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

April 1, 2013

GPS Factual Report

Specialist's Factual Report
by Bill Tuccio

A. EVENT

Location:	Greensburg, Indiana
Date:	December 2, 2012
Aircraft:	Piper PA-46-350P
Registration:	N92315
Operator:	Private
NTSB Number:	CEN13FA085

B. GROUP - No Group

C. SUMMARY

On December 2, 2012, about 1819 eastern standard time (EST), a Piper PA-46-350P, N92315, collided with the terrain while performing the RNAV (GPS) RWY 36 approach to the Greensburg Municipal Airport (I34), Greensburg, IN. The instrument rated private pilot and three passengers were fatally injured. The airplane was registered to an individual, and operated under the provisions of 14 *Code of Federal Regulations Part* 91 as a personal flight. Instrument meteorological conditions (IMC) existed at the time of the accident, which was operated on an instrument flight rules flight plan. The flight originated at Destin-Fort Walton Beach Airport (KDTS), Destin, Florida, at 1416 central standard time.

D. DETAILS OF INVESTIGATION

The NTSB Vehicle Recorder Laboratory received the following device:

GPS Manufacturer/Model:	Garmin GPSMAP 496
Serial Number:	19702439

Garmin GPSMAP 496 Device Description

The Garmin GPSMAP 496 is a battery-powered portable 12-channel GPS receiver with a 256-color TFT LCD display screen. 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 stores date, route-of-flight, and flight-time information for up to 50 flights. A flight record is triggered when groundspeed exceeds 30 knots and altitude exceeds 500 feet, and ends when groundspeed drops below 30 knots for 10 minutes or more. A detailed tracklog – 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 tracklog as a function of time or distance moved, depending on how the unit has been configured. Once the current tracklog memory becomes full, new information either overwrites the oldest information or the recording stops, depending on how the unit is configured. The current tracklog can be saved to long-term memory and 15 saved tracklogs can be maintained in addition to the current tracklog. Tracklog storage may be activated or de-activated at user discretion. All recorded data is stored in non-volatile memory[1]. The unit contains hardware and software permitting the download of recorded waypoint, route, and tracklog information to a PC via a built-in serial port using the NMEA 0183 version 2.0 protocol. The unit can also communicate with external devices such as a computer using 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 Vehicle Recorder Laboratory, an exterior examination revealed that the unit had sustained minimal damage (see figure 1). Power was applied to the accident unit and it started normally. Information was downloaded normally, without difficulty.

Figure 1. Photo of Garmin 496.

[1] Non-volatile memory is semiconductor memory that does not require external power for data retention.

GPS Data Description

The data extracted included 33 sessions (9,999 data points) from October 6, 2012[2] through December 2, 2012. The accident flight was the last flight recorded, starting at 20:05:04 UTC and ending at 23:16:42 UTC on December 2, 2012.

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 geometric altitude above mean sea level (MSL) (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

Figure 2 is a graphical overlay generated using Google Earth showing the entire accident flight. The recording began at 20:05:04 at Destin, Florida. The flight departed Destin at approximately 20:18:24 UTC and climbed to about 22,000 feet by 20:50:44. The aircraft began a descent out of 22,000 feet about 22:47:23. The last recorded point was at 23:16:42.

Figure 3 is graphical overlay generated using Google Earth showing the arrival and approach into I34. The aircraft passed the vicinity of the PULIC intersection 23:08:39 at 5,322 feet at a groundspeed of about 200 knots. The aircraft passed the vicinity of the ZIGDO intersection at 23:10:11 at 4,049 feet at a groundspeed of about 171 knots. The aircraft passed the vicinity of the HUMIG intersection at 23:12:34 at 2,434 feet at a groundspeed of about 138 knots. Figure 4 shows a two-dimensional overlay of the approach path on the FAA RNAV(GPS) RWY 36 approach chart (Version November 15, 2012 through December 13, 2012).

