GEO 465/565
Lab 5 – GPS Data Collection & Mapping

Collecting Waypoints in the Field

This exercise is designed to familiarize you with several key features of a standard consumer grade GPS. Using a Garmin eTrex Legend, you will learn how to:

Parts in red are optional

- ✓ Check the Satellite availability to determine which satellites and how many will be available at certain times of the day for your study location.
- ✓ Prepare the eTrex for use including setting its reference coordinate system/datum and changing the Time Zone.
- ✓ Collect and record waypoints in the field representing distinguishable land features (buildings).
- ✓ Download the waypoints from the GPS to the computer and add to ArcView.

Checking Satellite Availability

In planning a GPS data collection effort, one of the first considerations should be that of determining the number of satellites that will be available for your particular study area on the date and time of day that you plan to collect data. Time of day is important in terms of when satellites are in your area. Depending on your location and the potential for signal interference, ideally, you would choose a time of day to correspond with the maximum number of satellites available and the signal strength of those satellites.

We will determine the number of satellites available for our location by accessing this Interactive Satellite Prediction site:

http://sirius.chinalake.navy.mil/satpred/

Use these parameters for Oregon State University:

- Latitude (degrees°minutes'seconds") = 44°34'03" N
- Longitude (degrees°minutes'seconds") = 123°16'37" W
- Time = [(our current time in Pacific Daylight time) + (??? hours from GMT or UTC (Universal Time) on a 24 hour clock)].
- Altitude = **246 feet (convert this elevation to meters first)**
- Elevation Mask = 15 degrees

1. Determine which satellites will be available during our class period and note their assigned numbers on the GPS record worksheet. Also look at the graphic representation of each satellite orbit in relation to your stated coordinate location (OSU). To do this, click on the graphic icon of the world for each satellite.

2. Enter different times of the day and determine when, in a 24 hour period, the most satellites would be available for our coordinate location (OSU). Note this on the GPS record worksheet as well.

1 Field Procedure Summary

Each field group (2 students) should have a GPS unit and a GPS record worksheet. With this equipment, each group should assemble in the parking lot east of Wilkinson Hall and initialize the eTrex GPS units for use.

We will be creating the digital information on OSU support buildings which were not include in the official campus map but play an important role in academic life at OSU

We will be collecting waypoints to delineate the outline of Kelly Engineering building, the new COAS building (outlined in the parking lot adjacent to Wilkinson with flags), the Environmental Lab addition to Burt Hall, Fung's Maple Garden, and one waypoint apiece for the Beanery and Subway.

Note that we may have 10-12 satellites in our region if the horizon is clear of buildings and trees, etc. But as we will be collecting waypoints adjacent to buildings, we should expect some degradation in the number and strength of the satellite signals. Note that the positional accuracy of these units is <15 meters (49 feet) without any Differential or WAAS augmentation. We have been able to accuracy readings of 14 feet with these units. The key is to stand at each data location long enough to track a sufficient number of satellites.

Each group will record the following data for each waypoint collected as per the GPS Record Worksheet format shown at the end of these instructions:

- ✓ Date/Time
- ✓ Group members (and number of GPS receiver)
- ✓ Coordinate System and Datum used to mark the waypoints
- ✓ WAYPOINT ID as displayed on the receiver for each waypoint you collect
- ✓ The latitude, longitude and elevation for each waypoint you collect
- ✓ Accuracy information (in feet) as displayed on the Map page
- ✓ Attribute information that will be entered into the attribute table for each point (waypoint) when it is converted into a shapefile in ArcView. Note the following information for 2 different attributes: Cardinal direction for corners of building, using the compass to determine the direction; and the name of building.

Detailed Instructions:

NOTE:

- ✓ Words in [BRACKETS] refer to either individual buttons on the sides of the receiver or the round Click Stick on the receiver face.
- ✓ Note that the [CLICK STICK] allows you to move up/down or right/left to move through menu options, highlight fields, on-screen buttons, icons, enter data or move the map panning arrow. Although there is only one physical Click Stick, pressing the top, bottom, left or right portion of the key will result in the appropriate cursor movement, designated with these symbols [↑][↓][←][→]in the instructions.
- ✓ Words in <u>UNDERLINED CAPS</u> refer to menu options that appear on the receiver's screen. Use the [CLICK STICK] [↑][↓] movement to scroll up/down a list and highlight an option. Press in on the [CLICK STICK] to select a highlighted menu option. In these instructions, **"select'** would mean to highlight an option and press in on the [CLICK STICK] to select that option.
- ✓ Words in CAPS refer to data fields or screen titles.
- ✓ If you press and hold the [CLICK STICK] for at least two seconds this allows you to mark your current location as a waypoint.

