AGREEMENT

31251

THIS AGREEMENT is made and entered, in duplicate, as of August 1, 2009, for reference purposes only, pursuant to a minute order adopted by the City Council of the City of Long Beach at its meeting on July 21, 2009, by and between GEODETICS, INC., a California corporation, with a place of business at 2649 Ariane Drive, San Diego, CA 92117 ("Consultant"), and the CITY OF LONG BEACH, a municipal corporation ("City").

WHEREAS, the City requires specialized services requiring unique skills and software to be performed and used in connection with its ongoing subsidence monitoring and mapping ("Project"); and

WHEREAS, City has selected Consultant in accordance with City's administrative procedures and City has determined that Consultant and its employees are qualified, licensed, if so required, and experienced in performing these specialized services; and

WHEREAS, City desires to have Consultant perform these specialized services, and Consultant is willing and able to do so on the terms and conditions in this Agreement;

NOW, THEREFORE, in consideration of the mutual terms, covenants, and conditions in this Agreement, the parties agree as follows:

1. SCOPE OF WORK OR SERVICES.

A. Consultant shall furnish specialized services more particularly described in Exhibit "A", attached to this Agreement and incorporated by this reference, in accordance with the standards of the profession, and City shall pay for these services in the manner described in Exhibit "A", not to exceed (i) One Hundred Seventy-Eight Thousand Four Hundred Eighty Dollars ($178,480) over the first three years of the term and (ii) Twenty-Nine Thousand Seven Hundred Dollars over each of the option years described in Section 2, below.

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B. Consultant may select the time and place of performance for these services provided, however, that access to City documents, records, and the like, if needed by Consultant, shall be available only during City's normal business hours and provided that milestones for performance, if any, are met.

C. Consultant has requested to receive regular payments. City shall pay Consultant annually in advance following receipt from Consultant and approval by City of invoices showing the services or task performed or to be performed, the time expended (if billing is hourly) or to be expended, and the name of the Project. Consultant shall certify on the invoices that Consultant has performed or shall perform the services in full conformance with this Agreement and is entitled to receive payment.

D. Consultant represents that Consultant has obtained all necessary information on conditions and circumstances that may affect its performance and has conducted site visits, if necessary.

2. TERM. The term of this Agreement shall commence on August 1, 2009, and shall terminate on July 31, 2012, unless terminated earlier, as provided in this Agreement. City's City Manager shall have two options to renew the Agreement for a period of one-year each.

3. COORDINATION AND ORGANIZATION. Consultant shall coordinate its performance with City's representative, Mike Henry, or other employee designated by City. Consultant shall advise and inform City's representative of the work in progress on the Project in sufficient detail so as to assist City's representative in making presentations and in holding meetings on the Project.

4. INDEPENDENT CONTRACTOR. In performing its services, Consultant is and shall act as an independent contractor and not an employee, representative, or agent of City. Consultant shall have control of Consultant's work and the manner in which it is performed. Consultant shall be free to contract for similar services to be performed for others during this Agreement provided, however, that

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Consultant acts in accordance with Section 9 and Section 11 of this Agreement. Consultant acknowledges and agrees that a) City will not withhold taxes of any kind from Consultant's compensation, b) City will not secure workers' compensation or pay unemployment insurance to, for or on Consultant's behalf, and c) City will not provide and Consultant is not entitled to any of the usual and customary rights, benefits or privileges of City employees. Consultant expressly warrants that neither Consultant nor any of Consultant's employees or agents shall represent themselves to be employees or agents of City.

5. INSURANCE.

A. As a condition precedent to the effectiveness of this Agreement, Consultant shall procure and maintain, at Consultant's expense for the duration of this Agreement, from insurance companies that are admitted to write insurance in California and have ratings of or equivalent to A:V by A.M. Best Company or from authorized non-admitted insurance companies subject to Section 1763 of the California Insurance Code and that have ratings of or equivalent to A:VIII by A.M. Best Company the following insurance:

(a) Commercial general liability insurance (equivalent in scope to ISO form CG 00 01 11 85 or CG 00 01 10 93) in an amount not less than $1,000,000 per each occurrence and $2,000,000 general aggregate. This coverage shall include but not be limited to broad form contractual liability, cross liability, independent contractors liability, and products and completed operations liability. The City, its boards and commissions, and their officials, employees and agents shall be named as additional insureds by endorsement (on City's endorsement form or on an endorsement equivalent in scope to ISO form CG 20 10 11 85 or CG 20 26 11 85), and this insurance shall contain no special limitations on the scope of protection given to the City, its boards and commissions, and their officials, employees and agents. This policy shall be endorsed to

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state that the insurer waives its right of subrogation against City, its boards and commissions, and their officials, employees and agents.

(b) Workers' Compensation insurance as required by the California Labor Code and employer's liability insurance in an amount not less than $1,000,000. This policy shall be endorsed to state that the insurer waives its right of subrogation against City, its boards and commissions, and their officials, employees and agents.

(c) Professional liability insurance in an amount not less than $1,000,000 per claim.

B. Any self-insurance program, self-insured retention, or deductible must be separately approved in writing by City's Risk Manager or designee and shall protect City, its officials, employees and agents in the same manner and to the same extent as they would have been protected had the policy or policies not contained retention or deductible provisions.

C. Each insurance policy shall be endorsed to state that coverage shall not be reduced, non-renewed, or canceled except after thirty (30) days prior written notice to City, shall be primary and not contributing to any other insurance or self-insurance maintained by City, and shall be endorsed to state that coverage maintained by City shall be excess to and shall not contribute to insurance or self-insurance maintained by Consultant. Consultant shall notify the City in writing within five (5) days after any insurance has been voided by the insurer or cancelled by the insured.

D. If this coverage is written on a "claims made" basis, it must provide for an extended reporting period of not less than one hundred eighty (180) days, commencing on the date this Agreement expires or is terminated, unless Consultant guarantees that Consultant will provide to the City evidence of uninterrupted, continuing coverage for a period of not less than three (3) years, commencing on the date this Agreement expires or is terminated.

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E. Consultant shall require that all subconsultants or contractors which Consultant uses in the performance of these services maintain insurance in compliance with this Section unless otherwise agreed in writing by City's Risk Manager or designee.

F. Prior to the start of performance, Consultant shall deliver to City certificates of insurance and the endorsements for approval as to sufficiency and form. In addition, Consultant, shall, within thirty (30) days prior to expiration of the insurance, furnish to City certificates of insurance and endorsements evidencing renewal of the insurance. City reserves the right to require complete certified copies of all policies of Consultant and Consultant's subconsultants and contractors, at any time. Consultant shall make available to City's Risk Manager or designee all books, records and other information relating to this insurance, during normal business hours.

G. Any modification or waiver of these insurance requirements shall only be made with the approval of City's Risk Manager or designee. Not more frequently than once a year, the City's Risk Manager or designee may require that Consultant, Consultant's subconsultants and contractors change the amount, scope or types of coverages required in this Section if, in his or her sole opinion, the amount, scope, or types of coverages are not adequate.