Figure 5 is graphical overlay generated using Google Earth showing all recorded track points from HUMIG to the south side of the airport. Shortly after passing HUMIG, the aircraft's groundspeed increased to about 155 knots by 23:13:27 at an altitude of 1,795 feet. The calculated groundspeed remained above 150 knots until 23:14:21, when the

[2] All dates and times are referenced to Coordinated Universal Time (UTC).

aircraft was about .35 nautical miles from the runway 36 threshold at an altitude of 1,086 feet, the minimum recorded altitude south of the airport. The aircraft arrived at the runway 36 threshold at about 23:14:29 at 1,155 feet at a groundspeed of about 132 knots. Thereafter, the aircraft turned towards the northeast.

Figure 6 shows a detailed two-dimensional graphical overlay of the aircraft path near the airport on the RNAV(GPS) RWY 36 approach chart. The path is annotated to show directionality of the flight path. The dotted path to the left of the aircraft path is the published missed approach.

Figure 7 is a graphical overlay generated using Google Earth showing all track points for the aircraft on the first segment of its maneuvering north of the airport; the latter half of the track is omitted for clarity and is presented in subsequent figures. After passing the RW36 waypoint, the aircraft proceeded northeast and initially climbed to 1,434 feet by 23:14:46, slowing to a groundspeed of about 89 knots. The aircraft then descended to 1,243 feet at 23:15:03. The aircraft then climbed to a maximum recorded altitude in the depicted segment of 1,581 feet at 23:15:20, slowing to a groundspeed of about 95 knots. The aircraft then began to descend and turn towards the west.

Figure 8 is a graphical overlay generated using Google Earth showing all track points for the aircraft on the last segment of its maneuvering north of the airport; the initial part of the track is omitted for clarity and is shown in figure 7. The segment begins as the aircraft descended out of 1,503 feet at 23:15:29. The aircraft reached a minimum recorded altitude of 938 feet at 23:15:47 at a groundspeed of about 129 knots. The aircraft then climbed southeast before turning westerly. The calculated groundspeeds during the final segment varied between 46 knots and 131 knots. The aircraft climbed to maximum recorded altitude of 1,847 feet at 23:16:31, when the groundspeed was calculated as 46 knots. The aircraft then descended southeasterly until the last recorded point at 23:16:42.

Figure 9 is a graphical overlay generated using Google Earth showing the maximum distance of the flight path from the nearest runway threshold at I34 when the aircraft was north of the airport. The maximum distance was about 1.02 nautical miles from the runway 18 runway threshold at about 23:15:25.

Figures 10 and 11 compare air traffic control (ATC) and Garmin GPS 496 recorded altitude[3], latitude, and longitude. The x-axis shows the time recorded by the respective system, with no adjustments made for any latencies that may have existed in each recording method. The ATC Mode C altitude shown in the plots is the pressure altitude reported by the aircraft transponder, corrected for local altimeter by ATC computer processing. Thus, the ATC Mode C altitude is barometric altitude[4], reported in intervals of 100 feet[5,6].

[3] According to the Airman's Information Manual (March 10, 2011), "GPS derived altitude should not be relied upon to determine aircraft altitude since the vertical error can be quite large and no integrity is provided" (Section 1-1-19, paragraph 4).

[4] According to FAA Advisory Circular AC 20-130A, *Airworthiness Approval of Navigation or Flight Management Systems Integrating Multiple Navigation Sensors* (1995), barometric altitude is defined as

Figure 11 shows a period of approximately level flight between 23:11:24 and 23:12:34. During this period the GPS recorded altitude increased from 2,395 feet to 2,434 feet. During this same time period, the ATC Mode C recorded altitude increased from 2,200 feet to 2,300 feet. This time period corresponded to the aircraft approaching the HUMIG intersection on the RNAV (GPS) RWY 36 approach.

Tabular data used to generate figures two through eleven are included as Attachment 1[7]. This attachment is provided in electronic comma-delimited (.CSV) format.

"Altitude in the earth's atmosphere above mean standard sea level pressure datum plane, measured by a pressure (barometric) altimeter and corrected for local barometric pressure setting" (Appendix 3).

[5] According to 14 CFR 91.217, aircraft automatic pressure altitude reporting systems must be tested and calibrated to an accuracy of 125 feet.

