



## **DIFFERENTIAL GPS (DGPS) SITE OPERATIONAL ASSESSMENT**

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**NDGPS Site:** Kokole DGPS Site (880)  
**Inspector(s):** CWO4 William Iozzino, CWO3 Luisito Baytan  
**Date:** 04 AUGUST 2014

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### **REFERENCES:**

- (1) DGPS Concept of Operations, COMDTINST 16577.2 (AUG 1995)
- (2) 2010 Federal Radio Navigation Plan
- (3) Broadcast Standard for the USCG DGPS Navigation Service, CIM 16577.1 (APR 1993).
- (4) RTCM Recommend Standards for Differential GNSS Service, Version 2.3.

### **PURPOSE:**

- Validate advertised DGPS coverage of the Kokole DGPS site.
- Validate required RTCM message scheduling and delivery.
- Test differential correction accuracy versus a predetermined survey monument.

### **EQUIPMENT:**

Hemisphere R-110 DGPS Receiver  
Trimble MBA-2 Antenna

### **KOKOLE DGPS SITE PARAMETERS:**

Frequency	300 KHz
Forward Output Power	700 W
Transmission Rate	200 baud
Field Strength/Range	100 $\mu$ V/m (40.0 dB $\mu$ V/m) at 210 km

### **RESULTS:**

#### ***Signal Strength:***

A verification of the Kokole DGPS coverage area was conducted on the isle of Kauai and O'ahu. The advertised signal strength range is 210 km. Figure 1 below displays adequate signal strength, throughout the entire island of Kauai while the measurements taken on the island of O'ahu did not meet the advertised or predicted system requirements. Green points represent areas of satisfactory signal strength. Areas of unsatisfactory signal strength are represented with red points. A Far-Field (FF) signal strength measurement taken at a point on the eastern range ring (Table 1) was 31 dB $\mu$ V/m below the required 40.0 dB $\mu$ V/m signal strength. This effectively means that the Kokole site did not provide redundant coverage for the waters around Oahu during the period of the OA.

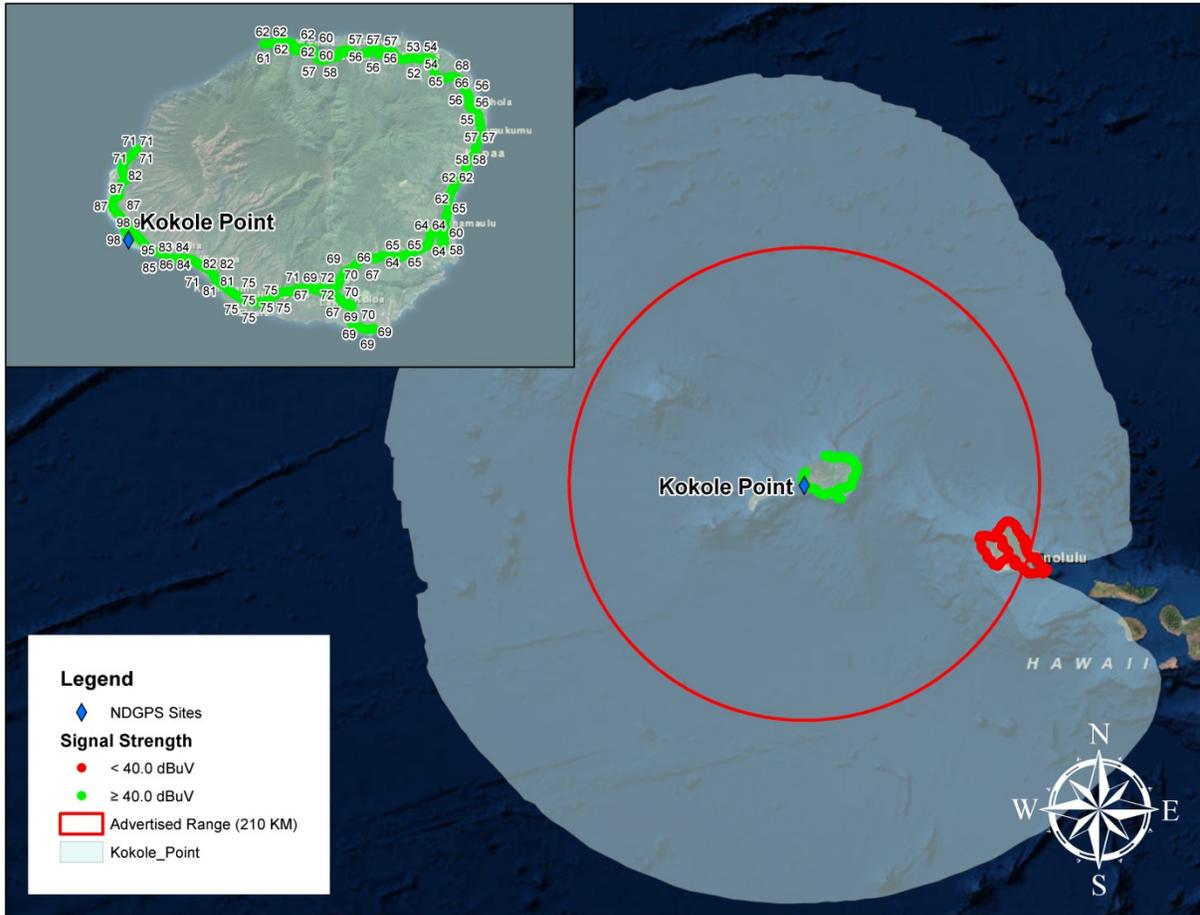


Figure 1: DNAV Signal Strength Results

Signal Strength	Signal to Noise ratio	Position
9 dB $\mu$ V/m	2 dB $\mu$ V/m	21° 18.200806' N, 157° 51.853785' W

