



DIFFERENTIAL GPS (DGPS) SITE OPERATIONAL ASSESSMENT

NDGPS Site: Pine River DGPS Site (841)
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Date: Jul 06 2014

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 Pine River 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

PINE RIVER DGPS SITE PARAMETERS:

Frequency	841 KHz
Forward Output Power	800 W
Transmission Rate	100 baud
Field Strength/Range	75 μ V/m (37.5 dB μ V/m) at 250 km

RESULTS:

Signal Strength:

A verification of the Pine River DGPS coverage area was conducted from Minneapolis, MN, north to Pine River DGPS sight and then west into North Dakota. The advertised signal strength range is 250 km or 135 NM. Figure 1 below displays adequate signal strength, beyond the advertised range of 250 km from the site and throughout the predicted coverage area. Green points represent areas of satisfactory signal strength. Areas of unsatisfactory signal strength are represented with red points. Far-field (FF) signal strength readings were taken in conjunction with the accuracy test from the south side of the site (Table 1). The southern FF readings were well above the required 37.5 dB μ V/m signal strength.

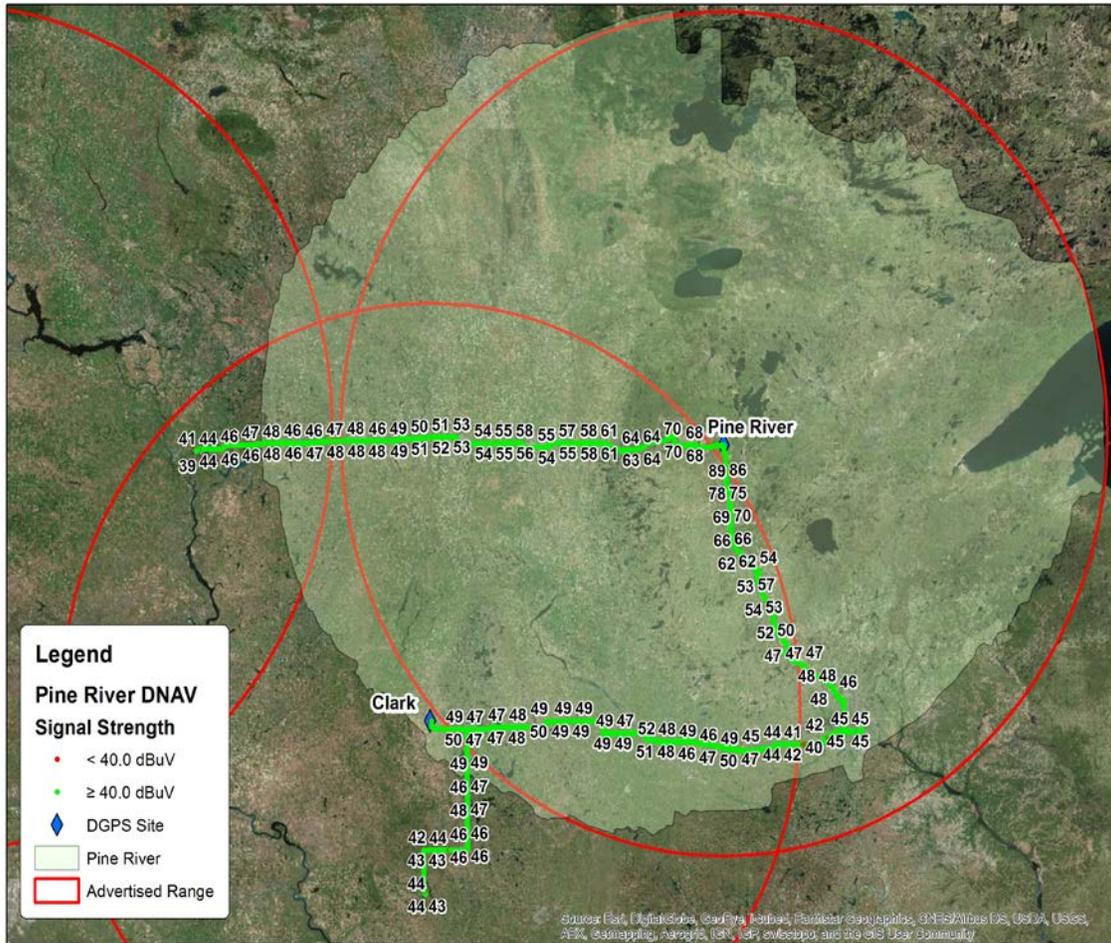


Figure 1: DNAV Signal Strength Results

Side	Signal Strength	Signal to Noise ratio	Position
A	48 dB μ V/m	36 dB μ V/m	45 05.330179 N, -93 25.3948666 W
B	46 dB μ V/m	36 dB μ V/m	

Table 1: South Far-Field Signal Strength Reading

RTCM Message Verification:

RTCM message scheduling, receipt, and content were checked during a remote system check. (Table 3 and 4). RTCM message scheduling on both Side A and Side B was validated with the DGPS watch and is in accordance with the Reference (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 active and standby Integrity Monitor computers. All message content was verified and is in accordance with Reference (4)

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 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 6 and 7). Side A was 0.6871meters, bearing 313.543056, away from the monument while Side B was 1.330 meters, bearing 337.683889, away from the monument. As per Reference (1) and (2), both respective distances were well within advertised accuracy requirements. A comparison between the GPS satellites in view at the Pine River 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 RS and IM 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 0.7460 meters; Side B's average deviation was 0.47220 meters. Both findings were consistent with the findings observed in the field and are well within system parameters.

NGS Monument ID:	AE8987
Monument LAT:	45° 5' 19.84512" N
Monument LON:	093° 25' 23.72003" W
Distance from DGPS Site	221.4 km

Table 5 Monument ID

Averaged LAT:	45° 05' 19.829796" N
Averaged LON:	093° 25' 23.697192" W
Antenna Distance from Monument:	0.6871 m (2.254261 ft)
Antenna Bearing from Monument:	313.54 °

Table 6: Side A Accuracy Check Results

Averaged LAT:	45° 05' 19.805280" N
Averaged LON:	093° 25' 23.696868" W
Distance from Monument:	1.330 m (4.363508 ft)
Bearing from Monument:	337.68 °

Table 7: Side B Accuracy Check Results

<i>Antenna Location</i>	<i>GPS Satellites Tracked (PRN)</i>											
Reference Station A	1	3	6	7	8	9	11	13	19	27	28	
Integrity Monitor A	1	2	3	4	5	6	7	8	9	10	11	
Reference Station B	1	3	6	7	8	9	11	11	19	27	28	
Integrity Monitor B	1	3	6	7	8	9	10	11	19	27	28	
NGS Monument Location, Side A	3	7	10	13	27	16	19	23	8	30		
NGS Monument Location, Side B	3	7	10	13	27	16	19	23	8	30		

Table 8: GPS Satellite Comparison

SUMMARY:

The Operational Assessment of the Pine River DGPS site revealed that the provided coverage is consistent with the predicted coverage plot and advertised range. Both northern and southern Far-Field signal strength readings were well within the required signal strength. The signal strength measurements throughout the predicted coverage area within the advertised range are satisfactory. 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). Finally, accuracy measurements and analysis proved that at a distance of approximately 221 km from the broadcast site, the horizontal accuracy is within the accuracy requirements set forth by Reference (1) and (2).