H. The procuring or existence of insurance shall not be construed or deemed as a limitation on liability relating to Consultant's performance or as full performance of or compliance with the indemnification provisions of this Agreement.

6. ASSIGNMENT AND SUBCONTRACTING. This Agreement contemplates the personal services of Consultant and Consultant's employees, and the parties acknowledge that a substantial inducement to City for entering this Agreement was and is the professional reputation and competence of Consultant and Consultant's employees. Neither party may assign or otherwise dispose of its rights or obligations

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under this Agreement without the prior written consent of the other party. Any unapproved assignment or delegation shall be void, and any assignee or delegate shall acquire no right or interest by reason of an attempted assignment or delegation

7. CONFLICT OF INTEREST. Consultant, by executing this Agreement, certifies that, at the time Consultant executes this Agreement and for its duration, Consultant does not and will not perform services for any other client which would create a conflict, whether monetary or otherwise, as between the interests of City and the interests of that other client. Consultant shall obtain similar certifications from Consultant's employees, subconsultants and contractors.

8. MATERIALS. Consultant shall furnish all labor and supervision, supplies, materials, tools, machinery, equipment, appliances, transportation, and services necessary to or used in the performance of Consultant's obligations under this Agreement.

9. OWNERSHIP OF DATA. All material, information and data furnished to Consultant, by City, in connection with this Agreement, including but not limited to documents, estimates, calculations, studies, maps, graphs, charts, computer disks, computer source documentation, samples, models, reports, summaries, drawings, designs, notes, plans, information, material, and memorandum ("Data") shall be the exclusive property of City. Copies of Data may be retained by Consultant but Consultant warrants that Data shall not be made available to any person or entity for use without the prior approval of City. This warranty shall survive termination of this Agreement for five (5) years. Consultant retains all rights to any information, work, invention, or development in any form or medium, including all materials, documents, information, software, or technology, created by Consultant as a result of performing the services except as otherwise provided in this Agreement. The application is the property of Consultant and Consultant retains all intellectual property rights to its software, or any modifications thereof, or enhancements created as part of customization services performed on behalf of the City.

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10. TERMINATION. Either party shall have the right to terminate this Agreement for any reason or no reason at any time by giving thirty (30) calendar days prior notice to the other party. In the event of termination under this Section, City shall pay Consultant for services satisfactorily performed and costs incurred up to the effective date of termination for which Consultant has not been previously paid.

11. CONFIDENTIALITY. The obligations of confidentiality and nondisclosure survive the termination of this Agreement. Either party may disclose to other party information, data, concepts, ideas, processes, methods, techniques, formulas, know-how, trade secrets, and improvements which are confidential and proprietary to the disclosing party (hereinafter referred to as "Confidential Information") so that Consultant can perform the Services. Confidential Information shall remain the property of the disclosing party. The receiving party agrees to hold all Confidential Information in confidence and will exercise the same degree of care to prevent disclosure to others as it takes to preserve and safeguard his/its own Confidential Information, but not less than a reasonable degree of care. The receiving party agrees not to disclose otherwise disseminate the Confidential Information to others, unless required to do so pursuant to applicable law, including without limitation the California Public Records Request Act. The receiving party will not reproduce Confidential Information nor use Confidential Information commercially or for any purpose other than the performance of his or its obligations under this Agreement.

12. BREACH OF CONFIDENTIALITY. Consultant shall not be liable for a breach of confidentiality with respect to Data that: (a) Consultant demonstrates Consultant knew prior to the time City disclosed it; or (b) is or becomes publicly available without breach of this Agreement by Consultant; or (c) a third party who has a right to disclose does so to Consultant without restrictions on further disclosure; or (d) must be disclosed pursuant to subpoena or court order.

13. ADDITIONAL COSTS AND REDESIGN. Any costs incurred by the City due to Consultant's failure to meet the standards required by the scope of work or

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Consultant's failure to perform fully the tasks described in the scope of work which, in either case, causes the City to request that Consultant perform again all or part of the Scope of Work shall be at the sole cost of Consultant and City shall not pay any additional compensation to Consultant for its re-performance.

14. AMENDMENT. This Agreement, including all Exhibits, shall not be amended, nor any provision or breach waived, except in writing signed by the parties which expressly refers to this Agreement.

15. LAW. This Agreement shall be governed by and construed pursuant to the laws of the State of California (except those provisions of California law pertaining to conflicts of laws). Consultant shall comply with all laws, ordinances, rules and regulations of and obtain all permits, licenses, and certificates required by all federal, state and local governmental authorities.

16. ENTIRE AGREEMENT. This Agreement, including all Exhibits, constitutes the entire understanding between the parties and supersedes all other agreements, oral or written, with respect to the subject matter in this Agreement.

17. INDEMNITY. Consultant shall, with respect to services performed in connection with this Agreement, indemnify and hold harmless the City, its Boards, Commissions, and their officials, employees and agents (collectively in this Section, "City") from and against any and all liability, claims, demands, damage, loss, causes of action, proceedings, penalties, costs and expenses (including attorney's fees, court costs, and expert and witness fees) (collectively "Claims" or individually "Claim"). Claims include allegations and include Claims for property damage, personal injury or death arising in whole or in part from any negligent act or omission of Consultant, its officers, employees, agents, sub-consultants, or anyone under Consultant's control (collectively "Indemnitor"); recklessness; and willful misconduct. Independent of the duty to indemnify, but only to the extent permitted by law and specifically by Civil Code Section 2782.8, and as a free-standing duty on the part of Consultant, Consultant shall defend City and shall continue this defense until the Claim is resolved, whether by settlement,

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judgment or otherwise. No finding or judgment of negligence, fault, breach, or the like on the part of Indemnitor shall be required for the duty to defend to arise. Consultant shall notify the City of any Claim within ten (10) days. Likewise, City shall notify Consultant of any Claim, shall tender the defense of the Claim to Consultant, and shall assist Consultant at Consultant's sole expense, as may be reasonably requested, in the defense.

18. AMBIGUITY. In the event of any conflict or ambiguity between this Agreement and any Exhibit, the provisions of this Agreement shall govern.

19. COSTS. If there is any legal proceeding between the parties to enforce or interpret this Agreement or to protect or establish any rights or remedies under it, the prevailing party shall be entitled to its costs, including reasonable attorneys' fees.

20. NONDISCRIMINATION.

A. In connection with performance of this Agreement and subject to applicable rules and regulations, Consultant shall not discriminate against any employee or applicant for employment because of race, religion, national origin, color, age, sex, sexual orientation, gender identity, AIDS, HIV status, handicap, or disability. Consultant shall ensure that applicants are employed, and that employees are treated during their employment, without regard to these bases. These actions shall include, but not be limited to, the following: employment, upgrading, demotion or transfer, recruitment or recruitment advertising, layoff or termination, rates of pay or other forms of compensation, and selection for training, including apprenticeship.