✓ To exit out of any menu, use the [CLICK STICK] [←][→] to select the on-screen "X" button (in the upper right corner) and then press in on the [CLICK STICK].

Initialization in the lab

1. Power up the GPS unit

1.1. To begin, press and hold the [POWER] for a few seconds to turn the unit On/Off. Read the warning message and then view the SATELLITE page. CHANGE THE MODE SO THAT THE UNIT IS NOT USING THE SATELLITES.

2.0 Clear any previously stored Waypoints from receiver memory:

2.1 In the MAIN MENU, Press [FIND] to access any previously collected waypoints.

2.2 Select WAYPOINTS and then select NEAREST (you will see a list of any previously stored waypoints that are nearest your current location).

2.3 Select the OPTIONS MENU (the page icon at the top right of the screen) and select DELETE ALL. At the warning "Do you really want to delete all waypoints?" – select YES. This will delete any previously stored waypoints that are near to your current location. There may still be some GARMIN factory stored waypoints that are not deleted.

2.4 Press [PAGE] to return to the MAIN MENU.

3.0 Set the correct Time Zone for our location:

3.1 From the MAIN MENU, select SETUP and then within this submenu, select the TIME option.

3.2 The following parameters should be set in this menu:

- 3.2.1 Time format = 24 (hour time format)
- 3.2.2 Time Zone = US Pacific
- 3.2.3 UTC Offset = -08 hrs 00 min
- 3.2.4 Daylight Savings Time = Auto

3.3 Select the on-screen "X" to exit out of this sub menu and return to the SETUP MENU. Note that you may need to press [PAGE] several times to get this menu.

4.0 Set **the Position Format (coordinate system display) and Datum**

4.1 From the SETUP MENU, select the UNITS option

4.2 The following parameters should be set in this menu:

- 4.2.1 Position Format = hdd°mm.mmm'
- 4.2.2 Map Datum = WGS84
- 4.2.3 Distance/Speed = Statute
- 4.2.4 Elevation = feet
- 4.2.5 Vertical Speed = ft/min
- 4.2.6 Depth = Statute

4.3 Select the on-screen "X" to exit out of this sub menu and return to the SETUP MENU.

4.4 Press [PAGE] several times to return to the SATELLITE page.

5.0 Change the default elevation to a more accurate reading

5.1 From the SATELLITE page, select the OPTIONS MENU from the top right part of the screen.

5.2 Select NEW ELEVATION and manually enter the elevation in feet for Corvallis (246 feet), using the [CLICK STICK] to highlight the desired numerals and then pressing the [CLICK STICK] in to select that number. Select "OK" to complete entry. Press [PAGE] several times to return to the SATELLITE page

Collecting waypoint positions for features in the Field

1. IN THE FIELD

1.1. In the field, when you have your GPS units powered up wait for enough satellites (want at least 4 satellites) to provide a 3D GPS Solution before continuing. You are now ready to navigate. On the Satellite page, check the relative signal strengths of the numbered satellites from step 1. Also note where, within the Skyview graphic on the receiver, these satellites are located. The inner ring represents a view above you at a 45° angle from vertical, whereas the outer ring represents the horizon and the center represents directly overhead.

Hint: you will have to stand in one place with the GPS unit away from your body for a few minutes to get a sufficient number of satellites with strong signal strengths. This should be your standard method of data collection for each of your data points. Don't rush the collection of data as your accuracy readings will be very poor.

2. RECORDING WAYPOINTS

2.1. **To record the receiver's current position as a waypoint:**

2.1.1. From the SATELLITE page, position the GPS receiver near the feature location you want to mark. Wait for a sufficient number of satellites to be tracked and a low enough value for the accuracy reading (± 20 feet is desirable and lower is better).

2.1.2. To collect a waypoint, press and hold the [CLICK STICK] until the MARK WAYPOINT page appears. The waypoint is automatically assigned a sequential 3-digit number.

2.1.3. From this screen, record on the GPS Record Worksheet, the waypoint ID, as well as the location in Latitude/Longitude and the elevation.

