

# Understanding Datum, Projection, And Transformation In ArcPad 7

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## Purpose

This guidance is intended to help users understand ArcPad's use of datums, projections, and transformations. General ArcPad functionality is not discussed here, as it is well documented in *Using ArcPad*, and in the *ArcPad Reference Guide*. All references to ArcPad refer specifically to ArcPad 7.0.1.

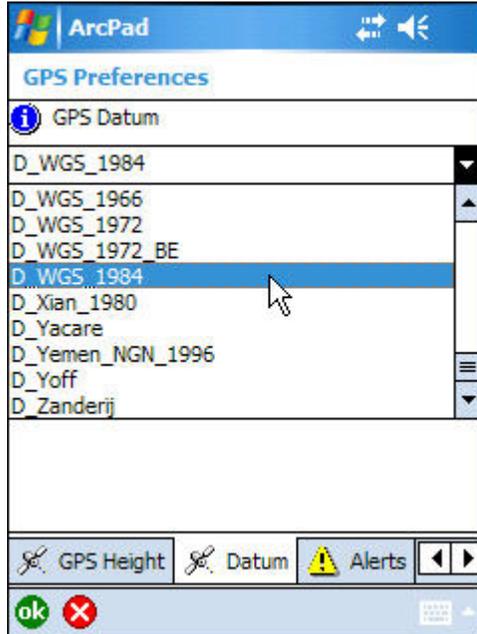
## Background

ArcPad converts latitude and longitude from a GPS receiver to coordinates expressed in terms of the current map's spatial reference (datum and projection). In order for this on-the-fly conversion to proceed as intended, users must establish three things.

1. The datum of incoming GPS latitude and longitude.
2. The current map's intended spatial reference.
3. The datum transformation necessary to convert coordinates of the GPS datum to coordinates of the map's spatial reference.

Each of these three steps is described in detail below.

## Step 1 – Establish The GPS Datum



The datum of incoming GPS latitude and longitude is established by making a selection from the **GPS Datum** dropdown list.

To do so, tap  – **GPS Preferences... – Datum**, as shown at left.

Once set, ArcPad will “expect” to receive GPS coordinates referenced to this datum, and all subsequent processing will be based on that expectation. **D\_WGS\_1984** is the default.

Don’t confuse the GPS datum with the intended spatial reference of ArcPad’s current map described in **Step 2**.

Most GPS receivers issue coordinates only in WGS84.

When GPS coordinates are streamed to ArcPad from a Garmin receiver, however, they are referenced to the Garmin’s currently selected **Map Datum**. For instance, if a Garmin’s **Map Datum** is set as illustrated at right, the GPS coordinates issued to ArcPad will also be referenced to **NAD27 CONUS**, not to **WGS84**. Therefore, Garmin users should set their Garmin’s **Map Datum** to **WGS84** to avoid a datum mis-match in ArcPad.

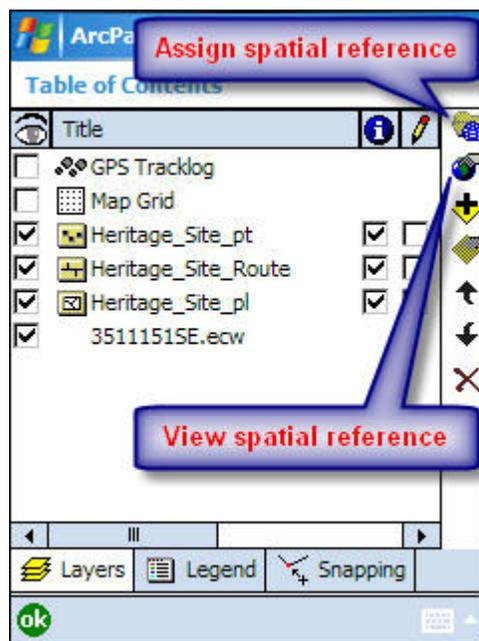
**Summary** – Set ArcPad’s **GPS Datum** to **D\_WGS\_1984**, and ensure that GPS receivers are issuing WGS84 coordinates to ArcPad.



## Step 2 – Establish The Intended Spatial Reference Of ArcPad's Current Map

The intended spatial reference (datum and projection) of ArcPad's current map are established by a projection (.prj) file, or by information embedded in an ArcPad map (.apm) file. The sequence ArcPad uses to establish a map's spatial reference is described below.

1. The default spatial reference for a newly opened, empty ArcPad map is WGS84 latitude and longitude decimal degrees.
2. If a projection file named **arcpad.prj** is found in the **.../My Documents** folder, its spatial reference becomes the default for a newly opened, empty ArcPad map.
3. If a data layer or map with a defined spatial reference is added to a newly opened, empty ArcPad map, that spatial reference replaces the default.



