

GIS

GEOGRAPHIC INFORMATION SYSTEMS

FOR CADASTRAL MAPPING

Chapter 7

2015 Cadastral Mapping Manual

GIS - GEOGRAPHIC INFORMATION SYSTEMS

What is GIS

For a long time people have sketched, drawn and studied the land using maps. In the last 20 years or so it has become possible to put these maps into the computer. Each year the computers become smaller and the maps become more sophisticated. These computerized maps along with the tools to create, model, analyze, and adjust the maps and spatially placed data make up a geographic information system.

A geographic information system (GIS) integrates hardware, software, and data for capturing, managing, analyzing, and displaying all forms of geographically referenced information.

GIS allows us to view, understand, question, interpret, and visualize data in many ways that reveal relationships, patterns, and trends in the form of maps, globes, reports, charts, and more.

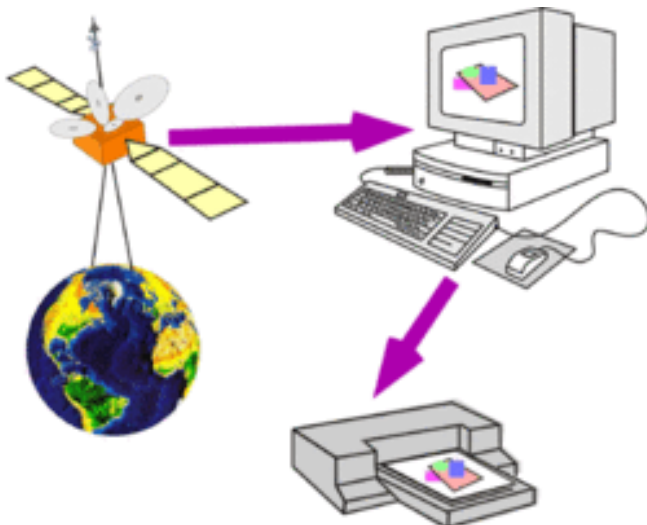


GIS and the Computer

The use of the computer for mapping and cartography was a natural outgrowth of the use of the computer in industry. Mapping with the computer started first as an extension of computer aided design (CAD), which is essentially the storing of lines, points and annotation to produce a picture. The move from drafting table to a computer was a giant step forward. The obvious benefits and advantages of using the computer for mapping are increased speed, accuracy and productivity, the ability to produce multiple hard copies at varying scales, easier editing, modifying and revising of map elements. This technology has influenced an abandonment of the old hand drawn plats in

favor of using the computer. Further adding to the migration away from traditional drafting technologies has been the reduced cost of both computer hardware, and software and the proliferation of software packages which cater to the cartographer.

A great development to the application of CAD has been cartographic production. Software was developed that allowed for the storing of points lines and polygons in a spatial location creating geographic data. One can also store additional information with these features that can be displayed as attributes associated with it. Examples for a line depicting a road might include information that identifies its



name, its width, or its paving material. A line representing a segment from a parcel boundary may have attributes such as the bearing and length of line. This type of mapping has become what we know as GIS. The amount of information associated with the individual map features is limited only by the need of the user.

The added element of a GIS provides the ability to establish a specific, spatial relationship between all the individual elements of a data set. This topological relationship allows the GIS to become an analytical and modeling tool to answer a variety of questions, and show specific conditions, criteria, or patterns in any area. GIS then becomes a very powerful tool to meet the needs of the cartographer and a wide variety of other applications and disciplines.

Receiving GIS Data

The data received in the Recorder's Office that is used to generate land divisions varies in the different counties. Some of the methods used to input data into GIS for land divisions might include documents such as warranty or quit claim deeds, subdivision or annexation plats, AutoCAD files and sometimes even a text file containing a saved traverse.

Documents are usually the source of a legal description. The GIS parcel data should NEVER replace a recorded document containing a legal description. The document is the official source for the information used to create parcel database.

A plat is a visual representation of a deed usually created by the surveyor or engineering firm that surveyed the property. Plats differ from a regular legal description in that they show a bearing and distance for each line or curve on the plat.

Some surveying or engineering firms may provide a copy of their subdivision as a Computer Assisted Drawing file. ArcGIS can import these CAD files in a DXF, DWG or DGN file format. Once the file is imported and correctly georeferenced it can be converted into GIS data features.

Text files are often used when one GIS professional is transferring a drawn legal description from one person to another. These saved traverse files are a text version of a legal description that has been entered previously into the GIS and saved as a text file.

Important Considerations

While cost is always a major factor, if not the overriding concern influencing the decision of which mapping software package to purchase. Another important consideration should be the value of purchasing a system that not only benefits the Recorder's office, but also the other county offices. If the Surveyor, Assessor, Planning and Zoning, and Public Works etc... not only have access to the Recorder's parcel layer but are able to use their own integrated map layers in GIS. The purchase cost and maintenance can be shared among all the offices using the system.

The burden of data collection and input is also spread out among several offices while the value of the system as a tool for analysis and modeling increases as these data layers are added. All the data layers mutually benefit all the offices by providing tools that facilitate the duties and functions of all the different entities.

There are additional benefits to the taxpayers, who ultimately pay for the services that county offices provide. The increased accuracy and productivity in the product produced improves

the quality of the services that are provided and lowers the overall cost of government to the taxpayer.

The GIS parcel layer will not replace a survey but only represents the parcel boundaries.

Coordinate Geometry

COGO is an acronym that stands for coordinate geometry. COGO is a method for calculating coordinate points from surveyed bearings, distances, and angles. It is also automated mapping software used in land surveying that calculates locations using distances and bearings from known reference points.

COGO was originally a subsystem of MIT's Integrated Civil Engineering System (ICES), developed in the 1960s. It later evolved into a suite of programs used in civil engineering for solving coordinate geometry problems. In the late 1990s ESRI had a GIS extension for ArcGIS that was called "cogo" containing a set of tools used for mapping the distances and bearings from legal descriptions and calculating closure. The tools on the COGO toolbar are now included as part of the normal ArcGIS software.



COGO is the capture and automation of bearings and distances to create GIS data. It stores line and curve data along with x,y coordinate values. This data stores attribute values that pertain to angles or directions and distance measurements. The directions displayed are shown with quadrant bearings using degrees, minutes, and seconds along with the displayed distance.

The most widely used of these tools on the COGO toolbar is the traverse tool.

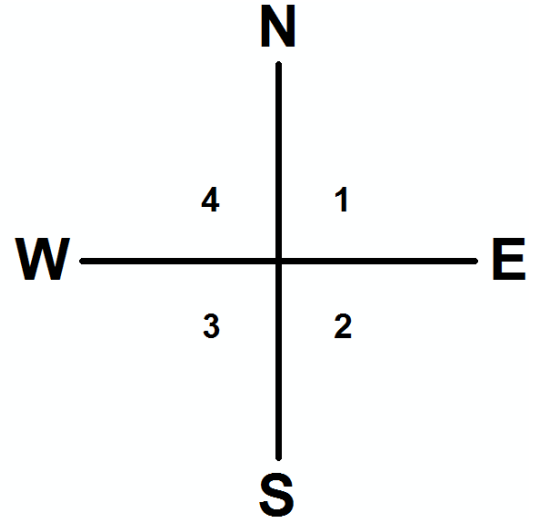
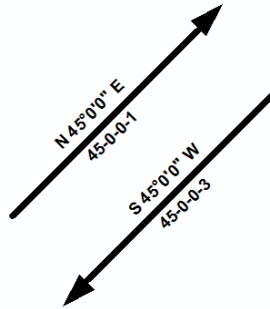


The traverse tool lets you create a sketch of multiple bearing and distance calls from a legal description or surveyed plat. Once you have started a traverse you can add, remove or re-order line and curve segments. Each course entered becomes a single line feature with the COGO attributes saved in the database that can be used later to display the information typed in.

