NATIONAL TRANSPORTATION SAFETY BOARD
Vehicle Recorder Division
Washington, D.C. 20594

April 14, 2017

Global Positioning System (GPS) Device Factual Report

Specialist's Factual Report
by Sean Payne

A. EVENT

Location:	Hollywood, Florida
Date:	September 3, 2016
Aircraft:	Cessna 172N
Registration:	N6091E
Operator:	Private
NTSB Number:	ERA16FA309

C. SUMMARY

On September 3, 2016 about 0952 eastern daylight time (EDT), a Cessna 172N, N6091E, was destroyed when it impacted the Atlantic Ocean, while maneuvering near Hollywood, Florida. The private pilot and pilot rated passenger were fatally injured. The airplane departed from Pompano Beach Airpark (PMP), Pompano Beach, Florida, and was destined for Ocean Reef Club Airport (07FA), Key Largo, Florida. The airplane was owned by Volux Aviation LLC, and operated by a private individual. Visual meteorological conditions prevailed and no flight plan was filed for the personal flight conducted under the provisions of 14 *Code of Federal Regulations* Part 91.

D. DETAILS OF INVESTIGATION

The National Transportation Safety Board (NTSB) Vehicle Recorder Laboratory received the following device:

GPS Manufacturer/Model:	Garmin aera 796
Serial Number:	2CY002644

Garmin aera 796 Device Description

The Garmin aera 796 is a battery-powered, portable, multi-function display and GPS receiver with a 7-inch diagonal, high resolution, LCD touch screen display. The unit includes a built-in Jeppesen database and is capable of receiving XM satellite radio for flight information including NEXRAD Radar, lightning, METARs, TAFs, and TFRs. The

unit can also perform and store weight and balance calculations. A built-in AOPA Airport Directory and SafeTaxi airport diagrams are included for selected airfields. With appropriate subscriptions, the unit is capable of storing and displaying geo-referenced VFR and IFR navigation charts, including IFR approach charts. The unit also has a "scratch pad" feature, allowing the user to hand write electronic notes.

The unit stores date, route-of-flight, and flight-time information for up to 50 flights. A detailed track log – including latitude, longitude, date, time, and GPS altitude information for an unspecified number of points – is stored within the unit whenever the receiver has a lock on the GPS navigation signal. Position is updated within the track log as a function of time or distance moved, depending on how the unit has been configured. Once the current track log memory becomes full, new information either overwrites the oldest information or recording stops, depending on how the unit is configured. The current track log can be saved to long-term memory. Track log storage may be activated or de-activated at user discretion. All recorded data is stored in non-volatile[1] memory.

The unit contains hardware and software permitting the download of recorded waypoint, route, and track log information to a PC via a built-in USB port. An internal button-battery is used to back-up power to the internal memory and real-time clock during those periods when main power is removed.

GPS Data Recovery

Upon arrival at the NTSB Vehicle Recorder Division, an exterior examination revealed the unit had sustained significant impact damage, as shown in figure 1. An internal inspection revealed the main internal board was intact, as shown in figure 2. Figure 2 shows the main, non-volatile memory chip, the SanDisk SDIN4C2-8G, was intact and secured to the board.

The SanDisk SDIN4C2-8G chip was removed from the main internal board and the 169-connection ball grid array (BGA) was re-soldered. The memory contents of the chip were successfully read and track log data points were decoded from the 8 gigabyte binary memory image.

[1] Non-volatile memory (NVM) – semi conductor memory that does not require power be applied to retain data.

Figure 1. Photo of damaged Garmin aera 796.

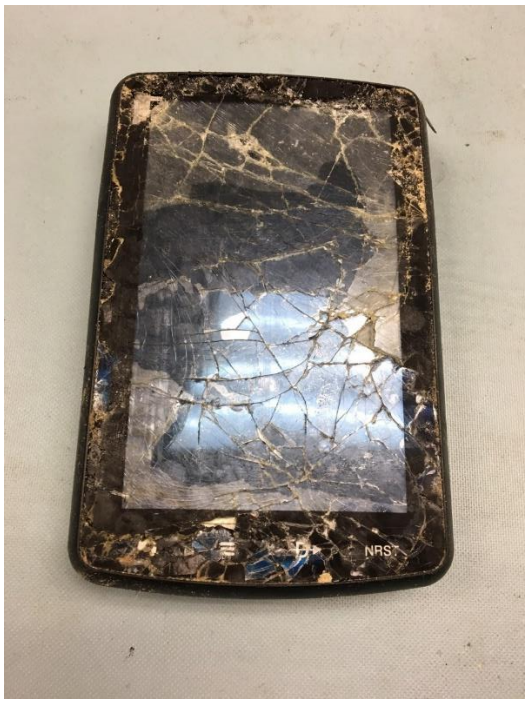

Figure 2. Photo of Garmin aera 796 main memory board with memory chip circled in red.

GPS Data Description

A total 34 tracklogs were extracted from the binary memory image. The 34th tracklong was recorded on September 3, 2016 and was associated with the accident flight. The recorded data was from the time period 13:32:31 UTC through 13:50:02 UTC. The recorded data began while the aircraft was in a ramp area at PMP. The tracklog ended while the aircraft was in flight about 850 feet offshore from the beach area just north of Harbour Inlet, Fort Lauderdale, Florida. The last data points were likely recorded to a volatile buffer within the device and were not recoverable.