[6] According to FAA Advisory Circular 20-163, *Displaying Geometric Altitude Relative to Mean Sea Level* (2009), "We define *geometric altitude relative to MSL* in this AC as the height above MSL, derived primarily from geometric sources. Those sources are systems (like global positioning systems [GPS]) not affected by local barometric pressure. Geometric altitude relative to MSL is therefore distinct from barometrically-derived altitude, and from height above reference surfaces other than MSL. Geometric altitude relative to MSL may include a barometric component, but the primary derivation source is geometric" (Section 3).

[7] ATC data used for figures 10 and 11 can be found in the NTSB docket for this investigation.

Figure 2. Google Earth overlay showing accident flight.

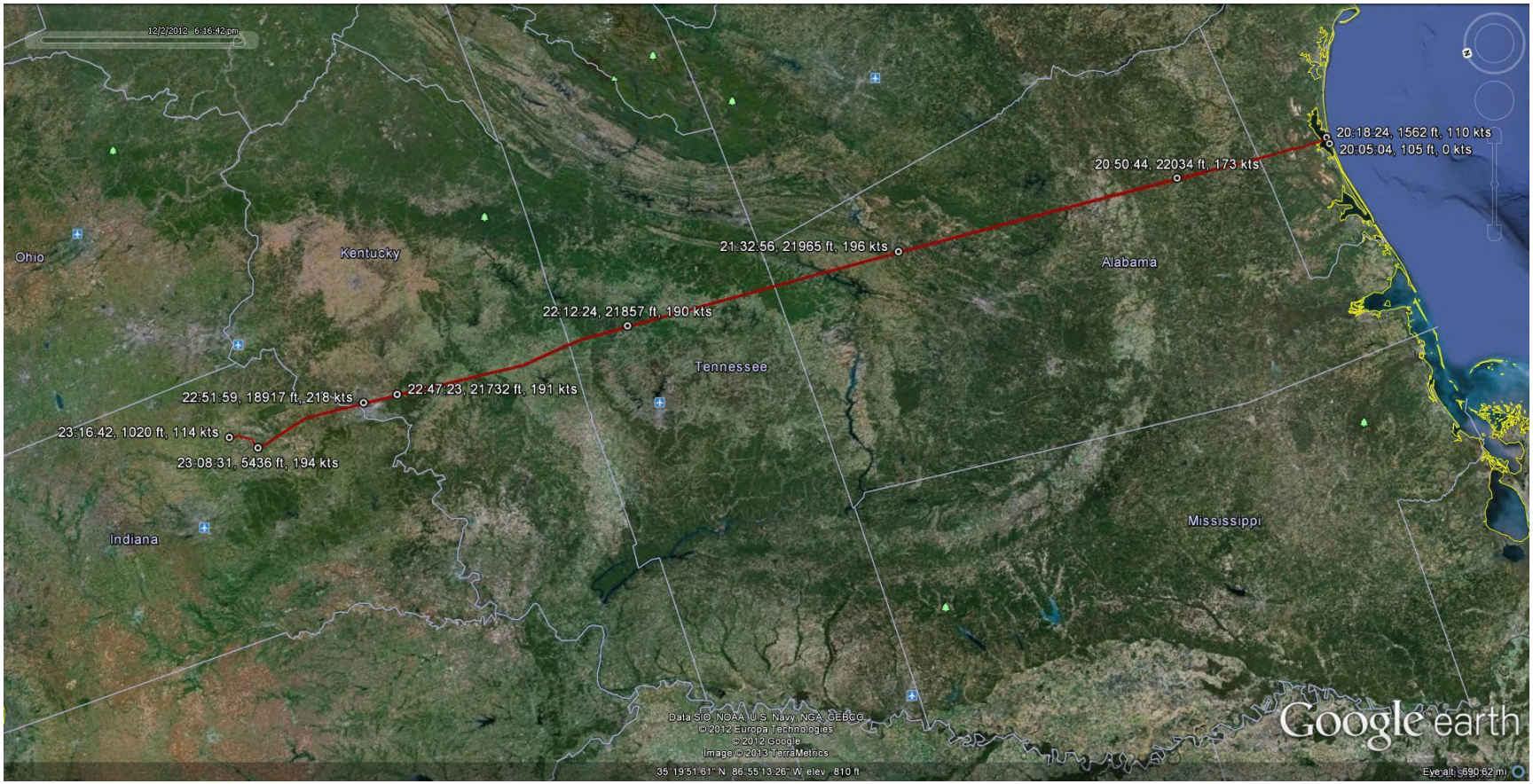

Figure 3. Google Earth overlay showing end of the accident flight.