The traverse tool will accept directions and distances in a variety of formats. Cadastral mapping uses the quadrant bearings.

Entering quadrant bearings in ArcGIS uses a number to represent which direction or quadrant you are heading.

For example the bearing North 45°0'0" East would be entered as 45-0-0-1 where 1 represents the Northeast quadrant. This method stores the attributes of that line or curve so that they may be displayed as it would read in a legal description.



Courses may be entered as straight lines with just a bearing and distance, or as tangent or non-tangent curves. For a curve you may provide any two curve parameters along with a bearing to construct the curve.

The advanced editing toolbar in ArcGIS contains many editing tools for creating and modifying parcel features.



Several of the tools in the advanced editing toolbar are used specifically to create and edit parcel polygons from the data created while using tools from the COGO toolbar for cadastral mapping.

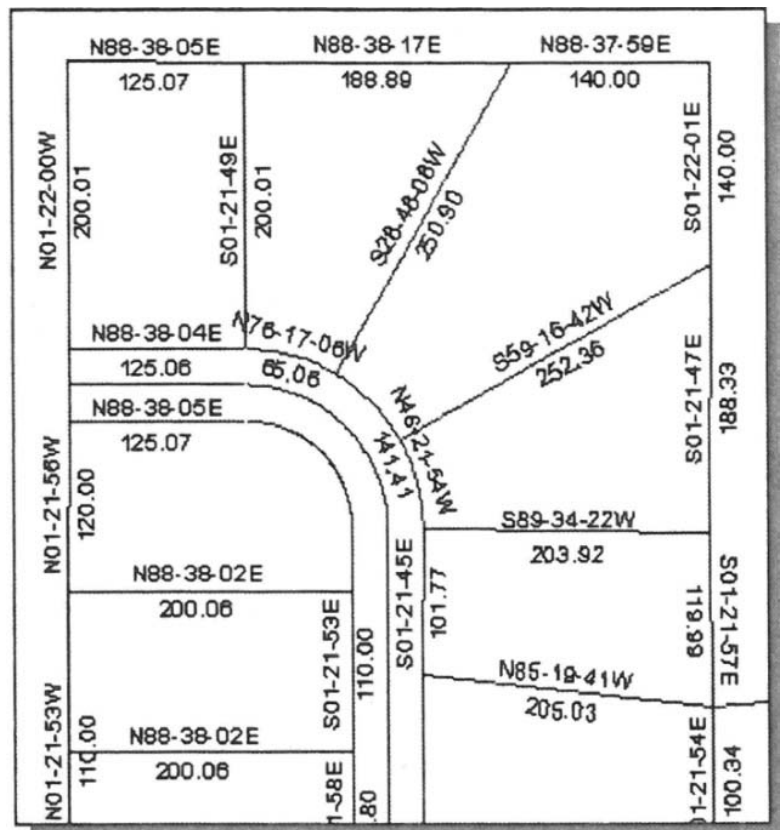
Drafting parcels in GIS

Drafting parcels with GIS uses all of the same principals as drafting descriptions by hand, however the methods for completing each step are much different. Drafting elements such as lettering, line weight and size, scale, lines and curves, and templates are used in both computer aided drafting and hand drafting. Other things such as tools, medium, pencils, erasers, and ink are not used in computer drafting. Although the techniques and tools may differ when using a computer to draft, learning and understanding how to draft parcels and legal descriptions by hand provides an essential foundation to computer based cadastral mapping.

There are many differences in terminology with regard to the "Point of Beginning" or POB that is referenced on property deeds. Utah utilizes the PLSS and therefore most documents reference a corner from the PLSS as the control point for the legal description. However there are other locations often referenced in a legal description such as centerline monuments or lot & block corners.

Line work and line weight are two important elements used on a hand drawn cadastral maps to denote important features. Those same elements can be implemented on a digital plat to greatly improve the quality of digital plats to show easily distinguishable features.

Making adjustments to the parcels usually has to do with a new description not fitting into the existing parcels in your GIS layer. This kind of discrepancy can be due to: changes in magnetic declination, air photo rectification, basis of bearing, inaccurate section corner data, or poorly managed spatial adjustment procedures. A controversy arises when descriptions collected with high accuracy survey equipment are moved or warped to fit into the existing GIS parcel framework. One absolute rule that is easy to follow is that the attributes of the boundary line segments must reflect the original document or survey from which they came. As a good rule of thumb when cadastral mapping in a digital environment is the fewer adjustments made to the new drawn description, the more accurate your drawn representation will be.



Drawing a Metes and Bounds Description using COGO in ArcGIS

Drafting parcels in GIS using the COGO in ArcGIS follows the same six steps from the hand drafting method but the tools used are different.

Let's use the legal description we mathematically rotated in chapter 5.

Part of the NW quarter of Section 23, Township 5 North, Range 2 West, Salt Lake Base and Meridian. Beginning at a point South 10° East 106.37 feet and North 80° East 72.48 feet from the Northwest corner of said section. Running thence North 63°44'45" East 75 feet; thence South 26°15'15" East 120.87 feet; thence South 70° West 75.45 feet; thence North 26°15'15" West 112.65 feet' to the point of beginning.

Step 1 The Defined Area

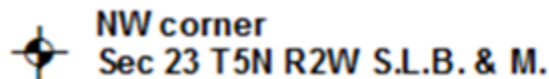
The first step is to determine what area you are working in and zoom into that area in your GIS data. For the example we are using the area is:

"Part of the NW quarter of Section 23, Township 5 North, Range 2 West, Salt Lake Base and Meridian."

Step 2 Find the Reference Point

If you have a The reference point in the description is the section corner or other known point that the description uses to tie the parcel boundary to a specific location. It is usually two or three calls into the description before it is stated. In the above example the reference is:

"... from the Northwest corner of said section."



Open the traverse tool and use the pointer to set your start point as the section corner or other known point referenced in the legal description.



