



## **DIFFERENTIAL GPS (DGPS) SITE OPERATIONAL ASSESSMENT**

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**NDGPS Site:** Chico DGPS Site (878)  
**Inspector(s):** LCDR Christian Hernaez, LT Michael Brashier  
**Date:** 23JAN12

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### **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 Chico 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  
Potomac Instruments 4100 FIM meter  
Hemisphere R110 Receiver  
Raven MBA-2 Antenna  
Dell Latitude 6300 Laptop  
Garmin GPSmap 60CS Handheld Receiver  
iPhone 5

### **CHICO DGPS SITE PARAMETERS:**

Frequency	318 KHz
Forward Output Power	770 W
Transmission Rate	100 baud
Field Strength/Range	75 $\mu$ V/m (37.5 dB $\mu$ V/m) at 402 km

### **RESULTS:**

#### ***Signal Strength:***

A verification of the Chico DGPS coverage area was conducted while traveling north from the southern range ring in the San Joaquin Valley north through the Sacramento Valley and then west to the coastline through the Coastal Mountains of northern California. The advertised signal strength range is 402 km. Per reference (3), the minimum signal strength for a site with a

transmission rate of 100baud is 37.5 dB $\mu$ V/m. Figure 1 below confirms adequate signal strength, at the advertised range of 402 km and throughout the predicted coverage area with the exception of the northwest portion where mountainous terrain and extremely dense forest cover inhibit reception. This area is the native environment of the Redwood Forest and other old growth protected forests. As the verification turned seaward and entered the Trinity National Forest the Coastal Mountain range signal strength began to decrease and become erratic. 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 the southern point along the advertised range (Table 1) and exceeded the required signal strength levels on both operational sides.