B. It is the policy of City to encourage the participation of Disadvantaged, Minority and Women-owned Business Enterprises in City's procurement process, and Consultant agrees to use its best efforts to carry out this policy in its use of subconsultants and contractors to the fullest extent consistent with the efficient performance of this Agreement. Consultant may rely on written representations by subconsultants and contractors regarding their

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status. Consultant shall report to City in May and in December or, in the case of short-term agreements, prior to invoicing for final payment, the names of all subconsultants and contractors hired by Consultant for this Project and information on whether or not they are a Disadvantaged, Minority or Women-Owned Business Enterprise, as defined in Section 8 of the Small Business Act (15 U.S.C. Sec. 637).

21. NOTICES. Any notice or approval required by this Agreement shall be in writing and personally delivered or deposited in the U.S. Postal Service, first class, postage prepaid, addressed to Consultant at the address first stated above, and to the City at 333 West Ocean Boulevard, Long Beach, California 90802, Attn: City Manager. Notice of change of address shall be given in the same manner as stated for other notices. Notice shall be deemed given on the date deposited in the mail or on the date personal delivery is made, whichever occurs first.

22. COPYRIGHTS AND PATENT RIGHTS. Consultant warrants that the Data does not violate or infringe any patent, copyright, trade secret or other proprietary right of any other party. Consultant agrees to and shall protect, defend, indemnify and hold City, its officials and employees harmless from any and all claims, demands, damages, loss, liability, causes of action, costs or expenses (including reasonable attorneys' fees) whether or not reduced to judgment, arising from any breach or alleged breach of this warranty.

23. COVENANT AGAINST CONTINGENT FEES. Consultant warrants that Consultant has not employed or retained any entity or person to solicit or obtain this Agreement and that Consultant has not paid or agreed to pay any entity or person any fee, commission, or other monies based on or from the award of this Agreement, excluding Consultant's agreement with Cardon Solutions. If Consultant breaches this warranty, City shall have the right to terminate this Agreement immediately notwithstanding the provisions of Section 10 or, in its discretion, to deduct from payments due under this Agreement or otherwise recover the full amount of the fee, commission, or

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other monies.

24. WAIVER. The acceptance of any services or the payment of any money by City shall not operate as a waiver of any provision of this Agreement or of any right to damages or indemnity stated in this Agreement. The waiver of any breach of this Agreement shall not constitute a waiver of any other or subsequent breach of this Agreement.

25. CONTINUATION. Termination or expiration of this Agreement shall not affect rights or liabilities of the parties which accrued pursuant to Sections 7, 10, 11, 17, 19, and 22 prior to termination or expiration of this Agreement.

26. TAX REPORTING. As required by federal and state law, City is obligated to and will report the payment of compensation to Consultant on Form 1099-Misc. Consultant shall be solely responsible for payment of all federal and state taxes resulting from payments under this Agreement. Consultant's Employer Identification Number is [redacted] If Consultant has a Social Security Number rather than an Employer Identification Number, then Consultant shall submit that Social Security Number in writing to City's Accounts Payable, Department of Financial Management. Consultant acknowledges and agrees that City has no obligation to pay Consultant until Consultant provides one of these numbers.

27. AUDIT. City shall have the right at all reasonable times during the term of this Agreement and for a period of four (4) years after termination or expiration of this Agreement to examine, audit, inspect, review, extract information from, and copy all books, records, accounts, and other documents of Consultant relating to this Agreement.

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IN WITNESS WHEREOF, the parties have caused this document to be duly executed with all formalities required by law as of the date first stated above.

GEODETICS, INC., a California Corporation

July 23rd, 2009

By Lydia Bock

Dr. Lydia Bock
Type or Print Name

President & CEO
Title

July 23RD, 2009

By Jeff Fayman

Dr. Jeff Fayman
Type or Print Name

V.P. Planning & Development
Title

"Consultant"

CITY OF LONG BEACH, a municipal corporation

August 6, 2009

By Assistant City Manager

City Manager

EXECUTED PURSUANT TO SECTION 301 OF THE CITY CHARTER.

"City"

This Agreement is approved as to form on July 29, 2009.

ROBERT E. SHANNON, City Attorney

By

Deputy

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Volume 1
Technical Proposal

RFP No: G0 09-036
Purchase of GPS Real-Time Network
Software, Installation, Support and Training

Offeror's Name:	Geodetics Inc.
Mailing Address:	2649 Ariane Drive San Diego, CA 92117
Phone:	(858)729-0872
Fax:	(858)729-0874
Submission Date:	15 May 2009
Submitted to:	City of Long Beach Purchasing Division Attn: Peggy Chambers 333 W Ocean Blvd/7th Floor Long Beach CA 90802

Points of Contact:

Contractual		Technical	
Name :	Dr. Lydia Bock	Name:	Dr. Jeffrey Fayman
Address:	2649 Ariane Dr., San Diego San Diego, CA 92117	Address:	2649 Ariane Dr. San Diego, CA 92117
Phone:	(858)729-0872	Phone:	(858)729-0872
Fax:	(858)729-0874	Fax:	(858)729-0874
Email :	lydia@geodetics.com	Email :	jfayman@geodetics.com

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Executive Summary

Geodetics, Inc., located in San Diego, California is pleased to respond to the Request for Proposal (Number GO 09-036 dated 5/1/09) from The City of Long Beach Subsidence and Geology Division

Geodetics has developed a unique, innovative system for accurate real time reference networks in regions of active deformation, suitable for network RTK, rapid (fast) static and static surveying, CGPS/CORS maintenance, geodetic control, height modernization, crustal motion/deformation monitoring, as well as a variety of dynamic/transportation/fleet and GIS/resource mapping applications. Our unique Epoch-by-Epoch™ precise instantaneous network ("PIN") positioning technology does away with initialization and re-initialization periods inherent in traditional RTK and network RTK systems allowing true dynamic solutions, hence the name for our software suite, Real Time Dynamics (RTD). Integral to the system is a server/client software suite (RTD Pro/Rover) sustainable over TCP/IP and/or serial communication links. The Geodetics system is compatible with equipment from all major GPS/GNSS manufacturers (Leica, Navcom, Novatel, Sokkia, Thales/Ashtech, Topcon, and Trimble), with and without internal RTK capability, and allows the recycling of most legacy equipment. Furthermore, Geodetics products are extensible to new developments in GPS modernization (third frequency, L2C) and availability of other GNSS constellations (GLONASS, GALILEO).

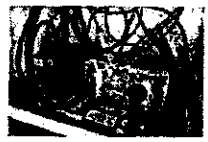
Our software solution for Long Beach is modeled after the successful implementation by the Scripps Institution of Oceanography (SIO) and its partners of the California Real Time Network (CRTN - http://sopac.ucsd.edu/projects/realtime) using licensed Geodetics' technology. CRTN currently numbers more than 75 CGPS RT stations. This unique network is a model of partnerships with the scientific community, local agencies (Orange and San Diego Counties), and water districts (Metropolitan Water District, Santa Clara Water District). With these and with a growing number of national and international deployments, Geodetics staff members have considerable hands-on experience and expertise in all aspects of real-time continuous GNSS operations.

