COASTAL GIS APPLICATION

Coastal Erosion and Shoreland Development Regulation

Town of Mosel, Wisconsin

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The Lake Michigan shore in northern Sheboygan County consists of steep bluffs approximately 50 feet in height. Long term recession rates of approximately two feet per year have been recorded along this segment of the shore. Storms and high water levels in the Great Lakes accelerate shoreline erosion and bluff erosion and increase flooding and property damages. During 1985-86, Lake Michigan set new record marks for high water levels in the 20th century, leading to unprecedented property damage. Recently, water levels in the Great Lakes have increased to a level that begins to concern the U.S Army Corps of Engineers.

In order to discourage development in erosion hazard areas, preserve shore cover and natural beauty and meet other public objectives, Sheboygan adopted a Shoreland-Floodplain Ordinance on October 27, 1970. The ordinance regulates development within 1000 feet of the ordinary high water mark of navigable lakes, ponds, flowages, and specified wetlands; 300 feet of navigable waterways; and within the 500 year floodplain.

Geographic information systems (GIS) may be utilized to more effectively manage development in the coastal zone. This GIS application assesses coastal erosion impacts and explores management issues related to shoreland development in the Town of Mosel in northern Sheboygan County.

General Instructions

These instructions are divided into seven sections. They are designed to be followed from front to back (i.e. Section One first, then Section Two, etc.). Earlier sections contain descriptions of basic ArcView 3.x operations. They also create themes that will be used in the later sections.

As you move through the application, you may need to refer back to earlier descriptions for performing a particular function. The Table of Contents is designed to help you move back and forth through the document.

Table of Contents

1. Inputting and viewing existing databases.

In this section, you will input and view five data sources -- floodplains, parcel boundaries, township zoning, a planimetric map and an orthophoto.

Create a project and a view.

From the ArcView File menu, choose **New Project**. Click the **New** button. An empty view screen may appear entitled View 1. If not, select the **View** icon and click **New**.

> The ArcView project window and the View window can be enlarged by using the maximize button in the upper right corner of the window or by grabbing the corners of the window with the mouse.

From the View menu, choose **Properties** to display the View Properties dialog box. Highlight the name **View 1** and type in "Data Layers" as the new name for this view. Set the Map Units to **feet** (the data are in the Sheboygan County Coordinate System). Click **OK**.

> Throughout this application, names will be provided for views, themes, files, etc.. You may choose to use other names. However, references to suggested file names will be made in later sections of the application so it will work best if you use the names provided.

With the project window active, from the File menu, choose **Save Project As...**.

> Like other windows-based programs, when a window is active in ArcView, the title bar will be blue. If multiple windows are opened, clicking on a window will make it <u>the</u> active window. Depending on the type of active window (e.g. view, project, table, etc.), different menu items and different buttons will appear at the top of the window. If you have trouble finding an open window, look in the Window menu option. At the bottom of the drop-down menu, you will see a list of open windows in your project.

Locate the directory where you wish to save your data. In the file Name input box, type a name for your project (8 characters or less). Click **OK**.

> An ArcView project file is assigned the extension ".apr". A project can contain multiple views, map layouts and attribute tables. For this Shoreland Zoning Applications model, all our work will be saved under a single project. You may wish to adjust this according to your data storage needs.

*Save your work frequently (select **Save Project** under any of the File menu)! If the ArcView program crashes, you can lose any changes made since your last save. If ArcView does crash and the project was recently saved, it will be very easy to recreate where you left off by simply opening the project.*

Add data files to view.

Click the **Add Theme** button to add data files as themes into your view. In the dialog box, for Data Source Type, choose **Feature Data Source**. Locate and highlight the following files and click **OK**: mosflood.shp, mospar.shp, mosplan.shp and moszone.shp. To add the digital orthophoto for the northern section of the township, click the **Add Theme** button; this time choose **Image Data Source**. Add the file called "moseldoq.tif."

To rename the themes, click on a theme name to make it active. When a theme is active, it is surrounded by a "raised" square in the Table of Contents. From the Theme menu, choose **Properties**. In the Theme Properties dialog box, make sure the **Definition** symbol is chosen (outlined by a box). Highlight the current theme name, type a new name and click **OK**. Rename the themes:

"mosplan.shp" to "Planimetric Map"
"mosflood.shp" to "Floodplains"
"moszone.shp" to "Town Zoning"
"moseldoq.tif" to "Orthophoto"
"mospar.shp" to "Mosel Parcels"

Click on the box in front of each theme to make the themes visible on the screen.

Themes are drawn based on the order they appear in the Table of Contents. In order to view a theme, you may need to move it above another theme. To do this, click on the name of the theme to make it active and drag it to a new site on the Table of Contents.

The **Zoom to Active Theme(s) button** can be used to zoom the view to Mosel Township (make sure one of the Township themes is active). You can also use the **Zoom In** button to focus on a smaller section of the view. Use the **Zoom to Full Extent** button to view all the data of all the themes.

Zoom to Active Theme(s)   **Zoom In**   **Zoom to Full Extent**

To display the Town Zoning theme by zoning codes, double click on the theme to bring up the Legend Editor (*Figure 1*). Under Legend Type,

choose **Unique Value**. For Values Field, choose **Zoning**. To change how each of these categories are labeled in the view, highlight the current Label description and change:

"A-1" to "Prime Agricultural"
"A-2" to "General Agricultural"
"B-1" to "Business"
"C-1" to "Conservancy"
"I-1" to "Industrial"
"R-1" to "Single Family Residence"
"R-2" to "Two Family Residence"
"R-3" to "Multiple Family Residence"

Click **Apply** in the Legend Editor to apply your changes to the view. Close the Legend Editor.
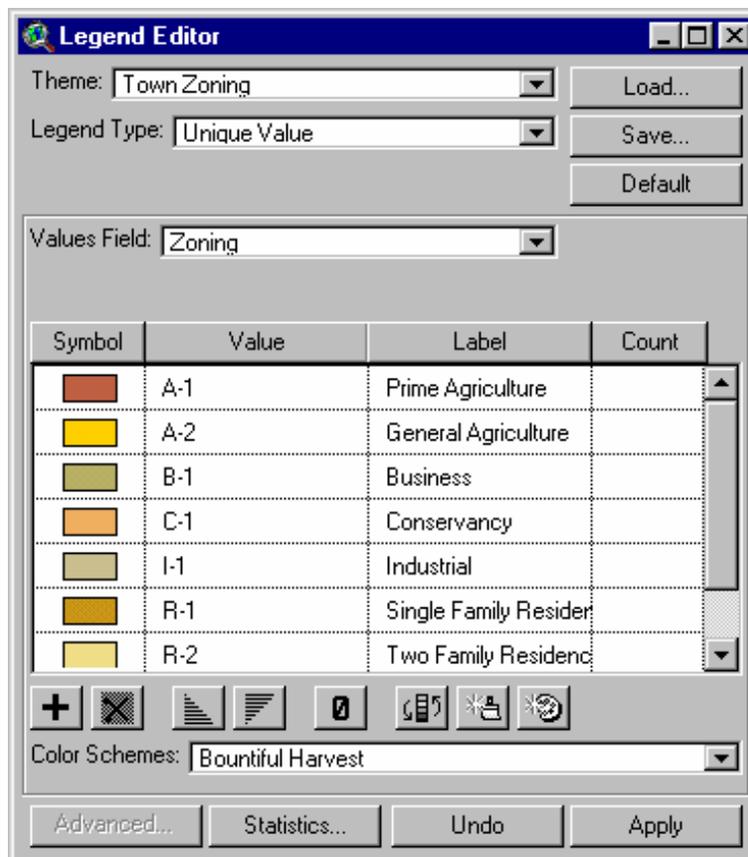
Figure 1. Legend Editor

If you wish to read longer label names, you may need to widen the Table of Contents display window.

Save your project.

2. Modifying existing themes.

In this section, you will create new data layers (parcels, transportation, hydrography, buildings, cemeteries and the bluff edge) by extracting information from existing themes.

Create new themes from the Planimetric Map.

The Planimetric Map theme has a data field called "lgds_level". The codes in this field distinguish line segments in the map according to their feature type. To display these individual features, you will need to query the associated database (attribute table) for specific criteria. This information can be stored in a query format or it can be used to create a new theme in the ArcView shapefile format.

