DGPS SITE OPERATIONAL ASSESSMENT

NDGPS Site: *Sturgeon Bay DGPS Site (832)*

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PURPOSE:

- Validate advertised DGPS coverage of the Mequon 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 M16577.1 (APR 1993).
(3) RTCM Recommend Standards for Differential GNSS Service, Version 2.3.

EQUIPMENT: Starlink DNAV-212 GPS Receiver
Raven MBA-2 Antenna
Hemisphere Crescent GPS Receiver
Potomac Instruments 4100 FIM meter

PARAMETERS:

Frequency	314 KHz
Forward Output Power	250 W
Transmission Rate	100 bps
Field Strength/Range	75 µV/m (37.5 dBµV/m) at 177 KM

RESULTS:

Signal Strength

A verification of the Sturgeon Bay Differential GPS (DGPS)) coverage area was conducted in conjunction with the Mequon DGPS coverage area. The advertised signal strength range is 177 KM. Figure 1 displays the signal strength measurements found 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 along the northern and southern points the DNAV route of the site (refer to Table 1 and Table 2).

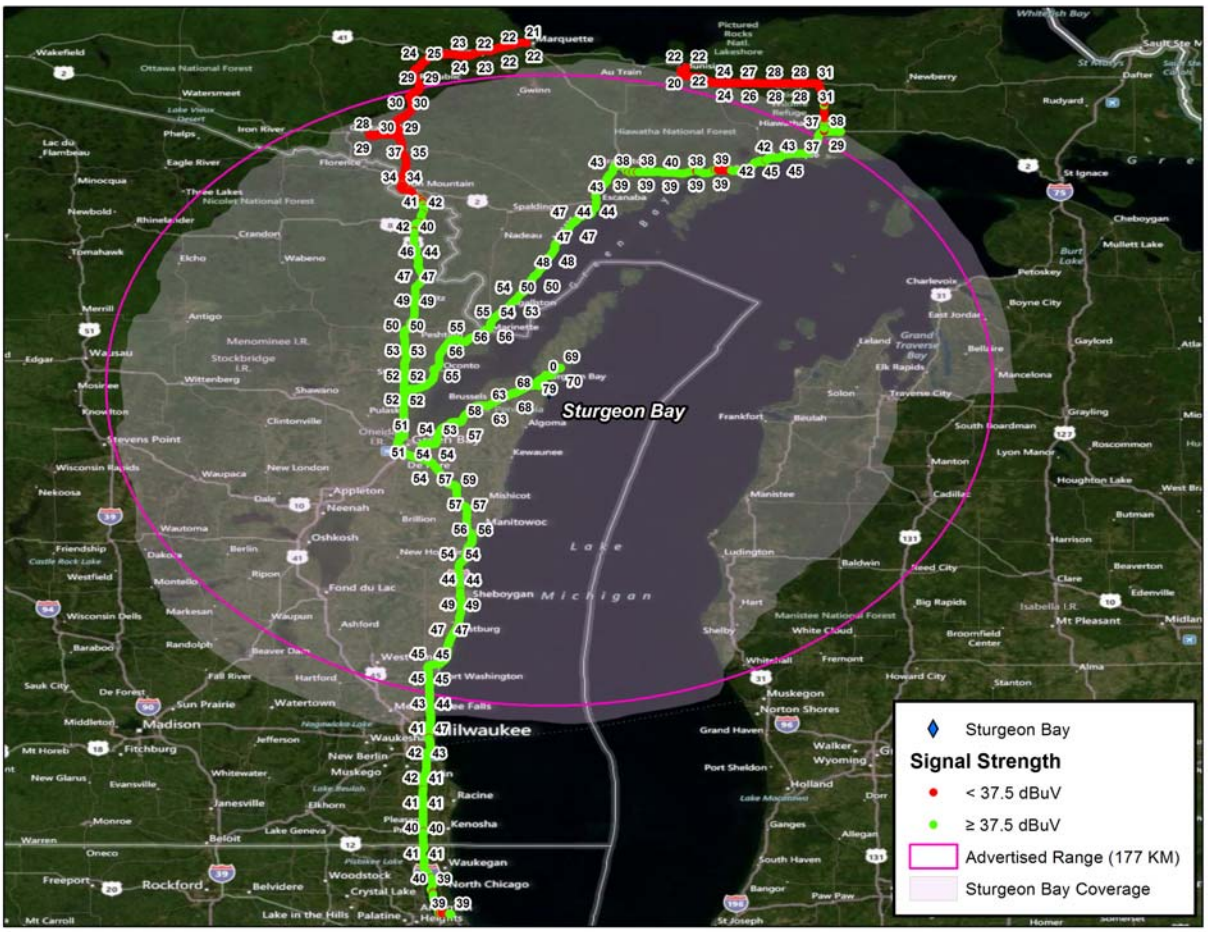

Figure 1: DNAV Signal Strength/FIM Results

Table 1: North Far-Field Signal Strength Reading

	POSITION	SS (DNAV-212 and MBA-2 Antenna)
Side A	46° 4.21794' N 085° 57.5052' W	33 dBµV/m, SNR = 13
Side B	46° 4.21794' N 085° 57.5052' W	37 dBµV/m, SNR = 16

Table 2: South Far-Field Signal Strength Reading

	POSITION	SS (DNAV-212 and MBA-2 Antenna)
Side A	43° 15.81414' N 087° 55.18098' W	44 dBµV/m, SNR = 16
Side B	43° 15.81414' N 087° 55.18098' W	44 dBµV/m, SNR = 15

RTCM Message Verification

RTCM message scheduling, receipt, and content were checked during the assessment (refer to Table 3 and 4). RTCM message scheduling on both Side A and Side B were 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. A review of the RTCM message content found an inaccurate Type 7 message for the Mequon DGPS site (#871). Type 7 message positions are required to be within 0.3 KM of latitude and 0.6 KM of longitude away from the referenced broadcast antenna. All other message content was verified and accurate.

Table 3: Side A RTCM Message Validation

Message Type	**Received**	**Scheduled**	**Content Verified/Accurate**
Type 3	Y	Y	Y
Type 5	N	N	N/A
Type 7	Y	Y	N
Type 9	Y	Y	Y
Type 16	Y	Y	Y