2.1.4. To save the waypoint, with the cursor highlighted on the "OK" field at the bottom of this screen, press the [CLICK STICK] to store this waypoint to the GPS memory.

2.1.5. If you do not want to save the waypoint, press the [PAGE] button before pressing any other to cancel the collection of data.

2.1.6. Once the waypoint is saved, the unit will return to the SATELLITE page. Without moving away from the recorded location, record the position accuracy reading as displayed in the top panel of the screen (status window). This will give you a general idea of the accuracy of the GPS waypoint just recorded.

NOTE: This is a quick way to save waypoints. When this procedure is used, the receiver automatically assigns labels to each saved waypoint. Provided that the receiver's waypoint memory has been cleared, the first waypoint you save will be assigned the label "001", the next one will be saved as "002" and so on. You can save up to 500 waypoints in the Garmin eTrex in this way.

You could name each waypoint with your own creative label, and identify it with a special symbol. To speed up the process, we have used the default entries. However, you may personalize the Waypoint by changing the Name field and map symbol field. To edit these attributes after you have saved the waypoint, press the [Find] button to open the Find menu. Select WAYPOINTS, then select NEAREST. A list of the current waypoints will be displayed. Select a known waypoint, using the [CLICK STICK]. Within the flag symbol, select the numeric identifier for that waypoint. An alpha-numeric keypad will appear on the screen. Select each letter or number to form a unique label, then, select "OK" to enter this data. If you like, you may also change the waypoint symbol by selecting the symbol block. A map symbol list will appear. Select the desired symbol with the [CLICK STICK]. To save the waypoint, with the cursor highlighted on the

"OK" field at the bottom of this screen, press the [CLICK STICK] to store this waypoint to the GPS memory.

2.2. When your team has completed their GPS data collection of data points defining the new Engineering building, the future COAS building and the Environmental Lab (as well as the waypoints for the Beanery, Subway and the outline of Fung's, please return to the Digital Earth lab.

New GIS skills:

- Downloading the GPS data to the computers
- Projecting data using the ArcView Projection Utility
- Uncompressing data
- Accessing metadata ("data about data") from a web site
- Adding and viewing images
- Adding GPS data
- Renaming views
- Creating new shape files and adding attribute information.
- On screen or "heads up" digitizing
- Producing a map of your study area that includes the 6 map elements

Downloading data from the Garmin:

1. Transferring data using the DNR Garmin utility

1 Note that each student will need to do the following steps individually at your own computer, even though you collected the data in pairs (**or you can just e-mail the points to your partner or get them out of the guest file**).

2 To safely connect the GPS unit to the computer, you will need to shut down your computer. From the Start menu, select Shut down (make sure the option is to completely shut down, not to restart). Click OK. Wait for your computer to shut down.

3 The GPS unit should be turned off at this point, if it is still on. Using the cable provided, open the rubber flap at the top back side of the eTrex GPS unit and slide the GPS connector into the unit. Make sure you align the slot in the connector with the raised guide on the GPS unit.

4 Then carefully connect the cable to the computer through the db9 port (serial port) in the back of the computer (the port has nine (9) pins and is located at the top left corner at the back of the computer with the aqua plate). Your eTrex is now connected to the computer. Power up the computer and log in.

5 We are now ready to setup the interface format. Power up the GPS unit and wait for it to finish initializing.

6 The Minnesota Department of Natural Resources (DNR) has written a utility that easily downloads GPS data from a Garmin unit directly into ArcView format. This utility can be found on the desktop of each computer in Digital Earth.

7 To start the utility, double-click on the **DNR Garmin** icon on the desktop.

8 This is the first time the utility has been used on your computer and so, in a pop-up "Set Default Projection" window, you will be prompted with the question: "Would you like to use the Default Projection (NAD83 – UTM Zone 15)?" Guess where UTM Zone 15 is? You will answer **"NO"** to this question so that we can set a different default projection.

