DIFFERENTIAL GPS (DGPS) SITE OPERATIONAL ASSESSMENT

NDGPS Site: Cold Bay, AK DGPS Site (898)
Inspector(s): CWO3 Louie Baytan
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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 Cold Bay 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 E6320 Laptop

COLD BAY DGPS SITE PARAMETERS

Frequency	289 KHz
Forward Output Power	500 W
Transmission Rate	100 baud
Field Strength/Range	75µV/m (37.5 dBµV/m) at 333 km

SUMMARY

The Operational Assessment of the Cold Bay DGPS site revealed that the provided coverage is mostly consistent with the advertised range. Although the signal strength measurements through most of the ferry route in the advertised range and beyond the predicted coverage area were satisfactory, the levels near the range ring and far-field signal strength readings were below the required level. 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, evaluated and are consistent with the requirements set forth by Reference (1) and (2). Coverage for the Cold Bay DGPS site was largely consistent with the predicted model. Finally, accuracy measurements and analysis proved that at a distance of approximately 287 km from the broadcast site, DGPS fixes could not be obtained and the horizontal accuracy is attributed to GPS fixes with poor Horizontal Dilution of Precision (HDOP).

RESULTS

Signal Strength

A verification of the Cold Bay DGPS coverage area was conducted using the Alaska Marine Highway System ferry from Chignik Bay, AK to the site and to Unalaska, AK. The advertised signal strength range is 333 km. Figure 1 displays adequate signal strength through most of the ferry route in the advertised range. However, the signal strength decreases as it approaches the range ring. Ferry transits behind mountain peaks appear to contribute to degraded signals. Additional far-field signal strength readings could not be obtained. Green points represent areas of satisfactory signal strength, whereas areas of unsatisfactory signal strength are represented with red points. As seen in Table 1, far-field signal strength reading was taken at the eastern point of the advertised range of the site. The far-field reading was below the required 37.5 dBµV/m signal strength on Side A.

