

# **Exercise 4: An Example of Massachusetts, USA Digital Data**

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# 1. Intro-fossgis-umass

## 1.1. Author Attribution

Major contributors to this curriculum include (alphabetical):

Maria Fernandez

Michael Hamel

Quentin Lewis

James Peters

Charlie Schweik

Alexander Stepanov

## 1.2. Module Licensing Information

Version 1.0.



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## 1.3. Reviewed by

Quentin Lewis

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# 2. An example of regional web resources: Massachusetts, USA digital data

## 2.1. Organization of Data in MassGIS

MassGIS maintains a comprehensive, statewide database of spatial information for environmental research, planning and management. You can read an overview of what MassGIS offers here: (<http://www.mass.gov/mgis/dd-over.htm>).

Two types of data are available from MassGIS: Vector data and Image data. They will be discussed more explicitly in the following sections, but here are the basics.

- Vector data are available as ARC/INFO Export Files (.e00) and ESRI Shapefiles. You can download them here <http://www.mass.gov/mgis/dwn-vect.htm> [<http://www.mass.gov/mgis/d?n-vect.htm>]. Spatially, they are provided at multiple scales:
  - MA town
  - USGS quad
  - Orthogonal Photo quad
  - Basin
  - Watershed Area
  - Soil Survey Area
- There are also indices that reveal the organization of these files. They are listed as follows:
  - Towns Index: [http://www.mass.gov/mgis/ix\\_town.htm](http://www.mass.gov/mgis/ix_town.htm)
  - USGS Quad Index: [http://www.mass.gov/mgis/ix\\_quad.htm](http://www.mass.gov/mgis/ix_quad.htm)
  - Orthophoto Quad Index: [http://www.mass.gov/mgis/ix\\_oq.htm](http://www.mass.gov/mgis/ix_oq.htm)
  - Basins Index: [http://www.mass.gov/mgis/ix\\_bas.htm](http://www.mass.gov/mgis/ix_bas.htm)
  - Watersheds Index: [http://www.mass.gov/mgis/ix\\_wat.htm](http://www.mass.gov/mgis/ix_wat.htm)
  - Soils Index: [http://www.mass.gov/mgis/st\\_soi.htm](http://www.mass.gov/mgis/st_soi.htm)
- Image data consists in MrSID and TIFF formats. You can download them here: <http://www.mass.gov/mgis/dwn-imgs.htm>. They are spatially organized as:
  - USGS topographic quad maps

- Orthophotos

You can find complete list of available layers at this link: <http://www.mass.gov/mgis/laylist.htm>.

## 2.2. Metadata

No matter where you find the data you plan to use, you must first evaluate the quality and appropriateness of that data for your application. Before using geographic data you need to find out how that data was generated, its original sources, and its projection. To obtain this information at the MassGIS website, you can use both "DataLayer Descriptions" and "Metadata" files for each data layer you plan to use. All MassGIS data is in the same projection:

**The datum for the MassGIS database is North American Datum 1983 (NAD83). The data are registered to the Massachusetts State Plane Coordinate System, Mainland Zone (Fipszone 2001). Units are meters. (Some imagery for Martha's Vineyard and Nantucket are also available in the Mass. Stateplane Island Zone).**

The Massachusetts State Plane Coordinate System, Mainland Zone meters is defined as follows:

```
Projection: Lambert Conformal Conic
Spheroid: GRS 80
Central Meridian: -71.5
Reference Latitude: 41
Standard Parallel 1: 41.71666666667
Standard Parallel 2: 42.68333333333
False Easting: 200000
False Northing: 750000
```

**Please note that if you are using data in other projections or in other units (e.g. feet) your data will not be spatially aligned to MassGIS data (unless your GIS software supports on-the-fly projection).**

Source: MassGIS website

## 2.3. Searching and downloading data

### Raster Data

MassGIS serves most raster data sets in 4x4 km tiles with an ID number. You can find the orthophoto quad index at [http://www.mass.gov/mgis/ix\\_oq.htm](http://www.mass.gov/mgis/ix_oq.htm). Check this link to read about the ways you can determine the orthophoto quad ID of your location of interest. The following image shows a close up (Amherst town boundaries and OQ outlines) of the PDF version of the MA statewide map:

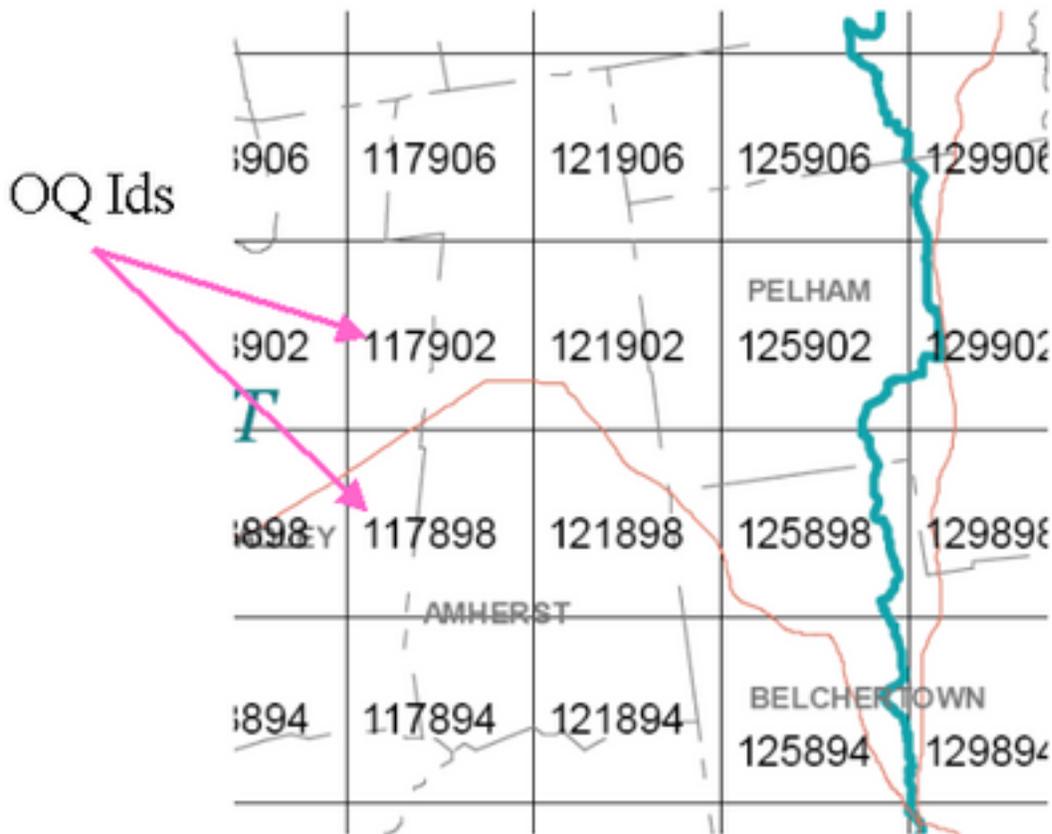


Figure 1: OQ IDs for Amherst

For example, if you decide you need OQ #117902, you can go to the download area for raster datasets <http://www.mass.gov/mgis/dwn-imgs.htm>:

1. Download the 1:5,000 Black & White Digital Ortho Images. As mentioned previously, it is a good habit and a learning tool to read the "data layer description" (<http://www.mass.gov/mgis/oqdesc.htm>).
2. QGIS can read Tiff format, but not MrSid. So, you would choose a 5m resolution Tiff image. (Note that 5m resolution image files are not as big as 2m resolution files, 640 KB compared to 4MB). The smaller 5m resolution Tiff image would result in less time to download, more space on your computer, and less time to generate GIS displays. (Always keep these implications in mind, and, when possible, get the least data intensive resolution you need for your application).
3. Download the .tif (image) file and tfw file (text file header with spatial information) from the ftp site: <ftp://data.massgis.state.ma.us/pub/ortho5/>.
4. Select the files 5\_117902.tfw and 5\_117902.tif and copy them to your work folder (eg., C:\temp\GISdata).
5. Then, follow the same procedure to download 1:25,000 scale USGS topographic maps (<http://www.mass.gov/mgis/ftpquad.htm>). Try to navigate to the file using the previous link, but if you have trouble, here is the direct link: <ftp://data.massgis.state.ma.us/pub/images/usgs>

Note: if you are unfamiliar with some of the available USGS maps at different spatial (map) scales, see

<http://erg.usgs.gov/isb/pubs/booklets/usgsmaps/usgsmaps.html>

## Vector Data

There are two principal file formats for vector data - shape files and coverages. The vector data available at MassGIS is in ARC/INFO Export File (.e00) or ESRI Shapefile format. Download the files in Shapefile format. What's the difference of those two formats? Topology. Vector data such as lines and polygons can have a From-To order. This information is useful if you are trying to determine the direction of a stream flow or questions about adjacency (e.g., which polygons share a common border). Arcview shape files don't store topology. Arc/Info coverages or layers do. ArcView shape files are easier to process because they don't store this extra information. This is the major difference between an Arcview Shapefile and a Arc/Info coverage. .E00 is the format for sharing ArcInfo layers.

## Shape files

Let's say that you are interested in land use (zoning) in Amherst and in adjacent areas of neighboring towns. You will want to get two data types from MassGIS: the town boundary and the zoning data.