Figure 4. Graphical overlay of flight path on RNAV (GPS) RWY 36 instrument approach chart.

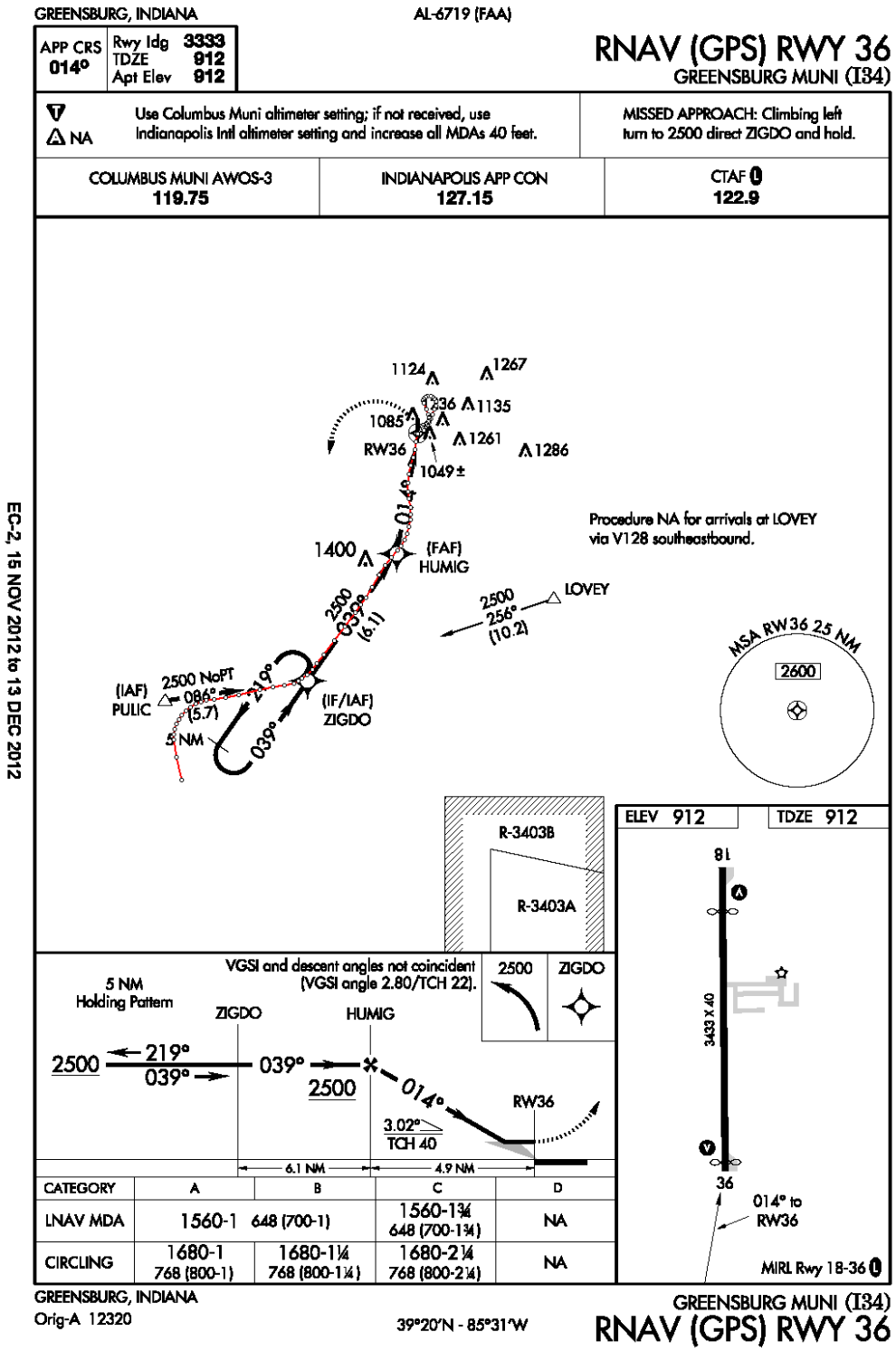

Figure 5. Google Earth overlay of all track points from HUMIG to the south side of airport.

