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**Reminder: How to change the datum of GPS data collected using GPS in a projection OTHER THAN WGS84.**

**\*NOTE: This document only refers to GPS data, not other GIS data.**

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**Background:**

For several years, GPS data have been collected by the Forest Service. In the early years of GPS, data were frequently collected in NAD27 so that they would agree with NAD27 base maps (e.g., topographic and other maps that were produced in NAD27) without any additional effort. In 1992, there was a national mandate to switch geographic datums to the NAD83 datum. For various reasons, this has not been done consistently across the agency. Recently, the Geospatial Advisory Committee has drafted a memo reaffirming this mandate, and has created a timeline for the final mandatory conversion. Conversion of legacy GIS vector data stored in NAD27 or other datums to the NAD83 datum will entail using standard GIS transformation methods.

**Problem identification:**

GPS receivers are designed to receive data from satellites in the WGS84 datum. If the GPS operator requests (via the GPS setup) that the data be **displayed** in NAD27, the GPS unit performs a transformation of the WGS84 coordinate to the requested coordinate system, e.g., NAD27, and outputs it to the display. This transformation procedure is often a mathematical equation or set of equations that is applied to the WGS84 coordinate to create the new coordinate. The problem occurs when that transformation method is not appropriate for the area where the GPS is being used (see the below graphics).

**Correct method of converting NAD27 GPS data to NAD83 coordinates:**

1. In order to correctly change a coordinate collected in a non WGS84 datum (e.g., NAD27) back to WGS84 (and then subsequently to NAD83), the operator needs to identify the transformation method that the GPS unit applied. For example, the Rockwell PLGR GPS unit uses the following “transformation parameters” (which are pieces of the equations used to perform the datum transformation) to transform the native WGS84 coordinate to NAD27 for display:

Local Geodetic Systems	Code	Name	$\Delta a(m)$	$\Delta f \times 10^4$	$\Delta X(m)$	$\Delta Y(m)$	$\Delta Z(m)$	
NORTH AMERICAN 1927	Mean Value (CONUS)	NAS-C	Clarke 1866	-69.4	-0.37264639	-8	160	176

The GPS unit’s documentation or technical support staff should be able to readily supply you with this information, which is a critical component of the functionality of the GPS.

2. Next, the user needs to identify which of the ESRI datum transformation methods corresponds to this set of parameters. One way to do this is to consult the ESRI document found at <http://support.esri.com/index.cfm?fa=knowledgebase.whitepapers.viewPaper&PID=43&MetaID=302> , which lists the transformation method name and the parameters used by ArcGIS to perform the transformation. Upon inspection of the document, the user will quickly see which parameters agree with those supplied by the GPS company. Then, in ArcToolbox or ArcMap, the user will select this datum transformation method in the projection dialogue when performing the reprojection.

In the example of the PLGR with the above parameters, I should use ArcMap's NAD\_1927\_To\_WGS\_1984\_4, because its parameters are the same as those used by the PLGR to transform from WGS84 to NAD27.

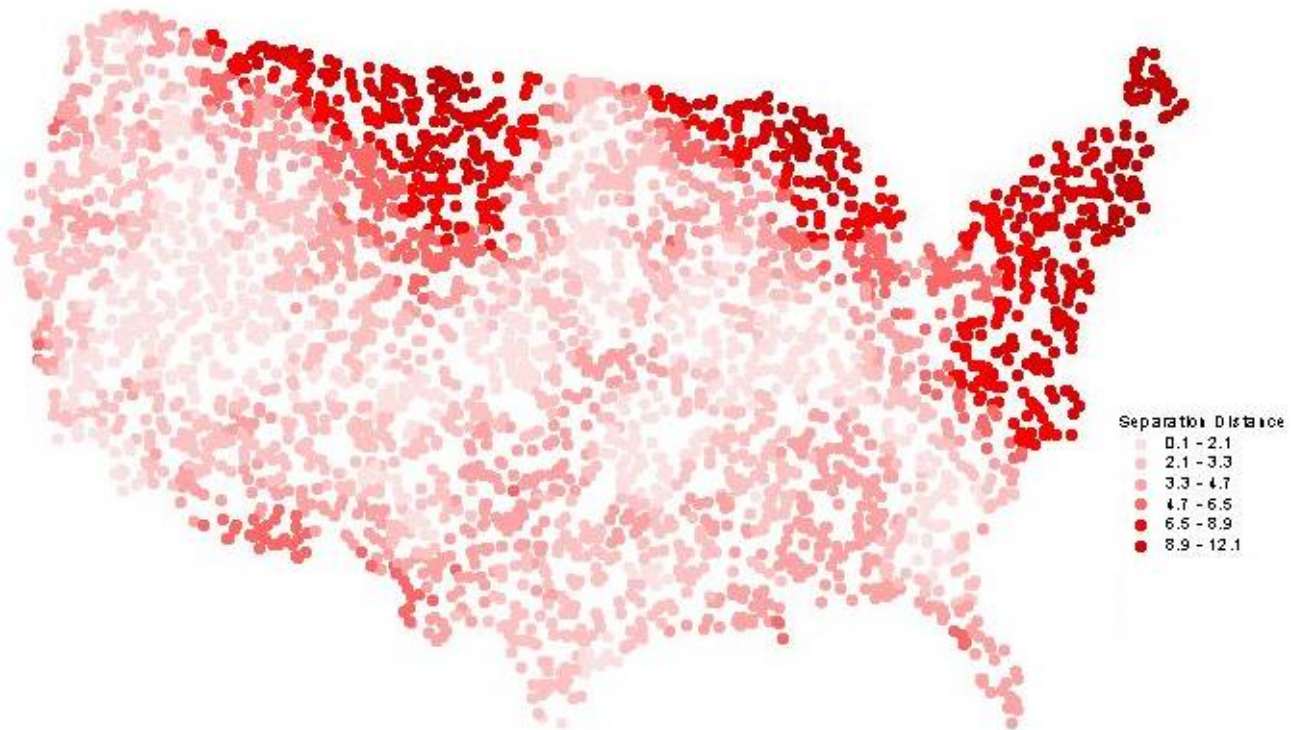
3. To then convert the WGS84 coordinate generated by ArcToolbox in step2 to NAD83, I should then consult the above document again, and choose the NAD83 to WGS84 conversion appropriate to your area – in the case of much of the United States, “NAD\_1983\_To\_WGS\_1984\_5”. (**Note** – WGS84 and NAD83 are generally within ~1 meter of each other – many people assume that WGS84 and NAD83 are equivalent for all practical purposes. I advocate taking the extra step to make the coordinates as correct as possible, however).