Table 4: Side B RTCM Message Validation

Message Type	**Received**	**Scheduled**	**Content Verified/Accurate**
Type 3	Y	Y	Y
Type 5	N	N	N/A
Type 7	Y	Y	N
Type 9	Y	Y	Y
Type 16	Y	Y	Y

Accuracy Validation

Positional data was collected for 10 minutes per side using the Hemisphere Crescent GPS receiver with a Raven MBA-2 antenna. The data was then post processed and compared to a National Geodetic Survey (NGS) marker to verify the horizontal accuracy of the broadcast correction (refer to Table 7). Side A was 1.11 m, bearing 124.07º, away from the monument. Side A's respective distance was well within advertised accuracy requirements. Side B was 0.53 m, bearing 123º, away from the monument. Side B's respective distance was well within advertised accuracy requirements. A comparison between the GPS satellites in view at the Mequon 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.

Table 5: Monument Information

NGS Monument PID:	**RL0239 (U-59)**
Monument LAT:	46º 5’ 1.25510” N
Monument LON:	088º 13’ 24.32491” W

Table 6: Side A Accuracy Check Results

Averaged LAT:	46º 5’ 1.23498” N
Averaged LON:	088º 13’ 24.3678” W
Distance from DGPS Site:	166.62 KM
Antenna Distance from Monument:	1.11 m (3.64 ft.)
Antenna Bearing from Monument:	124.07º

Table 7: Side B Accuracy Check Results

Averaged LAT:	46º 5’ 1.24578” N
Averaged LON:	088º 13’ 24.3456” W
Distance from DGPS Site:	166.62 KM
Antenna Distance from Monument:	0.53 m (1.73 ft.)
Antenna Bearing from Monument:	123º

Table 8: GPS Satellite Comparison

Antenna Location	***GPS Satellites Tracked (PRN)***											
Reference Station A	3	6	7	10	13	16	19	23	30			
Integrity Monitor A	3	6	7	10	13	16	19	23	30			
Reference Station B	3	6	7	8	10	13	16	19	23	30		
Integrity Monitor B	3	6	7	8	10	13	16	19	23	30		
NGS Monument Location	3	6	7	8	10	13	16	19	21	23	30	

SUMMARY:
The Operational Assessment of the Sturgeon Bay DGPS site demonstrated that the advertised range and the predicted coverage were not accurate near Iron Mountain, WI. The Far-field signal strength readings were satisfactory. Additionally, the signal strength measurements throughout the predicted coverage area were not satisfactory. All RTCM messages verified and evaluated and are consistent with the requirements set forth by Reference (2) and (3).