### 1. Town boundaries

- a. To give some context to the layers you have downloaded so far, you will get the Amherst town boundaries. However, there is no data for single town boundaries. What is available is Community Boundaries, a single layer for the entire state, containing the boundaries of the 351 communities in Massachusetts.
- b. Again, go to Download Free Vector Data (<http://www.state.ma.us/mgis/dwn-vect.htm>)
- c. Choose Statewide layers. Scroll down the table until you find Town Boundaries - no coast.
- d. Download the shapefile data (bndry.exe).

### 2. Zoning Layer

- a. Go back to <http://www.mass.gov/mgis/download.htm> and click "Download Data".
- b. Take a look at vector data available by town (this would include layers such as Land Use, Executive Office of Transportation-OTP Roads, 1:5,000 Road and Rail Centerlines and Zoning Districts).
- c. Go to Zoning, under political boundaries and click on the layer description link <http://www.mass.gov/mgis/zn.htm>
- d. Read through the descriptions of some of the attributes, for example PRIM\_USE and GEN\_USE.
- e. See that there are also some related tables that one could link to the spatial data, with secondary information, useful for analysis, planning, etc.
- f. Scroll down the table with the names of the towns until you find Amherst. Right-click on zn8.exe and click "save target as". Save the file in a work folder (C:\temp\GISdata)

## Coverages

Now for a moment, let us take a break for a minute from the exercise, in order to explain something. This section of

the tutorial is a resource for your future work.

- Often you will find free data on the Internet in ArcInfo Coverage format, not Shapefile format. The common way you find these is in the ArcInfo export format (i.e., .e00), which is an interchange file across platforms.
- **THE IMPORTANT THING TO REMEMBER** is that if you see data on the internet that has an extension of ".e00" it means that it is in interchange format, and you will have to convert it back to a coverage or a shape file. This is a common way people serve ArcInfo coverages on the Internet.
- QGIS cannot read or convert e00 files, but it can read coverages. ArcInfo export files are not in one of the formats supported by GDAL/OGR libraries either. One option for converting e00 files into ArcInfo coverages is the Import71 Utility (by ESRI, free download, but may not work in linux). You can also try the AVCIMPORT program to import E00 files and create coverages (it is open source software and should work in linux, but has not been tested).
- To download ArcInfo layers from MassGIS you need to RIGHT-CLICK and choose "save target as." Save it to your temp directory. **MAKE SURE IT DOESN'T PUT A ".txt" ON THE END OF THE FILE NAME.** This procedure will save "ArcInfo export" or "interchange" files to this directory.
- Note the file structure of ArcInfo coverages. There is a "Coverage name" folder and an "Info" folder. Look at the contents of each of the folders. ArcInfo coverages store the spatial data in the "Coverage name" folder and the attribute data in the "info" folder. This is the proprietary database structure of ArcInfo/ESRI.

## 2.4. Uncompressing the data

- Ok, now back to the exercise. Recall that before the discussion on Coverages above, we downloaded Shapefile data from MassGIS. After downloading, you need to make sure that all of the data are in a format that can be imported into QGIS. QGIS can read feature data stored in any of the following formats: shapefiles, ArcInfo coverages, dBASE tables of x,y coordinates, text files of x,y coordinates and CAD drawings.
- Next, you have to convert the downloaded executable (".exe") files to shapefiles. To do this navigate your computer to your work folder (i.e., c:\temp\data) and decompress the zn8.exe and bndry.exe zip files. The Linux command "unzip" is used to extract the data from the .exe files if it cannot be done in the "windows way". **MAKE SURE YOU KNOW WHERE THE DECOMPRESSED FILES WILL BE STORED.**
- Open the folder c:\temp\GISdata. How many files were unzipped from the Amherst zoning shape file? You will have to keep track of all of these files when backing up your work or moving data between computers.
  - zn8by.dbf is an attribute table in Dbase format with explanations for zoning codes
  - zn8p1.dbf is an attribute table in Dbase format
  - zn8p1.shp stores feature geometry
  - zn8p1.shx stores the spatial index to the features

## 2.5. Bringing the data into QGIS

Now that you have downloaded and/or converted the data, you need to input it into QGIS.

1. Open QGIS
2. Define the projection of the project or data frame:
  - a. In the top menu, go to settings > project properties > projection.
  - b. Click "Enable on the fly projection".
  - c. Go to Projected Coordinate Systems > Lambert Conformal Conic > NAD83/Massachusetts Mainland (in meters). Click OK.