Geodetics, as a Woman Owned Small Business (WOSB), is well known since 1999 for its excellent customer support, which only a small business can provide, and for the user-friendliness of its software products.

Part I

Requirement 1

Software shall be able to calculate the real-time three-dimensional position of each reference station utilizing existing components and infrastructure (see Figures 1 and 2).



Examples of GPS based receivers supported by RTD.

The Geodetics system solution is compatible with Long Beach's existing Trimble 5700 receivers and will run very well on the Dell PowerEdge 2950. Further, in the interest of future expansion of the Long Beach network, the solution is compatible with equipment from all major GPS/GNSS manufacturers (Leica, Navcom, Novatel, Thales/Ashtech, Topcon, Trimble, and Sokkia), and allows the recycling of most legacy equipment for base and rover receivers. Our approach basically treats the GPS receiver/antenna as an off-the-shelf item that is used strictly to provide raw carrier phase and pseudorange measurements, i.e., a raw GPS measurement engine. All other functions are controlled by RTD server/rover software. Geodetics software has no problem accommodating any mix of receivers/antennas in a RTN. Geodetics adds additional receiver support to its software applications as they become available, in particular as requested by customers. Furthermore, Geodetics products are extensible to new developments in GPS modernization (third frequency, L2C) and availability of other GNSS constellations (GLONASS, GALILEO).

Requirement 2

For network flexibility, the software must be compatible with a wide variety of dual-frequency geodetic grade survey receivers.

Since Geodetics does not manufacture GPS receiver hardware, our software solutions are "platform independent". Geodetics does not have "a dog in the hunt" in the sense that our software works equally well with equipment from all major GPS/GNSS manufacturers (Leica, Navcom, Novatel, Thales/Ashtech, Topcon, Trimble, and Sokkia). This can not be said for hardware manufactures that optimize their solutions to work best with their own hardware. Our approach basically treats the GPS receiver/antenna as an off-the-shelf item that is used strictly to provide raw carrier phase and pseudorange measurements, i.e., a raw GPS measurement engine. All other functions are controlled by RTD server/rover software. Geodetics software has no problem accommodating any mix of receivers/antennas in a RTN.

RTD supports all existing RTK rovers with its Standard and Enhanced RTK modes. RTD Rover software allows the user to derive full benefit from Geodetics unique system through the Guest and Smart Client modes. RTD Rover software has been integrated with Carlson SurvCE software.

Note: Geodetics will consider integration with other survey applications as requested by customers, and as supported by manufacturers.

Geodetics RTD Pro server supports several TCP/IP-based client servers. The *Standard RTK Server* provides RTCM version 2.2, 2.3, 3.0 (in progress), CMR, or CMR+ data to field receivers by assigning a unique IP and port number to each site. In this mode, for example, the user can sequence between different sites to multiply-determine position, as a way of improving precision and reliability [*Andrew*, 2003]. The *Enhanced RTK Server* provides RTCM data from the closest site in the network based on a NMEA position message sent by the field receiver to the server. Both of these options allow for conventional RTK solutions, and relieve the user of having to set up and maintain an RTK base station. The RTK computations are performed in the field GPS receiver and are dependent on the embedded RTK positioning algorithms. In OCRTN, ambiguity fixed solutions require several seconds to several minutes or more in typical field operations using geodetic receivers from three major GPS manufacturers [*Andrew*, 2003]. Distances from the closest base station can range up to 35 km when working in northeastern Orange County.

The *Guest RTCM* and *Smart RTCM* servers support users with Geodetics *RTD Rover*, using standard and proprietary RTCM messages. The Smart Client software operates on a Windows CE-based PDA, equipped with a wireless modem card. Unlike the Standard and Enhanced RTK servers, the positioning is performed on the server (Guest mode) or on the PDA (Smart Client mode) using Epoch-by-Epoch™ technology and not in the receiver, and is compatible with any dual-frequency GPS receiver. Raw (or RTCM) data from the receiver are collected by the PDA through a direct serial connection. RTCM data from a user-selectable number of base stations are collected by the PDA from the RTD server.

At each observation epoch, RTD Server/Rover will calculate a position for the rover receiver based on a rigorous Epoch-by-Epoch™ network solution, hence *Instantaneous Network RTK*. This server/client relationship provides zero initialization and re-initialization times compared to several seconds to several minutes compared to other available network RTK solutions. Furthermore, compared to virtual base station approaches, Smart Client uses unaltered raw data from real base stations, and (optionally) supplemented by network corrections transmitted in a proprietary RTCM message. This avoids reference frame localization issues associated with virtual base stations. The network corrections are primarily intended to reduce ionospheric refraction effects that are the limiting factors for instantaneous ambiguity resolution at extended ranges. Zenith delay parameters estimated at the client as part of the Epoch-by-Epoch™ positioning algorithm, reduce the effects of tropospheric refraction. The broadcast ephemeris is usually sufficient for most scenarios, but RTD Server/Rover can retrieve precise real-time orbits from a number of sources via the Internet.

RTD Rover is platform independent and does not require in-receiver RTK, allowing the use of most legacy equipment. RTD Rover makes use of TCP/IP or RS-232/Bluetooth communications to field receiver, reference stations and data controllers, such as Carlson SurvCE

In the direct Smart Client mode RTD Rover sends a NMEA GGA message to the server to a single IP port (to denote its approximate position), with a request for reference site data from the

n closest stations, or from *n* specified stations. At each observation epoch, the data from the *n* reference stations are transmitted in RTCM 2.3 format to the rover where they are adjusted together with the raw receiver data to estimate instantaneous rover positions. RTD Rover assigns very tight constraints to the transmitted base station coordinates for both the "float" and "fixed" solutions. *That is, the RTD Rover provides an independent overly constrained network adjustment at each observation epoch.* The position estimates and their covariances of the rover can be transmitted in NMEA GGA format to another application (e.g., Carlson SurvCE) running on the same device or an external data logger.

In the inverse Guest mode (see Figure 1), RTD Rover streams RTCM 2.3 data from the rover receiver to the RTD Pro server. A process on the server estimates the position of the rover with respect to a user-specified sub-network of 3 reference stations (either by closeness to the rover or by a specified list of reference stations). The adjusted instantaneous rover positions are streamed to the RTD Rover in NMEA GGA format over the same data channel. The advantages of this approach are as follows:

(1) It requires minimal CPU at data logger, since PIN positioning is performed at the server. Current data loggers have limited processing power and no floating-point processors (to conserve battery power).
(2) It is not communications bandwidth limited, since only a single output stream of RTCM messages is sent from rover to server, rather than multiple streams from server to rover in direct mode.
(3) Considering points (1) and (2), it is more amenable to processing very high-rate data (e.g., machine control, seismic monitoring).
(4) It allows a manager to determine the status of field units in real time. Raw data from the rover and the estimated PIN positions can be archived at the server, or fed into a local or external application in open Geodetics RYO binary format.
(5) It is straightforward to include and apply external troposphere and ionosphere models, geoid models, crustal velocity models (e.g., HTDP), etc., at the server side, using existing RTCM protocols.