↑ Traverse tool

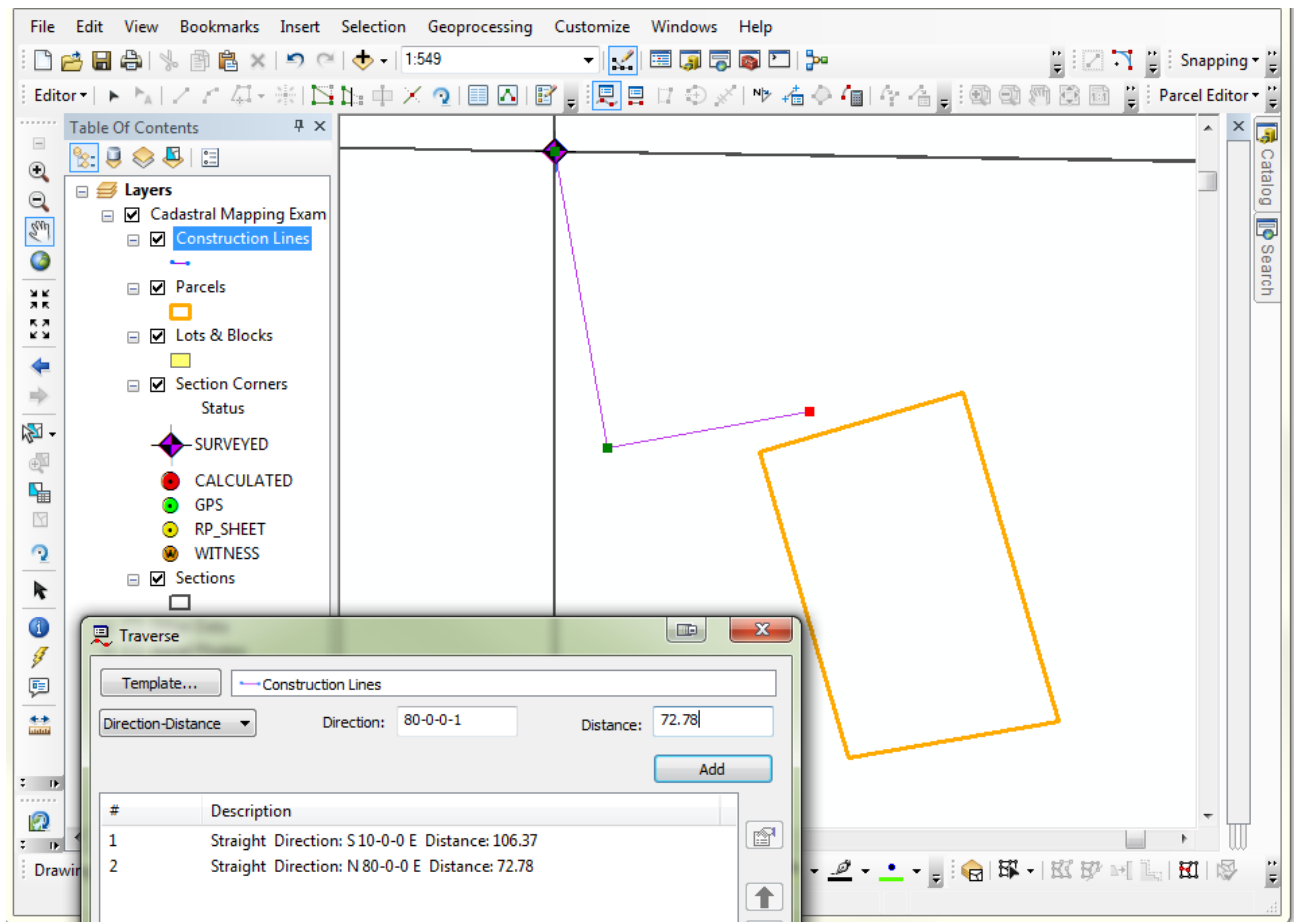


Step 3 Getting to the start

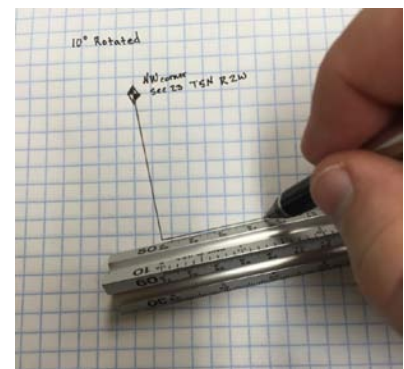
With a few exceptions, most legal descriptions give a set of bearings and distances from a known location such as a section corner to the starting point of the parcel being described.

In our example we have two bearings that take us from our section corner to the starting point.

"... a point South 10° East 106.37 feet and North 80° East 72.48 feet from..."



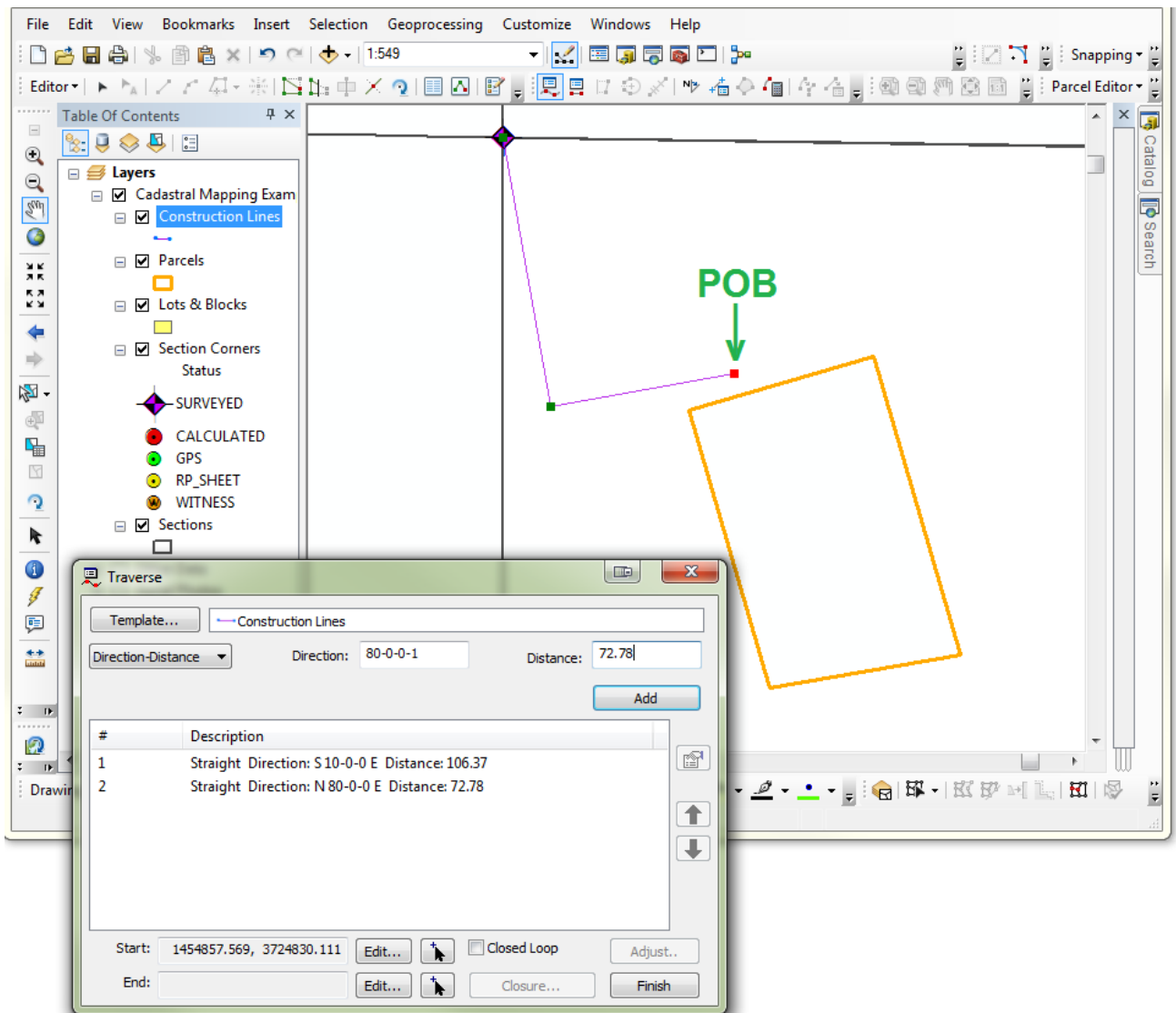
Just the same as when we were drawing the description by hand.



