



## DIFFERENTIAL GPS (DGPS) SITE OPERATIONAL ASSESSMENT

**NDGPS Site:** Brunswick, ME DGPS Site (800)  
**Inspector(s):** CWO3 Wayne Horn & CWO2 Marin Kaczmar  
**Date:** 14 Sep 2015

### REFERENCES

- (1) Broadcast Standard for the USCG DGPS Navigation Service, CIM 16577.1 (APR 1993).
- (2) Radio Technical Commission for Maritime Services (RTCM) Recommended Standards for Differential Global Navigation Satellite System (GNSS) Service, Version 2.3.
- (3) Differential Global Positioning System (DGPS) Concept of Operations, COMDTINST 16577.2 (AUG 1995).
- (4) 2014 Federal Radio Navigation Plan.

### PURPOSE

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

### EQUIPMENT

Trimble SPS461 Receiver  
Trimble GA 530 Antenna  
Dell Latitude E3620 Laptop

### BRUNSWICK DGPS SITE PARAMETERS

Frequency	316 KHz
Forward Output Power	750 W
Transmission Rate	100 baud
Field Strength/Range	75 $\mu$ V/m (37.5 dB $\mu$ V/m) at 322 km

### SUMMARY

The Operational Assessment of the Brunswick DGPS site revealed that the provided coverage is not consistent with the advertised range. Signal strength and signal-to-noise ratio (SNR) readings were satisfactory in meeting the majority of the advertised coverage. Readings were taken for the Brunswick DGPS site from the southwest to northeast coverage points, from Rhode Island to the border with Canada. However, the northeastern and southeastern regions fall short of meeting the advertised range; the likely cause being the dense granite mountain ranges that cover much of New England. In most cases, terrestrial masking would not impair the signal used to aid maritime transits. Furthermore, the area of concern is adequately covered by the neighboring Penobscot DGPS Site. All RTCM messages were verified, evaluated and are consistent with the requirements set forth by reference (1) and (2). Finally, accuracy measurements and analysis proved that at a distance of approximately 115 km from the broadcast site, the horizontal accuracy is sub-meter and within the accuracy requirements set forth by Reference (3) and (4).

## RESULTS

### Signal Strength

A verification of the Brunswick DGPS coverage area was conducted from the Connecticut/Rhode Island border northward along the coastline to US/Canada border at the Saint Croix River. The advertised signal strength range is 322 km. Figure 1 displays adequate signal strength from the site southward near the advertised range ring and highlights areas in the north that become disrupted by the topography. Green points represent areas of satisfactory signal strength, whereas areas of unsatisfactory signal strength are represented with red points. As seen in Table 1 and Table 2, far-field signal strength readings were taken at northeast and southwest points of the advertised range from both sides of the site. Both far-field readings were usable but below the required 37.5 dB $\mu$ V/m signal strength on both sides. The weakened signal strength is likely caused by the dense granite mountain ranges that cover much of New England.