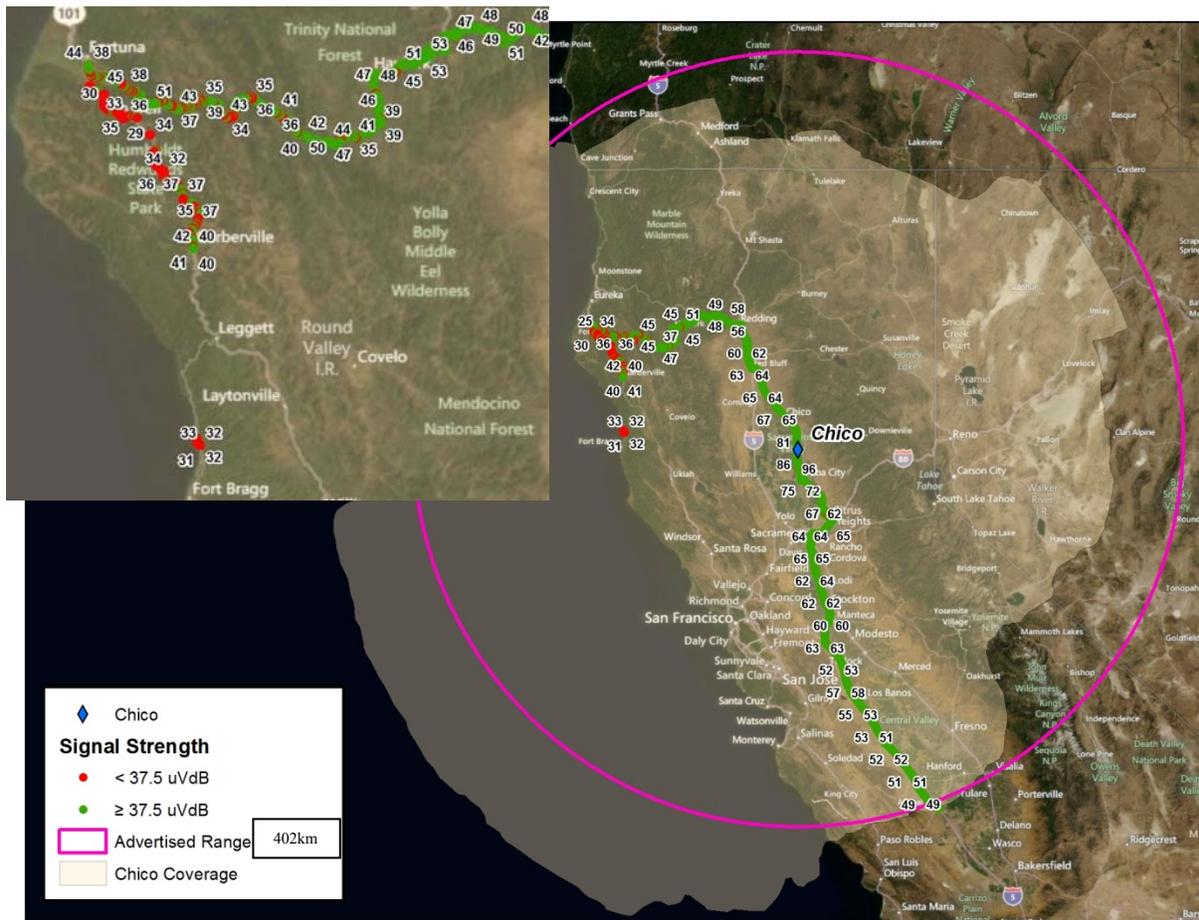


Figure 1: DNAV Signal Strength Results

	POSITION	Trimble SPS461	4100 FIM Meter
Side A SS	35° 59' 14.16"N 119° 57' 29.47"W	45 dB $\mu$ V/m, 32 SNR	49.1 dB $\mu$ V/m
Side B SS	35° 59' 14.16"N 119° 57' 29.47"W	45 dB $\mu$ V/m, 32 SNR	49.1 dB $\mu$ V/m

Table 1: Southern 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 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
Type 3	Y	Y	Y
Type 5 ( <i>ensure message is not being transmitted</i> )	N	N	N/A
Type 7	Y	Y	Y
Type 9	Y	Y	Y
Type 16	Y	Y	Y

Table 3: Side A RTCM Message Validation

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

Table 4: Side B RTCM Message Validation

***Accuracy Validation:***

Positional data was collected for 10 minutes per side using the Hemisphere R110 receiver with 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 (Table 5 & 6). Side A was 0.5606 meters away from the monument bearing 261.67°, while Side B was 0.7359 meters away from the monument, bearing 295.14°. Furthermore, a comparison between the uncorrected GPS position and the NGS Monument was conducted to see how effective the DGPS corrections were. Using a Garmin GPSmap 60CS handheld receiver the positional accuracy was 5.35 meters away from the monument. Using an iPhone 5, the positional accuracy was 38.86 meters from the monument. Therefore, the DGPS service provided from the Chico site significantly improves the positional accuracy in this area.

<b>NGS Monument ID:</b>	<a href="#">BBCP23</a>
Monument LAT:	38° 54' 50.84196" N
Monument LON:	123° 42' 31.36841" W

<b>Averaged LAT:</b>	38° 54' 50.84196" N
<b>Averaged LON:</b>	123° 42' 31.36841" W
<b>Distance from DGPS Site:</b>	185.3km
<b>Antenna Distance from Monument:</b>	0.560629865828147m (1.83933683ft)
<b>Antenna Bearing from Monument:</b>	261.6743°

Table 5: Side A Accuracy Check Results

<b>Averaged LAT:</b>	38° 54' 50.84196" N
<b>Averaged LON:</b>	123° 42' 31.39612984" W
<b>Distance from DGPS Site:</b>	185.3 km
<b>Distance from Monument:</b>	0.735918206 m (2.41442981 ft)
<b>Bearing from Monument:</b>	295.1419°

Table 6: Side B Accuracy Check Results

<i>Antenna Location</i>	<i>GPS Satellites Tracked (PRN)</i>										
Reference Station A	32	31	30	25	23	22	20	14	11	1	
Integrity Monitor A	32	31	30	25	23	22	20	14	11	1	
Reference Station B	32	31	30	25	23	22	20	14	11	1	
Integrity Monitor B	32	31	30	25	23	22	20	14	11	1	
NGS Monument Location, Side A	32	31	30	25	23	22	20	17	14	11	1
NGS Monument Location, Side B	32	31	30	25	23	22	20	17	14	11	1

Table 7: GPS Satellite Comparison

**SUMMARY:**

The Operational Assessment of the Chico DGPS site revealed that the overall provided coverage is consistent with the predicted coverage plot and advertised range; however, the northwest region is lower due to the terrain. The southern Far-Field measurement exceeded the required minimum signal. In addition, all RTCM messages were verified, 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 185 km from the broadcast site which is roughly half the advertised range, the horizontal accuracy is significantly better than sub-meter and on the order of 20X better than the accuracy requirements set forth by Reference (1) and (2).