Requirement 3
Software shall have the capability to download and process real-time streaming data from the National Geodetic Survey Continuously Operating Reference Stations (CORS)

Any CORS site providing access to its real-time stream data can be included and processed within the RTD network. For real-time applications, the PC workstation must be linked to each of the sites using one or more communication devices such as direct serial connection via an RS-232 cable or a TCP/IP network connection.

Requirement 4
Software shall have the capability to download and incorporate precise orbit and ionospheric corrections for accurate GPS position solutions.

RTD treats atmospheric effects using internal and external procedures, and separates the treatment of tropospheric and ionospheric effects. Unlike other network RTK approaches, RTD does not attempt to interpolate atmospheric effects across the network, recognizing that the atmosphere is by nature a turbulent process. RTD also includes the ability to input ultra-rapid orbits updated hourly by the SOPAC under contract to NOAA.

Internal Troposphere Treatment

Geodetics' unique Epoch-by-Epoch™ technology also permits estimation of a zenith tropospheric path delay ("troposphere delay") parameter simultaneously with site coordinates. This parameter is only a nuisance when the purpose is to monitor site positions and network integrity. However, the zenith path delay is useful if the purpose of the network is to monitor atmospheric water vapor, the most important element in short-term weather forecasting and climate studies.

In both Guest and Smart Client modes, a troposphere delay parameter is also estimated for the rover receiver on an epoch-by-epoch™ basis, as part of a rigorous sub-network analysis. Direct estimation of the troposphere correction at the rover is preferable to interpolation of a troposphere correction.

External Troposphere Treatment

RTD Version 3.5 includes the input of NOAA's Earth System Research Laboratory (ESRL) troposphere model for the continental U.S. for improved vertical coordinate precision, in real-time and post-processing modes. Evaluation of this model is being performed by Geodetics under contract to NOAA/ESRL and reveals factor of 2-3 improvement in vertical coordinate precision. This improvement is significant, in particular to meet NGS height modernization specifications.

This feature is in the process of being incorporated into RTD's Guest mode. The real-time NOAA model allows us to input accurate *a priori* zenith delay estimates at base and rover locations, and to constrain the Epoch-by-Epoch™ network solution that includes troposphere parameter estimates. The improvement in precision is due directly to reducing the well-known correlation between vertical coordinates, troposphere zenith delay, and antenna multipath.

Internal Ionosphere Treatment

RTD can produce single-epoch solutions using either independent L1 and L2 phase observations or ionosphere-free linear combinations of phase observations ("LC" or "L3") observations. The LC option should be used when rover distance from base are longer than a few kilometers.

Epoch-by-Epoch™ positions are instantaneous positions that are fully independent at each epoch of observation. That is, RTD provides an instantaneous snapshot of the receiver geometry at each epoch of observation. At each epoch of observation, RTD performs an independent adjustment of data collected by a group of GPS geodetic systems, which produces a consistent set of positions for each sensor. Single-epoch data analysis is a multi-step procedure that requires the resolution of integer-cycle phase ambiguities and the estimation of certain additional parameters such as zenith troposphere delay parameters. It is critical to be able to resolve phase

ambiguities to their correct integer values in order to determine position at the centimeter level. Once the phase ambiguities are resolved, RTD uses the ionosphere-free phase observable to estimate the base and rover coordinates. This performed independently at each observation epoch.

External Ionosphere Treatment

RTD Version 3.5 includes the input of NOAA's Earth System Research Laboratory (ESRL) ionosphere model for the continental U.S. for improved ambiguity resolution in real-time and post-processing modes. Evaluation of this model is being performed by Geodetics under contract to NOAA/ESRL and reveals improved ambiguity resolution over longer distances. This improvement is significant in both horizontal and vertical coordinates.

This feature is in the process of being incorporated into RTD's Guest mode. The real-time NOAA model allows us to input accurate *a priori* ionosphere TEC models as part of the Epoch-by-Epoch™ network. This results in improved single-epoch ambiguity resolution over longer distances and should be beneficial for CVSRN.

Precise Orbits

The following RTD options are available for acquiring GPS orbits:

- From the navigation messages collected by the network stations
- A broadcast ephemeris file in RINEX format
- An IGS "auto" file that includes concatenated navigation messages from many global or regional sites in RINEX format
- An IGS file in SP3 format (IGS files can be obtained from http://igscb.jpl.nasa.gov).
- Collection of ultra-rapid orbits (6 hour latency) from IGS analysis centers, suitable for real-time streaming applications if Internet connectivity is available.
- Collection of ultra-rapid orbits (1 hour latency) from SOPAC (http://garner.ucsd.edu/pub/products/) suitable for real-time streaming applications if Internet connectivity is available.

The last bullet is available through RTD's Guest mode.

Requirement 5

Software must be able to post-process raw data files generated during the biannual surveys without data file conversion by proprietary software.

Although RTD is designed for robust 24-7 real-time processing of GPS data, it also comes with a powerful post-processing capability, which can be performed in parallel with real-time operations.

RTD post-process mode currently supports:

- RINEX files from any type of single- or dual-frequency geodetic receiver
- Leica data files in LB2 or MDB format

- Ashtech data files in MBEN/PBEN binary format
- Trimble data files in RT17 format
- Novatel data files in OEM4 format
- Topcon data files in GRIL format using the rM message
- Navcom data files

Requirement 6
Software shall include a module to perform a least-square adjustment on the post-processed biannual survey data.

RTD starts with user-specified *a priori* values (reference positions) for site coordinates. Adjustments are estimated for these parameters independently at each epoch by means of a linearized least-squares algorithm. The user can specify that the adjustment be repeated (iterated), either a certain number of times or until the adjusted values are within a certain threshold. On the other hand if the adjustments are expected to differ only slightly from the *a priori* values (e.g., with a multi-site base network) it is more efficient not to iterate on the adjustment parameters.

The user can choose to update the reference positions based on an absolute pseudorange solution, or based on a relative pseudorange solution for a site with respect to the Master Site.

Requirement 7
All software and modules shall be fully integrated and reside on the existing City server located in Long Beach City Hall.

RTD will be installed on the existing City server located at Long Beach City Hall.

Requirement 8
Software shall be administrated by LBGO personnel and shall support four remote terminals for key personnel.

RTD places no limits on the number of remote terminals. Remote terminals are established through the use of Remote Desktop Connections.

Requirement 9
Software shall be in common usage to measure surface deformation.

The proposed solution is used in many surface deformation applications in the United States and worldwide (30 locations) including, but not limited to, the following deployments: geodetic control (30 locations worldwide, crustal deformation (California, Canada), structure deformation (Varrazano bridge, shaketable), subsidence (Venice, Italy), earthem dam (Diamond Valley Lake), volcano monitoring (Italy, Japan), land slide monitoring (Malaysia).

