



GRIDS & DATUMS

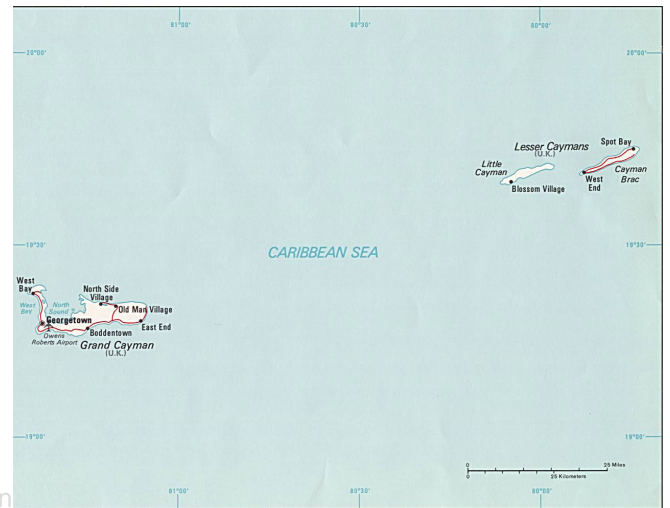
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The Grids & Datums column has completed an exploration of every country on the Earth. For those who did not get to enjoy this world tour the first time, *PE&RS* is reprinting prior articles from the column. This month's article on the Cayman Islands was originally printed in 1998 but contains updates to their coordinate system since then.

This month's topic features the Cayman Islands of the Caribbean Sea. The islands of Grand Cayman, Cayman Brac, and Little Cayman comprise this dependency of the United Kingdom. Columbus visited the islands in 1503, but the Spanish never settled there. The Cayman Islands (including Jamaica) were ceded to Britain in 1670 under the Treaty of Madrid. Later, the islands were colonized by settlers from Jamaica and remained a parish of Jamaica. In 1962, when Jamaica became independent, the Cayman Islands became a "direct" British Dependent Territory.

Property "Platt Books" (sic) were the first recorded land grants of land ownership on Grand Cayman (five parcels), and are dated 1730 and 1740. The Royal Navy performed its original hydrographic survey of Grand Cayman Island in 1773. In 1835, Captain Owen, R.N. determined the longitude difference between Fort George (Grand Cayman) and Morro Light, Havana Cuba. Captain Owen's survey produced the first Admiralty Chart of all three islands. Finlay's North Atlantic Directory of 1895 differed with that longitude by 49 seconds, and the discrepancy continued unresolved for 60 years. The difference was reflected between the Admiralty Chart No. 462 and the U.S. Army Map Service (AMS) 1:50,000 topographic maps of the islands. The AMS maps were based on the U.S. Naval Hydrographic Office Chart No. 0043 (20th) edition of 1933. H.M.S. Vidal, a hydrographic survey ship initiated a new survey in September 1954. The following month, using a geodetic astrolabe, Captain Owen's "Observation Spot" was validated to within 20 feet. The coordinates of the first Cayman Island geodetic datum, "Fort George Observation Spot 1835 Datum" are based on the Origin: $\Phi_0 = 19^\circ 17' 48.01''$ North, $\Lambda_0 = 81^\circ 23' 05.83$ West of Greenwich. The original datum was the basis of the Admiralty Chart No. 462, and was centered on the ruins of the old Fort George in

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Georgetown. Furthermore, a new "Observation Spot" was obtained by that astrolabe determination: $\Phi_0 = 19^\circ 17' 45.02''$ North, $\Lambda_0 = 81^\circ 23' 06.83$ West of Greenwich and was the basis of the new edition of Admiralty Chart No. 462 for the plan of Georgetown Anchorage.

The current reference system for the island of Grand Cayman was originally set by the Inter American Geodetic Survey (IAGS). It was lost for a number of years after a road was built over it, but was recovered in 1995. GC 1 1959 Datum is based on the Origin: $\Phi_0 = 19^\circ 17' 54.43''$ North, $\Lambda_0 = 81^\circ 22' 37.17$ West of Greenwich, with the defining orientation based on the azimuth from GC 34 to GC 10 being $334^\circ 13' 25.97''$. The datum is referenced to the Clarke 1866 ellipsoid. The scale was established by Tellurometer, a brand of electronic distance meter (EDM) invented and built in South Africa that uses microwaves rather than the currently more popular type of gizmo that uses Infra-Red (IR) light. The datum was established for the subsequent photogrammetric mapping

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performed by the British Directorate of Colonial Surveys (DCS), later renamed to the Directorate of Overseas Surveys (DOS). The original DCS survey consisted of 51 classical triangulation stations subsequently densified with DI-10 (IR EDM) traverse for 357 additional points. The establishment of elevations was accomplished by a series of both single-run loops and double-run spurs for a total of 147 stations. The fundamental benchmark on Grand Cayman Island is called "Vidal Spot," established from the observations of three months. There is some question on the validity of this benchmark elevation with respect to local mean sea level. (The full Metonic Cycle of 18.6 years is used at permanent tide gages for the determination of local mean sea level.) In 1977, the 512 Specialist Team of the Royal Engineers "on secondment" to DMA/HTC performed Doppler Satellite observations but results referenced to the NWL9D Datum were never sent to the Government of the Cayman Islands (accuracy was ± 1.5 meters). A subsequent survey by the U.S. National Geodetic Survey determined the WGS 84 coordinates of a number of existing stations on Grand Cayman Island in 1996-1997.