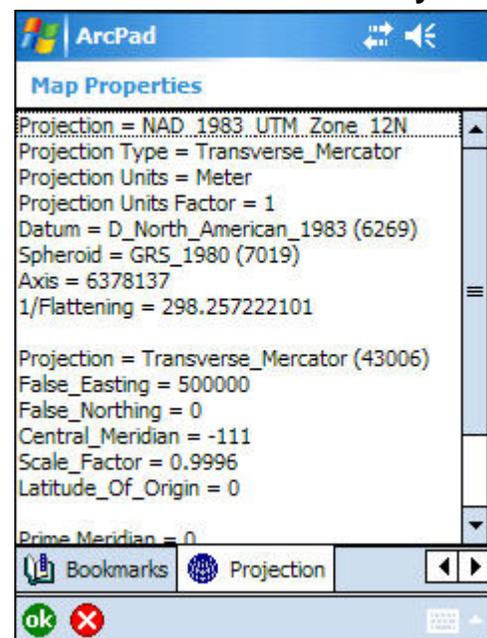
If a map's first added data layer lacks a defined spatial reference, one can be manually assigned by tapping the first icon along the **Table of Contents'** right margin, as shown at left, and making a selection from a folder containing .prj files.

A map's current spatial reference, illustrated below, may be viewed by tapping the second icon along the **Table of Contents'** right margin, or by tapping  - **Map Properties... - Projection**.

**Summary** – Users should copy a projection (.prj) file suitable for their area of interest to the **.../My Documents** folder and rename it **arcpad.prj**, or

else, ensure that

the first data layer or map added to a newly opened, empty ArcPad map has a defined spatial reference that accurately reflects its feature's coordinates.



### Step 3 – Establish A Datum-To-Datum Transformation

A datum-to-datum transformation is required when incoming GPS coordinates are referenced to WGS84 and ArcPad's map is referenced to NAD83 or to NAD27. This is so because each of these datums is based on a different spheroid, a mathematical model of Earth's dimensions. Two transformation complications can arise, however.

1. ArcPad may not support the transformation best suited to a particular situation. For example, ArcPad does not currently support the NGS-sanctioned WGS84-to-NAD83 transformation. Generally, the **NAD\_1983\_To\_WGS\_1984\_5** transformation (ArcPad's default WGS84-to-NAD83 transformation) is adequate for most users. However, those with more sophisticated equipment, a GeoXH and Zephyr antenna, for instance, may desire a transformation better able to capture the current separation between WGS84 and NAD83.

Trimble addresses this issue in their Support Note titled [GPS Pathfinder Office Software or the GPS Analyst Extension for ESRI ArcGIS Software: Resolving the NAD 83 Datum Transformation Issue](#), and Pathfinder Office software v3.1, and later, includes the current NGS-sanctioned transformation.

2. Multiple transformations may be available for any given datum pair. For example, ArcPad supports 21 WGS84-to-NAD27 transformations, and 5 WGS84-to-NAD83 transformations, each being suited to a particular geographic area. An ESRI document titled [Supported Geographic \(Datum\) Transformations](#) lists all supported transformations, as well as their area of intended use. Use this reference to determine the transformation best suited to an area of interest.

Fortunately, the PC-based **Datum Configuration Tool** introduced with ArcPad 7.0.1 permits users to easily define custom transformations, as well as set the default transformation for a given datum pair. The tool creates two files in the **.../ArcPad/System** folder.

1. **DefaultTransforms.dbf** contains a user-selected default transformation for each datum pair of interest to the user. ArcPad interrogates **DefaultTransforms.dbf** before referring to its internal default transformation table, and will use the listed transformation if it finds a record matching ArcPad's current GPS datum and map datum. If no match is found, ArcPad uses its internal default transformation for the current datum pair.
2. **Transforms.dbf** contains user-defined customized transformation parameters. ArcPad attempts to match each custom transformation's datum pair to ArcPad's current GPS datum and map datum, and applies the associated custom transformation parameters if a match is found. If no match is found, ArcPad uses its internal default transformation for the current datum pair.

Click **Start – Programs – ArcGIS - ArcPad 7 – Datum Configuration Tool** to define a custom transformation, or to set the default transformation for a given datum pair. The tool requires .NET Framework 2.0 to be installed. Click **Help** when the tool opens to obtain guidance.