A shapefile is an ArcView format for storing geometric and attribute information on a feature. When data in other spatial formats are converted into shapefiles, they maintain the extent and units from the original format. When a new shapefile is created, the extent and units of the new features are determined by existing themes within the view. Although a shapefile has geometric references, it does not have topology. Therefore, there may be limitations when using shapefiles or exporting them into another GIS software program.

To create a theme with information on roads and railroads, make the Planimetric Map theme active. From the Theme menu, choose **Properties**. Click the **Query** button to bring up the Query Builder dialog box (*Figure 2*).

From the Fields list, double-click **lgds_level**; this now appears in the expression box. Next, you want to set this equal to a value (click once on the '=' sign). From the Values list, double click '**1**'. Click once on the '**or**' button to continue building the query. Return to the Fields list and repeat the procedure for the values '**2**','**3**','**4**' and '**20**'. Your finished query should look like this: **([lgds_level] = 1) or ([lgds_level] = 2) or ([lgds_level] = 3) or ([lgds_ level] = 4 or ([lgds_level] = 20)**. Click **OK** in the Query Builder and Theme Properties Dialogue Boxes. Your view will now display only the transportation features of the Planimetric Map.

To convert this into a new theme, in the Theme menu, chose **Convert to Shapefile...**. Choose a directory and name the file "mostrans.shp." Click **OK**. Answer **Yes** to add this shapefile to the view. Change the theme name to "Transportation Routes."
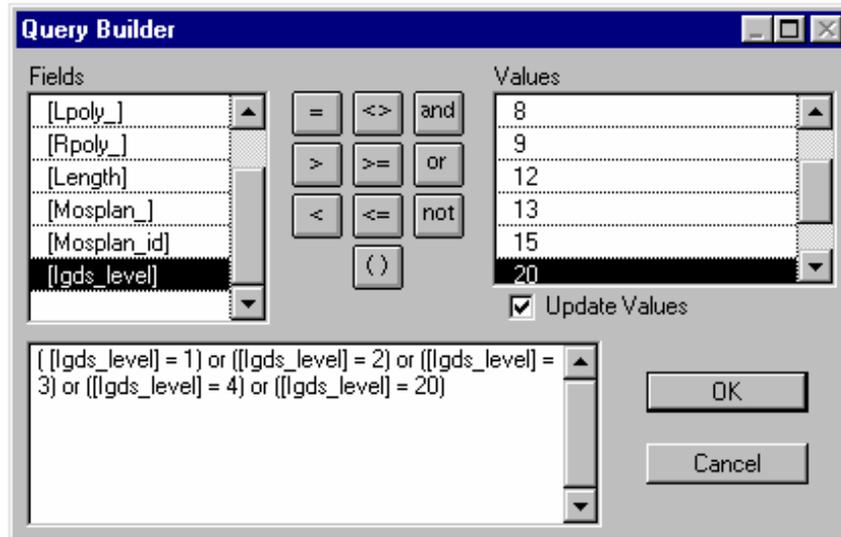
Figure 2. Query Builder

You now have two themes which appear to have the same information. However, the Planimetric Map theme still contains all its original information but, because of the query, is displaying only a portion of these features. To clear this query, highlight the Planimetric theme, then in the Theme Properties Dialog Box, click **Clear** followed by **OK**.

To create a theme with information on buildings, build the following query on the Planimetric Map theme: **([lgds_level] = 6) or ([lgds_level] = 8) or ([lgds-level] = 60)**. Create a shapefile, save the file as "mosbldg.shp," add it to your view and rename it "Buildings."

To create a theme with information on water bodies, make sure the last query is cleared then build the following query on the Planimetric Map theme: **([lgds_level] = 12) or ([lgds_level] = 13)**. Create a shapefile, save it as "moshydro.shp," add it to your view and rename it "Hydrography."

To create a theme with information on cemetery locations, build the following query on the Planimetric Map theme: **([lgds_level] = 15) or ([lgds_level] = 27)**. Create a shapefile, save it as "moscult.shp," add it to your view and rename it "Cemeteries."

Remember to clear the Planimetric Map theme's query.

Modify the parcel map to create unique parcel identification numbers.

You will now extract a separate theme for mapping parcel ownership in the Township. The new theme will be used for the rest of this application.

The file "mospar" contains the digital parcel map for the Town of Mosel. If you look at the individual records, you will find that some parcels (i.e. polygons) have identical parcel identification numbers. Using this database will cause problems in subsequent analysis, particularly when you try and link the database to other files. The best remedy for this situation would be to assign unique parcel identification numbers to each parcel. However, this is the job of the county records-keeper and not the GIS analyst. Another solution is to merge parcels with identical parcel ids and create a separate theme. By doing this, you can now use the spatial attributes of the parcel file in combination with non-spatial attributes (e.g. owners name) found in other files. The down side of this solution is that some information will be missing in your new file. Specifically, if two identically-numbered parcels are adjacent to each other, the line separating the parcels will disappear. In addition, two parcels that share identification numbers but are not adjacent will combine into one, non-contiguous feature.

Make the Mospar.shp or Mosel Parcels theme active. Click the **Open Theme Table** button to access the attribute data for the Mospar.shp theme. Click on the name of the field "parcel_id"; it is now selected and highlighted in grey.

To merge records based on the selected field, click the **Summarize** button.   Save   the   file   as "parcels.dbf." **Shape** should be the selected field and it should be summarized by **Merge**. Click **Add**. Now change the Field to **Area**, Summarize by **Sum**, and click **Add.** Click **OK**. In other words, you have merged parcels with the same identification number and calculated the area of any new parcels equal to the sum of its component parcel areas. Add the theme to the Data Layers view and rename it "Parcels."

When a theme is first created, it is displayed in a single color. With the Color Palette, you can modify how the theme is displayed. For this view, you will want to display only the outlines of the parcel theme. By making the non-outline portions transparent, you will be able to view other themes under this data layer.

Open the Parcel theme's Legend Editor, by clicking on the Legend Editor icon. Double click on the symbol box; the Fill Palette is now displayed.

Click the **Color Palette** button to change to the Color Palette (*Figure 3*). Select **Outline** in the Color box and click on your preferred choice from the colors displayed. Now, choose **Foreground** for Color and click on the first box (with the "x" through it). This indicates a clear foreground. Click **Apply**. Close the Legend Editor and the Color Palette.

 If you have trouble getting the Foreground Color to change to
transparent, try doing this process in two steps. In other words, choose
an Outline Color then double click again on the symbol box and choose
the Foreground Color.
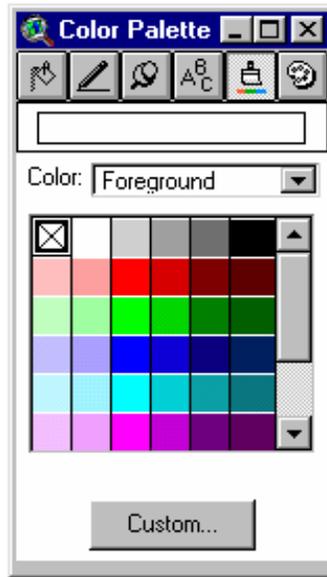
Figure 3. Color Palette

You may wish to remove the Mosel Parcel (Mospar.shp) theme from your
view. To do this, make this theme active. From the Edit menu, choose
Delete Themes. This command removes the themes from your view but
does not delete saved files from your directory. Click **Yes** to confirm these
deletions.

Save your project.

Close this view's window. Under the File command, click close. If there
are any attribute table windows open, close these as well.

3.   Creating a map of the jurisdiction of the Shoreland Zoning Ordinance.

In this section, you will create areas of shoreland zoning jurisdiction along lakes and rivers. A map of this information will be produced. You will also learn how to access a help file containing the text from the Ordinance document.

Create a new view.

From the Windows menu, open your project window by highlighting the name of your file, denoted by the .apr extension. Create a new view called "Shoreland Zoning Ordinance." Set the Map Units to **feet**. You can copy a theme between views, preserving the colors and other properties from the original theme. In the Data Layers view, make the Parcels and the Hydrography themes active.