The current reference system for the islands of Little Cayman and Cayman Brac, "LC 5 Astro Owen Island DOS 1961 Datum," is based on the Origin: $\Phi_0 = 19^\circ 39' 46.324''$ North, $\Lambda_0 = 80^\circ 03' 47.91$ West of Greenwich. The defining orientation is based on two azimuths, which is very unusual, but it is logical since there is one azimuth per island. The azimuth on Cayman Brac from CB 2 to CB 1 is $236^\circ 37' 36.33''$, and the azimuth on Little Cayman from LC 5 to LC 6 is $256^\circ 19' 02.03''$. This Datum is referenced to the Clarke 1866 ellipsoid also. The height Datum was based on the fundamental benchmark for Little Cayman, which was 3.266 meters. The height datum for Cayman Brac was based on BM 13, which was 3.720 meters. The original DOS survey consisted of 27 points, and there was a closed traverse around each island. A braced connection between the two islands was performed with angles and Tellurometer distances. Subsequently, 300 additional points were added with DI-10 distances.

During the Fall of 1997, with the gracious help of the Government Office of the Chief Surveyor of the Cayman Islands, I acquired the "complete" data set of their classical datums. I provided my graduate class with these data, which consisted of those points common to the two classical datums and to the WGS84 Datum. The results of that homework assignment developed a three-parameter solution for both datums, and a seven-parameter solution for the Grand Cayman Datum. The Three-Parameter transformation from the "GC 1 1959 Datum" to the WGS 84 Datum is: $\Delta X = +67.757$ meters, $\Delta Y = +106.114$ meters, $\Delta Z = +138.813$ meters. The highest residual of six common points did not exceed 0.90 meters. On the other hand, if we use a seven-parameter transformation, the accuracy is improved tenfold. Those parameters are: $\Delta X = -0.75$ meters, $\Delta Y = +7.93$ meters, $\Delta Z = +153.87$ meters, Scale = -13.63×10^6 , $R_x = -0.52$ arc seconds, $R_y = -6.49$ arc seconds, and $R_z = 1.46$

arc seconds. Only two points in common were observed by the U.S. National Geodetic Survey between WGS 84 and the local datum for the Little Cayman and Cayman Brac islands. Therefore, only a three-parameter transformation is possible: $\Delta X = +44.423$ meters, $\Delta Y = +108.983$ meters, $\Delta Z = +151.666$ meters. The highest residual for this two-point fit was 0.34 meters, and this relation should be considered quite approximate. The British West Indies (BWI) Grid is not used in the Cayman Islands. The Cayman Islands use the standard UTM Grid for both Datums on all three islands, and all islands are in Zone 17 (Central Meridian = 93° West).

UPDATE

The coordinate systems of the Cayman Islands have been completely updated since the last time a column was published on the country. The new datum is the Cayman Islands Geodetic Datum of 2011 (CIDG11). The ellipsoid by default is the GRS80 because the ITRF05(2011) is the reference system. With respect to the old datums, the following transformation from Grand Cayman Geodetic Datum of 1959 (GCGD59) to CIDG11 is: $\Delta X = -179.483$ m., $\Delta Y = -69.379$ m., $\Delta Z = -27.584$ m., $R_x = +7.862^2$, $R_y = -8.163^2$, $R_z = -6.0427^2$, $\delta s = -13.925$ ppm; the ESRI/Trimble Coordinate Frame Rotation convention being utilized. Transformation accuracy of ± 1 foot is claimed by the government. With respect to Cayman Brac and Little Cayman, the following transformation from Sister Islands Geodetic Datum of 1961 (SIGD61) to CIDG11 is: $\Delta X = +8.853$ m., $\Delta Y = -52.644$ m., $\Delta Z = +180.304$ m., $R_x = +0.393^2$, $R_y = +2.323^2$, $R_z = -2.96^2$, $\delta s = -24.081$ ppm; the ESRI/Trimble Coordinate Frame Rotation convention being utilized. Transformation accuracy of ± 1 foot is claimed by the government.

The new plane coordinate system for all of the Cayman Islands is the Cayman Islands National Grid (CING11) now using the Lambert Conformal Conic projection where: Latitude of False Origin is: $19^\circ 20'$ N, Longitude of False Origin is: $80^\circ 34'$ W, Latitude of 1st Standard Parallel is $19^\circ 20'$ N, Latitude of 2nd Standard Parallel is $19^\circ 42'$ N, Easting at False Origin is 2,950,000 Ft, Northing at False Origin is 1,900,000 Ft, and the International Foot convention is used where 1 meter = 0.3048 Ft. These parameters are defined by the National Government as published as EPSG Code 6391.

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