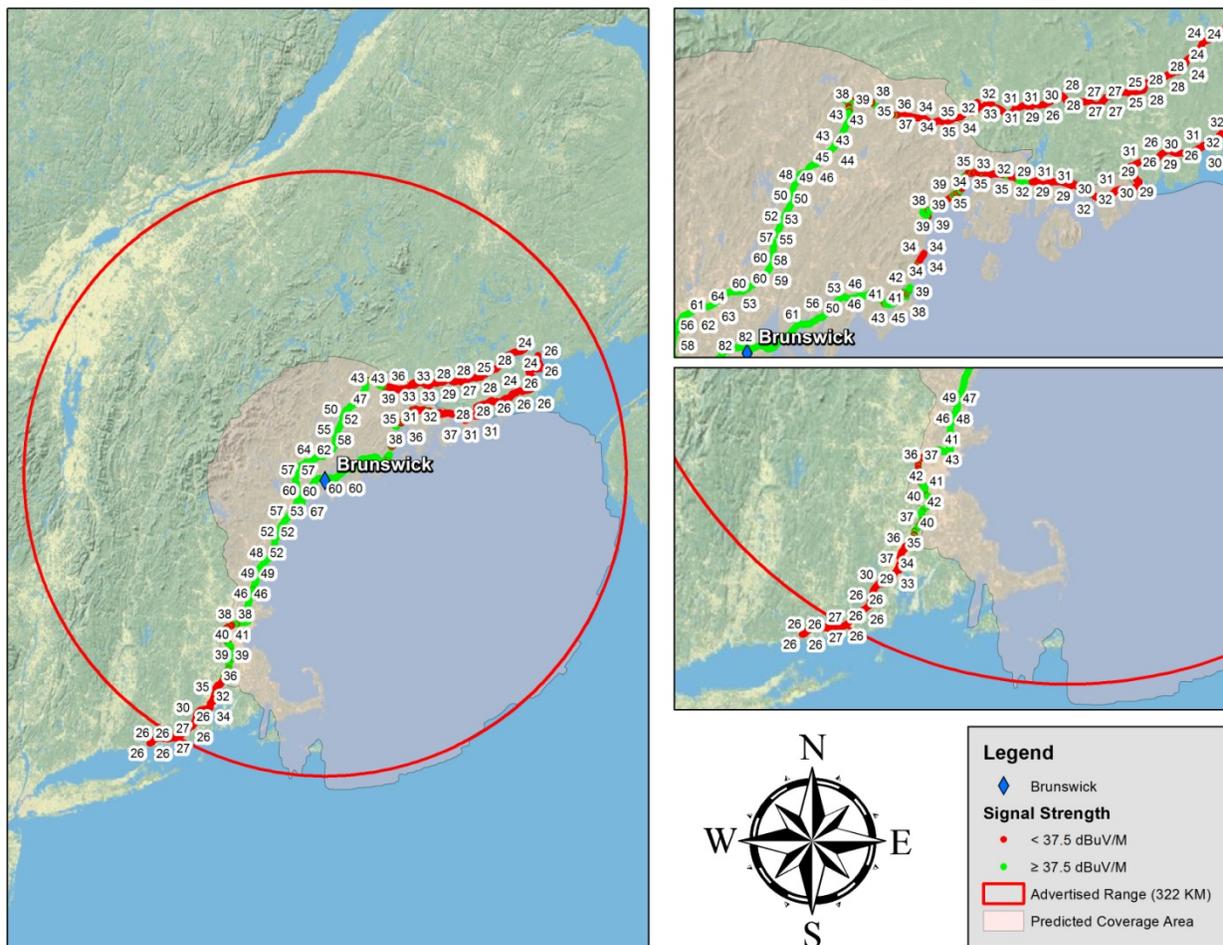


Figure 1: Signal Strength Results

Side	Signal Strength	Signal to Noise ratio	Position
A	30 dB $\mu$ V/m	13 dB $\mu$ V/m	41° 39' 32.0" N, 071° 32' 44" W
B	30 dB $\mu$ V/m	10 dB $\mu$ V/m	

Table 1: Southwest Far-Field Signal Strength Reading

Side	Signal Strength	Signal to Noise ratio	Position
A	26 dB $\mu$ V/m	9 dB $\mu$ V/m	45° 7' 25.946" N, 067° 8' 51.33" W
B	25 dB $\mu$ V/m	8 dB $\mu$ V/m	

Table 2: Northeast Far-Field Signal Strength Reading

### ***RTCM Message Verification***

Table 3 and Table 4 shows RTCM message scheduling, receipt, and content collected during the assessment. RTCM message scheduling on both Side A and Side B was validated with the DGPS watch and is in accordance with the Reference (1). 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 active and standby Integrity Monitor computers. All message content was verified and is in accordance with Reference (2).

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	Y
<i>Type 9</i>	Y	Y	Y
<i>Type 16</i>	Y	Y	Y

Table 3: 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	Y
<i>Type 9</i>	Y	Y	Y
<i>Type 16</i>	Y	Y	Y

Table 4: Side B RTCM Message Validation

### ***Accuracy Validation***

Positional data was collected for 12 minutes per side using the Trimble SPS461. The data was then post processed and compared to a National Geodetic Survey (NGS) marker (Table 5) to verify the horizontal accuracy of the broadcast correction (Tables 6 & 7). Side A was 0.2264

meters, bearing 293. 8186 ° from the monument while Side B was 0.1151meters, bearing 342.7452 ° from the monument. As per Reference (3) and (4), both respective distances were within advertised accuracy requirements. A comparison between the GPS satellites in view at the Brunswick DGPS site and at the NGS monument location was conducted (Table 8) 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 satellites being tracked by the Reference Station and Integrity Monitor GPS receivers at the site were different from those tracked at the NGS monument location. A two dimension radial review of the same time period was completed for the integrity monitors. Side A’s average deviation was 0.23024 meters; Side B’s average deviation was 0.22208 meters. Both findings were consistent with the findings observed in the field and are within system parameters.

<b>NGS Monument ID:</b>	<b>BBCD34</b>
Monument LAT:	44° 51' 43.78704" N
Monument LON:	069° 26' 41.05504" W
Distance from DGPS Site	115 km

Table 5: NGS Monument ID

<b>Averaged LAT:</b>	44° 51' 43.7900" N
<b>Averaged LON:</b>	69° 26' 41.0645" W
<b>Distance from Monument:</b>	0.2264 m (0.747282152 ft)
<b>Bearing from Monument:</b>	293. 8186 °

Table 6: Side A Accuracy Check Results

<b>Averaged LAT:</b>	44° 51' 43.7906" N
<b>Averaged LON:</b>	69° 26' 41.0566" W
<b>Distance from Monument:</b>	0.1151 m (0. 37762467 ft)
<b>Bearing from Monument:</b>	342. 7452 °

Table 7: Side B Accuracy Check Results

<i>Antenna Location</i>	<i>GPS Satellites Tracked (PRN)</i>										
Reference Station A	1	4	11	12	14	18	22	24	25	31	32
Integrity Monitor A	3	14	16	23	25	26	29	31	32		
Reference Station B	2	14	16	23	25	26	29	31	32		
Integrity Monitor B	3	14	16	23	25	26	29	31	32		
NGS Monument Location, Side A	1	4	7	8	11	13	17	19	28	30	
NGS Monument Location, Side B	1	4	7	8	11	13	17	19	28	30	

Table 8: GPS Satellite Comparison

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**RECOMMENDATION**

No changes recommended.

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