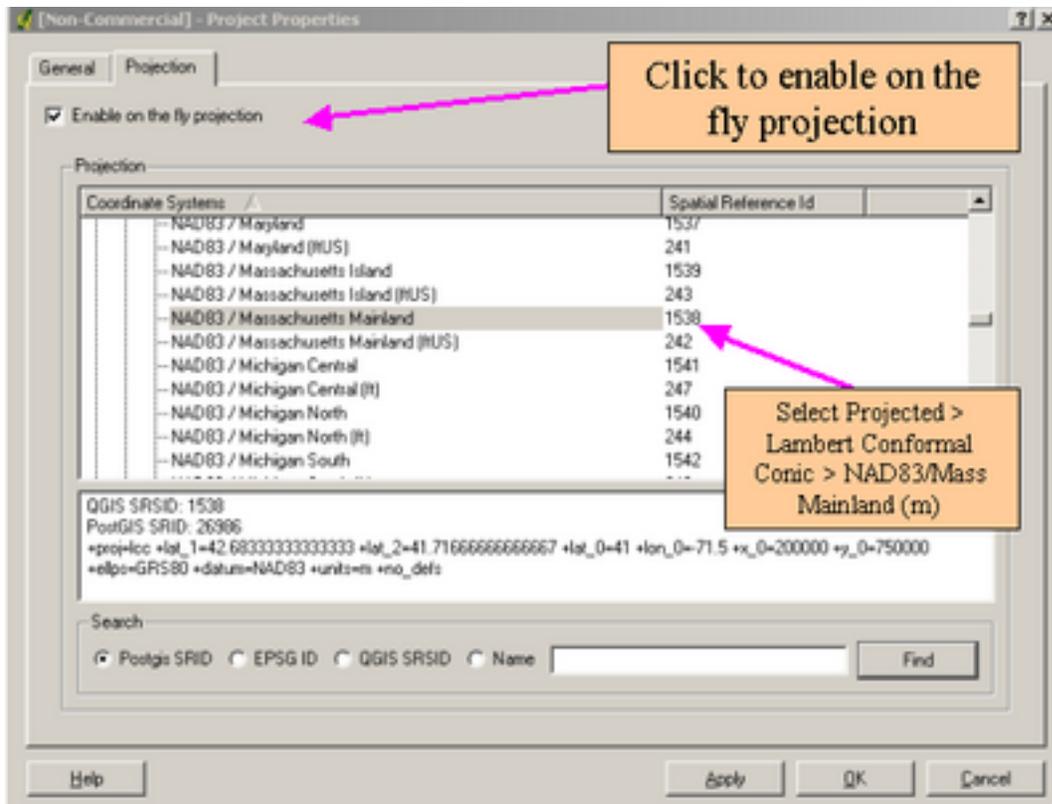


Figure 2: Setting Data Frame Properties

3. Add the vector layer bndry.shp from the main QGIS interface.
4. Right click on the layer in the table of contents and click on properties to bring up the properties of the layer.
  - a. Click the "general" tab > Spatial Reference System > Change:

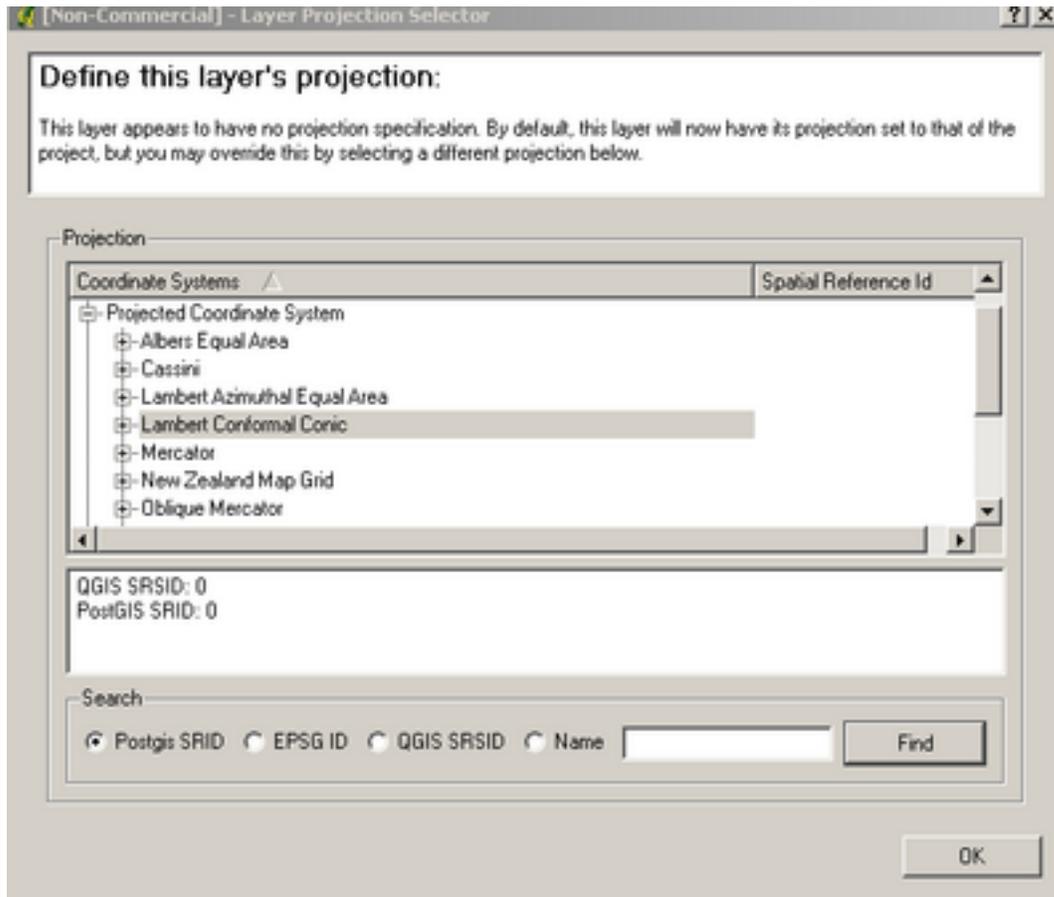


Figure 3: Setting Coordinate System

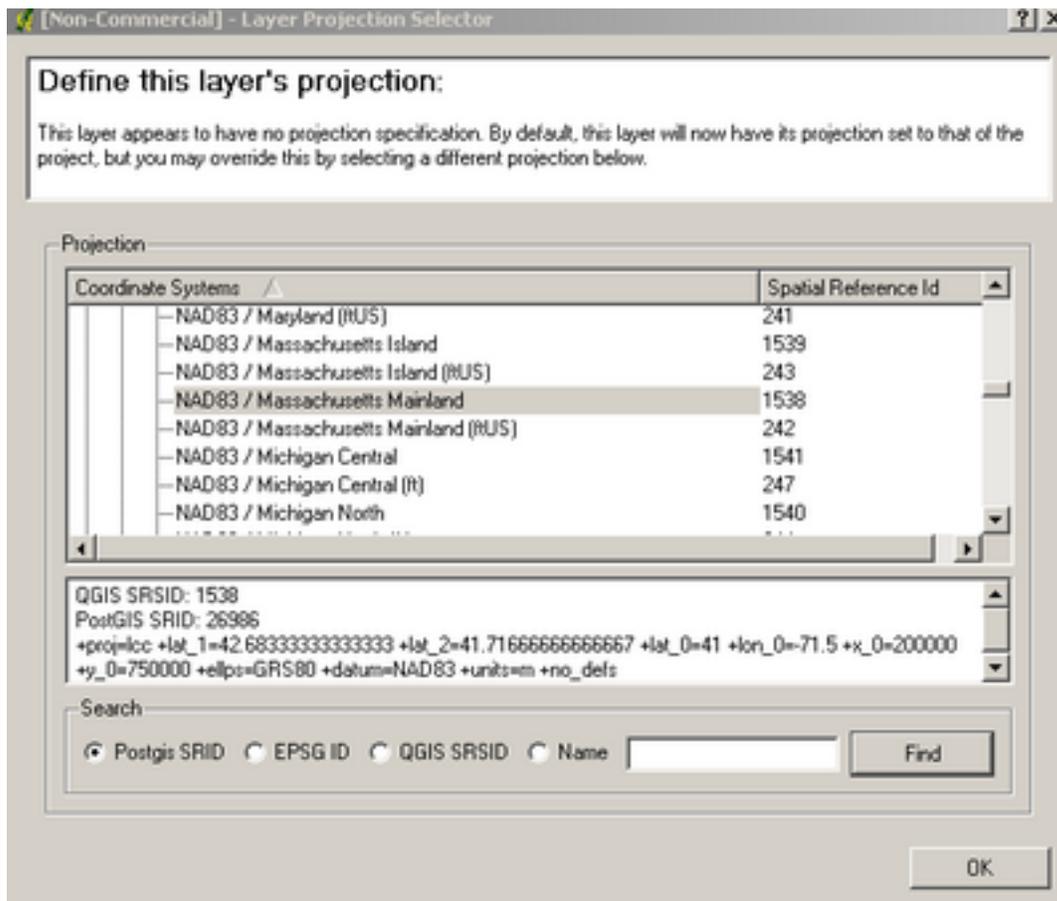


Figure 4: Setting Datum

5. Add the other vector layer (zoning), right click > properties.
  - a. Click the "general" tab: define projection as you just did for the town boundaries.
  - b. Change the name to "ZONING".
  - c. Click the tab "symbology" and change the display to transparent, yellow outlined polygons:

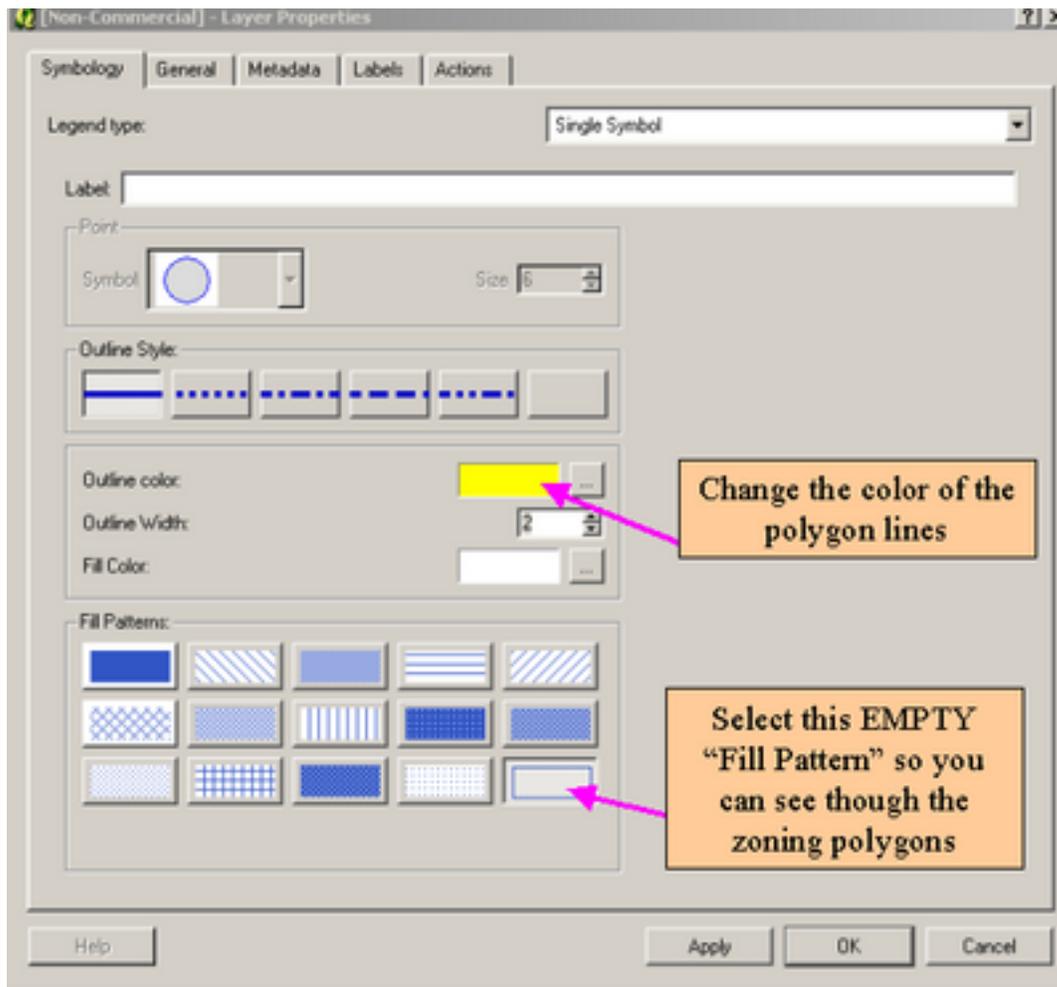


Figure 5: Changing polygon display

- d. Click the "labels" tab, and select "ZONECODE" as the field containing label. Be sure to check the display labels box.