> In order to make multiple themes active, simply hold down the shift key and select each theme. All selected themes should be surrounded by a raised box.

Select **Copy Themes** from the Edit menu. Now, in the Shoreland Zoning Ordinance View, choose **Paste** from the Edit menu.

Make the Hydrography theme the only active and visible theme. In the Legend Editor, set the Legend Type to **Unique Value** and the Values Field to **lgds_level**. Two values will be displayed. Label the value "12" as "Lakes and Ponds." Label the value "13" as "Rivers and Streams."

Add a field describing shoreland zoning jurisdiction distances.

Based on the Shoreland-Floodplain Ordinance, zoning jurisdiction for navigable waters is determined by the feature type (Lakes and Ponds = 1000 feet, Rivers and Streams = 300 feet).

Click the **Open Theme Table** button to access the attribute data for the Hydrography theme. Choose **Start Editing** from the Table menu. From the Edit menu, select **Add Field**. Name your field "Distance." This will be a number field; you can adjust the size of the field under **Width** and **Decimal Places**. In this case, keep the default settings and click **OK**.

Choose **Query** from the Table menu. Construct the query: ([lgds_level] = 12). Click on **New Set**. Data satisfying this query will now be highlighted yellow in the attribute table. Close the query

window. With the Distance field selected (highlighted in gray), press the **Calculate** button. In the expression box at the bottom left corner, type "1000" and Click **OK**.

Clear the selection by clicking the **Select None** button. Construct the next query: ([lgds_level] = 13) and give these data the Distance value "300." Clear the selection and choose **Stop Editing** from the Table Menu.

> Throughout these applications, you will be editing themes and tables. Before making any changes, you will always need to make these features ready for editing using the "start editing" function. If you find yourself unable to start an operation (e.g. adding a field to a table), check to make sure that "start editing" has been selected.   "Stop Editing" is equally important. Changes made to a theme must be saved, and when you stop editing a feature, you will always be prompted to indicate if you want to save these changes.

You are now going to access an ArcView program (referred to as an Avenue Script) which is not part of the original software package. This particular script was downloaded (free of charge) from the ESRI home page. You may wish to browse this web site (http://www.esri.com) to locate other useful scripts developed by ESRI staff and the ArcView user community.

Create shoreline jurisdiction zones using the buffering operation.

To create a shapefile illustrating this Distance information, you need to add the Avenue buffer script to your project. Return to your project window, select the **Script** icon and click **New**. Under the Script menu, choose **Load Text File...**. Locate the file called "buffer3.ave" and click **OK**. The script should now appear on your screen. You will need to compile the script by clicking the **Compile** button. Close the file and under the Project menu, rename "Script1" to "Theme.Buffer."

You need to add the Theme.Buffer script as a button to your view. To do this, select **Customize** under the Project window's Project menu. In the Customize dialog box (*Figure 4*), for Type select **View,** and for Category choose **Buttons**. Scroll to the end of the button display and highlight the Help button. Click **Separator** followed by **New**. Double-click on **Click** and in the Script Manager dialog box, choose **Theme.Buffer**. Click **OK**. Double-click **Help**, type "Runs Buffering Script" and click **OK**. Double-click on **Icon**, select **B** from the Icon Manager and click **OK**. Close the Customize dialog box and return to your Shoreland Zoning Ordinance view.

Figure 4. Customize Box

You are now ready to run the buffer script. In the view, make Hydrography the active theme. Click the **Theme.Buffer** button. A series of dialog boxes will appear on your screen. Name the file "buffers.shp." Make sure **Feature Buffer** is selected as the output display theme and click **OK**. Choose **Buffer Item** as the buffer distance input. When asked to select the item containing distance values, choose **Distance**. **Line** should be highlighted as the line buffering scheme.

When running this buffer script, make sure you include the ".shp" extension when choosing a name for your output file. If you get an error message regarding the production of the output files try exiting the Avenue script and rerunning the buffer operation, overwriting the previous shapefile.

When ArcView creates a buffer for a line segment, it locates the buffer a specified distance on both sides of the line. On both ends of the line segment, it forms a half circle which connects the two sides of the buffer. This half circle is located the specified distance from the the line endpoints. If you create a buffer from a multi-segmented line, you will see a series of circular buffers where the line segments meet.

To map the areas encompassed by the Shoreland Zoning Ordinance, you will join the numerous polygons created by the buffering script. Make the Buffers.shp theme active and click the **Open Theme Table** button. Choose **Start Editing** from Table menu. In order to merge the polygons based on a shared attribute, you will need to create a field with the same value for all the polygons. Add a new field named "Zone" and calculate all values for this field equal to "1". Make sure the Zone field name is selected and click the **Summarize** button. Name for your file "zone.dbf." **Shape** should be the selected field and it should be summarized by **Merge**. Click **Add** then **OK**. Add the theme to the Shoreland Zoning Ordinance view and rename it "Shoreland Zones." Delete the Buffers.shp theme from your view.

Create a map of the Shoreland Zoning Ordinance Jurisdiction.

Although you now have a display of this data on your computer screen, you will want to use the Layout capabilities of ArcView for creating mapping products. These layouts can contain views, tables, charts, scanned pictures and other graphic elements. They also can contain legends, north arrows, scale bars and additional text.

Make the themes Hydrography, Parcels and Shoreland Zones visible. Display them in the colors you wish for your map product. From the View menu, choose **Layout**. In the Template Manager dialog box, select the Portrait style and click **OK**. Your screen will now display the default layout for this view. In the Layout menu, select **Properties** and rename your layout "Shoreland Zoning Ordinance."

 If you maximize the Layout Window, you will then need to click the **Zoom to Page** button to fit the Layout Page to the Layout Window.

If you are happy with the default layout, you are now ready to export or print. Check the page setup settings by selecting **Page Setup...** under the Layout menu. Here you can set the orientation, size and resolution of the output. If you wish to export the file, choose **Export** under the File menu. An Export dialog box prompts you to choose the range of graphic export options (under the List Files of Type drop-down menu). If you wish to print the file, choose **Print** under the File menu. Printer setup options are also available in the File menu.

You may wish to modify the default layout. The following instructions highlight some of the graphic formatting options available.

To select a feature for editing, click the **Pointer** button, then click the feature. When a graphic is selected, it will be surrounded by an invisible box bordered by four squares. It can now be resized using the two-directional arrows or moved by simply dragging the box to the desired location. You may need to move other graphics around to make room for your selected graphic. To add a feature, click the **Text** button for text or choose one of the items from the **View Frame** drop-down menu. Now, click the mouse on the location where you wish to add the graphic.

Pointer   **Text**   **View Frame**

Border: You can add a border around the layout to give the map a clean look. To start, click and hold the **Draw Tool**. Drag the mouse down to the **Draw Rectangle Tool**, then release. Position the crosshairs in the upper left corner of the layout page, drag the cursor to define the box, then release the mouse button. While the box is selected, choose **Send to Back** from the Graphics menu. This will make it easier to select other graphic elements to edit.

Draw Tool   **Draw Rectangle Tool**

Text: Under the Window menu, select **Show Symbol Palette...** to access the Fill Palette. Click the **Font Palette** button. This will allow you to make changes in text font type, size and style. If you wish to modify the title to make it more descriptive, double-click on the title text. This brings up the Text Properties dialog box. Add "for Sheboygan County" to the title and click **OK**. Resize the layout title to 24 pt and add a subheading "Enacted 1970."

Scale Bar: Double-click on the scale bar to bring up the Scale Bar Properties dialog box. Experiment with the selections to customize the scale bar.

North Arrow: Double-click on the north arrow to bring up the North Arrow Properties dialog box. Choose a new arrow type and change its color using the Color Palette.

Close the layout.

Access a hypertext help file of the Shoreland-Floodplain Ordinance document.

Administering a zoning ordinance often requires reference to multiple maps and text documents. Managing these documents in a paper form can become complicated. ArcView, in concert with other software packages, can support creation of an "electronic zoning ordinance" integrating both text and maps. A Windows help file was created for the Sheboygan County Shoreland-Floodplain Ordinance using a software package called RoboHelp from Blue Sky Software.