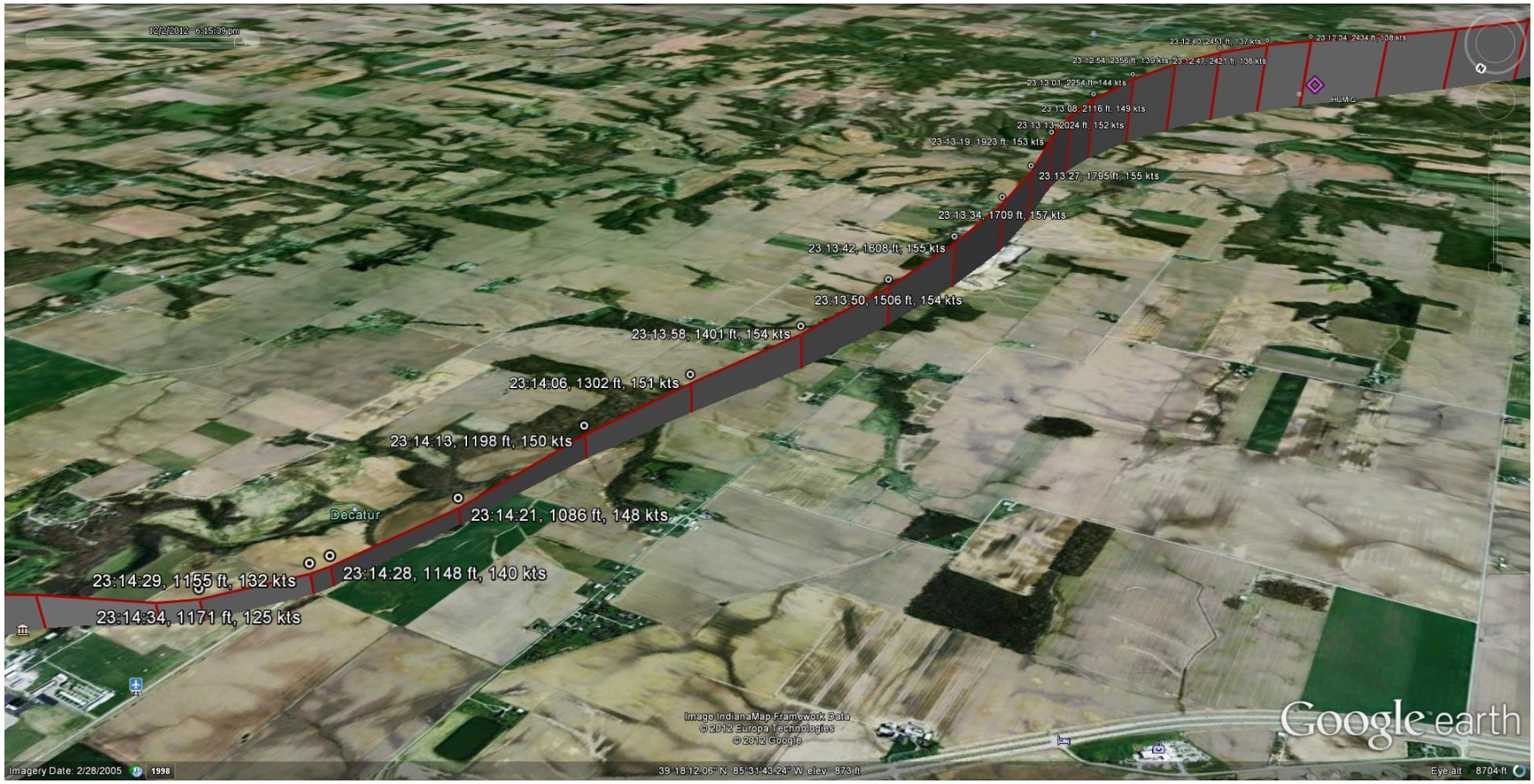

Figure 6. Graphical overlay of flight path north of airport on RNAV (GPS) RWY 36 instrument approach chart.