Table 1: East Far-Field Signal Strength Reading

***RTCM Message Verification:***

RTCM message scheduling, receipt, and content was checked during the assessment (Table 2 and 3). Receipt of all RTCM messages was validated utilizing a Remote Desktop session whereby the assessment team witnessed the on-time receipt of all messages on the Kokole side B Integrity Monitor. All message content was verified and is in accordance with Reference (4) with the exception of the location information provided in the Type-7 message for the Kokole DGPS site which places the site position 8 km to the north. RTCM message scheduling on both Side A and Side B was validated with the DGPS watch and is in accordance with the Reference (3).

Message Type	Received	Scheduled	Content Verified/Accurate
<i>Type 3</i>	Y	Y	Y
<i>Type 5 (ensure message is not being transmitted)</i>	N	N	N/A
<i>Type 7</i>	Y	Y	N
<i>Type 9</i>	Y	Y	Y
<i>Type 16</i>	Y	Y	Y

Table 2: Side A RTCM Message Validation

Message Type	Received	Scheduled	Content Verified/Accurate
<i>Type 3</i>	Y	Y	Y
<i>Type 5 (ensure message is not being transmitted)</i>	N	N	N/A
<i>Type 7</i>	Y	Y	N
<i>Type 9</i>	Y	Y	Y
<i>Type 16</i>	Y	Y	Y

Table 3: Side B RTCM Message Validation

**Accuracy Validation:**

The OA team placed a Trimble MBA-2 antennae atop of a National Geodetic Survey (NGS) marker and collected positional data for 10 minutes per side. Next, they post processed and compared the data to the published survey marker position in order to verify the horizontal accuracy of the broadcast correction (Table 4 and 5). Side A broadcasted a correction that was calculated to be 1.493 meters away from the monument, bearing 112.1°. Side B’s correction was calculated to be 1.730 meters away from the monument, bearing 108.4°. As per Reference (1) and (2), both respective distances were well within advertised accuracy requirements.

The OA team conducted a comparison (Table 6) between the GPS satellites in view at the Kokole DGPS site and at the NGS monument location to identify any differences in the GPS satellite geometry used at the respective locations; any differences in geometry could lead to accuracy discrepancies. In this case the Hemisphere R110 DGPS receiver received corrections for six GPS satellites during the accuracy check performed on side A and five on side B.

A two dimension radial review of the same time period was completed for the integrity monitors. Side A’s average deviation was 0.08764 meters; Side B’s average deviation was 0.09956 meters. Both findings were consistent with the findings observed in the field and are well within system parameters.

<b>NGS Monument ID:</b>	<b>AA3576</b>
Monument LAT:	21° 18.199816' N
Monument LON:	157° 51.865322' W
Distance from DGPS Site	210.15 km

<b>Averaged LAT:</b>	21° 18.1995124' N
<b>Averaged LON:</b>	157° 51.8645210' W
<b>Antenna Distance from Monument:</b>	1.493 meters (4.89 ft)
<b>Antenna Bearing from Monument:</b>	112.1°

Table 4: Side A Accuracy Check Results

<b>Averaged LAT:</b>	21° 18.1995213' N
<b>Averaged LON:</b>	157° 51.8643713' W
<b>Distance from Monument:</b>	1.730 meters (5.67 ft)
<b>Bearing from Monument:</b>	108.4°

Table 5: Side B Accuracy Check Results

<i>Antenna Location</i>	<i>GPS Satellites Tracked (PRN)</i>											
Reference Station A	2	5	6	12	15	17	18	24	26	28	30	
Integrity Monitor A	2	6	12	15	17	24	25	26	29			
Reference Station B	2	4	12	14	15	24	25	29				
Integrity Monitor B	2	4	12	14	15	24	25	29				
NGS Monument Location, Side A	2	6	12	15	24	25	26					
NGS Monument Location, Side B	2	6	12	15	24	25	26					

Table 6: GPS Satellite Comparison

**SUMMARY:**

The Operational Assessment of the Kokole DGPS site revealed that the provided coverage does not meet with the advertised or predicted coverage area. It should be noted though that while the signal received on the island of O’ahu was below the advertised 100µ V/m the Hemisphere R110 DGPS receiver was still able to achieve signal lock and make corrections during the accuracy check. Far-Field signal strength readings taken on the southeast side of O’ahu did not meet the required 100µ V/m, the receiver was however able to maintain signal lock and apply corrections. Additionally a review of the output/reflected power and near-field signal strength levels was conducted and found to be satisfactory. All RTCM messages were verified and evaluated and are consistent with the requirements set forth by reference (3) and (4) except as noted above for the Type-7 message. Finally, accuracy measurements taken very near the advertised range, 210.1 km from the site, revealed 1.4 to 1.8 meter horizontal accuracy which exceeds accuracy requirements set forth by Reference (1) and (2).