Once this correct wgs84 to nad83 method has been identified (typically NAD\_1983\_To\_WGS\_1984\_1), this method should be selected in the projection dialogue of ArcToolbox to obtain the final NAD83 coordinate.

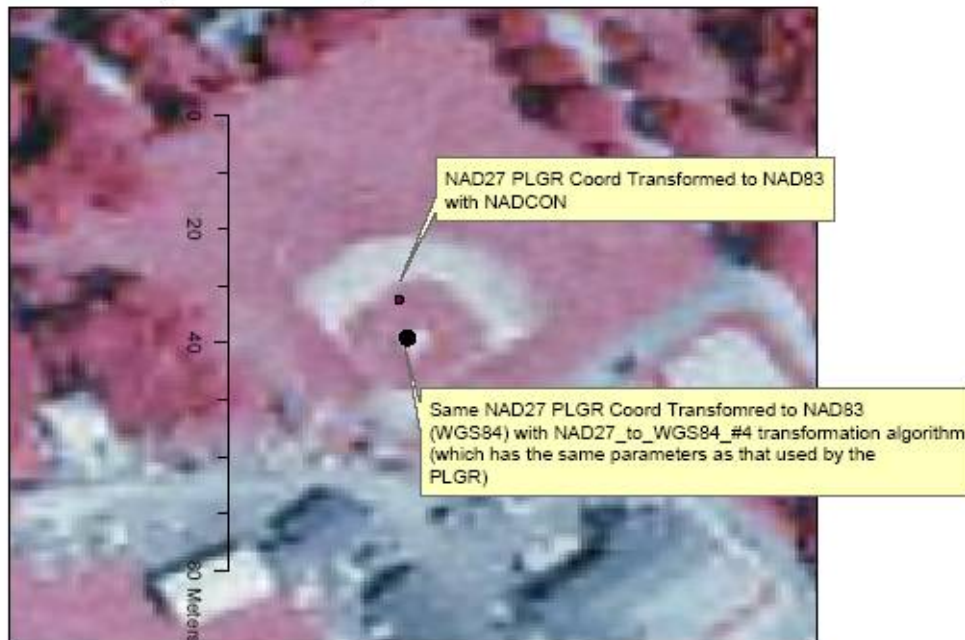
In summary, the main point is this: Convert NAD27 coordinates collected in GPS to WGS84 using the same method that is used by the GPS (be it NADCON or another transformation method). You can find the transformation method used by examining the GPS support information, or by calling the company with the GPS model number and software version. Cross reference this information with the information in the above ESRI document, and choose the appropriate ESRI transformation method (the one that corresponds to your GPS transformation parameters) to convert to WGS84. Finally, based on your location, choose once again from the ESRI document the correct ESRI transformation method to convert from WGS84 to NAD83.

**Important:**

Conventional wisdom in the GPS community is that it is always appropriate to use NADCON to transform any NAD27 GPS coordinate to NAD83. This is generally correct, unless your GPS does not use NADCON to convert from WGS84 to NAD27 (which often is the case). If you were to convert a PLGR GPS-based NAD27 coordinate to NAD83 using NADCON, and then did the same conversion correctly using the ArcMap #4 method (described above), and compared distances between the two sets of points, you would obtain the below distribution of separation distances. It is apparent that in the NE and NC US, and parts of the PNW US, there are significant (up to 12 meter) shifts introduced between the correct coordinate (correctly transformed using the Nad27\_to\_WGS84\_#4 method in ArcMap), and the coordinate produced using NADCON (in this case, incorrectly). For Alaska, the effect might be more severe. The same procedure described above applies in Alaska. The following two figures illustrate this effect graphically.



Example of How the PLGR's NAD27 Coordinates Were Converted from WGS84 Incorrectly (Coord was taken at center of pitcher mound; this is typical of findings when repeating experiment at surveyed benchmarks).



**Conclusion:**

By taking some extra effort to ascertain what transformation method your GPS used to collect your data, you can avoid the significant shifts portrayed above.