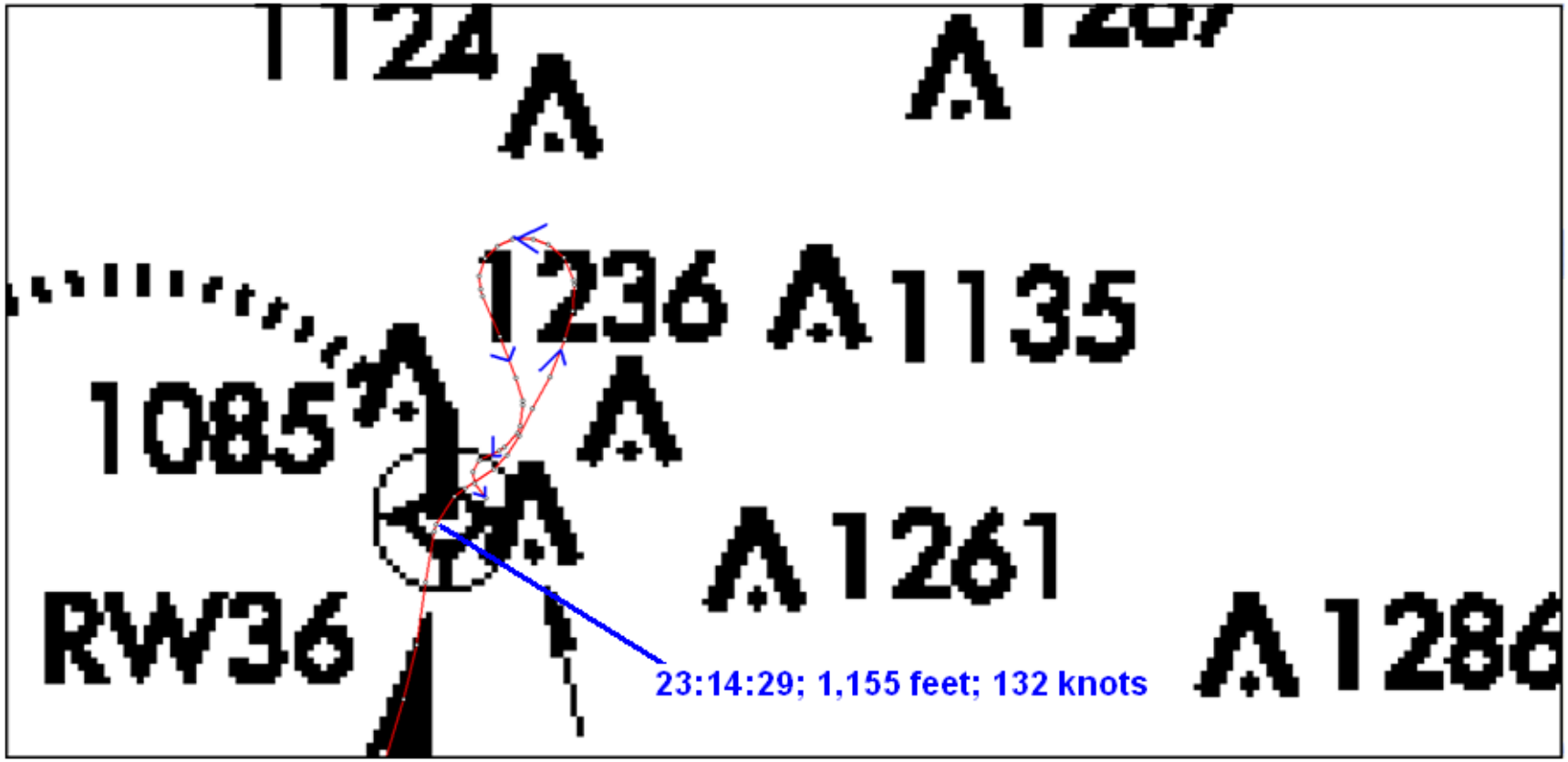

Figure 7. Google Earth overlay of first segment of aircraft path north of the airport.