> If you are using a computer operating system other than Windows (3.1, 95, NT, 98, 2000, XP), skip this section. If you are using one of these three systems, search for the Windows Help executable program for your operating system. The name of this program varies; try "**winhelp.exe**" or "**winhlp32.exe**". Typically, you will find these files under the following directories which vary by operating system:
>
> | Windows 3.1 | winhelp.exe | \windows\system\ |
> |---|---|---|
> | Windows 95 | winhlp32.exe | \windows\ |
> | Windows XP | winhelp.exe | c:\windows\ |
> | -or- | winhpl32.exe | c:\windows\system32 |
>
> When you find this program, note its full pathway name.
>
> From the Project window, highlight the **Scripts** icon and select **New**. Type **System.Execute("c:\windows\winhelp.exe c:\coastgis\shebord.hlp")**. If necessary, substitute the appropriate pathway in your system for the "c:\winnt\winhelp.exe" portion of the script and substitute the appropriate pathway for the shebord.hlp file to where the downloaded exercise data was stored. Click the **Compile** button. Rename the script1 as "Ordinance.Help."
>
> Customize the project by adding this as a button to your view. Bring up the customize window, located under the project window.   In the customize dialog box, choose **View** for Type and **Buttons** for Category. Double Click **Click** and select the Ordinance.Help script. Add a button after the icon added for the Theme.Buffer script (noted by the "B" icon). Double click **Icon** and select **Load**. Under List Files of Type, choose **Windows Bitmap (*.bmp)**. Select the file "**book.bmp**" as the icon for accessing the Ordinance. This icon will appear as a red book with a "Z" (for zoning).
>
> When the Ordinance is accessed through this Help system, the document operates in a manner somewhat similar to a home page on the web. Practice using the text links to move around the document.
> Save your project.

4.   Evaluating potential Lake Michigan erosion impacts.

In this section, you will identify potential impacts from the erosion of the Lake Michigan coastline. Based on parameters outlined in the Shoreland-Floodplain Ordinance, you will estimate the new location of the bluff edge as the current slope stabilizes *(Part I)*. In addition, using a 50-year time frame, you will project the future location of the shoreline and bluff edge.   From these projections, land and buildings at risk will be identified *(Part II)*. In addition, economic impacts to land and building values will be estimated *(Part III)*.   You will also examine potential impacts to nearby roads. The final analysis will focus on sediment loss from erosion of the 50-foot bluff *(Part IV)*.

Part I: Creating a map of the current stable slope, and projections of future shoreline and bluff edge locations.

Extract a Lake Michigan shoreline theme.

All estimates of recession are based on the current location of the shoreline. This theme will be extracted from the broader hydrography database.

Open the Shoreland Zoning Ordinance view. Make the Hydrography theme visible and active. Click the **Select Feature** button and then click on a section of the shoreline, highlighting it in yellow. Holding down the shift key, continue clicking on the shoreline until the entire shoreline is selected. Convert this selection to a shapefile, save as "lakemich.shp," add it to your view and rename it Lake Michigan Shoreline.

Open a new view and copy the following themes from previous views: Buildings, Transportation Routes, Orthophoto, Parcels and Lake Michigan Shoreline. Name this view "Shoreline Recession Scenarios" and set the map units to **feet**.

Create a map of the bluff edge as the current bluff erodes to a stable angle.

The Ordinance defines a stable slope angle as 2.5 feet of horizontal distance for every one foot of vertical distance. In this area of the County, the average bluff is 50 feet high. Therefore, the location for the top edge of the bluff, based on a stable slope, will be 125 feet inland from the shoreline. You will use the buffer operation to create a 125-foot

buffer from the shoreline. The inland line of the buffer is an estimation of the bluff edge location based on the current shoreline.

> Create a buffer around the Lake Michigan Shoreline theme named "buff_125.shp." Choose **Feature Buffer, Buffer Distance, 125** and **Line** in the appropriate dialog boxes.

Lets improve the look of this buffer by merging the multiple polygons into a single polygon. Although this will not change functional operations involving the buffer themes (e.g. overlays), it will produce clearer output products.

> Merge these multiple polygons by summarizing on the Buff_dis field. Save your file as "buf2_125.dbf" and add the file to your view.

Another way you can improve the look of your buffer is to clip off the portion of the polygon that extends both 125 feet into Lake Michigan and out from the endpoints of the shoreline line segment. You will do this with the help of a theme clipping script that will clip a point, line or polygon theme to the size of another polygon theme.

> Add the script "clip.ave" to your project, rename it as "ThemeClip" and compile the script. Customize the view by adding a button, assigning it the icon **"C"** and the Help description **"Runs Clipping Script,"** and linking this button to the new script.

> Click the **Clip** button. Choose **buf2_125.shp** as the intersect theme and **Parcels** as the clipping theme. In other words, the buffer will be clipped to the area where it overlaps with the parcels data (i.e. the land). Save your file as "sta_bluf.shp." Add the theme to your view, rename it "Current Stable Bluff," and display only the outline of the buffer. Delete the buff_125.shp and buf2_125.shp from your view.

> Now, move the Lake Michigan Shoreline theme to the top of the Table of Contents. The inland line of the buffer visually represents the bluff edge estimation.

If you zoom in on the Orthophoto, in certain areas you will be able to discern the current location of the bluff. Compare this with your estimation of the stable bluff location. Because the stable slope angle will actually vary depending on the underlying geological makeup of the slope, it is appropriate to think of the future bluff as falling somewhere within a range of locations around the setback estimation.

Create a map of the projected shoreline location after 50 years of recession.

The setback distance described in the Shoreland-Floodplain Ordinance is based on a long-term shoreline recession rate of two feet per year for the northern half of Sheboygan County. Because the Ordinance considers a 50-year period to be the "useful life of a typical residence," you will use this time interval as a basis for your analysis. In other words, the location of the Lake Michigan shoreline in 50 years is projected to be 100 feet inland from its current location. You will use the buffer operation to create a 100-foot buffer from the shoreline. The inland line of the buffer is an estimation of the future shoreline location.

> Create a buffer around the Lake Michigan Shoreline theme named "buff_100.shp." Choose **Feature Buffer, Buffer Distance, 100** and **Line** in the appropriate dialog boxes. Merge these multiple polygons by summarizing on the Buff_dis field. Save your file as "buf2_100.dbf." Clip this buffer to the Parcels theme, saving the file as "pred_shr.shp." Add the theme to your view and rename it "50-year Shoreline." Delete the buff_100.shp and buf2_100.shp files.

Create a map of the required setback from the Lake Michigan shoreline.

The total setback in northern Sheboygan County is based on both the recession of the shoreline and the stabilization of the slope. This distance totals 225 feet from the Lake Michigan shore. In order to map the setback requirements, you will use the buffer command to create a buffer from the current shoreline. The inland line of this buffer is one way to estimate the location of the bluff edge in 50 years. It will also illustrate the Lake Michigan setback requirements in the Ordinance.

> With the Lake Michigan Shoreline theme active, click the **Buffer** button. Save your file as "buff_225.shp." Select **Feature Buffer, Buffer Distance, 225** and **Line** in the appropriate dialog boxes. Use the summarize function on the buffer to merge the polygons into one polygon based on the shared value in the "buff_dis" field. Save this file as "buf2_225.dbf." Clip this buffer to the Shoreline Parcels theme, saving the file as "LM_setbk.shp" and renaming the theme "Lake Michigan Setback." Clear the unmerged and unclipped buffers from your Table of Contents. Visually examine the impact of shoreline recession on nearby buildings and roads.

Part II: Determining land and buildings at risk

Identify high risk land areas and buildings based on stabilization of the slope at its current location.

Add the theme "age.shp" to your view. This theme was created by locating a point on each parcel's primary structure that is closest to the Lake Michigan shoreline. Rename the theme "Shoreline Structures."

There is room for improving the Buildings theme. The data for the Buildings theme is classified into three categories: residential (from an aerial photo), agricultural and buildings (surveyed). However, there are inaccuracies in the classifications for this data set. In addition, the buildings could have been structured as polygons instead of multiple line segments to make their display, coding and analysis more effective. A close look at the features will illustrate the inconsistencies of the digitizing process. Because of these problems, a new simplified theme (age.shp) was created for this application.

