. Temp. Regimes (2 Climatic zones on e
- 2b. Temp. Regimes-FFD (7 Climatic zones
- 3a. Temp-Moisture. (used with Toolset 2.
- 3b. Temp-Moisture. (used with Toolset 2l
- 4. Slope-Curvature
- 5. Aspect
- 6. Map Unit Intersect
 - 1. Delete Shapefile or Raster Layers
 - 2. Slope-Mapunit Intersect
 - 3. **Curvature-Mapunit Intersect**
 - 4. Aspect-Mapunit Intersect
- Dissolve
- Intersect
- Intersect-Dissolve
- 7. Elevation Clip

Training

- contour_clip
- curvature
 - concave-concave
 - concave-convex
 - concave-linear
 - convex-concave**
 - convex-convex
 - convex-linear
 - linear-concave
 - linear-convex
 - linear-linear
- soil_clip
- curve_gen
- curvature
- hillshd_clip

Intersect Curvature Shapefile and Soil Layer, cont.

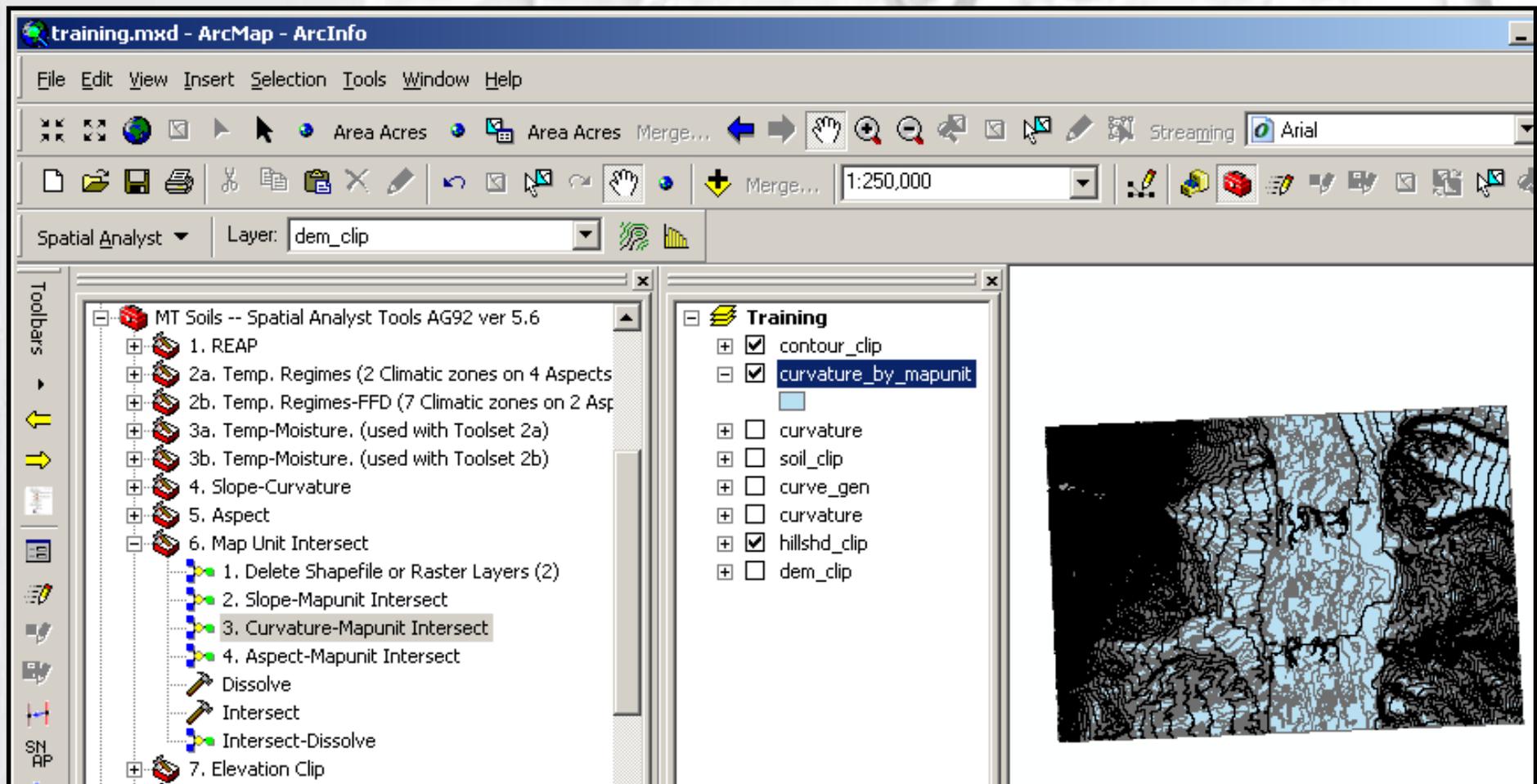


In the **Curvature-Mapunit Intersect** dialog box.

