Final Technical Report

1. USGS Award Number: G10AC00080

2. Project Title: Upgrades for Crustal Deformation GPS Monitoring Systems in Southern California under the American Recovery and Reinvestment Act (dated October 20, 2009, revised January 19, 2010 and February 5, 2010)

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4. Project Period: February 25, 2010 to May 31, 2011

Abstract

This is the final report for our work under the USGS National Earthquake Hazards Reduction Program (NEHRP) (Program Announcement 10HQPA0008) for "Proposals for Upgrades to Crustal Deformation Monitoring Systems under the American Recovery and Reinvestment Act." Specifically, we have performed work under Attachment B1 "U.S. GPS Stations Targeted for Upgrades: Proposed GPS Receivers and Antennas" and Attachment B2 "U.S. GPS Stations Targeted for Upgrades: Proposed Telemetry, Power and Other System Upgrades" of the program announcement. We (Scripps Orbit and Permanent Array Center – SOPAC) completed GPS equipment upgrades at 22 real-time high-rate continuous GPS stations in southern California, and non-GFE (real-time communication) upgrades at 23 continuous GPS station locations and one central telemetry hub (on Toro Peak).

Report Details

The upgrades that were made under this award are summarized in Tables 1 and 2, corresponding to Attachments B1 and B2 of the USGS announcement, respectively. The areas and stations affected are shown in Figure 1. Besides USGS ARRA funds, we received in-kind contributions from Orange County (Art Andrew and Ray Mathe) including field support from a staff of three personnel for approximately 8 days, and 25 Gel-cell batteries purchased by the County at a cost of $5,395 and installed at the Orange County stations (subset 2 in Figure 1). We also received field support from UNAVCO (Chris Walls) at PBO stations IID2, SBCC, SLMS and USGC, and USGS (Aris Aspiotis) at station DHLG. In a related effort, our radio equipment was removed from USGS SCIGN stations AZRY, COTD, PSAP and WIDC.

