

## Final Report

Submitted to the U.S. GEOLOGICAL SURVEY

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CALIFORNIA INSTITUTE OF TECHNOLOGY

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Project title: Upgrade of Joint USGS-Caltech  
Southern California Seismic Network

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## SUMMARY

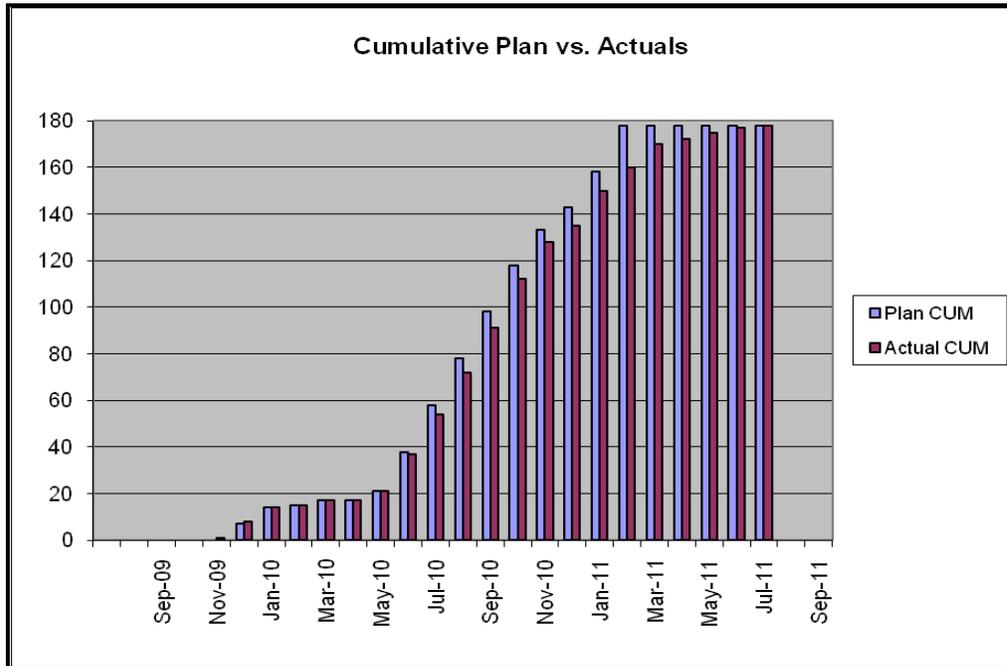
*The following improvements in monitoring and maintenance needs were accomplished by undertaking this upgrade:*

- 1) The data packetizing or telemetry delay time for 138 stations has been reduced by ~5 seconds, which will facilitate earthquake early warning development and testing.
- 2) During any given week the outage of CI network seismic stations has been reduced from about 15 stations per week to about 1 or 2 stations per week.
- 3) The on-site backup archive of waveform data is now accessible from the central site and can be retrieved to fill gaps to ensure data completeness.
- 4) Seismometer calibrations and re-centering are being performed automatically using ASL software and associated tools.
- 5) Noise steps that were present in the waveform data from the old dataloggers have been eliminated from the data.
- 6) Power consumption at most sites has been reduced by a factor of about 10.

*The following tasks were completed:*

- 1) Submitted all requested NEPA paperwork for the 178 stations in the upgrade.
- 2) Cleaned up configurations on older (pre-ARRA upgrade) Q330s in our network to bring their configurations in line with the standard configuration developed during the ARRA upgrade project.
- 3) Replaced 2g EpiSensors with 4g Isolated Supply EpiSensors at all stations (except for three stations located in buildings and designed to measure the building's motion and not ground motion). Also repaired EpiSensors as needed as they were removed from the field and entered the process of being upgraded to 4g and Isolated Supply.
- 4) Replaced CMG sensor cables to allow for remote re-centering of these sensors through the Q330 systems.
- 5) Replaced malfunctioning broadband sensors with spares as needed and sent malfunctioning sensors in for repair to replenish the spares pool.
- 6) Maintenance needs of dataloggers have been radically reduced.
- 7) Replaced all serial radios with Ethernet radios and upgraded older Ethernet radios to newer versions.
- 8) Reduced old, obsolete dataloggers to their components and recycled all components.
- 9) Wherever possible, power was pulled to the vault and the datalogger was moved into the vault to eliminate the need for long sensor cables and increase our flexibility to swap out sensors with alternates when the originals need repair or replacement.
- 10) Upgraded the Ft. Scotty telemetry hub to increase longevity and earthquake resilience: Installed power monitoring equipment and expanded battery backup to provide for 72 hours of uninterrupted power.

11) The chart below shows ARRA progress during the upgrade:



12) Upgraded 178 stations and generated updated dataless files for all. Dataless files were made available to the ANSS metadata server in Golden, Colorado, and the research community via SCEDC. Upgrade field work provided opportunities to enhance data quality at several stations (either by improving telemetry links or replacing bad sensors). These improvements are noted below. In addition, power systems were upgraded with new batteries and chargers at sites which needed it. A complete list of upgraded stations follows:

- CI.USC – completed 11/12/2009
  - GFE installed: Q330S (SN 3450) and FBA ES-T-4G-IS (SN 3732-IS)
  - Also upgraded DC power system, replaced batteries and replaced faulty GPS antenna
- CI.BBR – completed 12/2/2009
  - GFE installed: Q330S (SN 3435)
  - Also upgraded 2g FBA ES-T to FBA ES-T-4G-IS on 4/18/2011
- CI.BFS – completed 12/3/2009
  - GFE installed: Q330S (SN 3568) and FBA ES-T-4G-IS (SN 3774-IS)
- CI.DGR – completed 12/3/2009
  - GFE installed: Q330S (SN 3434) and FBA ES-T-4G-IS (SN 3736-IS)
  - Moved all equipment from building into vault to allow homeowner to tear down the old trailer that used to house the station equipment
  - Upgrade appears to have solved a persistent timing problem at this station (likely caused by the old data logger)
  - Also upgraded DC power system – new charger and batteries