In the example below, the current NGS-sanctioned WGS84-to-NAD83 transformation referred to by Trimble as **WGS84\_To\_NAD83\_COR96** is defined on the **Define Datum Transformation** tab. Click **Save** when all parameters have been entered.

**ArcPad 7 Datum Configuration Tool**

Define Datum Transformation | Select Default Datum Transformation | [About](#) | [Help](#) | [Download](#)

Datum Transformation Name: WGS84\_To\_NAD83\_COR96

Transformation Method: Coordinate\_Frame

**Datum 1**

From Datum: D\_WGS\_1984

Spheroid: WGS\_1984

Semi-major Axis: 6378137

Flattening: 0.00335281066474748

**Datum 2**

To Datum: D\_North\_American\_1983

Spheroid: GRS\_1980

Semi-major Axis: 6378137

Flattening: 0.00335281068118232

**Parameters**

Dx	0.9956	Rx	0.025915	Xcr	
Dy	-1.9013	Ry	0.009426	Ycr	
Dz	-0.5215	Rz	0.011599	Zcr	

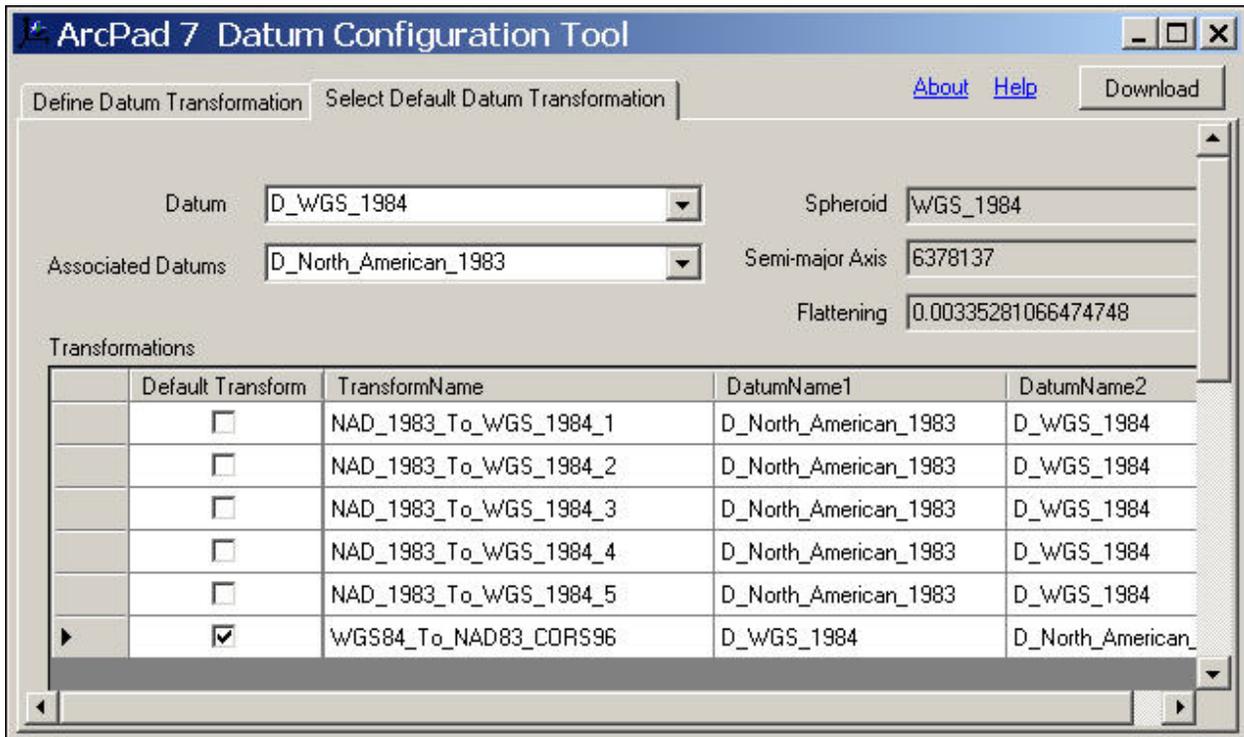
Scale Factor: 0.00062

Dataset:

[Save](#) | [Clear...](#) | [Manage...](#) | [Exit](#)