All land within this Current Stable Bluff theme is likely to become part of the bluff as it stabilizes. You will now select all buildings within this area as "high risk" of being lost to erosion processes.

With the Shoreline Structures theme active, under the Theme menu, choose **Select by Theme**. Select features of active theme that **Intersect** with the selected features of **Current Stable Bluff**. Click **New Set**.

Open the table for the Shoreline Structures theme and add a string field called "Risk." One record should be highlighted for being at high risk. With the Risk field highlighted, use the Calculate button to set this field equal to **"High"** (make sure to include the quotation marks to identify this as a string expression). Clear the selection on the Shoreline Structures theme and save your edits.

You will use the Shoreline Structures theme to determine whether the buildings on a parcel are impacted by bluff recession. You may recall that this point theme was created by locating one point on the major building of each parcel that is closest to the lake. For this analysis, you will assume that damage to this structure will result in the complete loss of improvement values on the property. Obviously, this estimate does not account for the value of other buildings on the property or partial damage to the primary building. The database for this analysis could be improved by associating each building with a separate value and by reformatting the building layer as polygons rather than line segments.

Identify moderate risk land areas and buildings found between the current stable slope location and the Ordinance setback zone.

Over the next 50 years, the Ordinance estimates that all the land within the setback zone will be lost to erosion from shoreline recession and bluff stabilization. Therefore, land areas and buildings between the Current Stable Bluff and the Lake Michigan Setback locations can be considered to be at "moderate risk" from the impacts of recession.

Ideally, a simple subtraction of the smaller buffer (Current Stable Bluff) from the larger buffer (Lake Michigan Setback) could be used to create a new polygon identifying these areas of moderate risk. However, ArcView 3.0 cannot perform this overlay operation without writing a new Avenue script. Instead, you will rely on visual interpretation to identify at-risk land areas and a query operation to identify at-risk buildings.

Visually examine the additional impacts to land from the estimated shoreline recession over the next 50 years. Use the **Select by Theme** operation to select all Shoreline Structures that intersect with the Lake Michigan Setback theme. If you examine this table, you will note that you have selected all the buildings within the buffer, including the one previously identified at high risk.

With the Shoreline Structures table open, build the following query: (**[risk] = ""**). Choose **Select From Set**. In other words, you have narrowed your selected building set to include only those buildings without a value in the Risk field. Now, calculate the Risk field equal to "Moderate". Clear the selection on the Shoreline Structures theme and save your edits.

Identify at-risk land areas and buildings within 50 feet of the setback.

One response to the threat of impacts from recession is to move the at-risk structures. In order to move these buildings, land is needed on all sides of the structure for the operation of moving equipment. It is estimated that at least 50 feet is needed on the side of the building facing the lake for this undertaking. This translates to an additional 50 feet of at-risk land inside the setback zone.

With the Lake Michigan Shoreline theme active, create a 275-foot buffer from this feature (buff_275.shp). Use the summarize function on the buffer to merge the polygons into one polygon based on the shared value in the "buff_dis" field. Save this file as "buf2_275.dbf." Clip this buffer to the Shoreline Parcels theme, saving the file as "at_risk.shp," and renaming the theme "Moving Area." Delete the buff_275.shp and buf2_275.shp files.

Use the **Select by Theme** operation to select all Shoreline Structures that intersect with the Moving Area. Build a query on this set to select only those structures without a value in the Risk field. Now calculate the risk field for this new set equal to **"At Risk"**. Clear the selection on the Shoreline Structures theme and save the project.

Part III: Estimating the economic impact of recession.

Based on the location of the projected shoreline, you will estimate economic impacts to assessed land values in the area. You will also estimate impacts to buildings and roads from bluff edge recession. All these analyses will be based on the recession rate assumed in the Shoreland-Floodplain Ordinance (i.e. two feet per year over a 50-year time frame).

For this analysis, you will be calculating the impact to lands based on the recession of the shoreline. The actual amount of land lost depends on both the recession of the shoreline cutting away the toe of the bluff, and the stabilization of the bluff causing recession of the bluff edge. Therefore, the total land lost will likely fall somewhere between the future shoreline location and the future bluff location.

Perhaps the best way to estimate this impact is to find the area between the current bluff edge and the future stable bluff location for each parcel. This could be used to estimate loss of land. However, without writing a new Avenue script, ArcView 3.0 cannot perform these analyses. It cannot create a one-sided buffer (e.g. 100-feet inland from current bluff edge) and cannot subtract one theme from another (e.g. current bluff edge from future stable bluff location). Therefore, your analysis will focus on a simpler operation – calculating the economic impacts to land lost from only recession of the shoreline.

Estimate the amount of land lost from shoreline recession.

Use the select by theme operation to select all parcels that are within 1000 feet of the shoreline. Save this theme as a shapefile by choosing Convert to Shapefile under the Theme menu. Save this theme as par_shor.shp and rename it "Shoreline Parcels." You will be using this parcel theme for the remainder of this section; delete the other Parcels theme from your view.

Add the Avenue Script "intrsect.ave" to your project. Rename it "Theme.Intersect" and add it as the button "I" to your view. This script creates a shapefile with polygons formed wherever two themes overlap. These polygons contain the attributes of both overlapping themes.

Begin by clicking the **Intersect** button. A series of question boxes will appear. Choose **Shoreline Parcels** as the intersect theme and **50-year Shoreline** as the overlay theme. Save the file as "landlost.shp."

Now, calculate the area of these new intersect polygons by adding a numeric field to the Attributes of Landlost table. Name this field "Intersect Area." (You may have to abbreviate the field name.) With the new field selected, click the **Calculate** button and in the expression box, type: **[Shape].ReturnArea**. This intersection area represents the amount of land lost in each parcel to recession over a 50-year interval (based on a recession rate equal to two feet per year).

Add a number field (2 decimal places) named "landlost" to the Attributes of Landlost table. Calculate this field equal to **Intersect Area / Sum_Area**. The landlost field estimates the proportion of land lost from the total area of the parcel.

Estimate the value of the land lost to shoreline recession.

You are now going to match each parcel's spatial information with data on the assessed value of the land. If you examine the data on land values, you will see that several records may share a common parcel identification number. This is because a parcel may be assessed in more than one category and the information is stored as multiple records. For this application, you will need to aggregate all multiple records so each parcel has only one total assessed value.

Both spatial and attribute information on the parcels must be aggregated to perform the analysis described in these GIS applications. In both cases, information is "lost" for analytical purposes when the individual records are combined under one parcel identification number. Clearly there is value in planning for GIS analysis functions when defining and refining database management systems.

From the Project window, add the values63.txt table to you project. (Be certain the file type is listed as .txt not .dbf.) Because ArcView cannot edit a text file, you will need to export this file into a dBase format. Under the File menu, select **Export**. Choose **dBase** as the export format and save this file (values63.dbf). Add the dBase file to your project and open the table.

Highlight the **Parcel_id** field; this is the field used to aggregate your data. Click the **Summarize** Button. In the dialog box, choose a directory and name for your file (valu_sum.dbf).Add the following three summary fields, then click **OK**:

Field:	Summarize by:
Acreage	Sum
Land_	Sum
Improv_	Sum

The new Valu_sum table will also be used to store data on the impact of recession on shoreline parcel assessment value. Both the Landlost and Valu_sum tables share common Parcel_id field values. With the join operation, you will match and append records between tables through this common identifier.

In performing the join operation, the Attributes of Landlost table will be the source table, and Value_sum will be your destination table. Make sure both tables are open. Click the title bar of the Attributes of Landlost table to make it active. Click on the **Parcel_id** field name in the this table. Now, click the title bar of the Value_sum table to make it active and highlight the **Parcel_id** field. Finally, click the **Join** button to execute the function. Examine the additional fields in the Value_sum table.

> When you execute a join, you are not affecting the physical files on the disk. Rather, you are establishing a relationship between two tables. When you save a project, you save the definition of this join in your view. Therefore, next time you open the project, ArcView will automatically rejoin the tables. When you want to make changes in joined tables, you need to be in the "home" table for the particular fields you wish to edit. Any changes you make will be reflected in the destination table if you choose **Refresh** from the Table menu. You can also make a permanent disk copy of a destination table by exporting this table to a new file.