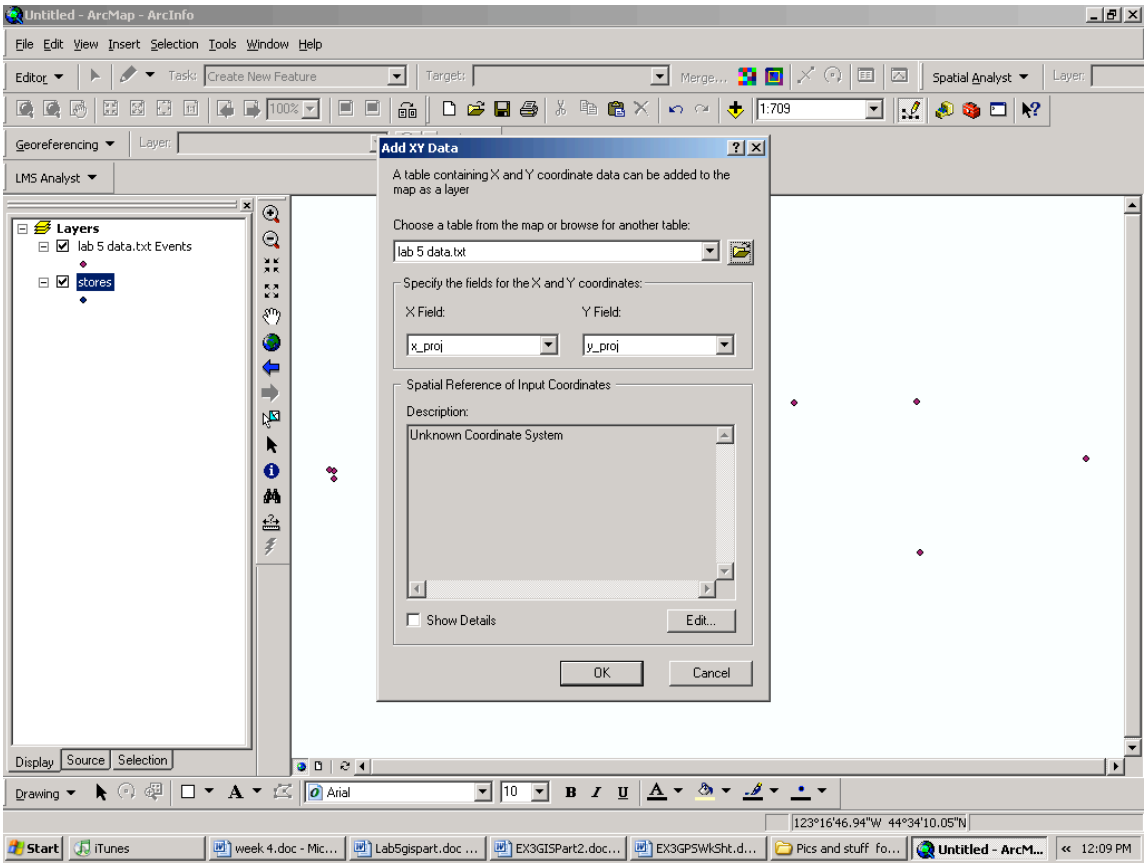
9 In the status bar at the bottom left of the window, you will see "Connecting…" and then "Connected" when the utility has successfully identified the Garmin GPS unit.

10 A DNR Garmin Properties window will open with the Projection tab selected. From this menu change the following parameters:
   1.10.1. POSC codes: EPSG 4326
   1.10.2. Datum: WGS84
   1.10.3. Projections: No Projection
11 **IF** the DNR software doesn't find the Garmin unit, just power down the GPS unit and then start it up again. The DNR Garmin utility should automatically find the Garmin unit and set up the correct interface. If this is not the case, set the following parameters, under the GPS menu, Set Port should be Port 1, and Set Port should be Baud Rate of 9600.
12 From the main menu bar, select the **Waypoint menu →Download**. This command automatically downloads the waypoints to the DNR Garmin interface. Note that data are listed with the Waypoint ID and latitude/longitude. The waypoints were collected in latitude and longitude (geographic coordinates) using WGS84 as the datum and this is the coordinate system that we are using to create an ArcView shapefile.
13 Within this DNR Garmin interface, you can **delete** any records that are not needed by clicking in the far left column for that record and then clicking the **Delete button (big red X) on the left panel of the interface**. If you collected two points for one location and know that one of them is bad, then delete it now. If you're not certain which is a better data point wait until we view the data in ArcView before deleting extra waypoints. In addition, if the Garmin unit had any factory waypoints already stored in it, delete these records at this time.
14 To save your waypoints, Go to File→Save to→file…, then save the file to your workspace and title it "lab_5_data". Use one of the text formats for your file type.