- CL.BOR – completed 12/9/2009
  - GFE installed: Q330S (SN 3446)
  - Also upgraded 2g FBA ES-T (which had a bad E component) to FBA ES-T-4G-IS; and replaced batteries on DC power system.
- CL.RPV – completed 12/9/2009
  - GFE installed: Q330S (SN 3567) and FBA ES-T-4G (SN 3755-IS)
  - Upgrade appears to have solved a cyclic noise problem (likely caused by the old data logger).
- CL.PER – completed 12/15/2009
  - GFE installed: Q330S (SN 3444)
  - Also upgraded FBA ES-T to FBA ES-T-4G (IS); and replaced batteries on DC power system
  - Upgrade resolved a time slew issue (caused by the old data logger).
- CL.GSC – completed 12/16/2009.
  - GFE installed: Q330HR (SN 3326), PB44 Baler (SN 11998) and FBA ES-T-4G (SN 3766-IS)
  - Upgrade visit provided an opportunity to recenter the STS1s (which cannot yet be recentered remotely), improving data quality substantially.
- CL.MPI – completed 1/13/2010
  - GFE installed: Q330S (SN 3569)
  - Also upgraded 2g FBA ES-T to FBA ES-T-4G-IS on 6/27/2011.
- CL.ISA – completed 1/13/2010
  - GFE installed: Q330HR (SN 3464); Baler (SN 11996); FBA ES-T-4G (SN 3762-IS)
  - New FBA solved a problem with the old FBA ES-T accelerometer (the old accelerometer was not recording data on the Z & E channels).
- CL.DRE – completed 1/14/2010
  - GFE installed: Q330S (SN 3442)
  - Also upgraded FBA-23 to FBA ES-T-4G (IS); upgraded DC power system; upgraded ethernet radios.
- CL.GLA – completed 1/14/2010
  - GFE installed: Q330HR (SN 3327); Baler (SN 11994); FBA ES-T-4G (SN 3763-IS)
  - Also upgraded the DC power system.
- CL.BAR – completed 1/27/2010
  - GFE installed: Q330HR (SN 3468); Baler (SN 12000); FBA ES-T-4G (SN 3772-IS)
  - Also upgraded frame relay frad, DC power system, and replaced batteries.
- CL.TOR – completed 1/29/2010
  - GFE installed: Q330S (SN 3453)
  - Also upgraded 2g FBA ES-T to FBA ES-T-4G (IS), and serial radios to Ethernet radios; upgraded solar regulator, and replaced batteries.
- CL.PHL – completed 2/10/2010
  - GFE installed: Q330HR (SN 3463); Baler (SN 15180); FBA ES-T-4G (SN 3767-IS)
  - Also upgrade power system and replaced batteries.

- CI.BBS – completed 3/26/2010
  - GFE installed: Q330S (SN 3439)
  - Also upgraded 2g FBA ES-T to FBA ES-T-4G (IS); upgraded frame relay frad; and replaced malfunctioning broadband sensor (it had several noise problems) with work broadband sensor.
- CI.OSI – completed 3/31/2010
  - GFE installed: Q330HR (SN 3475); Baler (SN 11997); FBA ES-T-4G (SN 3773-IS)
  - Also upgraded DC power system, and replaced batteries; and upgraded telemetry to cell modem.
- CI.SWS – completed 5/19/2010
  - GFE installed: Q330S (SN 3924); FBA ES-T-4G (SN 3778-IS)
  - Also upgraded from serial radios to Ethernet radios; upgraded DC power supply and replaced batteries.
- CI.WES – completed 5/20/2010
  - GFE installed: Q330S (SN 3811); FBA ES-T-4G (SN 4037-IS)
  - Also upgraded from serial radios to Ethernet radios.
- CI.LCP – completed 5/26/2010
  - GFE installed: Q330S (SN 3806); FBA ES-T-4G (SN 3753-IS).
- CI.NJQ – completed 5/27/2010
  - GFE installed: Q330S (SN 3930); FBA ES-T-4G (SN 3752-IS)
  - Also upgrade the frame relay frad.
- CI.LDR – completed 6/2/2010
  - GFE installed: Q330S (SN 3807); FBA ES-T-4G (SN 3780-IS)
  - Added a brick ring around the top of the vault to hold gravel backfill. The gravel reduces background noise, enhances temperature stability in the vault, and aids in filtering water away from the vault seals during heavy rains. Also upgraded to Ethernet radios.
- CI.DNR – completed 6/8/2010
  - GFE installed: Q330S (SN 3931); FBA ES-T-4G (SN 3749-IS)
  - Also installed a replacement STS2 as the one previously at the site had a bad vertical component; upgraded the DC power system; replaced the batteries; upgraded the frad; and solved an 18-minute spiking problem caused by the old data logger.
- CI.NBS – completed 6/8/2010
  - GFE installed: Q330S (SN 3928); FBA ES-T-4G (SN 3737-IS)
  - Also upgraded serial radios to Ethernet radios
- CI.GOR – completed 6/9/2010
  - GFE installed: Q330S (SN 3934); FBA ES-T-4G (SN 3760-IS)
  - Also upgraded telemetry link to cell modem; replaced aging broadband sensor with newer one; and installed a new vault to replace flooded one – the new vault is deeper for enhanced long-period background noise reduction
- CI.PMD – completed 6/9/2010
  - GFE installed: Q330S (SN 3777); FBA ES-T-4G (SN 3771-IS)