Add a number field called "lostvalu" to the Value_sum table and calculate this field equal to **landlost * Sum_Land_**. In other words, the lostvalu field contains the loss in assessed value for each shoreline parcel, based on a recession rate of 2 feet per year over a 50 year period. Now, under the Table menu, select **Remove All Joins**. Save edits.

This time with Valu_sum as the source table and Attributes of Shoreline Parcels as the destination table, join the tables on Parcel_id. Examine the data. Some of these parcels were not impacted by shoreline recession and therefore show no loss of land value. In addition, remember that two of the parcels are actually road right-of-way polygons and therefore have no assessed values.

To summarize the total economic impacts to land values for the Town of Mosel, narrow down your dataset to examine only those parcels financially impacted by shoreline recession. Build a query on the joined Shoreline Parcels theme. Select for all parcels where **lostvalu > 0**.

Note that two parcels adjacent to the coast are not selected. These parcels have no matches in the tax assessment database and may point out an error in that database.

You may want to create a table to store information about the total impacts of shoreline recession. In the project window, choose **New** for Tables and pick a directory and name for your new table (lostvalu.dbf). An empty table should appear on your screen, ready for editing. Add the following fields:

Name	Type	Width
Recession Rate	String	30
Original Value	Number	12
Lost Value	Number	12

From the Edit menu, choose **Add Record** to add a blank record

To find the values for the Original Value field, you will need to make the Attributes of Shoreline Parcels table active (a subset of this table should be selected). With the Sum_Land_ field highlighted, under the Field menu, choose **Statistics**. A box will appear with summary statistics for the Sum_Land_ field. You are interested in the total value of the land for the selected set; this is the Sum. Note this value. Now find the total value for the lostvalu field.

Once again, make the lostvalu.dbf table active and ready for editing. Click the **Edit** button; the cursor should now appear as a hand with a pointing finger. Type the sum of the Sum_Land_ values in the Original Value column and the sum of the lostvalu values in the Lost Value column. Save your edits.

Estimate impacts to buildings from bluff edge recession.

Bluff recession will impact buildings before shoreline recession. Therefore, the estimated 50-year bluff edge location, as projected from the Ordinance setback requirements, will be used for this analysis.

Make the Shoreline Structures, Buildings, Lake Michigan Setback and Lake Michigan Shoreline themes visible.

In order to obtain totals for improvement values (original and losses), you will need to join the Valu_sum.dbf (source table) and the table for the Shoreline Structures theme (destination table) on Parcel_id. For the Original Values, use the statistics operation to calculate the total value (sum) of the Sum_Improv field for these records.

Now you will determine which buildings are impacted from recession of the bluff. With the Shoreline Structures theme active, in the Shoreline Recession view, use the select by theme operation to select all points that intersect with the Lake Michigan Setback theme. Open the attribute table

for the Shoreline Structures theme. The selected set will be highlighted; note the sum statistics for Sum_Improv field.

Estimate the impacts to roads from bluff edge recession.

As with the buildings, recession of the bluff edge is a better predictor of impacts to roads than shoreline recession.

Make the Transportation Routes, Lake Michigan Shoreline and Lake Michigan Setback visible. Note how close the road (County LS) is to the current bluff edge. You will be using the intersect operation to estimate the length of road impacted by the bluff recession.

With the Transportation Routes theme active, select **Properties**. Build a query, selecting only records with **lgds_level = 2**. This narrows the theme down to just road centerlines, therefore preventing multiple counting of impacts to the same road section.

Click the **Intersect** button and choose **Transportation Routes** for the intersect theme and **Lake Michigan Setback** for the overlay theme. Choose a directory and name for your file (lostroad.shp) and add the theme to the Shoreline Recession Scenarios view. Rename the theme "Road Impacts".

To find the total length of road impacted, open the attribute table for the Road Impacts theme. Add a number field called "Impact Length." Calculate this field equal to: [Shape].ReturnLength (this calculates the lengths of the new line segments). To estimate the total length of road impacted by bluff recession, use the statistic function for a sum of the Impact Length field.

Save your project.

Part IV: Estimating the volume of sediment lost to erosion.

Shoreline erosion also impacts water quality in Lake Michigan by adding tons of sediment into the Lake. It is possible to estimate the volume of sediment that will be lost to erosion based on the bluff height, the recession rate, the time frame under consideration and the distance of shoreline under analysis. You will access the formula for calculating sediment volume through ArcView's hot link tool.

Set up a hot link to the file containing the sediment loss formula.

Hot links provide a tool for linking a theme in your view with an external file. These external files may contain text or images, or they may be used to access a customized script file. You can even use this tool to move between other views, layouts, tables and charts within your ArcView project. In this section, you will create a new theme that will act as a link to an image file containing the formula for calculating sediment loss.

With the Lake Michigan Shoreline theme visible, zoom to the full extent of your view. Create a new point theme, saving the file as sediment.shp. Place a point somewhere along the Lake Michigan shoreline, just offshore. Stop editing, save your edits and rename the theme "Sediment Formula." Open the legend editor for this theme and click the **Marker Palette** button. Choose a new symbol for this theme (e.g. 16-point star). Clicking on this symbol will access your hot link to the sediment formula.

To create the hot link, open the table for the Sediment Formula theme. Add a new string field named "hotlink," 50 characters in width. Edit the value in this field by typing the pathway name to the file called "formula.gif." For example, this may look like: c:\coastgis\formula.gif Stop editing and save your edits.

Click the **Theme Properties** button to access the theme properties dialog box for the Sediment Formula theme *(Figure 5)*. Select the **Hot Link** icon. Under Field, choose **hotlink**. Under Predefined Action, choose **Link to Image File**. The Script should be **Link.ImageFile**. Click **OK**.
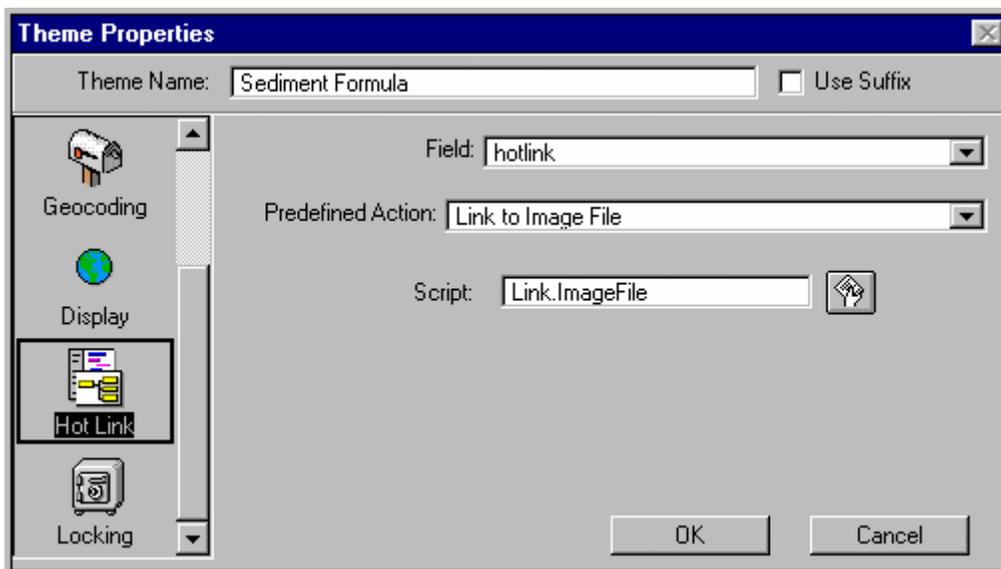

Figure 5. Theme Properties Box

Calculate the sediment loss from shoreline recession and bluff stabilization.

⚡   With the Sediment Formula theme active, click the **Hot Link** button. Your cursor will now appear as a lightning bolt. Place the bottom of the lightning bolt in the center of your Sediment Formula point and click the left mouse button. A window should now appear in your view displaying the sediment formula image file *(Figure 6)*. Examine the formula for computing the sediment loss.