Step 4 The Point of Beginning

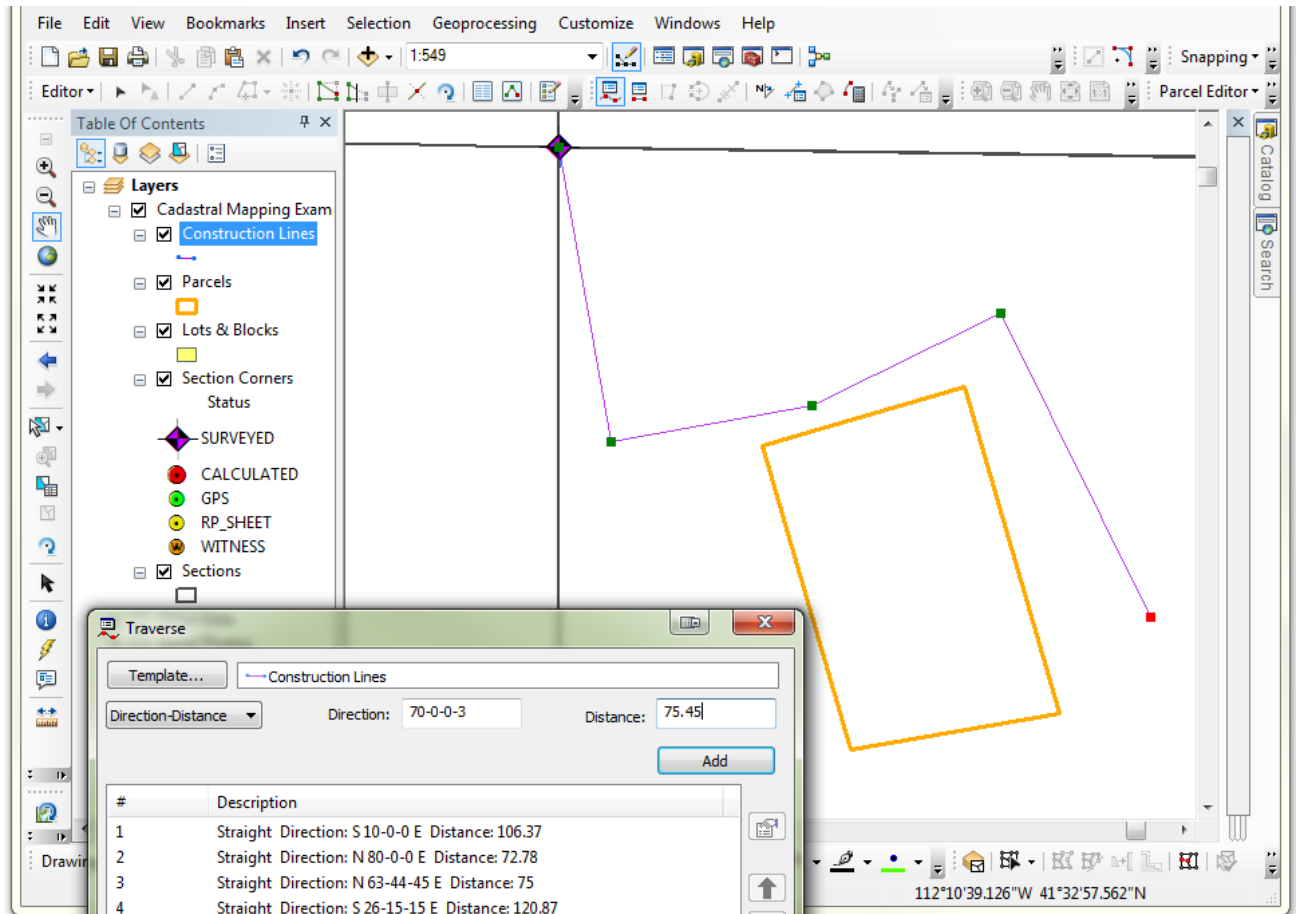
The starting point is usually known as the point of beginning. If the description has no closing errors this starting point should also be the ending point for the parcel. Any bearings and distances prior to the starting point are references. They do not describe the boundary of the parcel but are used to define where the parcel boundary is in relation to a known location.

“Beginning at a point... ..to the point of beginning.”