Projecting the GPS geographic coordinates

2. Use the ArcGIS Projection Utility to transform Geographic coordinates

1 Now we need to get the x,y,z coordinates into ArcGIS. Go to TOOLS – ADD XY data. In the *choose table from the map or browse to another table* filed browse to your folder where you saved the Garmin data points. After selecting the correct table, select a coordinate system by clicking **EDIT** in the bottom right of the Add XY Data tool. Then click **SELECT** then click **Geographic Coordinate Systems** (this allows you to choose a predefined coordinate system from a list) then click **WORLD** and the last one on the list **"WGS 1984.prj"** which is the projection that you gathered the data in. Click ok twice – Now you have projected your data.



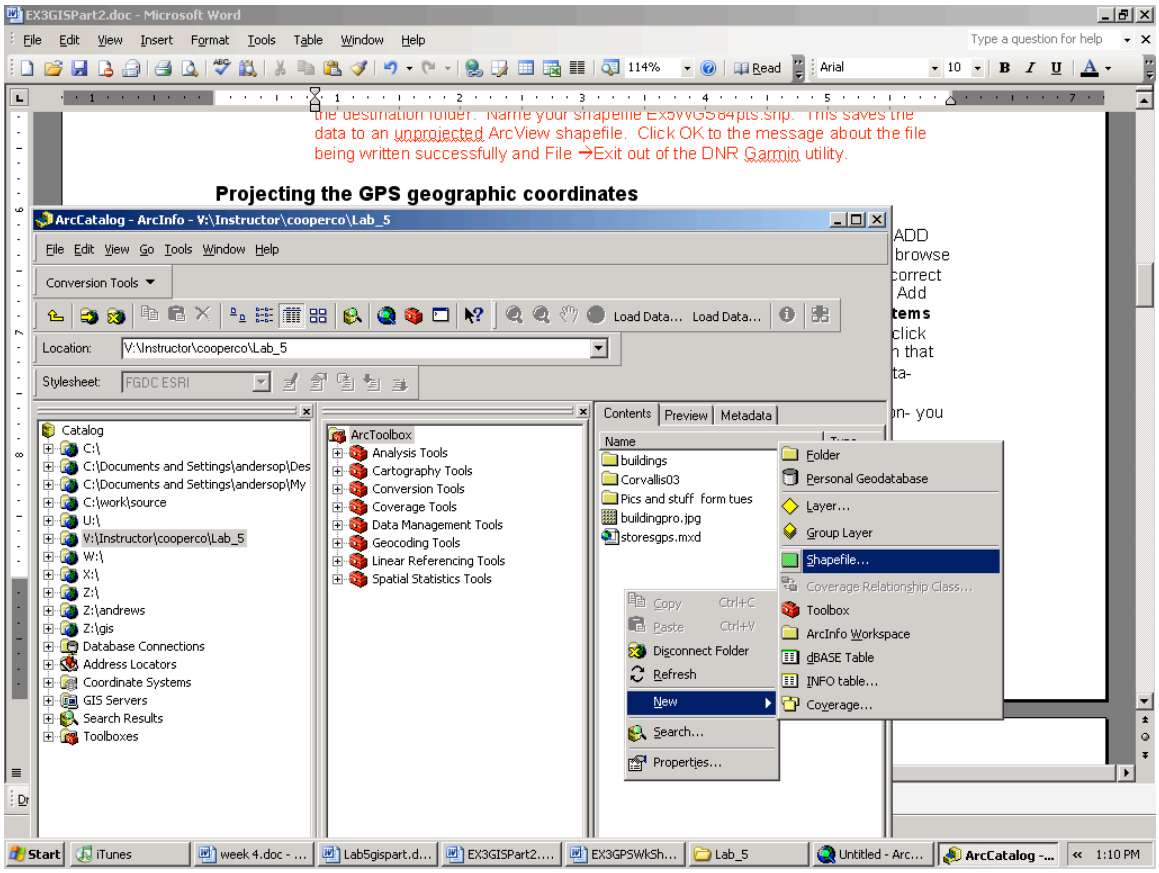
Create a shapefile from your displayed points.
Right click on your point layer you just displayed (lab_5_data.events) Go down to Data-> Export Data. Change the filename to newbuildings.shp and export it. Select yes for adding it to map now. After you shapefile "newbuildings" is created, remove the previous layer, keeping only the new "newbuildings" shapefile loaded.

