Latitude and longitude is a great coordinate system for curved surfaces, spheres, things like the planet, but there's a real problem when we were trying to sort of translate those latitudes and longitudes into flat maps. Remember when you were a kid and you tried to peel that orange all in one piece so that the rind came off all in one piece. If you took that piece and tried to flatten it out onto a flat piece of paper, there's no way that you can do that without either tearing or stretching or wrinkling that orange peel, and it’s been a real problem for map makers over the years because it’s just really difficult to convey that spherical surface onto a flat piece of paper that is the map that we most typically work with. So to deal with that, cartographers over the years have developed what are called projections, and projections are really a mathematical transformation of those spherical coordinates onto a flat piece of paper. Though not really technically correct, this illustration that we have here of this flashlight shining through this curved globe onto a flat piece of paper sort of gives you a sense of what the notion of what a map projection is. The map projection that we most typically use in federal agencies is called Universal Transverse Mercator. For instance, that’s what all of our quad maps are based on that projection. Here’s an illustration of a single UTM zone. As it turns out, there are 60 UTM zones worldwide and each one of those zones is 6 degrees wide. So for instance, here in Arizona we’re in UTM Zone 12. This Central Meridian that goes right up the middle of that UTM zone here in Arizona would be 111 degrees west longitude and since it’s 6 degrees wide, the eastern boundary of that would be 108 degrees west longitude and 114 degrees west longitude. So it’s a fairly narrow

strip and because it is a fairly narrow strip, that allows that projection from the spherical surface onto the flat surface to be relatively free of distortion. The UTM system really is like a piece of graph paper that you used in algebra or geometry class. The equator, right here would be the X axis and there is this imaginary line out here to the west called the Origin of False Easting, that would be similar to the Y axis on a piece of graph paper. So if that's the 0.0 point, it's a pretty easy matter to measure the number of degrees north that would be your northing, and the number of meters east of the Origin of False Easting, and that would give you the northing and easting of that position.

So Carl, how does this projection and this Universal Transverse Mercator System apply to GPS users?

Well, GPS users can set their GPS to report positions onscreen in UTM or, as we saw in some of the previous slides, in latitude and longitude. So GPS users really have the choice of seeing their positions displayed onscreen in any of those latitude and longitude formats that we already discussed, or they can see them expressed as UTMs. And one of the other advantages of seeing them expressed in UTMs is that almost all of the quad maps that the agencies use nowadays are UTM maps and have those same coordinates printed in the tick marks along the margins so that people can use their GPS receiver and a quad map sort of in tandem to keep track of their day's activities. In this slide we're taking a look at how these UTM zones are actually arranged. Remember that I

had said that there are 60 UTM zones worldwide. As it turns out, UTM zones 10 through 19 cover the continental U.S. or the contiguous U.S. I should say, and it's worth pointing out that each one of these UTM zones are also broken up into 8-degree latitude bands. So for instance, here in Arizona we're in UTM Zone 12, latitude band S. UTM coordinates are not unique from zone to zone, so for instance, the same set of UTM coordinates exist on Zone 12 as exist in Zone 13, as exist in Zone 14. So whenever you're expressing UTM coordinates, you also have to tell anyone that you're interacting with what coordinates those UTM coordinates refer to.

But your GPS will always know which zone you're in and will report that information to you automatically.

That's absolutely right because since those UTM zones are bounded by latitude and longitude, and your GPS receiver knows which latitude and longitude it's receiving, it can automatically adopt which UTM zone it's in and report that to you.

Another thing that I wanted to mention really quickly is that when you're dealing or making a setting to have your GPS receiver display UTM coordinates, that the setting is actually UTM UPS, is the setting that you want to select your GPS receiver to, and that can be confusing for some users because there's another

one called a UTM Grid or User Grid. But the one you're going to want to select when selecting it on your GPS is UTM UPS.

That’s right.

And that covers the basics of the two types of coordinate systems that you’ll be using, and now we’re going to go on to a more difficult, but equally important topic of datums.