- Also replaced damp sand covering the STS2 with dry sand to help prevent moisture-related problems in the sensor
- CI.SES – completed 6/10/2010
  - GFE installed: Q330S (SN 3942); FBA ES-T-4G (SN 3741-IS)
  - Also improved telemetry link, upgraded DC power system and replaced battery.
- CI.SYP – completed 6/10/2010
  - GFE installed: Q330S (SN 3815); FBA ES-T-4G (SN 3735-IS)
  - Also replaced the battery and upgraded from serial radios to Ethernet radios
- CI.SPG2 – completed 6/15/2010
  - GFE installed: Q330S (SN 3929); FBA ES-T-4G (SN 3779-IS)
  - Also replaced unstable, failing broadband with operational CMG-3T
- CI.WGR – completed 6/15/2010
  - GFE installed: Q330S (SN 3813); FBA ES-T-4G (SN 501-IS)
  - Also were able to solve an 18-minute spiking problem caused by the old data logger
- CI.FIG – completed 6/22/2010
  - GFE installed: Q330S (SN 3927); FBA ES-T-4G (SN 3740-IS)
  - Also replaced DC power system and battery; upgraded dubious radio telemetry link to cell modem
- CI.BLA2 – completed 6/23/2010
  - GFE installed: Q330S (SN 3808)
  - Also upgraded 2g FBA ES-T to FBA ES-T-4G (IS)
- CI.PLM – completed 6/23/2010
  - GFE installed: Q330S (SN 3940)
  - Also upgraded 2g FBA ES-T to FBA ES-T-4G (IS), upgraded frame relay frad
- CI.LDF – completed 6/28/2010
  - GFE installed: Q330S (SN 3812)
  - Also upgraded 2g FBA ES-T to FBA ES-T-4G (IS), replaced battery, upgraded frame relay frad
- CI.MLAC – completed 6/29/2010
  - GFE installed: Q330S (SN 3814)
  - Also upgraded 2g FBA ES-T (which had a low-frequency spiking problem) to FBA ES-T-4G (IS), upgraded DC power system and replaced battery
- CI.TIN – completed 6/29/2010
  - GFE installed: Q330S (SN 3925)
  - Also upgraded 2g FBA ES-T to FBA ES-T-4G (IS), upgraded DC power system, and replaced battery
- CI.SBC – completed 6/30/2010
  - GFE installed: Q330S (SN 3933)
  - Also upgraded FBA-23 to FBA ES-T-4G (IS)
- CI.GRA – completed 7/8/2010
  - GFE installed: Q330S (SN 3778)

- Also were able to solve an 18-minute spiking problem caused by the old data logger; upgraded from serial radios to Ethernet radios; and upgraded 2g FBA ES-T to FBA ES-T-4G (IS)
- CI.LGU – completed 7/8/2010
  - GFE installed: Q330S (SN 3810)
  - Also upgraded 2g FBA ES-T (which had a failed vertical component) to FBA ES-T-4G (IS), and improved the telemetry link by moving to cell modem
- CI.TUQ – completed 7/8/2010
  - GFE installed: Q330S (SN 3809)
  - Also upgraded 2g FBA ES-T to FBA ES-T-4G (IS), replaced battery, upgraded Ethernet radios
- CI.RVR – completed 7/9/2010
  - GFE installed: Q330S (SN 3937)
  - Also upgraded 2g FBA ES-T to FBA ES-T-4G (IS), upgraded DC power supply, replaced battery, upgraded frad
- CI.CGO – completed 7/13/2010
  - GFE installed: Q330S (SN 3922)
  - Also upgraded 2g FBA ES-T to FBA ES-T-4G (IS)
- CI.BEL – completed 7/14/2010
  - GFE installed: Q330S (SN 3780)
  - Also upgraded 2g FBA ES-T to FBA ES-T-4G (IS), replaced battery, upgraded from serial radios to Ethernet radios.
- CI.LBW1 – completed 7/14/2010
  - GFE installed: Q330S (SN 4164)
  - Also upgraded 2g FBA ES-T to FBA ES-T-4G (IS), upgraded DC power supply, replaced battery.
- CI.LBW2 – completed 7/14/2010
  - GFE installed: Q330S (SN 4112)
- CI.BC3 – completed 7/15/2010
  - GFE installed: Q330S (SN 4127)
  - Also upgraded 2g FBA ES-T to FBA ES-T-4G (IS), were able to solve an 18-minute spiking problem caused by the old data logger, replaced battery, and upgraded from serial radios to Ethernet radios.
- CI.PLS – completed 7/20/2010
  - GFE installed: Q330S (SN 4211)
  - Also upgraded 2g FBA ES-T to FBA ES-T-4G (IS), replaced battery.
- CI.SAL – completed 7/21/2010
  - GFE installed: Q330S (SN 4204)
  - Also upgraded 2g FBA ES-T to FBA ES-T-4G (IS), replaced battery.
- CI.WBS – completed 7/21/2010
  - GFE installed: Q330S (SN 4188)
  - Also upgraded 2g FBA ES-T to FBA ES-T-4G (IS), replaced ailing CMG-3T with operational one, upgraded Ethernet radios.
- CI.ERR – completed 7/22/2010
  - GFE installed: Q330S (SN 4166)

- Also upgraded 2g FBA ES-T to FBA ES-T-4G (IS), and were able to solve an 18-minute spiking problem caused by the old data logger.
- CI.CAR – completed 7/27/2010
  - GFE installed: Q330S (SN 4128)
  - Also upgraded 2g FBA ES-T to FBA ES-T-4G (IS), upgraded CMG-3ESP to a Trillium 240, replaced battery, upgraded Ethernet radios.
- CI.SLR – completed 7/28/2010
  - GFE installed: Q330S (SN 4113)
  - Also upgraded 2g FBA ES-T to FBA ES-T-4G (IS), replaced broken CMG-3T with operational one, replaced ailing telemetry phone line with cell modem, upgraded DC power system, replaced battery.
- CI.MUR – completed 7/29/2010
  - GFE installed: Q330S (SN 4205)
  - Also upgraded 2g FBA ES-T (which had high frequency noise problems and regular DC offsets) to FBA ES-T-4G (IS), replaced battery, upgraded telemetry link to cell modem.
- CI.PSD – completed 7/29/2010
  - GFE installed: Q330S (SN 4203)
  - Also upgraded 2g FBA ES-T (which had high frequency noise problems, regular DC offsets, and a failing north component) to FBA ES-T-4G (IS), replaced battery, and were able to solve an 18-minutes spiking problem caused by the old data logger.
- CI.QUG – completed 8/3/2010
  - GFE installed: Q330S (SN 4185)
  - Also upgraded 2g FBA ES-T to FBA ES-T-4G (IS), replaced battery.
- CI.SMS – completed 8/3/2010
  - GFE installed: Q330S (SN 4207)
  - Also upgraded 2g FBA ES-T to FBA ES-T-4G (IS), upgraded CMG-40T to CMG-3ESP.
- CI.WSS – completed 8/3/2010
  - GFE installed: Q330S (SN 3570)
  - Also upgraded 2g FBA ES-T to FBA ES-T-4G, upgraded DC power supply, replaced battery.
- CI.GR2 – completed 8/4/2010
  - GFE installed: Q330S (SN 4160)
- CI.FMP – completed 8/10/2010
  - GFE installed: Q330S (SN 4210)
  - Also upgraded 2g FBA ES-T to FBA ES-T-4G (IS), upgraded frad, replaced battery.
- CI.OLP – completed 8/11/2010
  - GFE installed: Q330S (SN 4177)
  - Also upgraded 2g FBA ES-T to FBA ES-T-4G (IS), upgraded DC power supply.
- CI.SDR – completed 8/11/2010
  - GFE installed: Q330S (SN 4122)