Making a New Shape File

Next we need to make the polygons out of the engineering building, the future COAS building, the Burt extension and Fung's maple garden - you can't make world class Chinese food in a point you really need a polygon.

1 Open **Arc Catalog** (yellow icon –looks like a file drawer or go to the start menu).

2 Browse to your personal folder and right click and click in the far right window (see screen shot below). Click **new** and then **shapefile**.



3 Name it **fungs** and change the **feature type to Polygon**. Click on the **Edit…** button and **Select** to set the GCS to **WGS 1984.prj**.

4 Repeat steps 2 and 3, creating a polygon shapefile named **new_buildings**.

5 Go back into ArcMap. Add the new shapefiles to your data frame. Open the Editor toolbar (available under Tools) and select **start editing** from the toolbar menu. Make sure that the fungs file is in the folder you start editing. Change your target if you have to.

6 Click the pencil (Sketch tool) and connect the dots around fungs – double clicking on the last dot.

7 Go back to the editor tool bar and save edits - now you have a polygon to cook or eat inside of.

8 Change your target to **new_buildings**. Repeat step 6 for the engineering building, the future COAS building and the Burt extension. Save your edits and stop editing.

Now we need to see how the new data matches up with existing datasets like streets. Is Monroe in the right place? Are the data points in the middle of the street or on the right side? Let's look at the streets and see.

Adding other Datasets

In the real world, data comes in many different forms. Often the data has to be processed to suit your needs. In the GIS world, one of the biggest processing steps is getting your data in the right projection so it all lines up appropriately for accurate assessment. In the United States, a wealth of data exists for free and is easily obtainable (thanks to Uncle Sam). The problem is that datasets you download can be in different projections, depending on who created the file. ArcGIS gives you the capability to take that dataset and transform it to the appropriate projection for your project. (Metadata can be crucial to finding what the original projection of the dataset is in)

- Add the **Streets** shapefile to your map project.
- Add the **Streets_Project** shapefile to your map project. This file has already been transformed for you.

The Street layers do not match up! They are identical datasets from the same source. Streets_Project has been transformed from the NAD27 datum to NAD27 (WGS84).

Question: How far off are the two coordinate systems in meters? (hint: you can change the display units by going to the properties of the data frame)

- After you have answered the question, remove the untransformed **Street** layer.
- Add the **buildings** shapefile from the data folder. (Click OK if there is a warning)

Notice how the store points line up with the Streets, but the buildings are misaligned. You can right click on your buildings later and select Properties-> then select the Source tab. There you will find what projection the dataset is currently in.

- Open up ArcToolbox and expand Data Management Tools -> Projections and Transformations -> Feature. Select Project.
- In the Project Window, select your **buildings** shapefile for the Input Dataset. Verify or change the Output dataset path so that it outputs to your student data folder. (name it Buildings_Project)
- For Output Coordinate System, click the select (hand) icon to the right. In the Spatial Reference Properties window click on the Import… button. Navigate to your **new_buildings** shapefile, select it and click Add. Then hit OK.
- For Geographic Transformation, click the down arrow and select NAD_1927_To_1984_10. Finally, select OK. It will crunch out the transformation and add it to the top of your Layer list. You can go ahead and remove the old **buildings** layer

Q Given the accuracy measurements of your data points (you wrote this down in the field) do the points for the Beanery, Fungs, and Subway line up with the street layer?