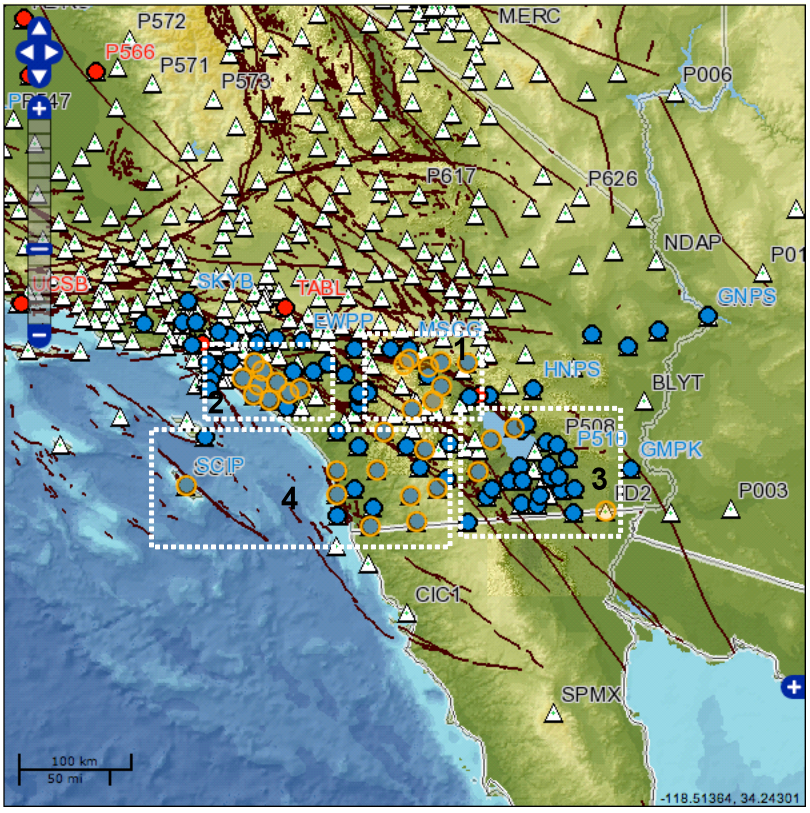

Figure 1. Map of California Real Time Network (CRTN) stations in southern California denoted by color-filled circles, and other continuous GPS stations from the SCIGN and PBO projects (denoted by white triangles). Continuous GPS stations upgraded with ARRA funds are denoted by orange circles. These are divided into 4 subsets. Subset 1 ("SAF-North") includes stations KYVW, PIN1, PIN2, and the Toro Peak telemetry hub. Subset 2 ("Orange County") includes BLSA, CCCS, FVPK, MJPK, OEOC, SACY, SBCC, SNHS, TRAK, WHYT. Subset 3 ("SAF-South") includes stations DHLG, IID2, SLMS, USGC, and Subset 4 ("San Diego") includes stations DESC, DSME, MONP, MVFD, NSSS, POTR, PMOB, RAAP, SCIP, SIO3, and SIO5.

We received a total of 30 Topcon GNSS receivers and antennas. We completed GPS equipment upgrades at 22 continuous GPS stations (Table 1) in southern California operated by the Scripps Orbit and Permanent Array Center (SOPAC – http://sopac,ucsd.edu) in Orange, San Diego and Imperial Counties, and non-GFE upgrades at 23 continuous GPS station locations and one central telemetry hub on Toro Peak (Table 2). Items that deviated from the proposed work are described in the footnotes under each table. Outstanding items include the pending upgrade of SIO3 and the temporary re-installation of the previous Ashtech Z-12 receivers at 8 Orange County stations. SIO3, which was replaced by SIO5 as the primary tracking station at Scripps Institution of Oceanography, will be upgraded as soon as we resolve some software and site issues, including a real-time telemetry feed and delivery of a new met package from NOAA. The 8 Ashtech units in Orange County will be replaced with Topcon units as soon as we get a software upgrade for RTD, which corrects the problems with the RTCM data used by Orange County surveyors.

Improvements in the southern California real-time CGPS infrastructure provided by the ARRA funds have ensured that civilian users will continue to have timely and robust access to real-time data provided by the California Real Time GPS Network (CRTN – http://crtn.ucsd.edu), other real-time data providers, and the California Spatial Reference Center (CSRC – http://csrc.ucsd.edu). These funds have provided direct economic benefits by maintaining access to a geodetic reference frame within a region subject to secular and transient crustal deformation, and are contributing to economic recovery at the local and state levels. The addition of GNSS capabilities enhances the work of local surveyors in local government, the private sector and several Caltrans districts. This project has provided support for a radio/field engineer (D. Glen Offield) and an SIO graduate student at Scripps Institution of Oceanography.

The completed upgrades are helping to sustain and improve crustal deformation monitoring in southern California, thereby contributing to geophysical research and enhancing public safety through earthquake early warning systems and rapid earthquake modeling. The project has also promoted the sharing of technical expertise and solutions among other scientists and network operators within the SCEC community.

Presentations

Bock, Y. (2010), CSRC Director's Report, CSRC Coordinating Council Fall Meeting, SIO, November 4, 2010.

Bock, Y., CSRC and CRTN Update (2010), League of California Surveying Organizations Meeting, Scripps Institution of Oceanography, La Jolla, December 2, 2010.

Bock, Y., B. Crowell, D. Melgar (2011), Real-Time GPS/Seismic Integration, presented to ANSS National Steering Committee, SIO, January 27-28, 2011. **Invited**

Bock, Y. (2011), The State of the CSRC, League of California Surveying Organizations' The State of NGS Meeting, Riverside County Flood Control and Water Conservation District, April 7, 2011. **Invited**

Bock, Y. (2011), CSRC Director's Report, CSRC Coordinating Council Spring Meeting, SIO, May 26, 2011.

Melgar, D., B. Crowell, Y. Bock (2011), Rapid near-source modeling with GPS, presented to ANSS Steering Committee, Boulder, CO, June 23rd, 2011. **Invited**