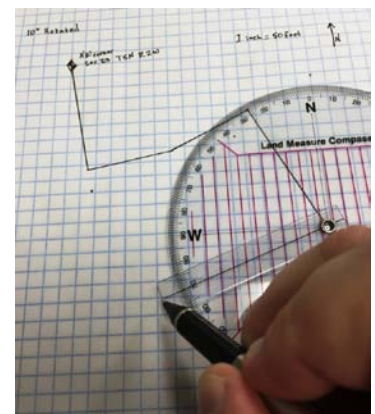


Step 5 The Property Boundaries

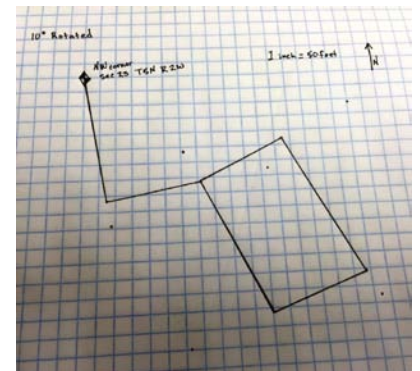
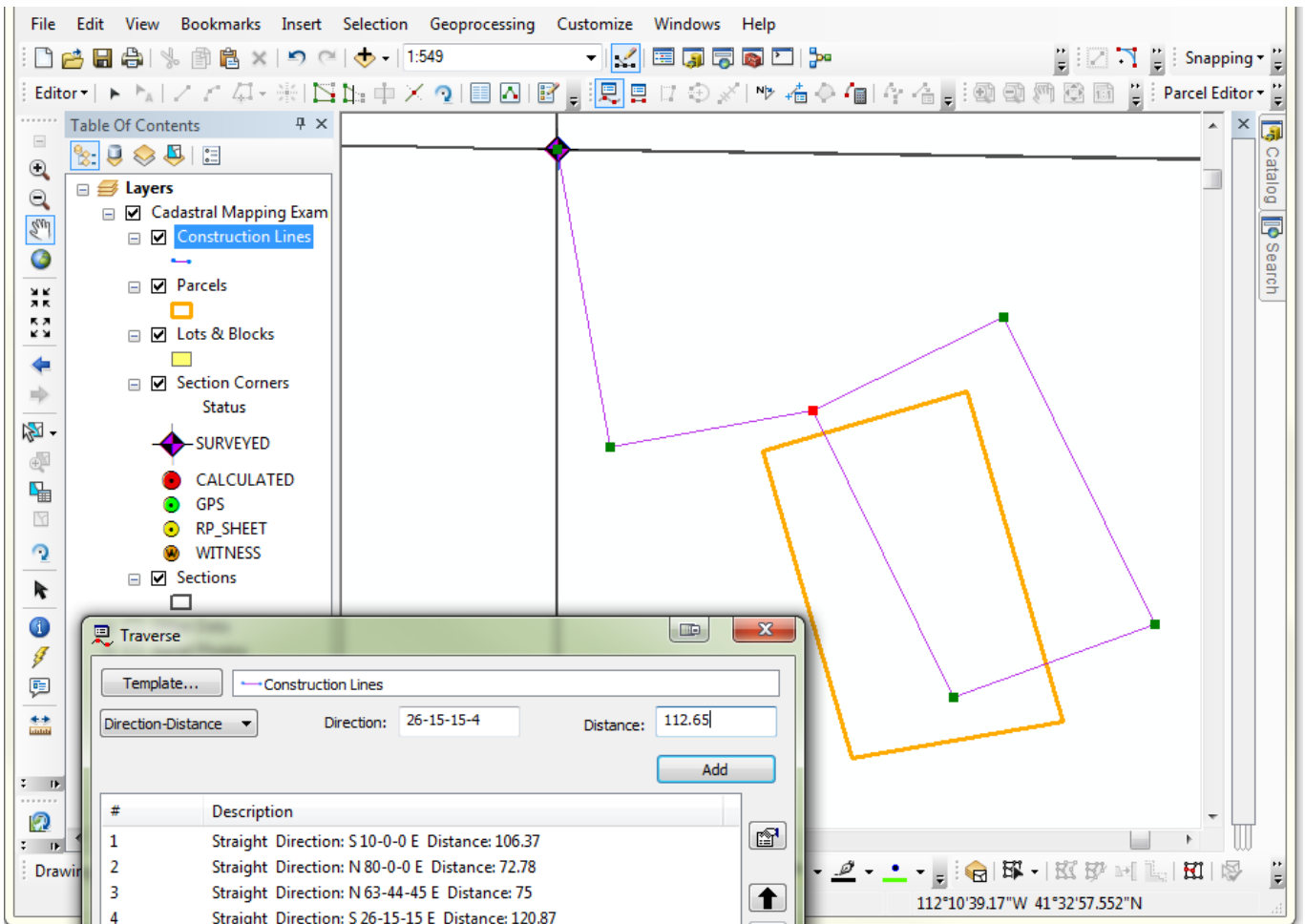
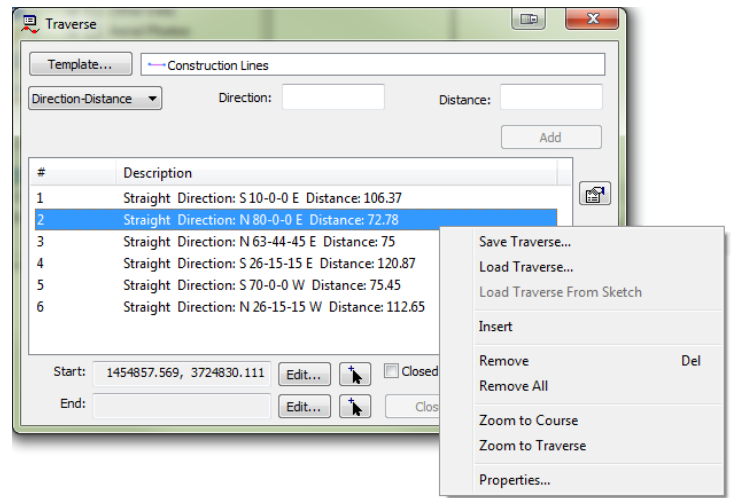
This is where we type in each of the bearings from the description and the computer draws a line along that bearing for the given distance. Each new bearing entered shows up and starts at the end of the previous bearing and distance.



“Running thence North 63°44'45" East 75 feet; thence South 26°15'15" East 120.87 feet; thence South 70° West 75.45 feet; thence North 26°15'15" West 112.65 feet...”