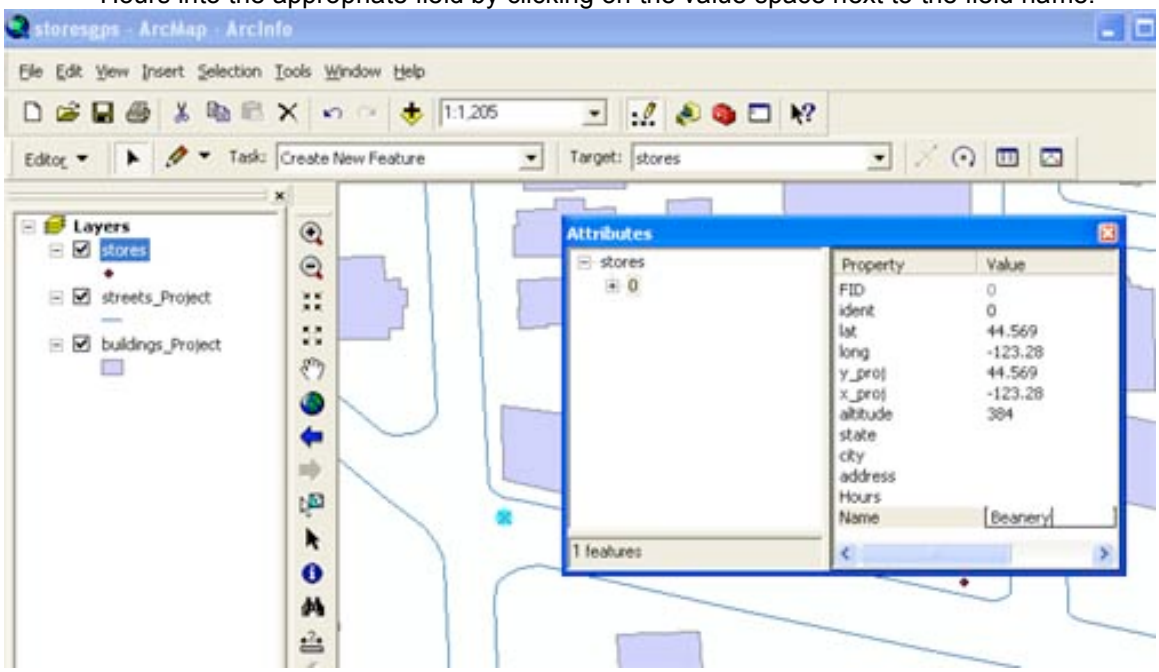
- The buildings and streets data was obtained from City of Corvallis, Public Works Department, 1245 N.E. Third Street, Corvallis, OR 97339. Color images are 6” pixel digital aerial orthophotographs (DOQs) taken April 29, 2002 and processed by 3Di West/GeoTerrra Mapping Group. 3400 West 11th Avenue, Eugene, OR 97402

Adding Attribute Data to the newbuildings and Fungs Shapefiles

The power of GIS is combining spatial information with non-spatial data. We are going to add information to your new_buildings and individual building polygons that you created.

- Open the attribute table for newbuildings (the point file). If you wish you can delete fields by right clicking on the field name and “delete field” for any excess fields you do not need.
- Add a field by selecting options->Add Field
- For Name, Type Hours. For Type, select text. Create another field for the store name.
- Display the Editor Toolbar if it is not already displayed. (Do this by dropping down from the Tools menu and selecting Editor Toolbar.

- Under the Editor Toolbar, dropdown from Editor and select Start Editing. Select the path that displays your created shapefiles in the window
- Make sure your Target is set to newbuildings. On the Editor Toolbar, use the edit tool (the arrow) and click on the point that represents the Beanery (Subway). When you have selected the point, click on the attribute button on the Editor Toolbar (you can find out what each button is by holding the cursor over it).
- In the attribute window you opened up for the Beanery(Subway), enter the Name and Hours into the appropriate field by clicking on the value space next to the field name.



- Using what you have just learned, edit the fungs shapefile similarly. When editing the newbuildings shapefile, you should delete the corner points of the individual buildings since you already created a polygon layer of them (select the point, right click, and delete).
- Save your edits and stop editing.

Hyperlinking Features

ArcMap gives you the ability to link features in your datasets to outside information. This can be to an outside file or a web address. We are going to link our store points to photographs of the store stored in your data folder. You can look at the photographs by browsing with My Computer.