- Also upgraded 2g FBA ES-T to FBA ES-T-4G (IS), replaced battery, upgraded frad, and were able to solve an 18-minutes spiking problem caused by the old data logger.
- CI.BTP – completed 8/12/2010
  - GFE installed: Q330S (SN 4176)
  - Also upgraded 2g FBA ES-T to FBA ES-T-4G (IS), replaced broken STS2 with Trillium 240, upgraded DC power supply, upgraded Ethernet radios.
- CI.JVA – completed 8/12/2010
  - GFE installed: Q330S (SN 4110)
  - Also upgraded 2g FBA ES-T to FBA ES-T-4G (IS), replaced battery, and were able to solve an 18-minute spiking problem caused by the old data logger.
- CI.EML – completed 8/17/2010
  - GFE installed: Q330S (SN 4209)
  - Also upgraded 2g FBA ES-T (which had a high frequency noise problem) to FBA ES-T-4G (IS) and replaced broken STS2.
- CI.PDR – completed 8/18/2010
  - GFE installed: Q330S (SN 4173)
  - Also upgraded 2g FBA ES-T to FBA ES-T-4G (IS)
- CI.JRC2 – completed 8/19/2010
  - GFE installed: Q330S (SN 4195)
  - Also upgraded 2g FBA ES-T to FBA ES-T-4G (IS), replaced ailing CMG-3ESP with new CMG-3ESPC, upgraded from serial to Ethernet radios.
- CI.EDW2 – completed 8/20/2010
  - GFE installed: PB44-baler (SN 15201)
  - Also upgraded 2g FBA ES-T to FBA ES-T-4G (IS), upgraded from serial to Ethernet radios.
- CI.DPP – completed 8/24/2010
  - GFE installed: Q330S (SN 4182)
  - Also upgraded 2g FBA ES-T (which had a high frequency noise problem) to FBA ES-T-4G (IS), replaced battery.
- CI.SMM – completed 8/24/2010
  - GFE installed: Q330S (SN 4202)
  - Also upgraded 2g FBA ES-T (which had a intermittent high frequency noise problem) to FBA ES-T-4G (IS), upgraded DC power supply, upgraded Ethernet radios.
- CI.CLC – completed 8/25/2010
  - GFE installed: Q330S (SN 4189)
  - Also upgraded 2g FBA ES-T (which had a intermittent high frequency noise problem) FBA ES-T-4G (IS), upgraded Ethernet radios, and were able to solve an 18-minute spiking problem caused by the old data logger.
- CI.CTC – completed 8/31/2010
  - GFE installed: PB44-baler (SN 15202)
  - Also upgraded 2g FBA ES-T to FBA ES-T-4G (IS), upgraded Ethernet radios.
- CI.MTP – completed 8/31/2010

- GFE installed: Q330S (SN 4170)
- Also upgraded 2g FBA ES-T to FBA ES-T-4G (IS), upgraded DC power supply, replaced battery.
- CI.RUS – completed 9/1/2010
  - GFE installed: Q330S (SN 41010)
  - Also upgraded 2g FBA ES-T to FBA ES-T-4G (IS), and corrected timing problem – the old data logger had a bad GPS engine that was stamping data with the year 1991.
- CI.SBB2 – completed 9/2/2010
  - GFE installed Q330S (SN 4184)
  - Also upgraded 2g FBA ES-T to FBA ES-T-4G (IS), replaced battery.
- CI.VCS – completed 9/2/2010
  - GFE installed: Q330S (SN 4165)
  - Also installed replacement FBA ES-T-4G (IS), upgraded DC power supply, replaced battery, upgraded fiber transceivers, replaced water-damaged STS-2 with operational one, repaired vault to help prevent future leaks, and corrected timing problem – the old data logger had a bad GPS engine that was stamping data with the year 1991.
- CI.SBPX – completed 9/8/2010
  - GFE installed: PB44-baler (SN 15209)
  - Also upgraded 2g FBA ES-T to FBA ES-T-4G (IS).
- CI.SNO – completed 9/8/2010
  - GFE installed: PB44-baler (SN 49900)
  - Also upgraded 2g FBA ES-T to FBA ES-T-4G (IS), upgraded solar charger, replaced older STS-2 with brand new Trillium 240 to allow for regular maintenance work on the STS-2.
- CI.MCT – completed 9/9/2010
  - GFE installed: Q330S (SN 4162)
  - Also upgraded 2g FBA ES-T to FBA ES-T-4G (IS), replaced battery, upgraded from serial radios to Ethernet radios.
- CI.SMR – completed 9/9/2010
  - GFE installed: PB44-baler (SN 15204)
  - Also upgraded 2g FBA ES-T to FBA ES-T-4G (IS), and replaced water-damaged STS-2 with operational one.
- CI.SMW – completed 9/9/2010
  - GFE installed: PB44-baler (SN 15210)
  - Also upgraded 2g FBA ES-T to FBA ES-T-4G (IS)
- CI.CFS – completed 9/14/2010
  - GFE installed: PB44-baler (SN 13504)
  - Also upgraded 2g FBA ES-T to FBA ES-T-4G (IS).
- CI.MWC – completed 9/14/2010
  - GFE installed: Q330S (SN 4175)
  - Also upgraded 2g FBA ES-T to FBA ES-T-4G (IS), upgraded DC power supply, replaced battery, upgraded from serial radios to Ethernet radios.
- CI.BLY – completed 9/21/2010
  - GFE installed: PB44-baler (SN 13505)