Please see Appendix A: "Deformation Monitoring and Early Warning SystemUtilizing Epoch-by-Epoch™ GPS Based Technology" *paper presented in Malaysia 2006 for Slope Engineering Branch, Ministry Of Works (JKR)*

Requirement 10
The software will be capable of expansion in the future. Expansion may include additional reference stations or a Real-Time Kinematic (RTK) function for surveyors.

Additional reference receivers can easily be added to RTD (without stopping the network to do it). Geodetics has been involved in the development of the California Real Time Network (CRTN) in a piecemeal evolving fashion that includes partnering with various entities. We initially supported the Orange County RTN with 10 stations, and later scaled up to include San Diego County, and then MWD. The network now numbers more than 70 stations.

RTD allows access to network RTK data in 4 basic flavors. All but one requires only a single IP port to be accessible to external users (not withstanding IT issues). Standard RTK requires an IP port for each of *n* CGPS stations, and can support several RTK formats including different flavors of RTCM and CMR. Standard RTK and Enhanced RTK can support any RTK-enabled GPS receiver, while Smart Client and Guest modes are available to clients with RTD Rover software.

Requirement 11
The vertical accuracy of the RTN software shall be clearly stated in feet.

Currently, all measurements are provided in meters. Should Geodetics' solution be selected for this project, we will modify the statistics window, which presents the user with vertical accuracy, to present this information in feet.

Requirement 12
The software shall incorporate the existing Long beach geoid model.

It is straightforward to include and apply external troposphere and ionosphere models, geoid models, crustal velocity models (e.g., HTDP), etc., at the server side, using existing RTCM protocols.

Part II

1. Install and configure the RTN software with the existing GPS infrastructure.

Geodetics will install and configure the RTN software with the existing GPS infrastructure. It is assumed that data connections to the reference receivers and IT support to navigate Long Beach firewalls etc. will be provided by the customer.

It is assumed that the installation and configuration task will take 2 days to perform.

2. Perform a quality control evaluation by comparing benchmark elevations calculated by the new software and the existing software.

Geodetics will perform a quality control evaluation by comparing benchmark elevations calculated by the new software and the existing software. It is assumed that Long Beach staff will support Geodetics in operating the existing software.

It is assumed that no more than 4 days per year will be required for this activity. Additional analysis will be provided if requested by LBGO on an hourly basis.

3. Provide software training for LBGO personnel and Public Works surveyors on the installed software in Long Beach

Geodetics will provide software training for LBGO personnel and Public Works surveyors on the installed software in Long Beach. It is assumed that no more than one 1/2 day training session will be required.

Part III

1. Provide ongoing technical support, software upgrades and maintenance

Geodetics will provide software upgrades and maintenance for LBGO personnel and Public Works surveyors on the installed software in Long Beach.

Maintenance support includes:

- Software upgrades for one year
- Email support (up to 8 hrs) for one year from date of purchase (72 hour response time)

If requested by LBGO additional support may be provided on an hourly basis.

7: Warranty/Maintenance and Service

7.1 *The length and terms of the warranty/maintenance and service provided for the RTN software.*

Geodetics, Inc will provide support for its software products for THREE (3) YEARS from date of original purchase (Year 4 and 5 are optional).

Date of original purchase shall mean the date of the invoice to the original customer for the product.

This warranty does not cover and shall be void for damage or failure resulting from misuse, neglect, accident, alteration, abuse, improper installation, non-approved antenna, cables, accessories, or operation in an environment other than intended. Improper service or repair by anyone other than Geodetics personnel, or improper connections with peripherals or other causes not arising from defects in materials or workmanship voids this warranty.

In no event will Geodetics be liable for any indirect, incidental, special or consequential damages whether through tort, contract or otherwise. This warranty is expressly in lieu of all other warranties, expressed or implied, including without limitation the implied warranties of merchantability or fitness for a particular purpose. The forgoing states the entire liability of Geodetics with respect to the products herein.

7.2 *Vendors must specify if subcontractors will perform warranty/maintenance/service, location(s) where warranty/maintenance/service will be performed, along with contact name and phone number for each location.*

All warranty/maintenance/service will be provided by Geodetics. No subcontractors will be used to perform warranty/maintenance/service.

8: Company Background and References

Company ownership: If incorporated, the state in which the company is incorporated and the date of incorporation.

Geodetics is a privately held corporation. Geodetics was incorporated in the state of California on 22 April, 1999.

Location of the company offices

2649 Ariane Drive
San Diego California, 92117

Location of the office servicing any California account(s).

2649 Ariane Drive
San Diego California, 92117

Number of employees both locally and nationally

Geodetics currently employs 30 people.

Location(s) from which employees will be assigned

2649 Ariane Drive
San Diego California, 92117

Name, address and telephone number of the vendor's point of contact for a contract resulting from this RFP

Dr. Lydia Bock

2649 Ariane Drive
San Diego, CA 92117
858-729-0872

Company background/history and why vendor is qualified to provide the services described in this RFP.

Geodetics had its beginnings as a joint project between the newly created Geodetics and Leica Geosystems in 1999. Geodetics was responsible for developing a state-of-the-art reference network solution. The result, CRNet, was one of the first reference network solutions to hit the market.

Geodetics moved forward and continued the development which evolved into the current RTD family of products. The RTD family of products as broadened considerably since these early days. Today, Geodetics is a thriving business with customers in both the civilian and military markets. Geodetics products are used world-wide in a wide variety of civilian applications and Geodetics has a significant presence in the United States Department of Defense including work with the U.S. Army, Navy and Air Force.

Geodetics' facilities and development processes are ISO:9001 compliant. As such, all software developed by Geodetics undergoes a rigorous quality process, which leads to extremely high-quality products. Because Geodetics is not a GPS hardware manufacturer, Geodetics early-on adopted a philosophy of remaining hardware platform neutral. The objective is to work equally well with the hardware from all major GPS hardware manufacturers. Geodetics does not gear its solutions to work optimally with one vendor's hardware at the expense of others. When one looks closely, one finds that this approach is quite unique. It is Geodetics belief that this is the best approach and offers significant benefits to its customers.

The scientific underpinning of all Geodetics products is a new class of network-centric instantaneous, real-time precise GPS positioning and navigation algorithms, referred to as Epoch-by-Epoch™ (EBE).

Length of time vendor has been providing services described in this RFP to the public and/or private sector. Please provide a brief description

Geodetics was founded in 1999 and has been in operation for 10 years. Since its inception, Geodetics has become a recognized leader in state-of-the-art high-accuracy real-time positioning and navigation systems and sells GPS related products and services in both the civilian and military markets. Geodetics offers a full range of GPS consulting and analysis services as well as a family of application products based on its Epoch-by-Epoch™ technologies. Civilian applications include reference network management, surveying, deformation monitoring, mapping, airborne navigation, wireless and hand-held applications, fleet tracking and machine control applications.

