



DGPS SITE OPERATIONAL ASSESSMENT

NDGPS Site:	Saginaw Bay DGPS Site (837)
Inspector(s):	LT Christian Hernaez, CWO3 William Iozzino
Date:	20JUN12

PURPOSE:

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

REFERENCE:

- (1) DGPS Concept of Operations, COMDTINST 16577.2 (AUG 1995).
- (2) Broadcast Standard for the USCG DGPS Navigation Service, COMDTINST M1677.1 (APR 1993).
- (3) RTCM Recommend Standards for Differential GNSS Service, Version 2.3.

EQUIPMENT:

Trimble SPS461 Receiver
Trimble GA 530 Antenna
Potomac Instruments 4100 FIM meter

PARAMETERS:

Frequency	301 KHz
Forward Output Power	250 W
Transmission Rate	100 baud
Field Strength/Range	75 μ V/m (37.5 dB μ V/m) at 137 km

RESULTS

Signal Strength:

A verification of the Saginaw Bay Differential GPS (DGPS) coverage area was conducted from Alpena, MI, along the coast of Lake Huron, to Detroit, MI. The advertised signal strength range is 137 km. Figure 1 below displays adequate signal strength, beyond the advertised range of 137 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 at northern and southern points of the advertised range from both sides of the site (Table 1 and Table 2). Both northern and southern FF readings were well above the required 37.5 dB μ V/m signal strength on both sides.

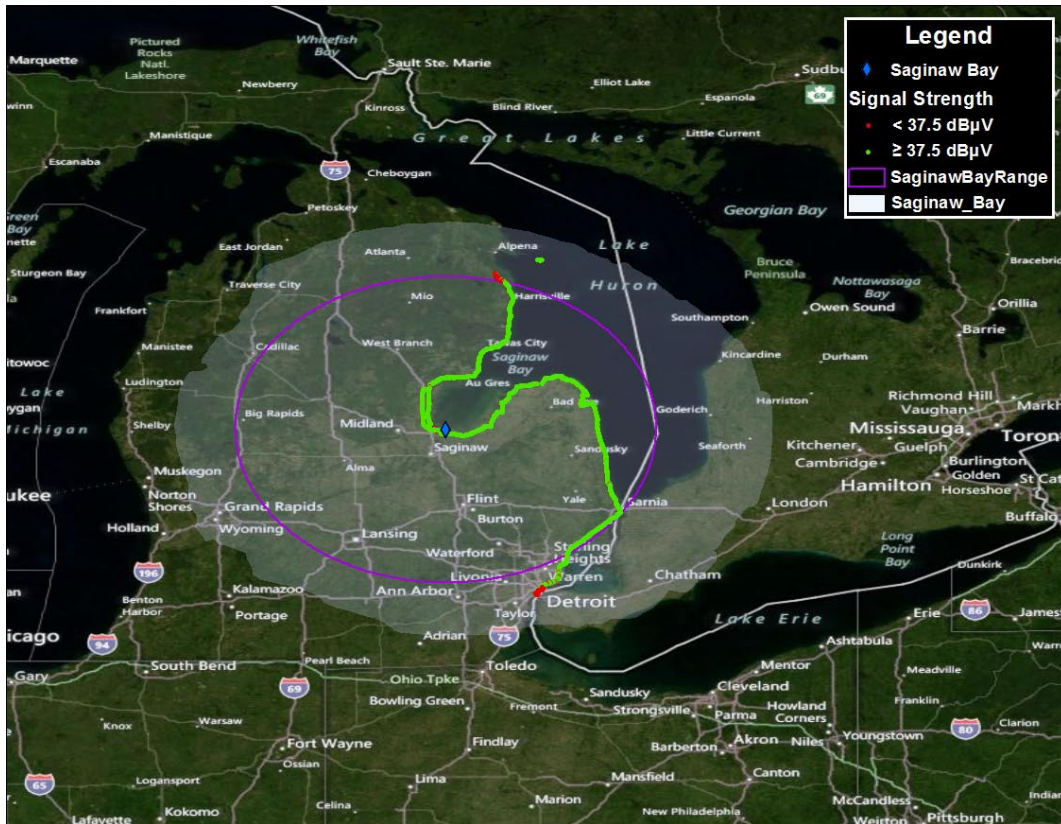


Figure 1: DNAV Signal Strength Results

	POSITION	Trimble SPS461	4100 FIM Meter
Side A SS	44° 50' 44.0"N 083° 24' 25.8"W	39 dBμ V/m, 12 SNR	39.5 dBμ V/m
Side B SS	44° 50' 44.0"N 083° 24' 25.8"W	39 dBμ V/m, 12 SNR	39.0 dBμ V/m

Table 1: North Far-Field Signal Strength Reading

	POSITION	Trimble SPS461	4100 FIM Meter
Side A SS	42° 59' 34.6"N 082° 25' 52.4"W	46 dBμ V/m, 29 SNR	47.9 dBμ V/m
Side B SS	42° 59' 34.6"N 082° 25' 52.4"W	46 dBμ V/m, 30 SNR	47.0 dBμ V/m

Table 2: South Far-Field Signal Strength Reading

RTCM Message Verification:

RTCM message scheduling, receipt, and content were checked during the assessment (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 (2). 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 (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	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 5 and 6). Side A was 0.167813 meters, bearing 342.2985°, away from the monument while Side B was 0.22339 meters, bearing 321.9743°, away from the monument. Both respective distances were well within advertised accuracy requirements. A comparison between the GPS satellites in view at the Saginaw 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 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 0.19964 meters; Side B's average deviation was 0.22928 meters. Both findings were consistent with the findings observed in the field and are well within system parameters. Furthermore, a comparison between the uncorrected GPS position and the NGS Monument was conducted to see how effective the DGPS corrections were. GPS accuracy was 1.15788 meters away from the monument. Therefore, the DGPS site is effectively improving the positional solution by over 80%.

NGS Monument ID:	BBCB16
Monument LAT:	43° 24' 54.89125" N
Monument LON:	084° 32' 17.59513" W

Averaged LAT:	43° 24' 54.8964258" N
Averaged LON:	084° 32' 17.5974042" W
Distance from DGPS Site:	34 km
Antenna Distance from Monument:	0.167813 m (0.550594 ft)
Antenna Bearing from Monument:	342.2985°

Table 5: Side A Accuracy Check Results

Averaged LAT:	43° 24' 54.8969472" N
Averaged LON:	089° 32' 17.6012634" W
Distance from DGPS Site:	34 km
Distance from Monument:	0.22339 m (0.732943 ft)
Bearing from Monument:	321.9743°

Table 6: Side B Accuracy Check Results

<i>Antenna Location</i>	<i>GPS Satellites Tracked (PRN)</i>										
Reference Station A	14	16	20	23	25	30	31	32			
Integrity Monitor A	14	16	20	23	25	29	30	31	32		
Reference Station B	14	16	20	23	25	29	30	31	32		
Integrity Monitor B	14	16	20	23	25	30	31	32			
NGS Monument Location, Side A	14	16	20	23	25	29	30	31	32		
NGS Monument Location, Side B	14	16	20	23	29	30	31	32			

Table 7: GPS Satellite Comparison

SUMMARY:

The Operational Assessment of the Saginaw Bay 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, were 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 (2) and (3). Finally, accuracy measurements and analysis proved that at a distance of approximately 34 km from the broadcast site, the horizontal accuracy is sub-meter and within the accuracy requirements set forth by Reference (1) and (2).