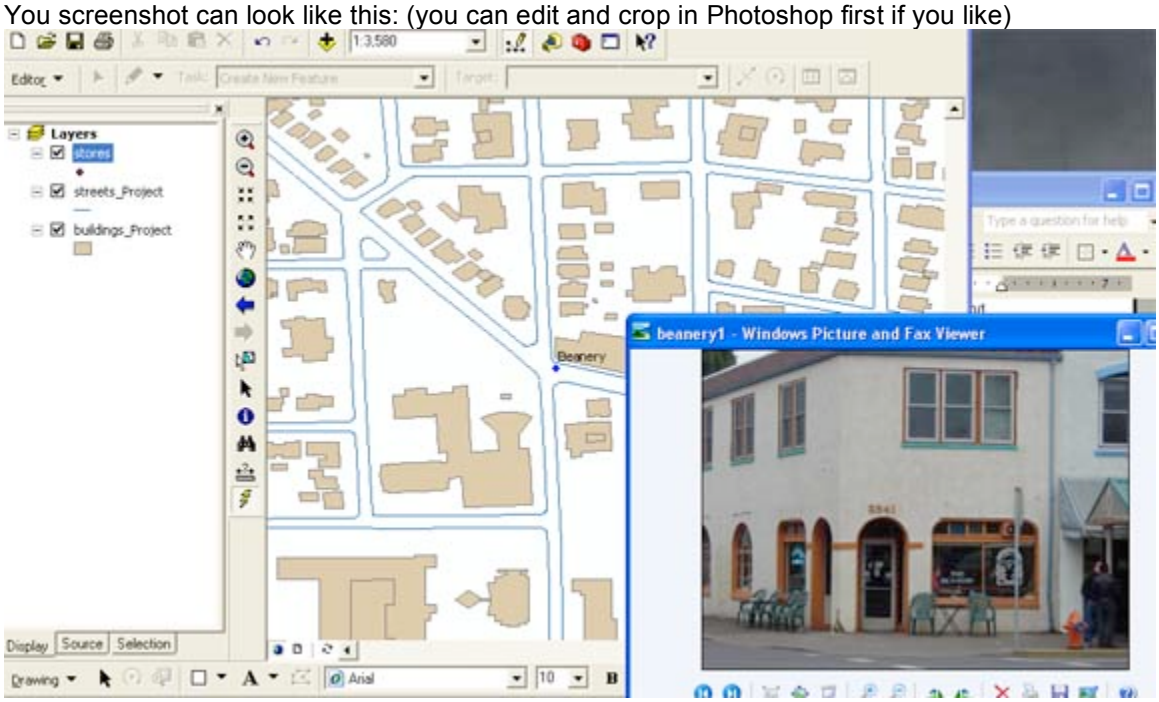
- Once you have decided which pictures to use. In ArcMap, use the identify tool on your newbuildings layer and click on the Beanery. Right click on the identified feature in the Results window and select "Add Hyperlink." Keep Link to a Document selected and browse to your selected picture you want associated with your point. Now click OK. You will notice that your hyperlink button becomes active. You can now use it to select your point and see the picture.
- Add a picture for Fung's.

Q Explore the City of Corvallis FTP site, ftp://ftp.ci.corvallis.or.us/pw/gis/readme/datadictionary.html for information (metadata) on the data layers we will be working with. **Answer the following questions in your lab report:**

1 What is the purpose of the data dictionary?
2 In what coordinate system are all of the data stored?
3 What is the Vertical datum used for this coordinate system? (hint: you'll have to read through the data dictionary for this information).

4 List five (5) other data sets that are available through the City of Corvallis GIS (include their names and descriptive information).

Make a Map Layout of your newbuildings and a screen shot of a hyperlinked image.
You screenshot can look like this: (you can edit and crop in Photoshop first if you like)



When making your map layout. Remember a North Arrow, Legend, Scale bar, Title, Name, Data Source, and Neatline. You can label your stores by going to properties of your newbuildings layer and using the label tab (select Name for Label Field). For labeling any streets or buildings from the buildings_project shapefile, you will have to insert the label yourself. (If you open their attribute tables you can see that there is no field with street names or building names) You can go ahead and label Wilkinson Hall and Monroe Street. Play around with your layout tools and use the help if necessary. The question mark button is a quick way to find information about what a particular button does. When you are done crafting a nice map layout, export it as a jpg into your answer document.

Assessing the accuracy of the GPS data points

- **Creating Buffer polygons around the GPS data points**
- To get a sense of the level of positional accuracy obtained by the GPS units you will create a buffer around each data point that represents this positional uncertainty.
- Manually calculate the **average** accuracy value(you wrote these in you GPS log) for all the data points you obtained. You will use this value as a general representation of the distance with which to create a buffer, even though some of the data points were very likely more accurate.
- Open the toolbox (the little red box icon in the upper right) click **index** and type in **buffer.** Click your store point file (the location of the newbuildings) as the **input field** and then change the **units to feet**. Then type in the average accuracy in to the **Linear unit** field. Make sure you are saving it to your file (that is the output field).
- **Create a map layout of these buffer polygons** to document the level of positional accuracy obtained with the eTrex GPS units. Your map should include the six (6) map elements presented, including an appropriate descriptive title. **Include this map in your Lab report**