- Also upgraded 2g FBA ES-T to FBA ES-T-4G (IS), upgraded the Ethernet radios.
- CLDJJ – completed 9/22/2010
  - GFE installed: Q330S (SN 4238)
  - Also upgraded 2g FBA ES-T to FBA ES-T-4G (IS), upgraded DC power supply, replaced battery, upgraded frad, and corrected timing problem – the old data logger had a bad GPS engine that was stamping data with the year 1991.
- CLLRL – completed 9/22/2010
  - GFE installed: Q330S (SN 4105)
  - Also upgraded 2g FBA ES-T to FBA ES-T-4G (IS), upgraded Ethernet radios.
- CLMSC – completed 9/22/2010
  - GFE installed: PB44-baler (SN 13509)
  - Also upgraded 2g FBA ES-T to FBA ES-T-4G (IS), replaced older STS-2 with brand new STS-2.5 to allow for regular maintenance work on the STS-2.
- CLCCC – completed 9/23/2010
  - GFE installed: Q330S (SN 4114)
  - Also upgraded 2g FBA ES-T (which had a bad spiking problem and a failing E component) to FBA ES-T-4G (IS), replaced ailing STS2 with operational one, upgraded Ethernet radios, replaced battery.
- CLWWC – completed 9/28/2010
  - GFE to install: PB44-baler (SN 13510)
  - Also upgraded 2g FBA ES-T to FBA ES-T-4G (IS), replaced older STS-2 with brand new STS-2.5 to allow for regular maintenance work on the STS-2, upgraded solar panels and regular, replaced battery, upgraded Ethernet radios.
- CLLJR – completed 9/29/2010
  - GFE to install: PB44-baler (SN 13506)
  - Also upgraded 2g FBA ES-T to FBA ES-T-4G (IS).
- CLFHO – completed 9/29/2010
  - GFE to install: PB44-baler (SN 13507)
  - Also upgraded 2g FBA ES-T to FBA ES-T-4G (IS), upgraded solar panel, replaced battery, upgraded broadband from CMG-3ESPC to brand new STS-2.
- CLSVD – completed 9/29/2010
  - GFE to install: PB44-baler (SN 13503)
  - Also upgraded 2g FBA ES-T (which had an unstable Z component) to FBA ES-T-4G (IS), replaced older STS-2 with brand new STS-2.5 to allow for regular maintenance work on the STS-2.
- CLBTC – completed 10/06/2010
  - GFE installed: Q330S (SN 4179)
  - Also upgraded 2g FBA ES-T (which had intermittent noise problems) to FBA ES-T-4G (IS), moved telemetry link to lower-cost cell modem, upgraded DC power system, replaced battery.

- CI.JEM – completed 10/06/2010
  - GFE installed: PB44 Baler (SN 13502)
  - Also upgraded 2g FBA ES-T to FBA ES-T-4G (IS).
- CI.MOP – completed 10/07/2010
  - GFE installed: Q330S (SN 4104)
  - Also upgraded 2g FBA ES-T to FBA ES-T-4G (IS), replaced battery.
- CI.OLI – completed 10/08/2010
  - GFE installed: Q330S (SN 4169)
  - Also upgraded 2g FBA ES-T (which had a failed N component) to FBA ES-T-4G (IS), upgraded fiber transceivers.
- CI.BRE – completed 10/12/2010
  - GFE installed: Q330S (SN 4315)
  - Also upgraded 2g FBA ES-T to FBA ES-T-4G (IS), upgraded DC power system, replaced battery, upgraded fiber transceivers.
- CI.TFT – completed 10/12/2010
  - GFE installed: Q330S (SN 3941); FBA ES-T-4G (SN 3739-IS)
  - Also upgraded 2g FBA ES-T to FBA ES-T-4G (IS), replaced failing CMG-40T with operational CMG-3ESPC, upgraded DC power system, upgraded frad.
- CI.TA2 – completed 10/13/2010
  - GFE installed: PB44 Baler (SN 17551)
  - Also upgraded FBA-23 to FBA ES-T-4G (IS), replaced battery, and solved a response problem on the broadband sensor (CMG-40T).
- CI.LPC – completed 10/14/2010
  - GFE installed: PB44 Baler (SN 17561)
  - Also upgraded 2g FBA ES-T to FBA ES-T-4G (IS), replaced older STS-2 with brand new STS-2.5 to allow for regular maintenance work on the STS-2.
- CI.VES – completed 10/19/2010
  - GFE installed: Q330S (SN 4115)
  - Also upgraded 2g FBA ES-T (which had a failed E component) to FBA ES-T-4G (IS), upgraded DC power system, replaced battery.
- CI.BCW – completed 10/20/2010
  - GFE installed: PB44 Baler (SN 13508)
  - Also upgraded 2g FBA ES-T (which had a failed N component) to FBA ES-T-4G (IS).
- CI.STC – completed 10/21/2010
  - GFE installed: Q330S (SN 4240)
  - Also upgraded 2g FBA ES-T to FBA ES-T-4G (IS), replaced battery, upgraded fiber transceivers.
- CI.SBI – completed 10/22/2010
  - GFE installed: Q330S (SN 4167)
  - Also upgraded 2g FBA ES-T to FBA ES-T-4G (IS), replaced battery, upgraded Ethernet radios.
- CI.STS – completed 10/22/2010
  - GFE installed: Q330S (SN 4168)