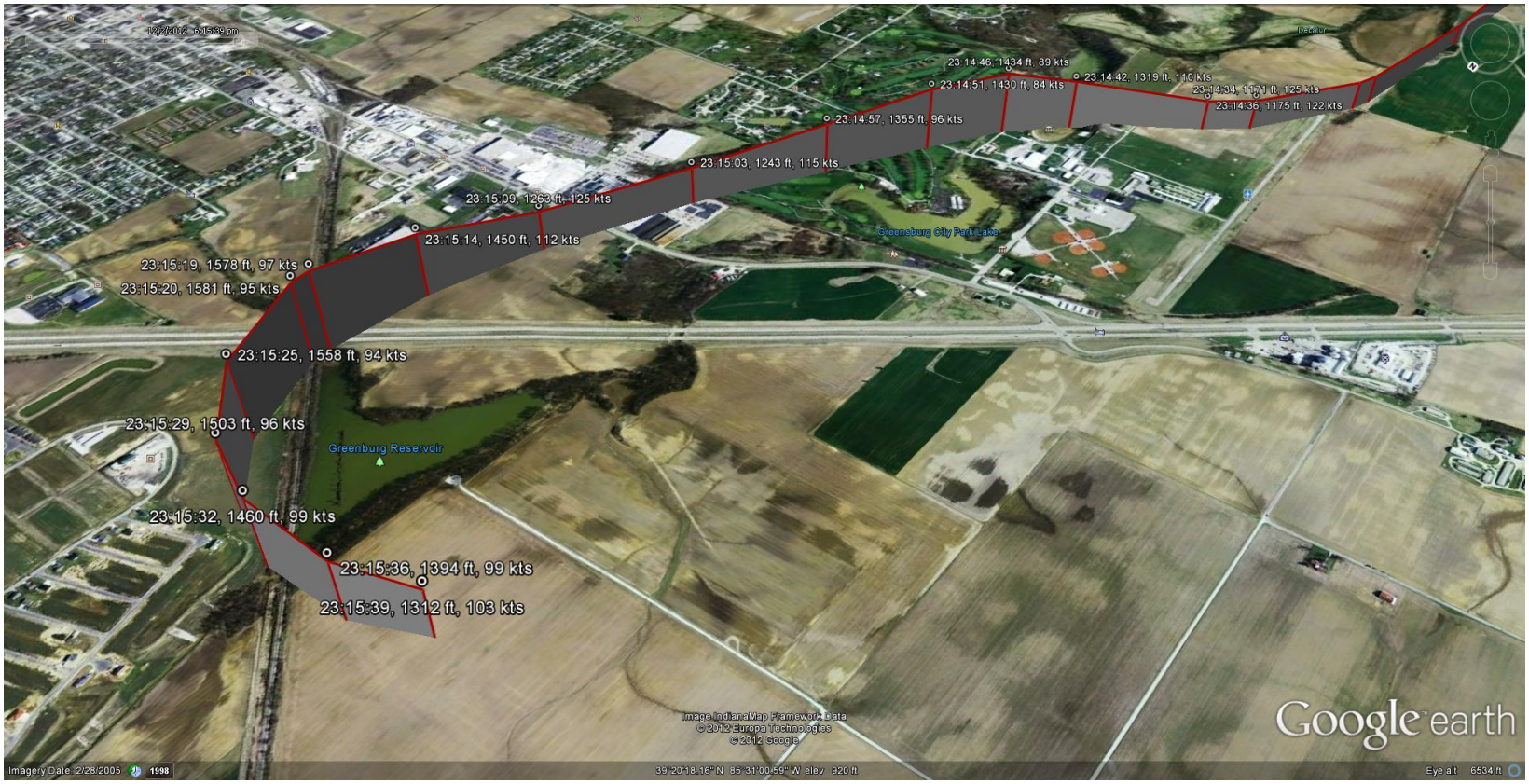

Figure 8. Google Earth overlay of second segment of aircraft path north of the airport until end of recording.