Four variables are necessary for calculating this value: height of the bluff (h), recession rate (r), time frame under consideration (t) and length of area under analysis (l). For this application, you will define these variables as: h = 50 feet, r = 2 feet/year and t = 50 years. The length will be equal to the shoreline length for the Township. You may also wish to calculate the sediment loss per mile of shoreline. If you decide to apply this formula to another geographical area, remember to adjust the bluff height and recession rate values accordingly.

Open the table for the Lake Michigan Shoreline theme. Calculate the total length of the shoreline by finding the sum statistics for the length field. Note this value for your sediment loss formula. Calculate the sediment loss value based on the stable slope described by the Ordinance setback distance. You may wish to convert these values from cubic feet into cubic yards (divide by 27). Save your project.

Loss = ((r * t * h) - (1.25 * h)) * l

where: h = bluff height
r = recession rate
t = time frame under consideration
l = length of shoreline under analysis

If the future stable bluff is located further inland than the future bluff, use the formula:

Loss = ((r * t * h) + (1.25*h*h)) * l

Figure 6. Sediment Loss Formula

5. Identifying parcels which may be difficult to develop.

In this section, you will identify vacant parcels along the Lake Michigan shoreline which may be difficult to develop under current zoning regulations.

Create buffer themes based on setback distances.

In this area of Sheboygan County, the setback requirements for all "Principle Buildings" (e.g. homes, commercial buildings) along the Lake Michigan Shoreline is 225 feet from the high water mark of Lake Michigan and 75 feet from any navigable inland waters (with certain exceptions). In addition, Town of Mosel zoning requirements include an 80-foot setback from road centerlines.

> Return to your Shoreland Zoning Ordinance view. For this section, you will focus on the required setbacks within the zones, rather than on the zones themselves. You already have a theme illustrating the required Setback from Lake Michigan. Copy this theme from your Shoreline Recession Scenarios view. Also copy the Transportation Routes and Buildings themes from the Data Layers view.

> With the Hydrography theme active, create a buffer which illustrates a setback zone of 75 feet for all inland waters. Save the file as "iw.shp" and choose **Feature Buffer**, **Buffer Distance**, **75** and **Line** for the buffering scheme. Merge the buffers into one polygon (summarize on the field "Buff_dis") and save this as "iw_sb.dbf." When the theme is added to your view, rename it "Inland Waters Setback."

> Now, make the Transportation Routes theme active. You will need to narrow down this theme to show only road centerlines. Under the Theme Properties menu, select **Query**. Build the following query: ({lgds_level} = 1) and click **OK**. Now, buffer this selected set with an 80-foot buffer distance. Save the file as "rd.shp." Merge the buffers into one polygon as "rd_sb.shp" and rename the theme "Road Setback."

> Finally, you are going to create a theme with all three of these setbacks merged into a single zone representing undevelopable lands. To do this, you will need to add a new Avenue Script. Under the Script menu, select **Load Text File...**, and choose the file "mrgthems.ave." Compile the script and rename it "Theme.Merge." Customize your view window by adding this script as a button with an "M".

Click your new **Merge** button. A series of question boxes will ask you which themes you wish to merge. Highlight **Road Setback**, and click **OK**. Repeat this procedure for **Lake Michigan Setback** and **Inland Waters Setback**. Click **Cancel** to end the selection of themes. Save your file as "nobd.shp." Add the theme to the Shoreland Zoning Ordinance view.

If you examine the attributes of this merge theme, you will note that each of the buffers is a separate record (therefore, a separate feature). By creating a field with a shared value and using the summarize operation, now merge the three buffers into a single theme. Save this file as "nobuild.dbf." Bring the new file into the view and rename it "Undevelopable Lands."

You may want to clear themes from your view. For example, you will no longer need to access any of the original buffers (all should end in .shp) so these can be removed from your view.

Calculate the amount of developable land for each parcel.

In order to narrow down this analysis, you will now select vacant parcels along Lake Michigan. In order to select only vacant parcels, you will first select parcels with buildings and then reverse this selection.

Make the Parcels theme active and display it with a gray foreground and with colored outlines. Choose **Select By Theme...** in the Theme menu to create a new set by selecting parcels that intersect with buildings. Now, reverse this set to highlight vacant parcels by opening the parcels theme table and clicking the **Switch Selection** button.

Close the table and, with the Parcels theme active, do another **Select By Theme...**. Select features of **Lake Michigan Shoreline**. Highlight **Are Within Distance Of** in the top box and type **1000** for the selection distance. Click **Select from Set** to chose only from the previously selected vacant parcels.

At this point, you can visually examine the impacts of the various setback zones on vacant property. The **Measure** button is a tool for obtaining measurements from the view screen. However, you may want to obtain more exact measurements of developable land for these parcels.

Begin by clicking the **Intersect** button. Choose **Parcels** as the intersect theme and **Undevelopable Land** as the overlay theme. Save the file as "intrsect.shp" and rename it "Intersection." This file contains polygons representing the undevelopable land for each parcel.

You can use these undevelopable lands to find the total developable area for each parcel. First, add a number field (named "Area") to the Attribute of Parcels table. Click the **Calculate** button, type the following in the expression box: [Shape].ReturnArea   and click **OK**. This will calculate the area of the polygons in this shapefile. Now, repeat this procedure for the Intersection table, adding a number field (named "Intersection Area") and calculating the area of these polygons.

Now, with Intersect as the source table and the Parcels as the destination table, join the tables on the field "Parcels_id." Add a number field to the Attributes of Parcels called "Develop" and calculate this field equal to Sum_Area minus Intersect Area. In other words, you are calculating the amount of land in each parcel that does not fall into one of the setback zones.

You can fill in the gaps in this analysis by including the 107 parcels which have no overlap with the setbacks themes and therefore, have no values for "Develop." Build a query on your Attributes of Parcels table, selecting for Develop values >= 0. Reverse this selection. Highlight the Develop field name and calculate this field equal to **Sum_Area**. In other words, if there is no overlap with a setback zone, a parcel's total area is considered developable.

Chart the amount of developable land on vacant, lakeshore parcels.

Once again, you are going to restrict your analysis to vacant parcels, with no buildings, within 1000 feet of the Lake Michigan Shoreline. With the Parcels theme active, use the **Select by Theme...** operation to select this set.

One way to examine this data is to make a chart illustrating the amount of developable land for each shoreline parcel. Open the Parcels theme table. Click the **Create Chart** button.   From the Chart Properties Dialog Box, name your chart "Developable Lands." Select the field **Develop** and click the **Add** button. Choose to label the series using **Parcel_id**. Click **OK**. Your chart will now be displayed.

You may wish to modify the default chart. Begin by clicking the **Chart Element Properties** button to allow chart editing. The following instructions highlight some of the chart format options available.

Legend: Click anywhere on the legend to access the Chart Legend Properties dialog box. By clicking at a location on the Legend Position Diagram, you can move your legend to one of five location. Place the legend below the chart.

Title: Click anywhere on the title to access the Chart Title Properties dialog box. Change your title to "Amount of Developable Land Along the Lake Michigan Shoreline."

Axis: Under the Chart pull down menu, select **Hide X Axis** to hide the group field name from view.

> Remember, there is a direct link between your chart, your table and your view. Changes in any of these documents will be reflected in the other two! For example, if you change a Group Label in your chart, your table will now display the field with this new label as an alias.

Color: Click the **Chart Color** button to access symbol palettes. From the Color Palette, choose a new color for your title by clicking on the color and then clicking on the title.

> There are a number of other chart options available. For example, if you wish to display your data as another type of chart (e.g. bar), simply click the appropriate button on the button bar. A variety of additional editing capabilities are available under Layout. Simply import your chart into a layout using the **Chart Frame** tool. Now you can improve your chart by adding text and changing fonts.

Bar Chart Gallery   **Chart Frame**

Close Chart Window.

Flag vacant, lakeshore parcels with minimal developable lands.

Although visual interpretation of maps and charts will give you an overall view of this issue, you may want a more qualitative solution to help you with your decisions. In this section, we will flag parcels will less than 25,000 available square feet for development as "parcels for potential concern." The 25,000 square feet value is somewhat arbitrary; it is simply intended to represent a value for which siting a home may be more difficult.

These may be parcels where zoning administrators will pay extra attention when evaluating any submitted permits. However, feel free to change this value if 25,000 does not make sense to you.