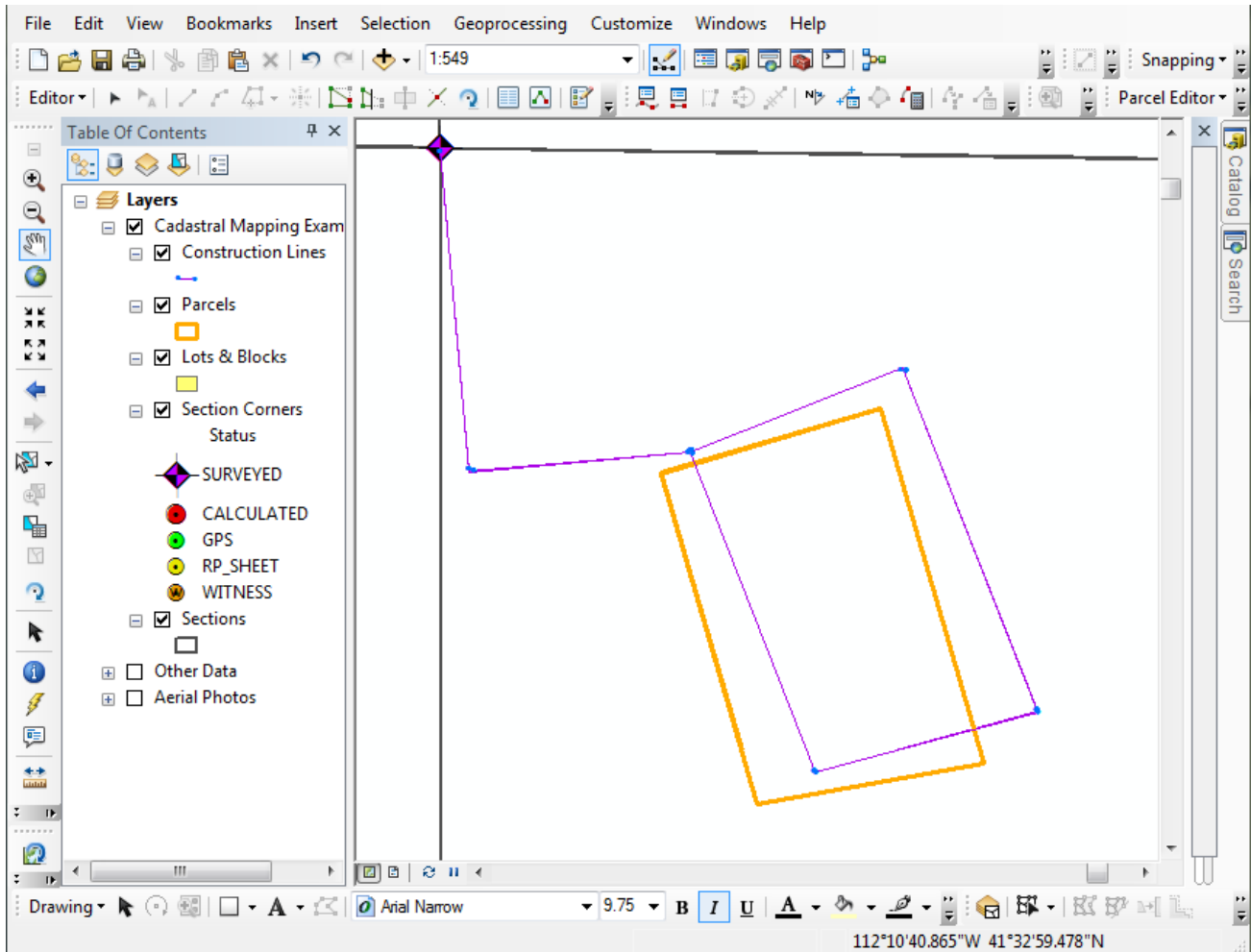


When we have drawn the entire perimeter of the parcel boundary lines from the legal description ending back at the point of beginning we have a completed parcel drawing. Before finishing the traverse, if your software allows you, it would be wise to save the traverse in case you have to redraw the description again.




Step 6 Rotate the Description

Sometimes the description needs to be rotated to meet the section line. As you can see in our completed traverse, the parcel shown in orange does not match up with the pink traverse of our description. Also our first line does not match up with our section line.





If it was rotated to match the section line our construction drawing of our description should line up with our parcel. We have mentioned that there is more than one way to rotate a description. In ArcGIS, the easiest way to rotate a description, is to draw the description as written and then use the rotate tool and physically rotate the drawing to match the section line.

To rotate a description in ArcGIS, first highlight all of the lines you just created. With the lines you selected an X appears in the center of the selection

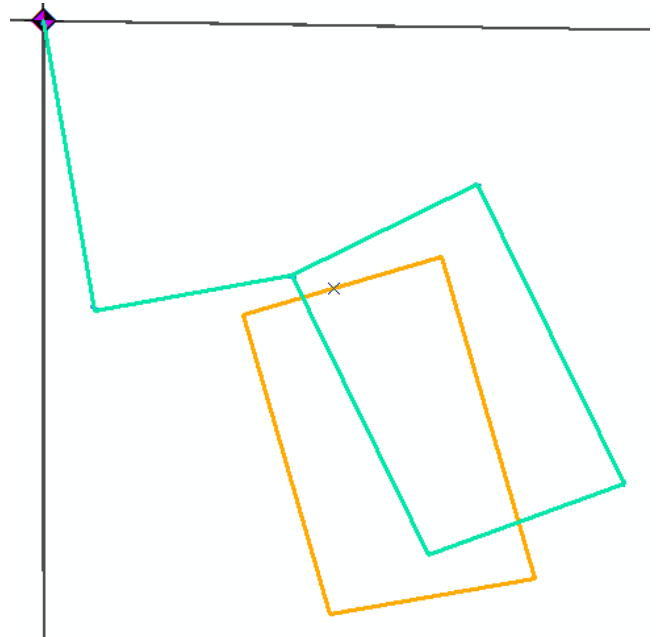
Find the Rotate tool. 

It should be in your editor toolbar.

Click the rotation tool and your pointer will change to like this. 


Hover the pointer over the X until the pointer changes to this. 

Click and drag the X to snap on the section corner that the traverse started from. This X will be the rotation point where the description will rotate around.

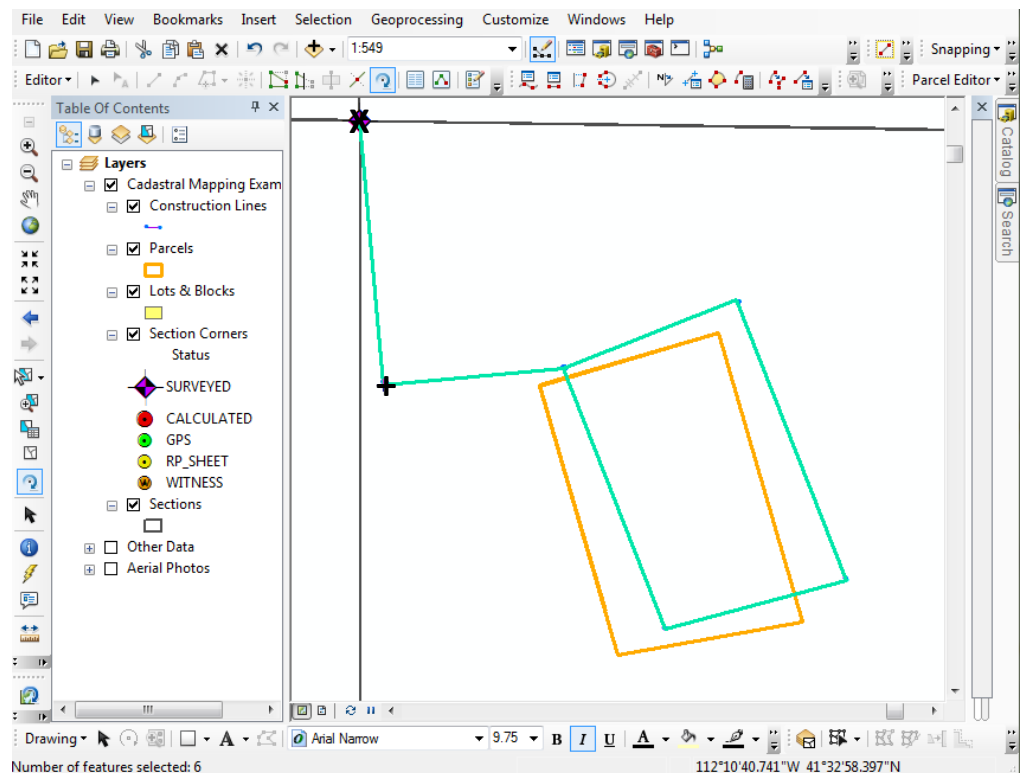


Next we need a snapping point. The + will be the snapping point for the rotation. If you do not already see the + hold shift and type s [Shift + S] and it will appear.

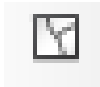
Hover, then click and drag the snapping point + to the end of the first bearing.

Using the rotation pointer, click and rotate the highlighted drawing clockwise until the snapping point + snaps to the section line. 