Table 1. Summary of Receiver/Antenna Upgrades

U.S. GPS Stations Targeted for Upgrades (Final Report)								
Proposed GPS Receivers and Antennas (in format of Attachment B1 of proposal)								
Network Code	**Station Code**	**Existing GPS Receiver**	**Existing GPS Antenna**	**Radome**	**Final GPS Receiver (GFE)**	**Final GPS Antenna (GFE)**	**Status**	**Date Completed**
SOPAC	blsa-1	ASHTECH Z-XII3	ASH701945B_M	SCIT	Topcon model CR-G3*	Topcon Net G3-A	**done**	6/9/2011
SOPAC	cccs	ASHTECH Z-XII3	ASH701945B_M	SCIT	Topcon model CR-G3*	Topcon Net G3-A	**done**	6/11/2011
SOPAC	fvpk-2	ASHTECH Z-XII3	ASH701933B_M	SCIT	Topcon model CR-G3*	Topcon Net G3-A	**done**	6/8/2011
SOPAC	mjpk	ASHTECH Z-XII3	ASH701945B_M	SCIT	Topcon model CR-G3	Topcon Net G3-A	**done**	6/8/2011
SOPAC	monp	ASHTECH Z-XII3	ASH701945B_M	SCIS	Topcon model CR-G3	Left old antenna	**done**	7/29/2011
SOPAC	mvfd	ASHTECH Z-XII3	ASH701945B_M	SCIT	Topcon model CR-G3	Topcon Net G3-A	**done**	5/5/2011
SOPAC	nsss	ASHTECH Z-XII3	ASH701945B_M	SCIT	Topcon model CR-G3	Topcon Net G3-A	**done**	4/11/2011
SOPAC	oeoc	ASHTECH Z-XII3	ASH701945B_M	SCIT	Topcon model CR-G3*	Topcon Net G3-A	**done**	5/26/2011
SOPAC	pin1	ASHTECH Z-XII3	ASH701945B_M	SCIS	Topcon model CR-G3	Left old antenna	**done**	5/11/2011
SOPAC	pin2	ASHTECH Z-XII3	ASH701945B_M	SCIT	Topcon model CR-G3	Topcon Net G3-A	**done**	5/11/2011
SOPAC	pmob	ASHTECH Z-XII3	ASH701945B_M	SCIT	Topcon model CR-G3	Topcon Net G3-A	**done**	5/5/2011
SOPAC	sacy-6	ASHTECH Z-XII3	ASH701945B_M	SCIT	Topcon model CR-G3*	Topcon Net G3-A	**done**	5/23/2011
SOPAC	scip-3	ASHTECH Z-XII3	ASH700936D_M	SCIS	Topcon model CR-G3	Left old antenna	**done**	6/2/2011
SOPAC	sio3-4	ASHTECH Z-XII3	ASH701945B_M	SCIS	(Topcon model CR-G3)	(Topcon model CR-G3)	pending	
SOPAC	sio5	ASHTECH Z-XII3	ASH701945B_M	SCIT	Topcon model CR-G3	Left old antenna	**done**	8/29/2011
SOPAC	snhs-1	ASHTECH Z-XII3	ASH701945B_M	SCIT	Topcon model CR-G3*	Topcon Net G3-A	**done**	6/10/2011
SOPAC	trak-5	ASHTECH Z-XII3	ASH701945B_M	Enclosure	Topcon model CR-G3*	Topcon Net G3-A SCIT	**done**	5/26/2011
SOPAC	whyt	ASHTECH Z-XII3	ASH701945B_M	SCIT	Topcon model CR-G3*	Topcon Net G3-A	**done**	6/8/2011
SOPAC	desc	LEICA GRX1200PRO	LEIAT504	SCIT	Topcon model CR-G3	Topcon Net G3-A	**done**	4/14/2011
SOPAC	dsme	LEICA GRX1200PRO	LEIAT504	SCIT	Topcon model CR-G3	Topcon Net G3-A	**done**	4/7/2011
SOPAC	potr	LEICA GRX1200PRO	LEIAT504	SCIT	Topcon model CR-G3	Topcon Net G3-A	**done**	4/5/2011
SOPAC	raap	LEICA GRX1200PRO	LEIAT504	SCIT	Topcon model CR-G3	Topcon Net G3-A	**done**	4/6/2011
* Returned Ashtechs temporarilly until RTD's RTCM issue can be resolved								
1 Data now flowing through MJPK repeater, had CDMA cell phone previously								
2 Replaced faulty Topcon antenna on 6/13/2011								
3 Problem removing older SCIGN adapter, left old antenna								
4 Upgrades pending, need to add Vaisala WXT met sensor support for NOAA								
5 Removed enclosure, replaced with SCIT radome, added SCIGN adapter, antenna height changed								
6 Communications problem at SACY and CAT2, data falling behind								