Resumes for key staff to be responsible for performance of any contract resulting from this RFP

Dr. Lydia Bock – President and CEO
Dr. Bock is a business and technology (engineering) consultant focusing on business development, product, technology, and market evaluation. Dr. Bock has worked in business development with a variety of companies ranging from startups through small and large companies as well as on government contracts, analyzing market share, competition and services and evaluating vendors, strategies, and developing alliances.

Dr. Bock's experience spans a wide variety of hi-tech industries including electronics, semiconductors, telecommunications, computer (hardware and software), knowledge management, and defense industries. Her main activities are in business strategizing and development, process and infrastructure (Internet, networks, architectures, e-commerce, Supply Chain Management (SCM), logistics) assessment and design, deployment planning, and legacy system integration in the business, design and manufacturing arenas.
Dr. Bock received her Ph.D. from the Massachusetts Institute of Technology in Materials Engineering, with a minor in Business Administration from the Sloan School of Management (1988), M.Sc. from the Ohio State University in Civil Engineering (1979), and B.Sc. from Israel Institute of Technology, in Civil Engineering (1977).

Dr. Jeffrey Fayman - VP, Business and Product Development
Dr. Fayman brings many years of consulting experience on custom software solutions for firms such as Price Waterhouse, Gensia Pharmaceuticals and Science Applications International (SAIC) and Cisco Systems. Dr. Fayman Co-founded and served as VP Business Development for Virtue Ltd. - a startup company developing 3D solutions for the Internet and e-Commerce applications. Dr. Fayman serves on the board of directors for Estimotion Inc. Dr. Fayman holds a B.A. in business administration and a M.Sc. in Computer Science, both from San Diego State University. He holds a Ph.D. in Computer Science from the Technion - Israel Institute of Technology where he published over 20 papers in the academic literature in the fields of Robotics, Computer Vision and Computer Graphics.

David B. Honcik - Director of Software Engineering
Mr. Honcik has over 18 years experience in structured software design for applications including Windows programs, graphics, telecommunications, aerospace, flight simulation, and real-time embedded systems. He is familiar with all stages of the software life cycle including requirements specification, design, coding, test, documentation, formal validation, and configuration control. Mr. Honcik has experience with advanced design methodologies including object-oriented design and UML, and extensive experience in C/C++, MFC, Windows NT/95/98, and embedded systems.

In the last decade, Mr. Honcik has worked as a software engineer for Qualcomm in San Diego, California (1997-1999), Metz Smith Inc. in Redmond, Washington (1995-1997), Allied Signal Aerospace in Redmond, Washington (1993-1995), Sundstrand Data Control in Redmond, Washington (1992-1993), DELCO Systems Operations, Goleta, California (1990-1991), and Boeing in 1981-1989.

8.2.1 Does this proposal include the use of subcontractors?

Yes _____ No ___ X ___ Initials _____LB__

8.3 References

1. Client Name: Geomatics & Land Information Systems, Orange County
Project Description: Wireless Network RTK, Surveying and Geodetic Control, and deformation Monitoring Services
Project Dates: Since 2001 (on-going)
Technical environment: Continuous reference network for Geodetics control and deformation monitoring for the county of Orange.
Staff assigned to reference engagement: Dr. Lydia Bock, Dr. Jeff Fayman, Mr. David Honcik
Client Project manager: Art Andrew, PLS
H.G. Osborne Building
300 N. Flower Street
Santa Ana, CA 92703-5000
Ph: 714 713-0057; Email: Art.Andrew@rdmd.ocgov.com

2. Client Name: Geodetic Control & Deformation Programs, Infrastructure Unit, Metropolitan Water District
Project Description: Geodetic Control & Deformation Monitoring
Project Dates: Since 2001 (on-going)
Technical environment: Geodetic control and dam deformation monitoring (Diamond Valley Lake).
Staff assigned to reference engagement: Dr. Lydia Bock, Dr. Jeff Fayman, Mr. David Honcik
Client Project manager: Cecilia Whitaker, PLS
700 Moreno Avenue, La Verne, California 91750
Ph: 909-392-2591, Email: cwhitaker@mwdh2o.com

3. Client Name: Italian Civil Protection Authority, Istituto Nazionale di Geofisica e Vulcanologia
Project Description: Volcano Monitoring, Landslide and Dam Monitoring
Project Dates: Since 2002 (on-going)
Technical environment: Deformation monitoring Stromboli Volcano (Aeolian Islands)
Staff assigned to reference engagement: Dr. Lydia Bock, Dr. Jeff Fayman, Mr. David Honcik
Client Project manager: Dr. Mario Mattia
Sezione di Catania
Unità Funzionale Deformazioni e Geodesia
Piazza Roma, 2 - 95123 Catania - ITALY
Direct phone: +39 095 7165805 - Fax: +39 095 435801
e-mail: mattia@ct.ingv.it - web: www.ct.ingv.it

4. Client Name: Geological Survey of Canada, Natural Resources Canada
Commission géologique du Canada, Ressources naturelles Canada
Project Description: Crustal deformation monitoring
Project Dates: Since 2004 (on-going)
Technical environment: Active Geodetic Control, Crustal Deformation Monitoring (Northern America)
Staff assigned to reference engagement: Dr. Lydia Bock, Dr. Jeff Fayman, Mr. David Honcik
Client Project manager: Michael Schmidt, P.Eng.
MSchmidt@nrcan.gc.ca
TEL +1 250-363-6760 FAX +1 250-363-6565
Geological Survey of Canada, Natural Resources Canada
Commission géologique du Canada, Ressources naturelles Canada
PO Box 6000 Sidney BC Canada V8L 4B2
Street/Rue: 9860 West Saanich Rd, North Saanich BC, Canada V8L 3S1

Please see Appendix A: "Deformation Monitoring and Early Warning SystemUtilizing Epoch-by-Epoch™ GPS Based Technology" *paper presented in Malaysia 2006 for Slope Engineering Branch, Ministry Of Works (JKR)*

9: Cost

See Volume 2: Cost proposal

10: Additional Requirements from Funding Source

Not applicable

11: Terms, Conditions and Exceptions

The following are Geodetics':

- Software license agreement
- Software maintenance support agreement
- Warranty policy

SOFTWARE LICENSE AGREEMENT

THIS AGREEMENT ALLOWS YOU TO INSTALL AND USE THE SOFTWARE ON A SINGLE COMPUTER. BY OPENING THE SEALED DISK PACKAGE, OR INSTALLING THE SOFTWARE, YOU ARE CONFIRMING ACCEPTANCE OF THE SOFTWARE AND AGREEING TO BECOME BOUND BY THE TERMS OF THIS AGREEMENT ("AGREEMENT"). THIS AGREEMENT CONSTITUTES THE COMPLETE AGREEMENT BETWEEN YOU ("LICENSEE") AND GEODETICS, INC. ("LICENSOR").

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LICENSOR grants to you a limited, non-exclusive, non-transferable, personal license ("License") to install and operate the computer software contained in this package ("Software") only on a single computer.