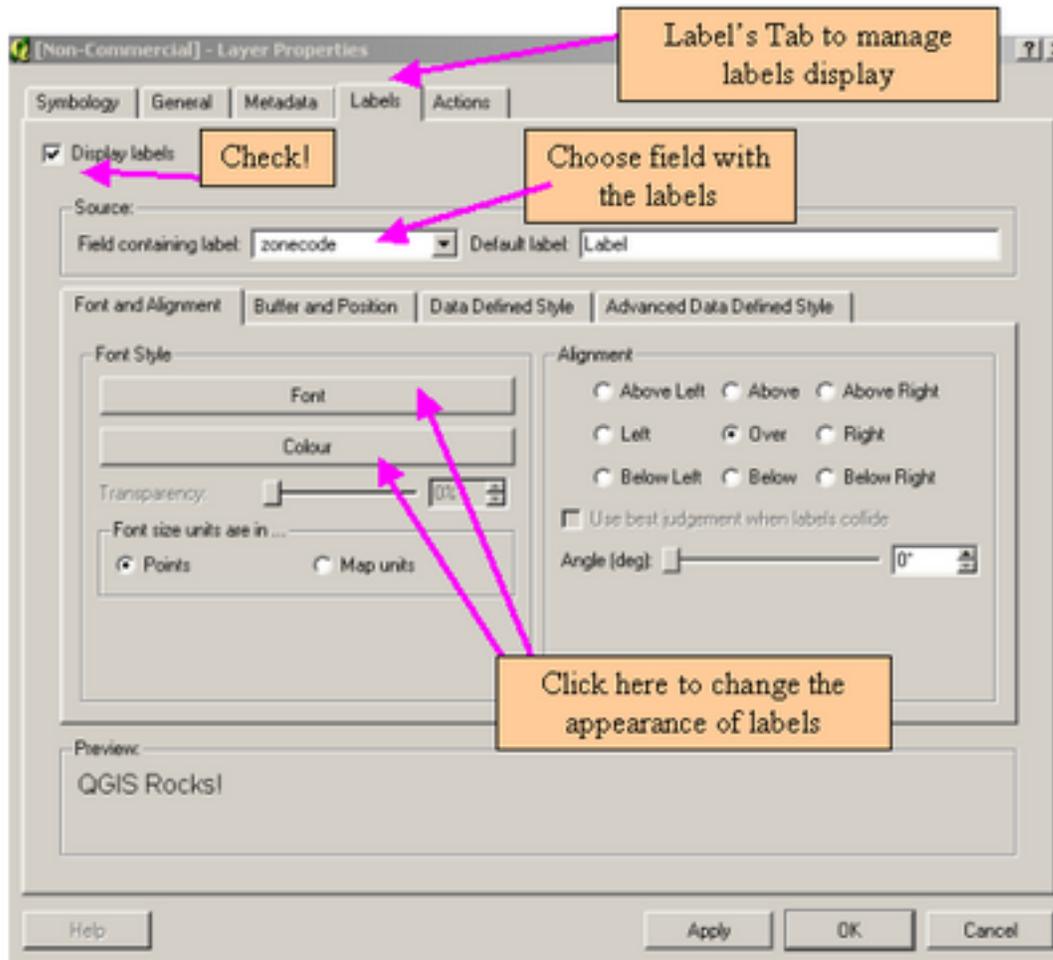


Figure 6: Labelling zoning polygons

e. This is what the codes mean (extracted from the file "zn8by.dbf")

|    | A        | B                              |
|----|----------|--------------------------------|
| 1  | ZONECODE | ZONEDIST                       |
| 2  | 8R-O     | Outlying Residence             |
| 3  | 8R-LD    | Low Density Residence          |
| 4  | 8R-N     | Neighborhood Residence         |
| 5  | 8R-VC    | Village Center Residence       |
| 6  | 8R-G     | General Residence              |
| 7  | 8R-F     | Fraternity Residence           |
| 8  | 8B-G     | General Business               |
| 9  | 8B-G     | General Business               |
| 10 | 8B-G     | General Business               |
| 11 | 8B-L     | Limited Business               |
| 12 | 8B-VC    | Village Center Business        |
| 13 | 8COMM    | Commercial                     |
| 14 | 8OP      | Office Park                    |
| 15 | 8LI      | Light Industrial               |
| 16 | 9PRP     | Professional and Research Park |
| 17 | 8FPC     | Flood Prone Conservancy        |
| 18 | 8ED      | Education                      |