- Under **Input Features**, add a soil layer and a curvature shapefile.
- In the **Dissolve Field** window, check **MUSYM** and **curvature**. This will aggregate data based on map symbol and curvature.
- Click **OK** to begin process.
- The model will create a shapefile named **curvature_by_mapunit.shp**.

Intersect Curvature Shapefile and Soil Layer, cont.

The **curvature_by_mapunit.shp** layer is automatically loaded into the project.



Export Soil\Curvature Intersect Data Table

In the Data Frame window:

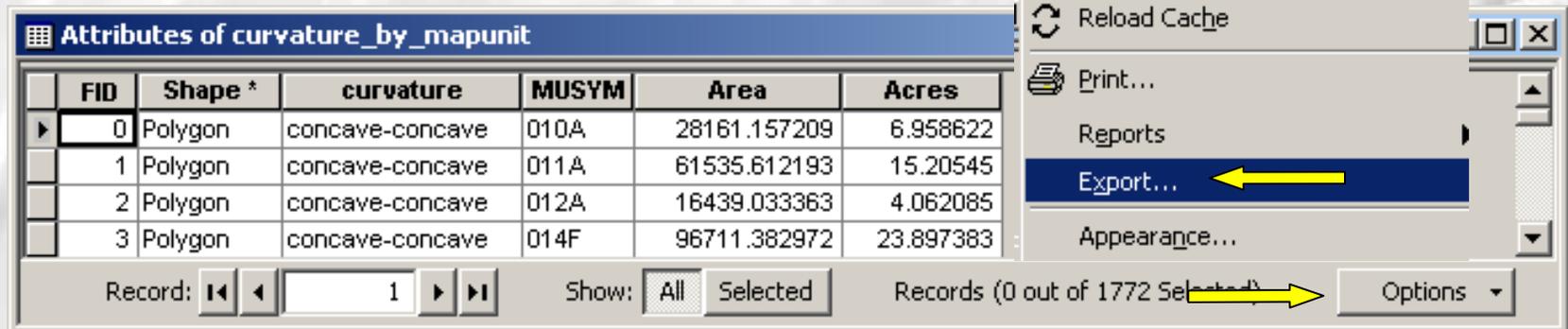
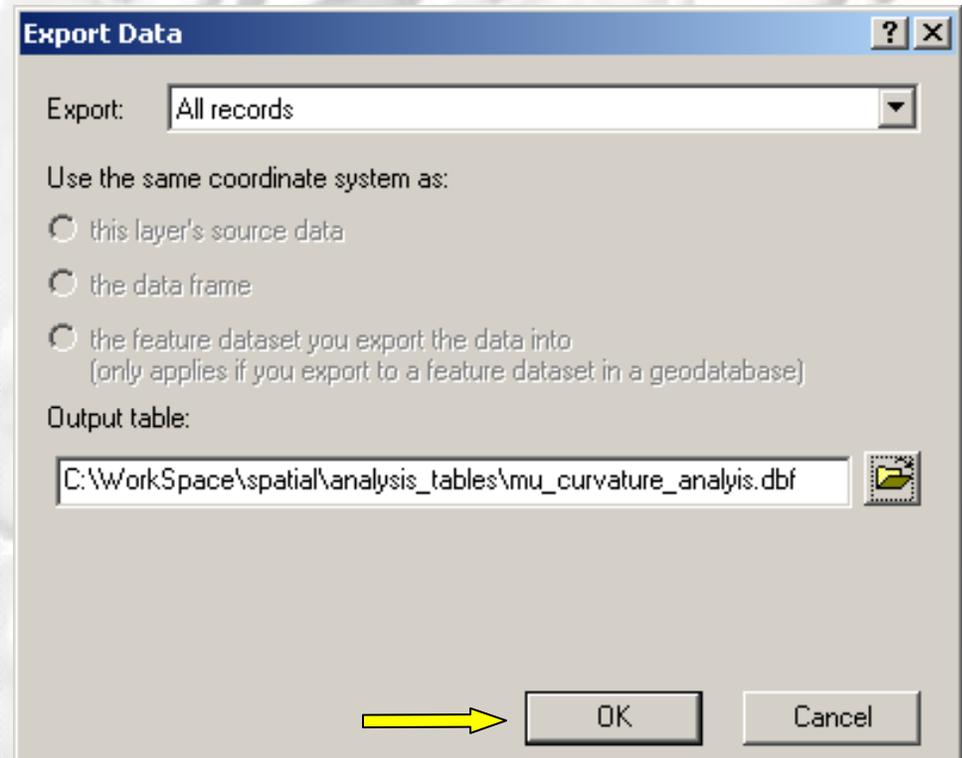
- Click on the **curvature_by_mapunit**.
- Next, click on the **Calculate Area/Acres** icon to calculate acres.
- After the acre calculation completes its process, right-click on **curvature_by_mapunit** and select **Open Attribute Table**.