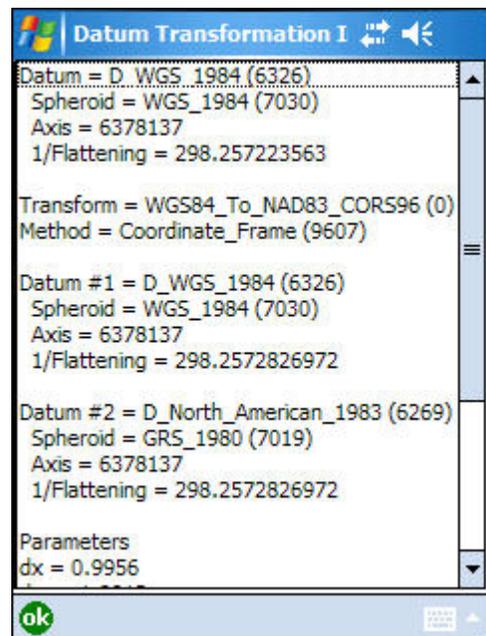
Click the **Select Default Datum Transformation** tab to set a default transformation for the user-selected datum pair, and place a check mark in the box corresponding to the desired default transformation. Notice that the list includes not only ArcPad's internal transformations for the datum pair, but the newly defined transformation as well.

Click the **Download** button to send newly defined custom and/or default transformations to an attached Windows Mobile handheld device.



In ArcPad, tap - **GPS Preferences... - Datum** - to confirm that the currently active transformation is appropriate for ArcPad's current datum pair, as illustrated at right.

**Summary** – Use the PC-based **Datum Configuration Tool** to create customized transformations, or to set the default transformation for a given datum pair.



## Datum Issues Associated With Differential Correction

GPS data inherit the datum of their differential correction source because corrections are issued relative to, and in terms of, the correction source's datum. For instance, autonomous (uncorrected), WAAS/SBAS-corrected, and CORS-corrected GPS data are all referenced to WGS84 because those sources are all referenced to WGS84. NDGPS-corrected GPS data, however, are referenced to NAD83 because the NDGPS (U.S. Coast Guard) beacons are referenced to NAD83.

This situation has implications for those using an NDGPS real-time differential correction source because incoming GPS coordinates are already referenced to NAD83, not WGS84, by virtue of their NDGPS lineage. Therefore, users with a NAD83-based GIS who collect NDGPS-corrected data with no subsequent post-processing should set ArcPad's GPS datum to **D\_North\_American\_1983**. No transformation needs to be specified because the datum of incoming GPS and the datum of ArcPad's map are both NAD83. ArcPad recognizes that they match, and attempts no transformation.

The following table summarizes appropriate action when the datum component of the ArcPad map's spatial reference is NAD83.

If The Differential Correction Source Is:	Set ArcPad's GPS Datum To:	Use this Datum-To-Datum Transformation:
Autonomous (no correction)	D_WGS_1984	NAD_1983_To_WGS_1984_5 or WGS84_To_NAD83_CORS96
WAAS/SBAS	D_WGS_1984	NAD_1983_To_WGS_1984_5 or WGS84_To_NAD83_CORS96
Post-processing using CORS base data referenced to ITRF00/WGS84	D_WGS_1984	NAD_1983_To_WGS_1984_5 or WGS84_To_NAD83_CORS96
Real-time correction from an NDGPS beacon <b>with</b> subsequent post-processing using CORS base data referenced to ITRF00/WGS84	D_WGS_1984	NAD_1983_To_WGS_1984_5 or WGS84_To_NAD83_CORS96
Real-time correction from an NDGPS beacon only, <b>with no</b> subsequent post-processing	D_North_American_1983	No transformation needs to be specified because the datum of incoming GPS and the datum of ArcPad's map are both NAD83. ArcPad recognizes that they match, and attempts no transformation.

## Useful References

**ArcPad Reference Guide** (~1.3 MB) and **Using ArcPad** (~5.9 MB) on-line at:  
<http://support.esri.com/index.cfm?fa=knowledgebase.documentation.viewDoc&PID=26&MetalID=1126>

**Supported Geographic (Datum) Transformations** (~160 KB) on-line at:  
<http://support.esri.com/index.cfm?fa=knowledgebase.whitepapers.viewPaper&PID=19&MetalID=758>

**ArcPad 7 Datum Configuration Tool** (~80 KB) in ArcPad's local install directory Help folder, for instance:  
<C:\Program Files\ArcPad 7.0\Help\ArcPad 7 Datum Configuration Tool.pdf>

Trimble Support Note - **GPS Pathfinder Office Software or the GPS Analyst Extension for ESRI ArcGIS Software: Resolving the NAD 83 Datum Transformation Issue** (~300 KB) on-line at:  
[http://trl.trimble.com/docushare/dsweb/Get/Document-170369/SprtNote\\_PFO-GPSA\\_NAD83Datum.pdf](http://trl.trimble.com/docushare/dsweb/Get/Document-170369/SprtNote_PFO-GPSA_NAD83Datum.pdf)