Figure 7: Table with codes descriptions

6. Add the raster layer (orthophoto quad).
  - a. Change the name of the layer to CAMPUS.

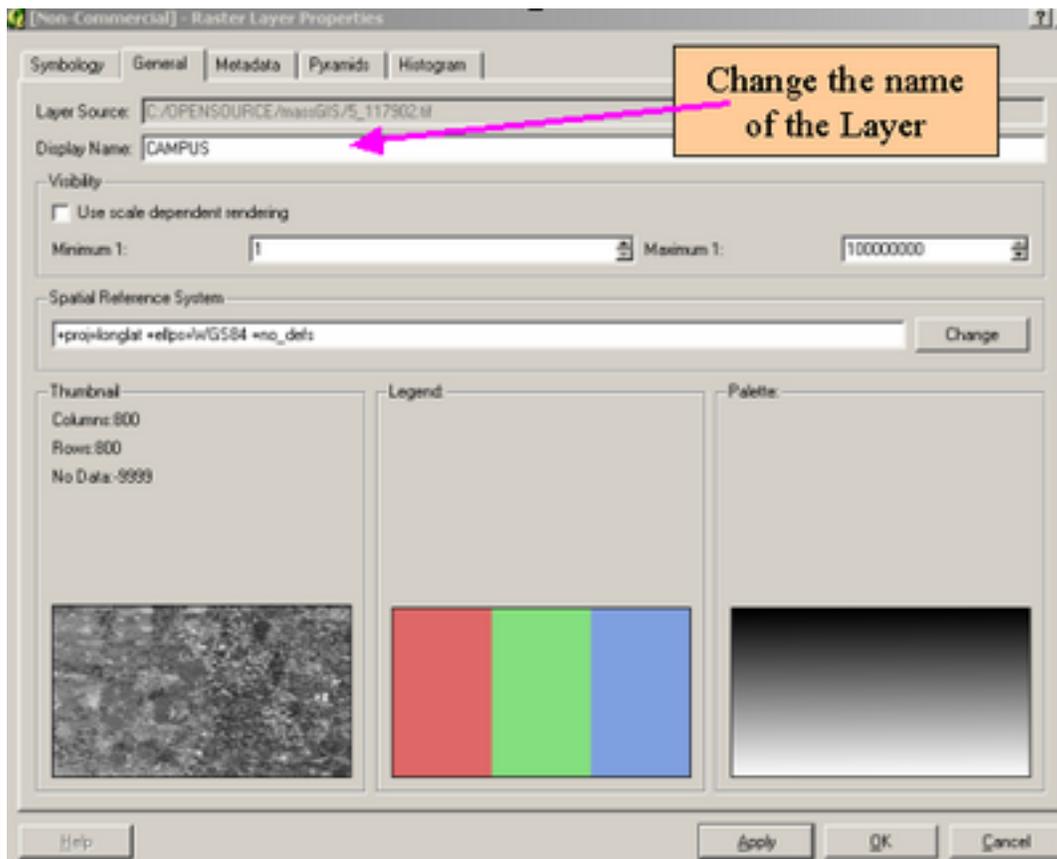


Figure 8: Changing raster display

7. In the table of contents, arrange the order of the different layers.
  - a. Your project display looks more or less like this, right? If it does, you have completed these procedures correctly.

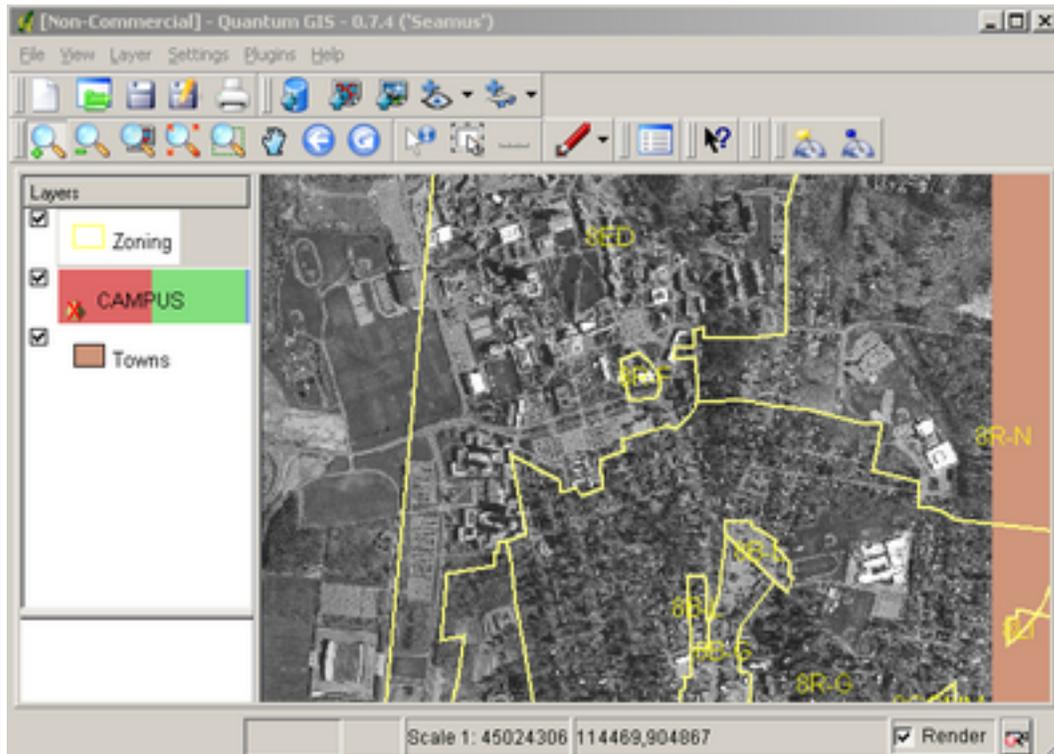


Figure 9: This is the project display so far