FID	Shape *	curvature	MUSYM	Area	Acres
0	Polygon	concave-concave	010A	28161.157209	6.958622
1	Polygon	concave-concave	011A	61535.612193	15.20545
2	Polygon	concave-concave	012A	16439.033363	4.062085
3	Polygon	concave-concave	014F	96711.382972	23.897383

Export Soil\Curvature Intersect Data Table, cont.

Follow the steps outlined below to analyze data from this table in an Excel Pivot Table.

- To export your table, click on the **Options** button and select **Export**.
- Under **Output table**, the file can be placed in any folder and should be saved to a **dBase Table** file format.
- Click **“OK”**.
- In the menu that follows, select **“No”** to add the table to ArcMap.



Summarize Curvature by Map Units

The image shows a Microsoft Excel window titled "Microsoft Excel - Book1". The "File" menu is open, with "Open..." selected. A yellow arrow points to the "Open..." option. To the right, a text box says "Start Microsoft Excel". Below the Excel window, an "Open" dialog box is shown. The "Look in:" field is set to "analysis_tables", with a yellow arrow pointing to it. The file list contains "mu_curvature_analysis.dbf" (selected with a yellow arrow) and "mu_slope_analysis.dbf". Below the dialog, a text box says "From Excel's Menu Bar:" followed by a list of instructions. At the bottom of the dialog, the "Files of type:" field is set to "dBase Files (*.dbf)", with a yellow arrow pointing to it. The "Open" button is also highlighted with a yellow arrow.

Start Microsoft Excel

From Excel's Menu Bar:

- Click on **File** → **Open**.
- In the **Look in:** field, navigate to where the export file that was created in ArcMap (**mu_slope_analysis.dbf**) exists.
- In the **Files of type:** window, select **dBase Files**.
- Select the **mu_curvature_analysis.dbf** file and click **Open**.

Summarize Curvature by Map Units, cont.