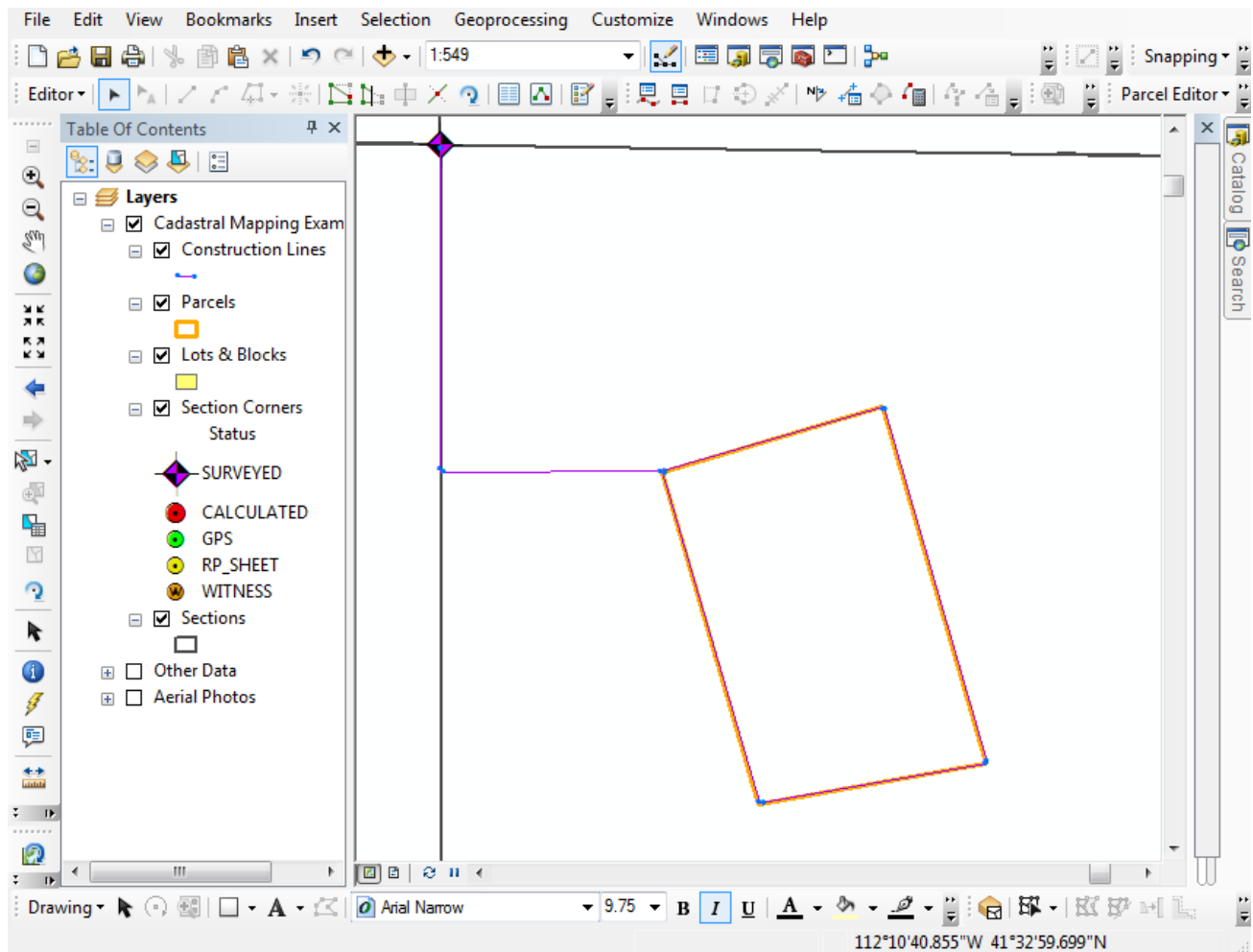
The Rotation point X and the Snapping point + should both be on the section line and the description should match up with the parcel.



Clear your selection with the unselect all button.

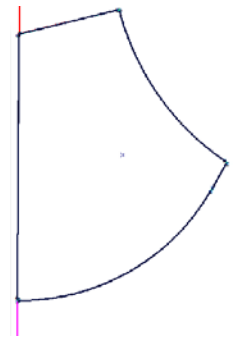


You should have your rotated construction lines match up with the parcel line.

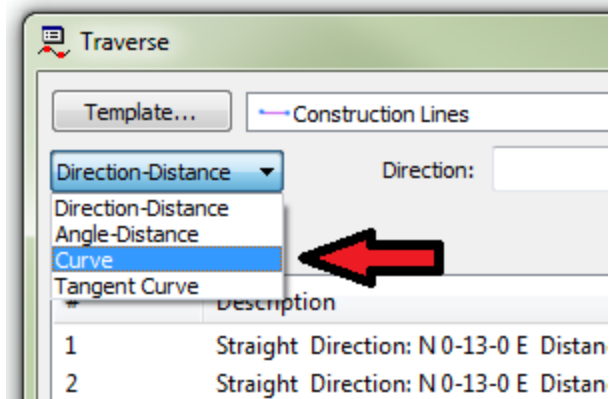


Drawing a Curve using COGO

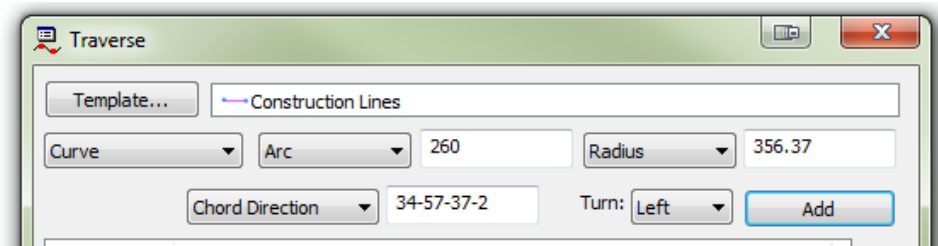
Hand drafting a curve usually requires drawing the chord bearing and distance and then tracing a template to get the appropriate radius and arc length.



In GIS drawing a curve is much simpler. While using the traverse tool from the COGO toolbar, select the dropdown to change from Direction-Distance to curve or tangent curve.



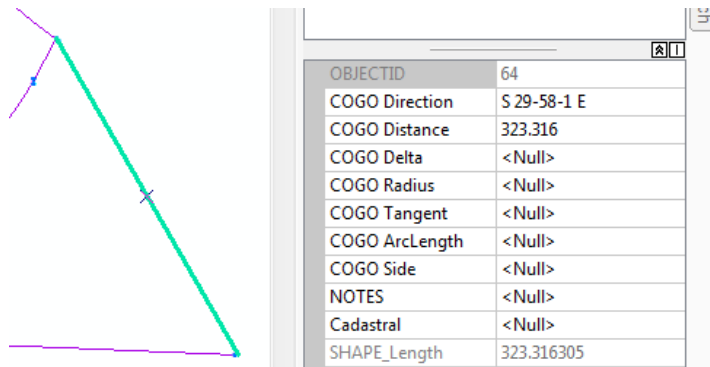
To draw a curve you need to know if it turns left or right, at least two of the following items: arc length, radius, angle, chord length. Last you will need to know the chord direction, the radial direction or the tangent direction. Usually the turn, arc length, radius, chord direction and chord distance are given to describe the curve.



NOTE: When drawing a tangent curve, you do not need to enter a direction. With a tangent curve the radius of the curve is always at a 90° angle to the previously drawn line.