GPS Parameters Provided

Table 1 describes data parameters provided by the GPS device. Date, Time, Latitude, Longitude, and GPS Altitude are recorded by the device. Groundspeed and Track are derived from the recorded parameters.

Table 1: GPS Data Parameters

Parameter Name	Parameter Description
Date	Date for recorded data point (MM/DD/YYYY)
Time	Time (UTC) for recorded data point (HH:MM:SS)
Latitude	Recorded Latitude (degrees)
Longitude	Recorded Longitude (degrees)
GPS Alt	Recorded Mean Sea Level (MSL) GPS Altitude (feet)
Groundspeed	Average groundspeed between current and previous data point (knots)
Track	Average true course between current and previous data point (degrees)

OVERLAYS AND TABULAR DATA

Figures 3 through 6 were generated using Google Earth.

Figure 3 shows the departure of the aircraft from PMP. The orientation is north up. The flight log began at 13:32:31 UTC and was recorded in the ramp area of PMP. By 13:42:53, the aircraft had taken runway 5 at PMP. The aircraft began a takeoff roll at PMP and by 13:43:41 had climbed away from runway 5 to the southeast.

Figure 4 shows the aircraft's climbout from PMP and a turn conducted to the south over the water. The orientation of the image is to the northeast. By 13:45:12, the aircraft was over the ocean and had turned southbound. The recorded GPS altitude was 1,035 feet and the groundspeed was 66 knots.

Figure 5 shows the last recorded portion of the tracklog. The orientation of the image is facing northeast. The last recorded point of the accident flight was captured at 13:50:02 at an altitude of 440 feet and a groundspeed of 85 knots.

Figure 6 is a top down, north up overview of the entire tracklog recorded for the accident flight.

Tabular data used to generate figures 3 through 6 are included as Attachment 1. This attachment is provided in electronic comma-delimited value (.CSV) format.

Figure 3. Google Earth overlay of the aircraft's taxi and departure from PMP.