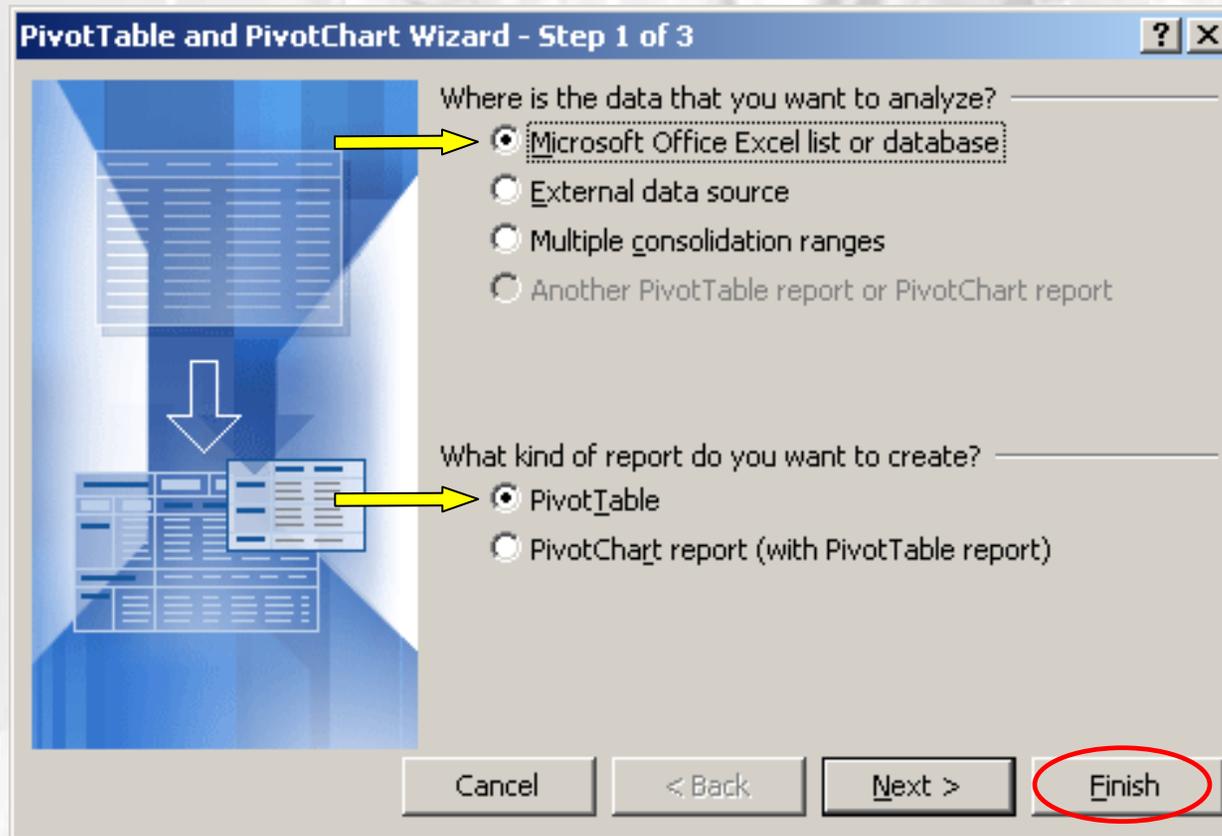
The screenshot shows the Microsoft Excel interface with the 'Data' menu open. The menu items are: Sort..., Filter, Form..., Subtotals..., Validation..., Table..., Text to Columns..., Consolidate..., Group and Outline, PivotTable and PivotChart Report..., Import External Data, List, XML, and Refresh Data. A yellow arrow points to the 'PivotTable and PivotChart Report...' option. The background shows a topographic map of a terrain.

	A	D
1	MUS	Acres
2	010A	6.95862194629
3	011A	15.20544977290
4	012A	4.06208514399
5	014F	23.89738273220
6	016E	1.73774077851
7	017C	93.19326763370
8	020C	20.50981531930
9	020E	73.20808156160
10	024E	10.0658390900
11	026E	8.17579749369
12	050E	1.66511554400
13	052D	33.00874378890
14	052F	129.53334174100
15	100E	0.84810890925

To create a Pivot Table:

- Click on **Data**.
- In the drop down menu, select **Pivot Table and PivotChart Report...**

Summarize Curvature by Map Units, cont.



In the **Pivot Table Wizard**:

- Check the radio button for **Microsoft Office Excel list or database**.
- Check the radio button for **Pivot Table**.
- Click "**Finish**".

Summarize Curvature by Map Units, cont.