Updating attributes for the bearing and distance of a line

Highlight the line and click Update COGO Attributes button on the COGO toolbar



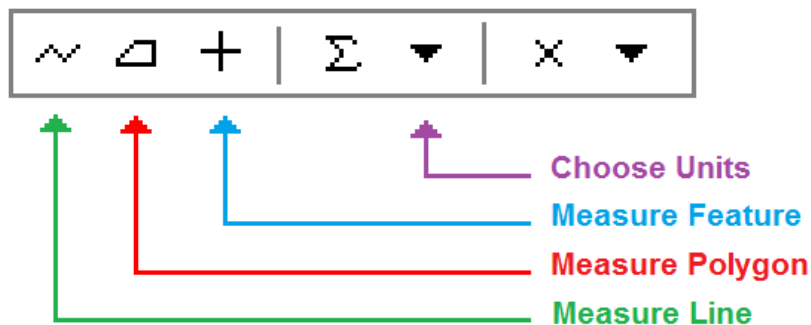
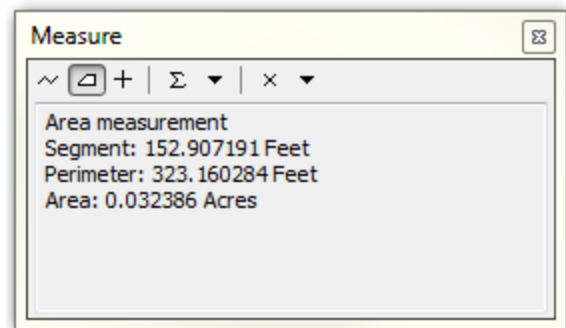
The computer will calculate the direction and distance of the selected line and update the information in the appropriate attribute fields.

Measuring distance and area

Measure Tool



The measure tool will open up a measuring toolbox where you can measure a line, an area, or an existing feature within your GIS environment. It also allows you to change what units are displayed for distance and area.

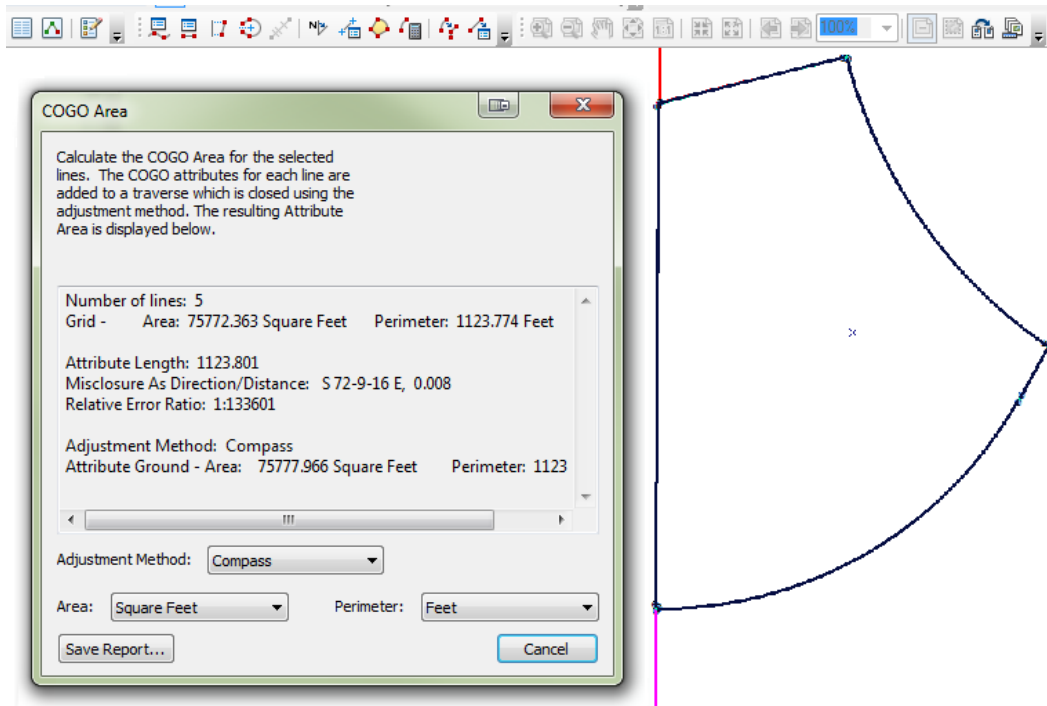


Calculating area from your drafting lines

If you want to measure or calculate the area of a COGO drawing before you have created a polygon feature in the parcel layer you can use the COGO Area tool.



Select the COGO lines that would form the boundaries of the parcel you were drawing, excluding the lines leading to the POB, and then click the area tool from the COGO toolbar.



The selected COGO lines will turn black and a pop up box will appear with the calculated information and some drop-down options to change to the results into your desired units.

Additional Information

Additional training for cadastral mapping using GIS is available online through ESRI. Two good courses offered by ESRI are “Introduction to editing Parcels Using ArcGIS Desktop 10” and “Managing Parcel Data Using ArcGIS Desktop 10.” Both classes are low cost web courses that are available online at training.esri.com

There are also a lot of ArcGIS COGO tutorials available online. Some of the resources are available from ESRI

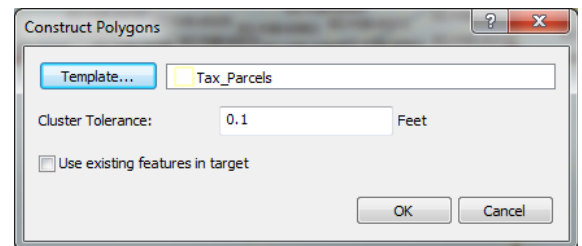
NOTE: *If your county is using a 3rd party extension in ArcGIS or some other software besides ArcGIS to draw your legal descriptions you will need to get the specifics on how to draw and rotate parcel descriptions from your own office.*

Examples for Drafting with GIS

Below is an example of a simplified twelve step outline for editing parcels in ArcMap.

- 1) *Determine, for sure, that the tax parcel in question actually needs to be changed.*
- 2) *If change or break off is needed then continue with editing.*
- 3) *Obtain both the old legal description and new legal description to determine where the change will occur.*
- 4) *Draw the new legal description in COGO using the two-point line Tax Parcel Construction layer.*
 - a. *Make sure to snap to the most recent and updated layer of Section Corners.*
 - b. *Draw the old legal description.*
 - c. *Rotate the old and new descriptions to the same basis of bearing as the section line.*
 - d. *Compare the new legal description with the old legal description.*
 - e. *Draw the parcels surrounding the new legal description to check for overlaps or gaps.*
- 5) *Save each traverse so that the descriptions may easily be re-drawn again.*
- 6) *Once the new legal description is drawn, construct a new polygon using the appropriate tool.*

- a. *To construct a new parcel polygon using the COGO lines, the target layer (Tax Parcels) needs to be visible and selectable.*
- b. *Select the previously drawn lines for the new description and click the construct polygon tool from the topology tool bar.*
- c. *Select the appropriate template for the new polygons.*



- 7) *Merge or cut any applicable overlaps, and correct any misplaced gaps.*
- 8) *The surrounding parcels may also need to be re-constructed to ensure their correct placement.*
- 9) *Rotate the parcel into correct placement only if the rotation snaps to a section line and the surrounding parcels have been redrawn and rotation is needed. (See the section on rotations)*
- 10) *Check newly drawn parcel against other layer such as Roads, Townships, Sections, Water Courses, Cities, Railroads, etc.*

NOTE: Often the Tax Parcel will not line up with all or any of these other layers. This does not mean it is wrong, but is a good reference to check your work.
- 11) *Input the necessary data into the attribute table so that the newly created parcels reflect their new parcel number.*
- 12) *Save Edits.*