The vacant, lakeshore parcels without buildings should be highlighted. Create a query on this theme, selecting from the current set any parcels with less than 25,000 feet of developable land. Move these records to the top of the table using the **Promote** button. Add a string field to the Parcels theme called "Flagged." Type "Yes" in this field for the 7 of 9 highlighted records. (If you look at the map, you will find that two of these parcels are road right-of-ways -- Parcel_id 99633411 and 99633442 -- and should not be flagged.)

The accuracy of these buffers in determining setback distance is only as good as the accuracy of the lines on which they are based. Any user of these model applications should be aware of the following data limitations and the assumptions made in this analysis:

1. *The Shoreland-Floodplain Ordinance requires a 75-foot setback from the ordinary high water mark for all inland navigable waters. In this analysis, you made two assumptions that could be challenged: (1) all inland waters are <u>navigable</u>, and (2) the rivers and streams can be portrayed by one "centerline" (rather than their two shorelines).*
2. *The Town of Mosel Zoning Ordinance requires a minimum setback of 80 feet from road centerlines, with a 100-foot requirement for state and federal highways. However, the digitized road segments do not differentiate between county, state, federal or "unofficial" (e.g. military base) road segments. Your 80-foot buffer will be inappropriate in some places.*
3. *As you know, the dynamic nature of the Lake Michigan shoreline makes it a difficult feature to digitize accurately. The location of the ordinary high water mark, the basis for this setback, is not static. Therefore, the setback cannot be static.*
4. *Without information describing the creation of this digitized shoreline, we cannot be certain whether the digitized line represents the ordinary high water mark, the location of the water's edge at the time an aerial photograph was taken, or some other feature that was interpreted as the "shoreline." This type of background information about a GIS data feature is called "metadata" and should always be recorded when a GIS layer is created!*

Save your project.

6.   Identifying potential shoreland permit compliance issues.

In this section, you will evaluate aerial photographs and permit information to identify whether structures along the Lake Michigan shoreline are in compliance with the shoreland permit regulations.

Evaluate aerial photographs to determine the age of structures.

Old aerial photographs of Sheboygan County are a good source for tracking the development of this area over the last sixty years. From these photos, it is possible to determine the approximate age of the structures along the shoreline. Of particular importance to this application is the date October 27, 1970. Structures built prior to this date are considered "non-conforming" uses if they do not meet current requirements of the zoning districts. Structures built after the effective date of the ordinance that do not meet the requirements of the ordinance and do not possess a proper variance or permit may not be compliant. In these cases, further investigation may be warranted. Aerial photos from the years 1941, 1961, 1967, 1971, 1978 and 1992 were used to determine the age of major structures within 1000 feet of the Lake Michigan Shoreline. In the Shoreline Structures theme, the field "When_built" contains the range of years when buildings first appeared in the location of the point.

> Copy the Shoreline Structures theme from the Shoreline Recession Scenarios view into your Shoreland Zoning Ordinance view and make it the active theme. Use the **Select by Theme...** operation to select all of the shoreline structures that intersect with the Lake Michigan Setback theme. To find out if any of these structures were constructed after the ordinance went into effect, build the following query in the attribute table: ([When_built] = "1972 - 1978") or ([When_built] = "1978 - 1992"). Click **Select from Set**. Two points should be highlighted.

> Now you will see if these two structures have shoreland permits. Add the table "moselplg.dbf" to your project under the project window. Using moselplg.dbf as the source table and Attributes of Shoreline Structures as the destination table, join the tables on the Parcel_id field. You will note that neither of the selected structures have permits. Therefore, further review may be warranted to determine if they are in compliance with the Ordinance. Save your project.

This application points out the difficulties in working with a changing feature like the Lake Michigan Shoreline. If the shoreline was a farther distance away when these buildings were constructed, they may have been in compliance with the ordinance at that time. Using photogrammetric techniques, you could determine the distance of these structures from the shoreline at the time the photos were taken.

7.   Informing landowners about septic tank regulations.

In this section, you will generate a form letter, asking landowners for information about their septic systems.

Link attribute files containing information on parcels, sanitary systems and land ownership.

Return to your Data Layers view. Add the dBase file called "moselsan.dbf" and "ownerwww.dbf" to your project. Both these attribute files share the Parcel_id field in common with the Parcels theme. With the ownerwww.txt file as the source table and the Attributes of Parcels as your destination table, join these tables.

Perform a second join using the moselsan.dbf as the source table and the Attributes of Parcels as the destination table. Once again, use Parcel_id as the common field.

> In order to make the Attributes of Parcels table less complicated, you can hide some of the fields from view. From the Table Menu, choose **Properties**, and uncheck any fields which you wish to hide. These fields won't appear if you print the table. In addition, they can't be used to label or query the theme.

Display developed parcels without sanitary permits.

Make the Parcels and Buildings themes visible. Display the Parcels theme in gray, outlined by another color. Clear any selection you may have on this theme.

You will now find all the parcels that are developed (i.e. overlap with the Buildings theme). With the Parcels theme active, under the Theme menu, choose **Select by Theme...**. Select the features of **Buildings**, and make sure **Intersect** is displayed in the top box. Click **New Set**. Convert these features to a shapefile, save the file as "developed.shp," add the file to your view and rename it "Developed Parcels." Click the **Clear Selected Features** button for the Parcels theme.

Make the Developed Parcels theme visible and active. In order to select only the parcels without sanitary permits, we will first select those with permits and then reverse the selection. In the attribute table, under the

Table menu, choose **Query.** Build the following query: ([Sanpermit] > 0). Select **New Set**. Now click the **Switch Selection** button. All of the parcels with buildings, but without recorded sanitary permits, will be highlighted.

Mail merge ownership data with a form letter using Microsoft Word.

For this section, a form letter called "notify.doc" has been created. This letter is intended to illustrate the capabilities of coupling the GIS and word processing functions. Feel free to edit the letter and insert additional merge fields to make this exercise more relevant to your applications.

First, you need to save your current selection as a dBase file. Make sure your Attributes of Developed Parcels table is open. To export the database file, from the File menu, choose **Export**. Highlight **dBase** and click **OK**. Choose a directory and name to save your file (notify.dbf). Save your project, minimize the ArcView screen and open Microsoft Word.

Open the file "notify.doc." In the Tools menu, select **Mail Merge**. From the Mail Merge Helper box, under Step 1 -- Main Document, choose **form letters** from the Create drop-down menu. A question box will appear; click **Active Window**.

Proceed to Step 2. Select **Open Data Source** under the Get Data drop-down menu. From the List of Files Type, choose the **dBase(*.dbf)** option. Select "notify.dbf" and click **OK**. In the Confirm Data Source dialog box, highlight your appropriate dBase connection and click **OK**. A question box will appear stating that no merge fields have been identified; click the **Edit Main Document** button. Place the cursor below the line "Sheboygan County Property Owner." From the Insert Merge Field scroll list, select **STREET**. Move to the next line and add the merge field **CITY**. Now, type a comma followed by a space and the letters "WI" and two spaces. Add the merge field **ZIP5**.

To proceed with the final step, choose **Mail Merge** from the Tools menu. Under Step 3, click **Merge...**. The Merge Box will appear; simply click the **Merge** button and the program will produce 273 separate form letters for all of the affected properties.

Save your project.

Evaluation:

Coastal Erosion and Shoreland Development Regulation - Town of Mosel, WI

Please complete the following evaluation to help us better understand your experience with this tutorial and to increase the effectiveness in future updates to the exercise.

How useful did you find this exercise?
- □ Very Useful
- □ Somewhat Useful
- □ Not very Useful

How would you rank the difficulty of the exercise?
- □ Too easy
- □ Just the right level of difficulty
- □ Very difficult

Were the instructions easy to follow?
- □ I strongly agree
- □ I agree
- □ I disagree
- □ I strongly disagree
- □ Not sure

Did you feel the content was appropriate in understanding the GIS applications?
- □ I strongly agree
- □ I agree
- □ I disagree
- □ I strongly disagree
- □ Not sure

Would you recommend this exercise to co-works, fellow students, etc?
- □ Yes
- □ No
- □ Maybe

Please add any suggestions that you may have in assisting with the future development and updates to this exercise.

Please mail this evaluation form to:
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