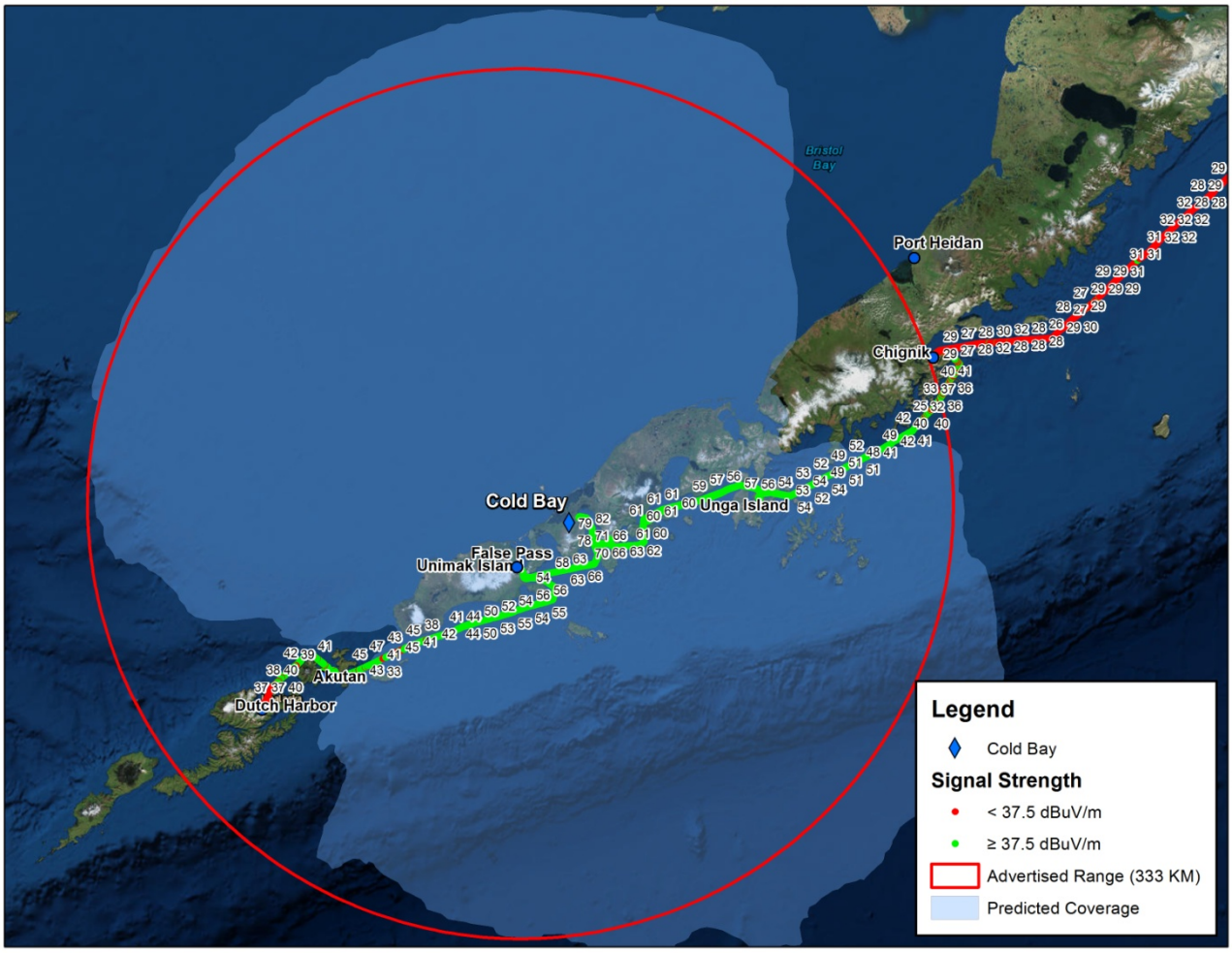

Figure 1: Signal Strength Results

Side	Signal Strength	Signal to Noise ratio	Position
A	26 dBµV/m	4 dBµV/m	56° 22' 55.84" N, 157° 53' 57.87" W

Table 1: East Far-Field Signal Strength Reading

RTCM Message Verification

Table 2 and Table 3 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
Type 3	Y	Y	Y
Type 5 (ensure message is not being transmitted)	N	N	N/A
Type 7	Y	Y	Y
Type 9	Y	Y	Y
Type 16	Y	Y	Y

Table 2: Side A RTCM Message Validation

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

Table 3: Side B RTCM Message Validation

Accuracy Validation

Positional data was collected for a minimum of 10 minutes per side using the Trimble SPS461. The data was then post processed and compared to a National Geodetic Survey (NGS) marker to verify the horizontal accuracy of the broadcast correction (Table 5 and Table 6). A DGPS fix could not be obtained at the NGS marker location. Hence with only GPS fixes, Side A was 2.030 meters, bearing 272.4775º from the monument while Side B was 2.004 meters, bearing 267.7206° from the monument. The respective distances were within advertised accuracy but cannot be attributed to DGPS required in Reference (3) and (4). A comparison between the GPS satellites in view at the Cold Bay DGPS site and at the NGS monument location was conducted (Table 7) 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 almost identical to 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 0.14727 meters; Side B's average deviation was 0.13578 meters. These findings are within system parameters but were not consistent with the findings observed in the field. The disparity between the accuracy at the NGS marker and the site's integrity monitor may be attributed to terrestrial masking that caused weaker signal reception and no DGPS fix at the NGS marker in Dutch Harbor, AK.

NGS Monument ID:	**BBBB51**
Monument LAT:	53° 52' 28.05115"N
Monument LON:	166° 31' 58.04662"W
Distance from DGPS Site	287 km

Table 4: NGS Monument ID

Averaged LAT:	53° 52' 28.05399" N
Averaged LON:	166° 31' 58.158" W
Distance from Monument:	2.030 m (6.6601 ft)
Bearing from Monument:	272.4775°

Table 5: Side A Accuracy Check Results

Averaged LAT:	53° 52' 28.04857" N
Averaged LON:	166° 31' 58.15658" W
Distance from Monument:	2.004 m (6.5748 ft)
Bearing from Monument:	267.7206°

Table 6: Side B Accuracy Check Results

Antenna Location	***GPS Satellites Tracked (PRN)***										
Reference Station A	2	5	12	20	21	23	25	26	29	31	
Integrity Monitor A	5	7	13	15	18	19	20	28	30		
Reference Station B	2	5	12	20	21	23	25	26	29	31	
Integrity Monitor B	2	5	12	20	21	23	25	26	29	31	
NGS Monument Location, Side A	2	5	12	21	25	26	29				
NGS Monument Location, Side B	2	5	12	21	25	26	29				

Table 7: GPS Satellite Comparison

NAVCEN INTERNAL ONLY: The following information will be placed in an OA index for internal tracking purposes and removed before posting.

Discrepancies - Correct RefSta ID logged in file are inconsistent with numbers displayed on Hydropro software.

RECOMMENDATION

PNT Branch will conduct analysis with COAST software to determine if increasing BCS output power may overcome terrestrial masking through Unimak Pass and Unalaska Island, part of the Great Northern Circle route and inside the advertised range.

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