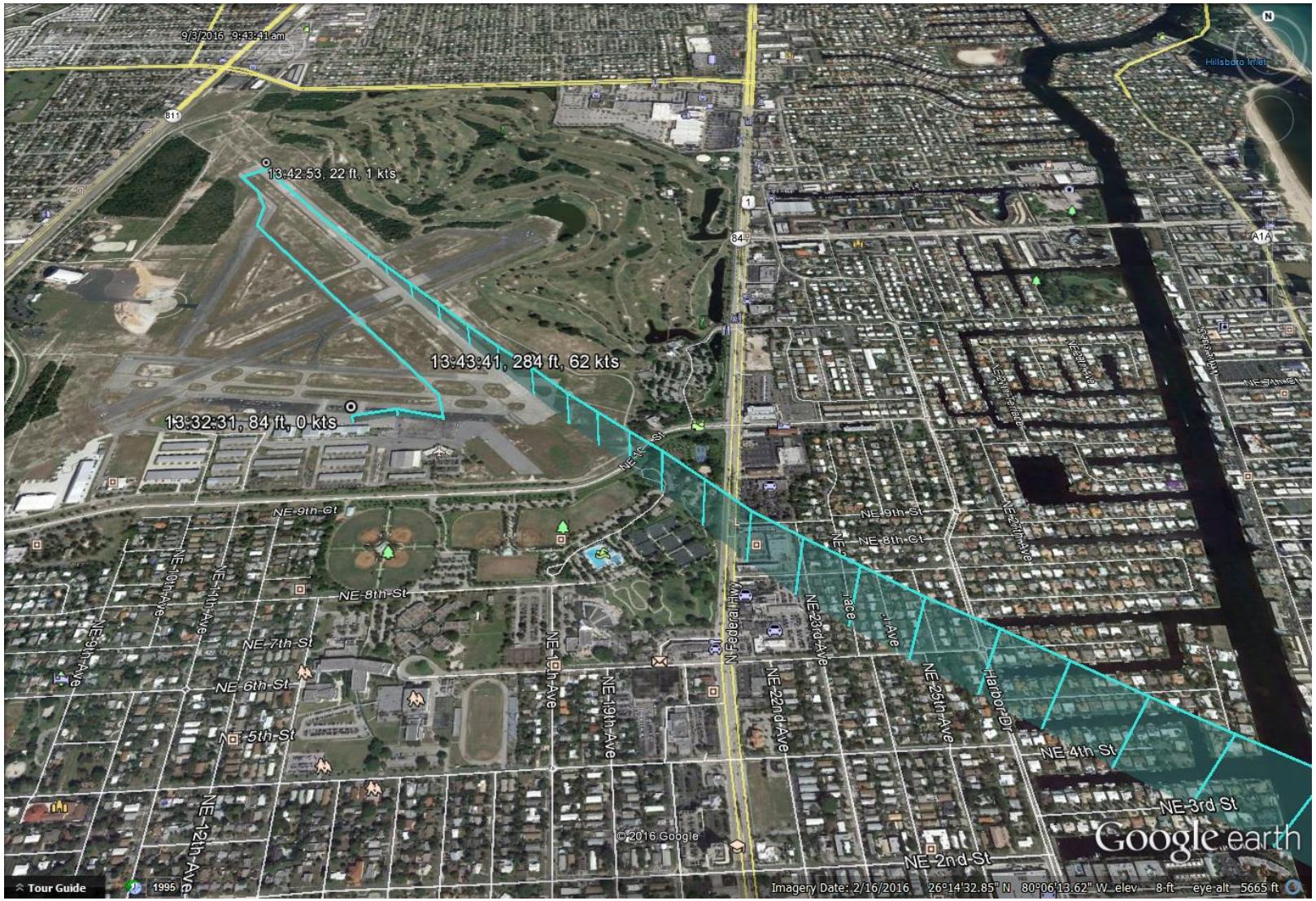

Figure 4. Google Earth overlay of the aircraft's departure leg from PMP as it turned south over the water.

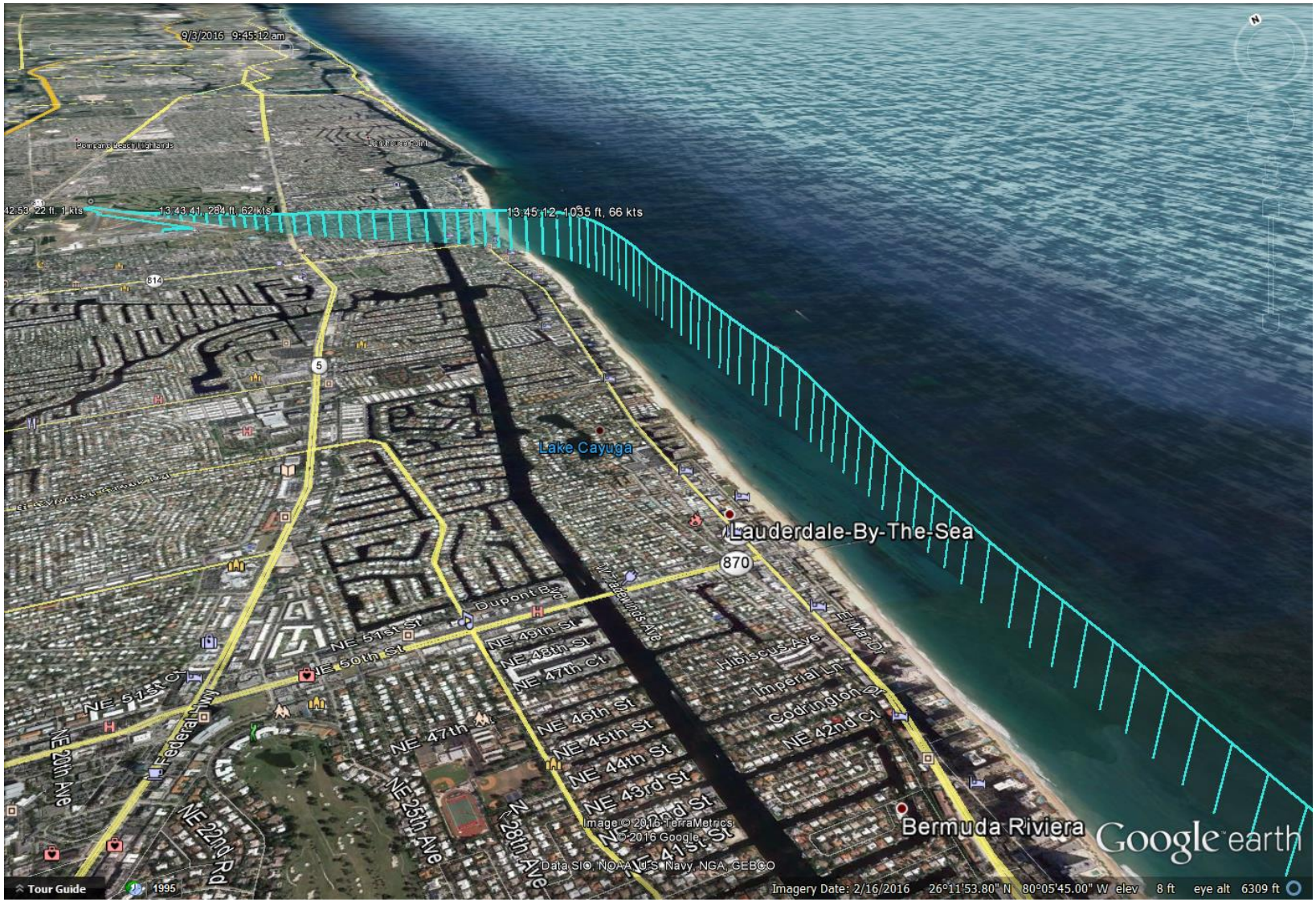

Figure 5. Google Earth overlay of the final portion of the accident tracklog. The view is looking toward the northeast.

Figure 6. Top down, north up overview of the entire accident flight recording.