- Also upgraded 2g FBA ES-T to FBA ES-T-4G (IS), and solved an 18-minute spiking problem caused by the old data logger.
- CI.ALP – completed 10/26/2010
  - GFE installed: Q330S (SN 3935)
  - Also upgraded 2g FBA ES-T to FBA ES-T-4G (IS), replaced battery, upgraded fiber transceivers.
- CI.BOM – completed 10/26/2010
  - GFE installed: PB44 Baler (SN 17546)
  - Also upgraded 2g FBA ES-T to FBA ES-T-4G (IS), upgraded Ethernet radios, upgraded older CMG-3ESP to brand new STS-2.5.
- CI.RXH – completed 10/26/2010
  - GFE installed: PB44 Baler (SN 17549)
  - Also upgraded 2g FBA ES-T to FBA ES-T-4G (IS).
- CI.SLB – completed 10/26/2010
  - GFE installed: PB44 Baler (SN 17564)
  - Also upgraded 4g FBA ES-T to FBA ES-T-4G (IS), solved a response problem on the broadband sensor (CMG-40T), upgraded Ethernet radios.
- CI.IDO – completed 10/27/2010
  - GFE installed: PB44 Baler (SN 17553); FBA ES-T-4G (SN 3734-IS).
- CI.NSS2 – completed 10/27/2010
  - GFE installed: PB44 Baler (SN 17556)
  - Also upgraded 4g FBA ES-T to FBA ES-T-4G (IS), upgraded older CMG-3ESP to brand new STS-2.5, replaced battery.
- CI.THM – completed 10/27/2010
  - GFE installed: PB44 Baler (SN 17558)
  - Also upgraded 4g FBA ES-T to FBA ES-T-4G (IS).
- CI.ADO – completed 10/28/2010
  - GFE installed: Q330S (SN 4201)
  - Also upgraded 2g FBA ES-T to FBA ES-T-4G (IS), upgraded fiber transceivers.
- CI.ARV – completed 11/03/2010
  - GFE installed: PB44 Baler (SN 17560)
  - Also upgraded 2g FBA ES-T (which had intermittent high frequency noise problems) to FBA ES-T-4G (IS).
- CI.RIO – completed 11/03/2010
  - GFE installed: Q330S (SN 4242)
  - Also upgraded 2g FBA ES-T (which had problems on the E component) to FBA ES-T-4G (IS), replaced battery.
- CI.CHF – completed 11/05/2010
  - GFE installed: Q330S (SN 4236)
  - Also re-installed all sensors (station had been closed for several months because of a wildfire in the area), upgraded 2g FBA ES-T to FBA ES-T-4G (IS), replaced battery, upgraded frad.
- CI.MAG – completed 11/07/2010
  - GFE installed: Q330S (SN 4163)
  - Also upgraded 2g FBA ES-T to FBA ES-T-4G (IS).

- CI.GMR – completed 11/09/2010
  - GFE installed: PB44 Baler (SN 13500)
  - Also upgraded 2g FBA ES-T (which had intermittent noise problems) to FBA ES-T-4G (IS).
- CI.NEE2 – completed 11/09/2010
  - GFE installed: PB44 Baler (SN 17554)
  - Also upgraded 2g FBA ES-T (which had intermittent noise problems) to FBA ES-T-4G (IS), replaced malfunctioning STS-2 with operational one, upgraded frad.
- CI.PSR – completed 11/10/2010
  - GFE installed: PB44 Baler (SN 13512)
  - Also upgraded 2g FBA ES-T to FBA ES-T-4G (IS), upgraded Ethernet radios, replaced failing CMG-3ESP with operational one.
- CI.SDG – completed 11/10/2010
  - GFE installed: Q330S (SN 4131)
  - Also upgraded 2g FBA ES-T to FBA ES-T-4G (IS) and replaced malfunctioning CMG-3T with operational CMG-3ESPC, upgraded frad.
- CI.DSC – completed 11/16/2010
  - GFE installed: PB44 Baler (SN 13501)
  - Also upgraded 2g FBA ES-T to FBA ES-T-4G (IS), replaced battery, upgraded Ethernet radios.
- CI .PDE – completed 11/16/2010
  - GFE installed: Q330S (SN 4196)
  - Also upgraded 2g FBA ES-T to FBA ES-T-4G (IS).
- CI.STG – completed 11/17/2010
  - GFE installed: Q330S (SN 4181)
  - Also upgraded 2g FBA ES-T to FBA ES-T-4G (IS), replaced battery, upgraded fiber transceivers, solved an 18-minute spiking problem on the broadband sensor.
- CI.SDD – completed 11/18/2010
  - GFE installed: Q330S (SN 3457)
  - Also upgraded 2g FBA ES-T to FBA ES-T-4G (IS), upgraded DC power supply, upgraded fiber transceivers.
- CI.DEV – completed 11/22/2010
  - GFE installed: Q330S (SN 4171)
  - Also upgraded 4g FBA ES-T to FBA ES-T-4G (IS), replaced older STS-2 with brand new STS-2.5 to allow for regular maintenance work on the STS-2.
- CI. MGE – completed 11/22/2010
  - GFE installed: Q330S (SN 4237)
  - Also upgraded 4g FBA ES-T to FBA ES-T-4G (IS), replaced older STS-2 with brand new STS-2.5 to allow for regular maintenance work on the STS-2.
- CI.PDU – completed 11/22/2010
  - GFE installed: Q330S (SN 4174)