Figure 9. Google Earth overlay showing maximum distance of flight path north of airport from I34 runway threshold.

Figure 10. Comparison of ATC and GPS recorded altitude, latitude, longitude, and time below 10,000 feet.

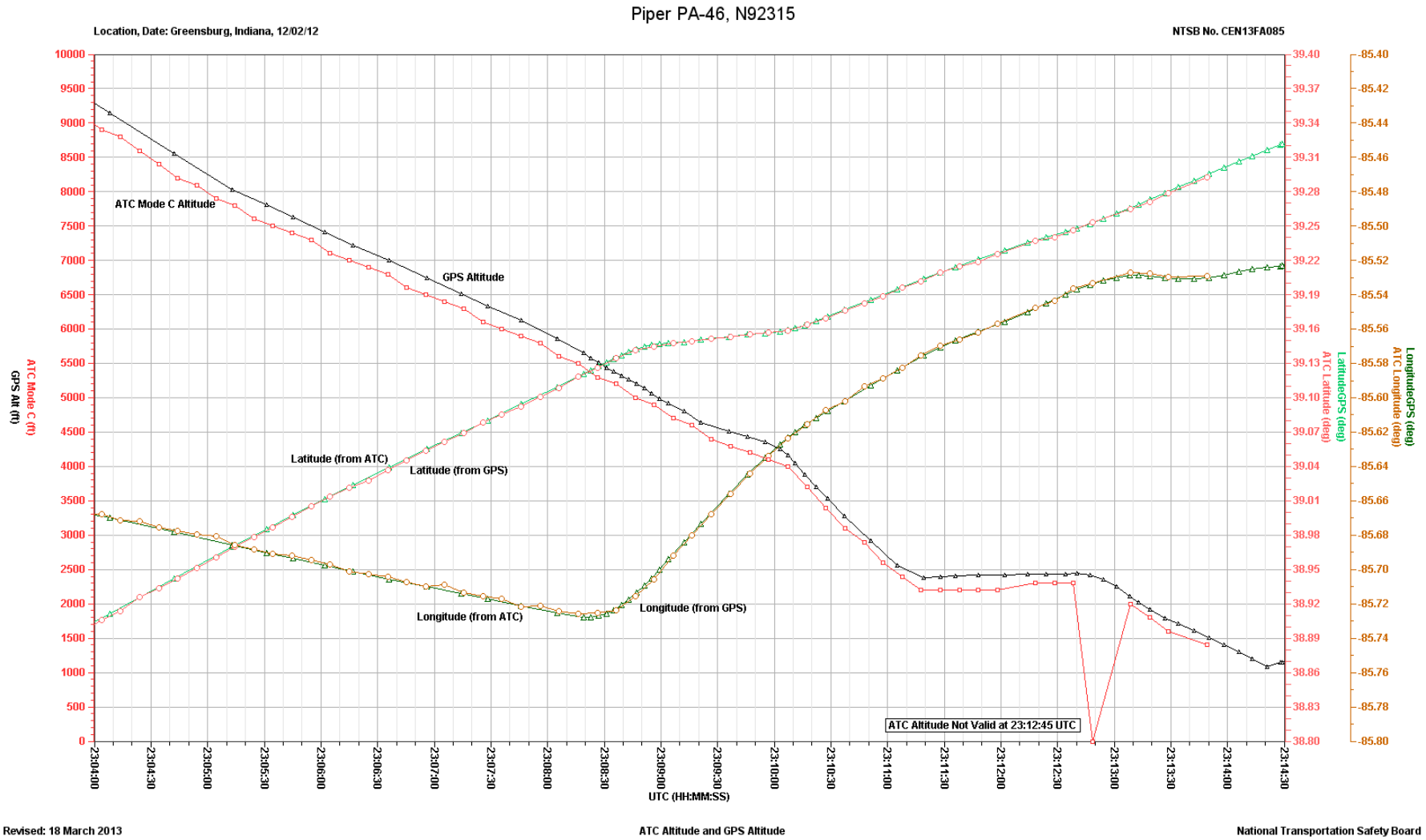

Figure 11. Comparison of ATC and GPS recorded altitude, latitude, longitude, and time below 3,000 feet.