Table 2. Summary of Non-GFE Equipment

U.S. GPS Stations Targeted for Upgrades (Final Report)						
Proposed Telemetry, Power, and Other System Upgrades (in the same format as Attachment B2)						
Network Code	**Station Code**	**Existing Telemetry**	**Proposed Telemetry**	**Proposed Non-GFE Equipment (proposed for purchase under cooperative agreement)**	**Status**	**Date Completed**
SOPAC	blsa-1	2G Raven modems	3G cell modem;Add buffer	Proxicast LanCell2; SIO Telemetry Buffer	**done**	6/9/2011
SOPAC	cccs-2	2G Raven modems	3G cell modem;Add buffer	Proxicast LanCell2; SIO Telemetry Buffer	**done**	6/11/2011
SOPAC	desc	WiLAN/EION	Add buffer	SIO Telemetry Buffer	**done**	4/14/2011
SOPAC	dsme	WiLAN/EION	Add buffer	SIO Telemetry Buffer	**done**	4/7/2011
SOPAC	fvpk	Freewave to OCRTN	Add buffer	SIO Telemetry Buffer	**done**	6/8/2011
SOPAC	mjpk-3	Freewave to OCRTN	Add buffer	Tower (repeater station), SIO Telemetry Buffer	**done**	6/8/2011
SOPAC	monp	WiLAN/EION	no change	no change	**done**	7/29/2011
SOPAC	oeoc	Freewave to OCRTN	Add buffer	SIO Telemetry Buffer	**done**	5/26/2011
SOPAC	pin1	WiLAN/EION	AFAR radio	AFAR AR-24027 radio	**done**	5/11/2011
SOPAC	pin2	WiLAN/EION	AFAR radio	AFAR AR-24027 radio;relocate electronics	**done**	5/11/2011
SOPAC	potr	WiLAN/EION	Add buffer	SIO Telemetry Buffer	**done**	4/5/2011
SOPAC	raap	WiLAN/EION	Add buffer	SIO Telemetry Buffer	**done**	4/6/2011
SOPAC	sacy	Freewave to OCRTN	Add buffer	SIO Telemetry Buffer	**done**	5/23/2011
SOPAC	sio5-4	WiLAN/EION	Power upgrade	Install new post, relocate electronics, PV Power	**done**	8/29/2011
SOPAC	snhs-1	2G Raven modems	3G cell modem;Add buffer	Proxicast LanCell2; SIO Telemetry Buffer	**done**	6/10/2011
SOPAC	trak-5	Freewave to OCRTN	Add buffer	SIO Telemetry Buffer	**done**	5/26/2011
SOPAC	whyt	Freewave to OCRTN	Add buffer	SIO Telemetry Buffer	**done**	6/8/2011
USGS	dhlg-4	WiLAN/EION	AFAR radio	AFAR AR-24027 radio;taller tower (repeater station);PV power	**done**	5/4/2011
USGS	kyvw	WiLAN/EION	AFAR radio	AFAR AR-24027 radio	**done**	10/12/2010
NUCLEUS	iid2	2G modems	AFAR radio	AFAR AR-24027 radio; ANDREW 23dBi semi-parabolic antenna	**done**	4/17/2010
NUCLEUS	sbcc	Freewave to OCRTN	Add buffer	SIO Telemetry Buffer	**done**	5/25/2011
NUCLEUS	slms	2G modems	AFAR radio	AFAR AR-24027 radio; ANDREW 23dBi semi-parabolic antenna	**done**	4/22/2011
NUCLEUS	usgc	2G modems	AFAR radio	AFAR AR-24027 radio; ANDREW 23dBi semi-parabolic antenna	**done**	4/21/2011
Toro Peak	Hub	WiLAN/EION	AFAR radio	AFAR AR-24027 radio,more telemetry cells	**done**	11/18/2011
1 Installed Freewave radio instead of cell phone upgrade, routed through upgraded MJPK communications						
2 Fixed performance issue with existing 2G cellphone						
3 Upgraded power and telemetry to handle two additional stations (BLSA and SNHS)						
4 Did not upgrade to PV prower						
5 Installed new receiver enclosure, radome, and added SCIGN adapter (caused antenna change)						