- Also upgraded 2g FBA ES-T to FBA ES-T-4G (IS), replaced battery, upgraded DC power supply, upgraded fiber transceivers, solved an 18-minute spiking problem on the broadband sensor.
- CI.SPF – completed 11/30/2010
  - GFE installed: Q330S (SN 4305)
  - Also upgraded 2g FBA ES-T to FBA ES-T-4G (IS), replaced battery.
- CI.BAK – completed 12/01/2010
  - GFE installed: Q330S (SN 4311)
  - Also upgraded 2g FBA ES-T to FBA ES-T-4G (IS).
- CI.DEC – completed 12/02/2010
  - GFE installed: Q330S (SN 4331)
  - Also upgraded 2g FBA ES-T to FBA ES-T-4G (IS).
- CI.LLS – completed 12/13/2010
  - GFE installed: Q330S (SN 4303)
  - Also upgraded 2g FBA ES-T to FBA ES-T-4G (IS), upgraded DC power supply, upgraded fiber transceivers.
- CI.TEH – completed 12/14/2010
  - GFE installed: Q330S (SN 4320)
  - Also upgraded 2g FBA ES-T to FBA ES-T-4G (IS), upgraded DC power supply, and solved 18-minute spiking problem on the broadband sensor.
- CI.LCG – completed 12/15/2010
  - GFE installed: Q330S (SN 4312)
  - Also upgraded 2g FBA ES-T to FBA ES-T-4G (IS), replaced battery, upgraded fiber transceivers.
- CI.LFP – completed 12/22/2010
  - GFE installed: Q330S (SN 4133)
  - Also upgraded FBA-23 to FBA ES-T-4G (IS), replaced battery, upgraded DC power supply, pulled commercial power to the vault and installed data logger in vault, corrected timing problem – the old data logger had a bad GPS engine that was stamping data with the year 1991.
- CI.WLT – completed 12/23/2010
  - GFE installed: Q330S (SN 4310)
  - Also upgraded 2g FBA ES-T to FBA ES-T-4G (IS), upgraded fiber transceivers.
- CI.RRX – completed 1/5/2011
  - Replaced aging sensor vault with new, deeper sensor vault
  - GFE installed: Q330S (SN 4321)
  - Also upgraded 2g FBA ES-T to FBA ES-T-4G (IS), replaced battery, upgraded DC power supply.
- CI.CHN – completed 1/6/2011
  - GFE installed: Q330S (SN 4248)
  - Also upgraded 2g FBA ES-T to FBA ES-T-4G (IS), replaced battery, upgraded fiber transceivers.
- CI.MLS – completed 1/6/2011
  - GFE installed: Q330S (SN 4339)

- Also upgraded FBA-23 to FBA ES-T-4G (IS), replaced failing CMG-40T with operational CMG-40T, upgraded fiber transceivers.
- CI.WTT2 – completed 1/6/2011
  - Abandoned the vault and moved all sensors to the floor of the room that houses the data logger; this improved the background noise spectrum significantly
  - GFE installed: Q330S (SN 4351)
  - Also upgraded 2g FBA ES-T to FBA ES-T-4G (IS).
- CI.RIN – completed 1/12/2011
  - GFE installed: Q330S (SN 4232)
  - Also installed FBA ES-T-4G (IS), upgraded DC power supply, replaced battery.
- CI.RINB – completed 1/12/2011
  - GFE installed: PB44 Baler (SN 17555)
  - Moved EpiSensor to CI.RIN
- CI.DLA – completed 1/13/2011
  - GFE installed: Q330S (SN 4336)
  - Also upgraded 2g FBA ES-T to FBA ES-T-4G (IS).
- CI.LGB – completed 1/13/2011
  - GFE installed: Q330S (SN 4340)
  - Also upgraded 2g FBA ES-T to FBA ES-T-4G (IS), and solved an 18-minute spiking problem caused by the old data logger.
- CI.MPP – completed 1/13/2011
  - GFE installed: Q330S (SN 4208)
  - Also upgraded 2g FBA ES-T to FBA ES-T-4G (IS), and moved telemetry link to newer more reliable Ethernet microwave backbone on Edwards Air Force base.
- CI.SRN – completed 1/18/2011
  - GFE installed: Q330S (SN 4316)
  - Also upgraded 2g FBA ES-T to FBA ES-T-4G (IS), replaced ailing CMG-3ESP with operational one.
- CI.CLT – completed 1/21/2011
  - GFE installed: Q330S (SN 4250)
  - Also upgraded 2g FBA ES-T to FBA ES-T-4G (IS), replaced battery, upgraded fiber transceivers, and solved a telemetry problem that was causing large numbers of gaps in the data.
- CI.SNCC – completed 1/25/2011
  - GFE installed: Q330HR (SN 3462); PB44 Baler (SN 15181); FBA ES-T-4G-IS (SN 3776-IS)
  - Also replaced battery, upgraded DC power supply, and dramatically improved telemetry link, solving a bandwidth problem that has plagued this station for a few years. The ARRA-supplied GFE was actually installed 4/26/2010, but because of telemetry problems very little data was coming through. Between the site visit to solve the telemetry problem, the increased bandwidth for moving data, and the data storage capability of the new baler, all the missing data was retrieved.

- CI.RSB – completed 1/26/2011
  - GFE installed: Q330S (SN 4343)
  - Moved EpiSensor to CI.RSS, added a second borehole EpiSensor (from CI.RSS), replaced battery, upgraded DC power supply.
- CI.RSS – completed 1/26/2011
  - GFE installed: Q330S (SN 4307)
  - Also installed upgraded FBA ES-T-4G (IS) (previous 2g FBA ES-T from CI.RSB had a failing Z component), and moved acquisition of the borehole EpiSensor data to CI.RSB.
- CI.SCZ2 – completed 1/24/2011
  - GFE installed: Q330S (SN 4319)
  - Also upgraded 2g FBA ES-T to FBA ES-T-4G (IS), upgraded serial radios to Ethernet radios.
- CI.MSJ – completed 2/1/2011
  - GFE installed: Q330S (SN 4338)
  - Also upgraded 2g FBA ES-T to FBA ES-T-4G (IS), replaced battery, replaced ailing CMG-3ESP with operational CMG-3T, solved a water intrusion problem in the vault.
- CI.LAF – completed 2/4/2011
  - GFE installed: Q330S (SN 4318)
  - Also upgraded 2g FBA ES-T to FBA ES-T-4G (IS), replaced failing STS-2 with operational CMG-3ESPC, replaced fiber transceivers.
- CI.LTP – completed 2/4/2011
  - GFE installed: Q330S (SN 4313)
  - Also upgraded 2g FBA ES-T (which had a noise problem on the N component) to FBA ES-T-4G (IS), replaced fiber transceivers.
- CI.VTV – completed 2/10/2011
  - GFE installed: Q330S (SN 4337)
  - Also upgraded FBA-23 to FBA ES-T-4G (IS), upgraded frad.
- CI.FUR – completed 2/16/2011
  - GFE installed: Q300S (SN 4317)
  - Also replaced failing FBA-23 with FBA ES-T-4G (IS), replaced battery.
- CI.SHO – completed 2/16/2011
  - GFE installed: Q330S (SN 4334)
  - Also replaced failing FBA-23 with FBA ES-T-4G (IS)
- CI.CWC – completed 2/22/2011
  - Installed brand new vault just outside the building which formerly housed the station, greatly improving the noise profile of the station
  - GFE installed: Q330S (SN 3939)
  - Also upgraded aging FBA-23 to FBA ES-T-4G (IS), replaced battery, upgraded DC power supply.
- CI.MIK – completed 2/22/2011
  - GFE installed: PB44 Baler (SN 13514)
- CI.MIKB – completed 2/22/2011
  - GFE installed: PB44 Baler (SN 13470)
- CI.HEC – completed 2/24/2011