Microsoft Excel - mu_curvature_analysis.dbf

File Edit View Insert Format Tools Data Window Help Adobe PDF

Type a question for help

10 B

A3

Drop Page Fields Here

(Drop MUSYM and Curvature in here)

Drop Column Fields Here

Drop Row Fields Here

Drop Data Items Here

(Drop the Acres field here)

PivotTable Field List

Drag items to the PivotTable report

- MUSYM
- curvature
- Area
- Acres

From the PivotTable Field List:

- Drag and drop the “**MUSYM**” and “**Curvature**” fields into the **Drop Row Fields Here** box (make sure the MUSYM field is left of the Curvature field).
- Drag and drop the “**Acres**” field to the **Drop Data Items Here** box.

Summarize Curvature by Map Units, cont.

Microsoft Excel - mu_curvature_analysis.dbf

File Edit View Insert Format Tools Data Window

10 B

C2

	A	B	C	D
1				
2				
3	Sum of Acres			
4	MUSYM	curvature	Total	
5	180D	concave-concave	30.20194831	
6		concave-convex	15.54430593	
7		concave-linear	69.86004909	
8		convex-concave	16.20201839	
9		convex-convex	59.5823489	
10		convex-linear	71.93848045	
11		linear-concave	32.73823698	
12		linear-convex	61.25433519	
13		linear-linear	177.2306448	
14	180D Total		534.5523681	
15				

The resulting table displays the number of acres by curvature for each map unit.

The table also lists the total acres by map unit.

Summarize Curvature by Map Units, cont.

To calculate the percent composition for each curvature class by map unit:

	A	B	C
1			
2			
3	Sum of Acres		
4	MUSYM	curvature	Total
5	180D	concave-concave	30.20194831
6		concave-convex	15.54430593
7		concave-linear	69.86004909
8		convex-concave	16.20201839
9		convex-convex	59.5823489
10		convex-linear	71.93848045
11		linear-concave	32.73823698

- Double-click on the **Sum of Acres** field.
- Click on **Options**.
- Under **Show data as:**, select “**% of column**”.
- Click “**OK**” to finish.

PivotTable Field

Source field: Acres

Name: Sum of Acres

Summarize by:

- Sum
- Count
- Average
- Max
- Min
- Product
- Count Nums

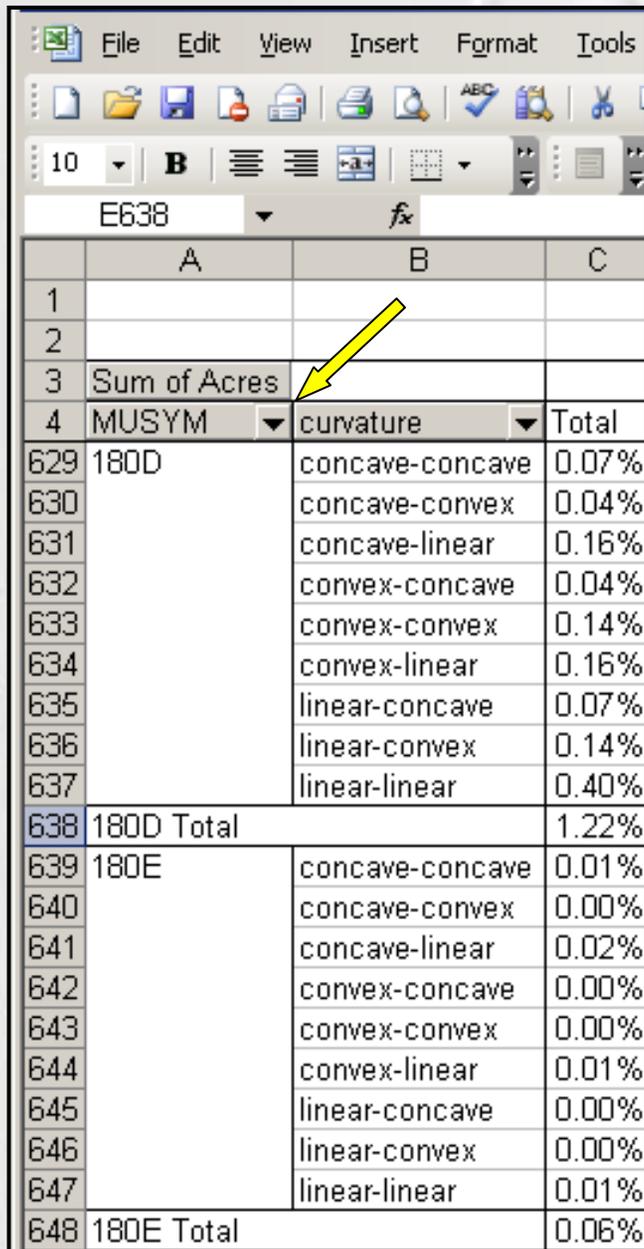
Show data as: % of column

Base field: MUSYM

Base item:

Options >>

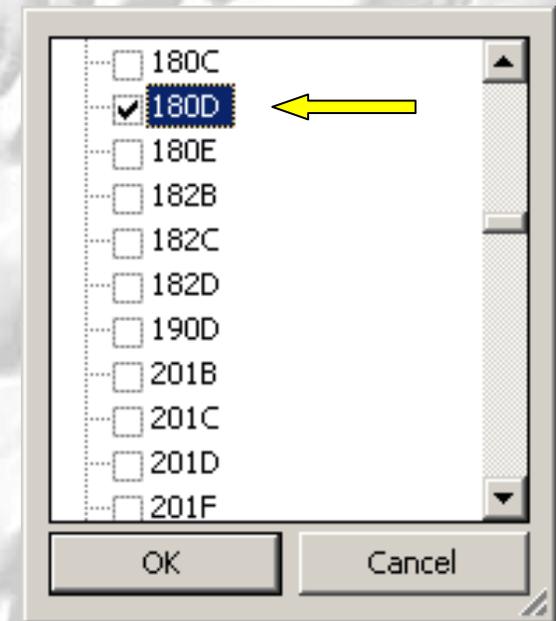
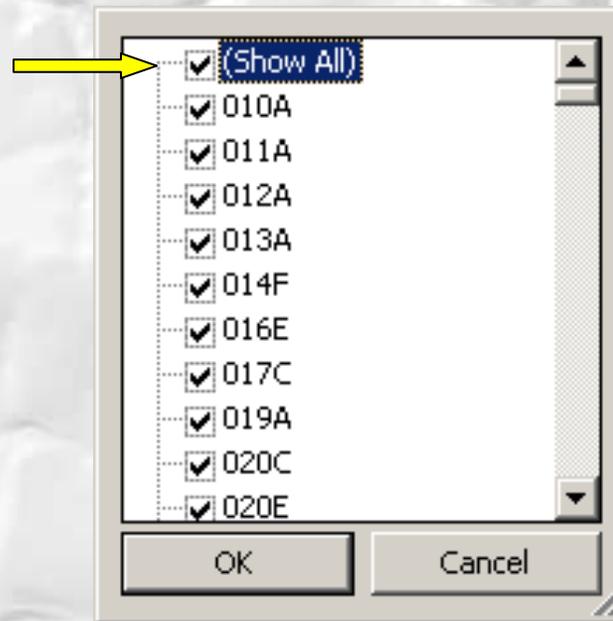
Summarize Curvature by Map Units, cont.



	A	B	C
1			
2			
3	Sum of Acres		
4	MUSYM	curvature	Total
629	180D	concave-concave	0.07%
630		concave-convex	0.04%
631		concave-linear	0.16%
632		convex-concave	0.04%
633		convex-convex	0.14%
634		convex-linear	0.16%
635		linear-concave	0.07%
636		linear-convex	0.14%
637		linear-linear	0.40%
638	180D Total		1.22%
639	180E	concave-concave	0.01%
640		concave-convex	0.00%
641		concave-linear	0.02%
642		convex-concave	0.00%
643		convex-convex	0.00%
644		convex-linear	0.01%
645		linear-concave	0.00%
646		linear-convex	0.00%
647		linear-linear	0.01%
648	180E Total		0.06%

To assess slope for a single map unit:

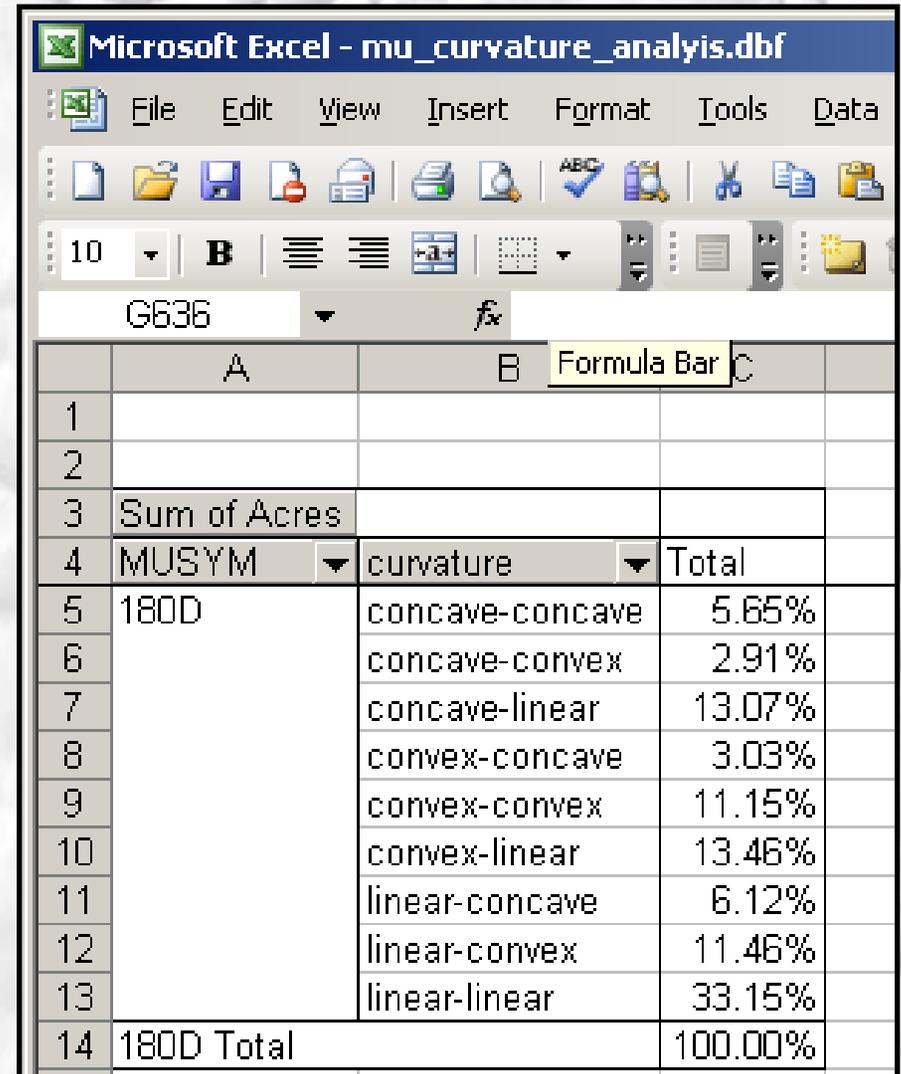
- Click on the **down arrow** next to **MUSYM**.
- Uncheck the box next to **(Show All)**.
- Next, place a check next to any single map unit and click **“OK”**.



Summarize Curvature by Map Units, cont.

The results show the % composition for each curvature class in map unit 180D.

To view results for other map units, click on the down arrow, uncheck the current map unit and place a check next to a different map unit.



Microsoft Excel - mu_curvature_analysis.dbf

File Edit View Insert Format Tools Data

10 B

G636 f&

	A	B	Formula Bar	C
1				
2				
3	Sum of Acres			
4	MUSYM	curvature	Total	
5	180D	concave-concave	5.65%	
6		concave-convex	2.91%	
7		concave-linear	13.07%	
8		convex-concave	3.03%	
9		convex-convex	11.15%	
10		convex-linear	13.46%	
11		linear-concave	6.12%	
12		linear-convex	11.46%	
13		linear-linear	33.15%	
14	180D Total		100.00%	