- GFE installed: Q330S (SN 4308)
- Also upgraded 2g FBA ES-T to FBA ES-T-4G (IS), upgraded Ethernet radios.
- CI.PASC – completed 3/1/2011
  - GFE installed: 2 PB44 Balers (SN 17548 & SN 17559)
  - Also upgraded 2g FBA ES-T to FBA ES-T-4G (IS).
- CI.IRM – completed 3/2/2011
  - GFE installed: Q330S (SN 4333)
  - Also upgraded 2g FBA ES-T to FBA ES-T-4G (IS), replaced battery, upgraded frad.
- CI.PDM – completed 3/3/2011
  - GFE installed: Q330S (SN 4306)
  - Also upgraded 2g FBA ES-T (which had a noise problem on the E component) to FBA ES-T-4G (IS), replaced battery, upgraded Ethernet radios.
- CI.GATR – completed 3/8/2011
  - GFE installed: PB44 Baler (SN 17557)
  - Also upgraded 2g FBA ES-T to FBA ES-T-4G (IS), upgraded Ethernet radios.
- CI.SLA – completed 3/8/2011
  - GFE installed: Q330S (SN 4346)
  - Also upgraded 2g FBA ES-T (which had an intermittent noise problem on the N component) to FBA ES-T-4G (IS), upgraded frad.
- CI.GSA – completed 3/10/2011
  - GFE installed: Q330S (SN 4191)
  - Also upgraded 2g FBA ES-T to FBA ES-T-4G (IS), upgraded DC power supply.
- CI.HLL – completed 3/15/2011
  - GFE installed: Q330S (SN 4304)
  - Also upgraded 2g FBA ES-T to FBA ES-T-4G (IS), replaced battery, upgraded fiber transceivers, upgraded CMG-40T to CMG-3ESPC.
- CI.SCI2 – completed 3/16/2011
  - GFE installed: PB44 Baler (SN 13513)
  - Also upgraded 2g FBA ES-T to FBA ES-T-4G (IS), replaced battery.
- CI.WNS – completed 3/18/2011
  - GFE installed: PB44 Baler (SN 17562)
  - Also upgraded 2g FBA ES-T to FBA ES-T-4G (IS), replaced battery, upgraded frad DC power supply, and replaced lightning protection board which solved a noise problem on one of the bore hole sensor channels.
- CI.DAN – completed 3/30/2011
  - GFE installed: PB44 Baler (SN 17563)
  - Also upgrade FBA-23 to FBA ES-T-4G (IS), replaced battery, upgraded frad.
- CI.IKP – completed 4/5/2011
  - GFE installed: Q330S (SN 4309)

- Also installed brand new vault, STS-2, and FBA ES-T-4G (IS), thereby reactivating an excellent station that unfortunately had been offline for almost 20 years.
- CI.DJJB – completed 4/19/2011
  - GFE installed: PB44 Baler (SN 17547)
  - Also solved problem with the down hole EpiSensor, returning it to full operational order.
- CI.LUG – completed 5/5/2011
  - GFE installed: Q330S (SN 4190)
  - Also replaced a broken fiber optic line to re-establish telemetry; sealed conduit that was allowing water intrusion to the vault; upgraded FBA-23 to FBA ES-T-4G (IS); replaced battery; upgraded DC power supply; and re-installed sensors to re-activate a station that had been off-line for just over 2 years.
- CI.MPM – completed 5/18/2011
  - GFE installed: PB44 Baler (SN 17579)
  - Also installed long sensor cables so as to install data logger and baler in a small job box outside the tunnel housing the station to ease access to those components.
- CI.VOG – completed 5/26/2011
  - GFE installed: Q330S (SN 4215)
  - Also installed brand new vault, CMG-3T, FBA ES-T-4G (IS), thus bringing on-line a wonderfully quiet station.
- Ft. Scotty telemetry hub upgrade – completed 6/16/2011
  - Installed new battery back-up and power monitoring systems to provide a full 72 hours of backup power in case of a commercial power outage.
- CI.CIA – completed 6/29/2011
  - GFE installed: Q330S (SN 4183)
  - Also replaced malfunctioning STS2 with an operational STS2; replaced broken FBA-23 with operational FBA ES-T-4G (IS); and replaced old shallow vault with brand new deeper vault, improving the noise profile of the station.
- CI.CBC – completed 6/30/2011
  - GFE installed: PB44 Baler (SN 17552)
  - Also, with a generous donation from Kinometrics, added a Q330S, an additional FBA ES-T, and the capability of recording all channels of the existing FBA ES-T sensors, thereby greatly adding to the building monitoring capability of this station.
- CI.LMR2 – completed 7/13/2011
  - GFE installed: PB44 Baler (SN 13511)
  - Also upgraded 2g FBA ES-T to FBA ES-T-4G (IS).