2. Usage Restrictions
You may not make or distribute copies of the Software, or electronically transfer the Software from one computer to another or over a network. You may not decompile, reverse engineer, disassemble, or otherwise reduce the Software to a human-perceivable form. You may not rent, lease or sublicense the Software. You may not modify the Software or create derivative works based upon the Software. You may not export the Software into any country prohibited by the United States Export Administration Act and the regulations hereunder.

3. Ownership
This agreement gives you limited rights to use the Software. You do not become the owner of, and Geodetics retains title to, the Software, and all copies thereof. All rights not specifically granted in this Agreement, including Federal and International Copyrights, are reserved by Geodetics.

4. Termination
The license is effective until terminated. The license will terminate without notice from LICENSOR if you fail to comply with any provisions of this Agreement. Upon termination you must cease all use of the Software and Documentation and return them, and any copies thereof, to LICENSOR.

5. General
This Agreement shall be governed by and construed in accordance with the Laws of the State of California and the United States.

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SOFTWARE MAINTENANCE SUPPORT AGREEMENT

Maintenance support includes:

- Software upgrades for one year
- Email support (up to 8 hrs) for one year from date of purchase (72 hour response time)

WARRANTY POLICY

Geodetics, Inc warrants its Global Positioning System (GPS) products are free from defects in materials and workmanship under normal use as follows:

1) GPS products are warranted for ONE (1) YEAR from date of original purchase.
2) GPS Antennas are warranted for ONE (1) YEAR from date of original purchase.
3) Software Support is provided for ONE (1) YEAR from date of original purchase.
4) Cables are warranted for NINETY (90) DAYS from date of original purchase.

Date of original purchase shall mean the date of the invoice to the original customer for the product. If the product becomes defective during its warranty period, Geodetics will, at its option provide product replacement or product repair.

This warranty does not cover and shall be void for damage or failure resulting from misuse, neglect, accident, alteration, abuse, improper installation, non-approved antenna, cables, accessories, or operation in an environment other than intended. Improper service or repair by anyone other than Geodetics personnel, or improper connections with peripherals or other causes not arising from defects in materials or workmanship voids this warranty.

In no event will Geodetics be liable for any indirect, incidental, special or consequential damages whether through tort, contract or otherwise. This warranty is expressly in lieu of all other warranties, expressed or implied, including without limitation the implied warranties of merchantability or fitness for a particular purpose. The forgoing states the entire liability of Geodetics with respect to the products herein.

Warranty Replacement Procedure. You must obtain a **RETURN MATERIAL AUTHORIZATION (RMA)** number by calling Customer Service at (858) 729-0872 before shipping any product to Geodetics. A Customer Service Agent will do troubleshooting to see if the product is defective. If so, the following information will be required: 1. Your contact information 2. Product Serial Number

Once you have obtained an RMA number, you will be advised of proper shipping procedures to return any defective product. Do not include manuals, cables, antennas or other materials. Geodetics only replaces the defective unit and will not return other accessories. Customers are responsible for the freight charges to Geodetics. We suggest using a carrier that provides tracking information. Geodetics is not responsible for packages lost in transit to Geodetics.

"Out of Warranty" Products. If your product is not covered under warranty, we offer Repair Services for a fee. Geodetics warranty only covers failures due to defects in materials or workmanship. Warranty does not apply if, in the judgment of Geodetics, the product fails due to damage from shipment, handling, storage, accident, abuse or misuse, or damage that is attributable to acts of God, or if it has been used or maintained in a manner not conforming to product manual instructions, has been modified in any way, or has had any serial number removed or defaced.

City of Long Beach
Gas and Oil Department
211 E Ocean Blvd, Suite 500
Long Beach CA 90802

Attachment A
CERTIFICATION OF COMPLIANCE WITH TERMS AND CONDITIONS OF RFP

I have read, understand and agree to comply with the terms and conditions specified in this Request for Proposal. Any exceptions MUST be documented.

YES ✓ NO _____ SIGNATURE Lyn Bl

EXCEPTIONS: Attach additional sheets if necessary. Please use this format.

EXCEPTION SUMMARY FORM

RFP SECTION NUMBER	RFP PAGE NUMBER	EXCEPTION (PROVIDE A DETAILED EXPLANATION)
—	—	None

City of Long Beach
Gas and Oil Department
211 E Ocean Blvd, Suite 500
Long Beach CA 90802

Attachment C

STATEMENT OF NON-COLLUSION

The proposal is submitted as a firm and fixed request valid and open for 90 days from the submission deadline.

This proposal is genuine, and not sham or collusive, nor made in the interest or in behalf of any person not herein named; the proposer has not directly or indirectly induced or solicited any other proposer to put in a sham proposal and the proposer has not in any manner sought by collusion to secure for himself or herself an advantage over any other proposer.

In addition, this organization and its members are not now and will not in the future be engaged in any activity resulting in a conflict of interest, real or apparent, in the selection, award, or administration of a subcontract.

Lydia Bock 5/15/09

Authorized signature and date

Dr. Lydia Bock, President and CEO

Print Name & Title

Appendix A

Deformation Monitoring and Early Warning System Utilizing Epoch-by-Epoch™ GPS Based Technology

Dr. Jeff Fayman, VP Product Development, Geodetics, Inc., USA, jfayman@geodetics.com
Dr. Lydia Bock, CO-CEO, Geodetics, Inc., USA, lydia@geodetics.com

Abstract

The following describes a deformation monitoring and early warning system that is based on Geodetics Inc. Real-Time Dynamic (RTD) system. RTD is unique in that it monitors the integrity and network geometry on an Epoch-by-Epoch™ (EBE) basis and allows site coordinates to adjust in the event of tectonic/seismic deformation, ground subsidence, site malfunction, etc.

The system's Epoch-by-Epoch™ technology provides instantaneous positioning relative to one or multiple reference stations. This revolutionary advance in high-precision GPS analysis technology provides for robust real-time integrity monitoring and enhanced early warning capabilities. For the first time, a user can determine the state of the network independently at each instant in time. This "network epoch" is the basic building block of the RTD system that can easily manipulate sequences of independent network epochs to automatically monitor changes in the state of the network.

At each epoch of observation, RTD performs an independent adjustment of data collected by a group of GPS geodetic systems, which produces a consistent set of positions for each sensor. RTD handles streaming, re-formatting, processing, archiving, and dissemination of data in real-time. Additionally, RTD analyzes the data, and generates alarms, statistics, reports and more. RTD carries out a continuous, simultaneous adjustment of the data, modeling the dynamic state of the entire network caused by ionosphere, troposphere and other factors.

In this paper, various applications of RTD to deformation monitoring will be shown as well as an RTD based slope monitoring system designed for the Malaysian Highways Authority. The system is a complete state-of-the-art solution, including hardware and software, installation, integration, maintenance and support, designed for precise real-time GPS detection of slope deformation along the Malaysian Highways.

Introduction

Accurate monitoring of deformations of land features such as slopes, land subsidence and earthen dams as well as structures such as bridges, and tall buildings, is now possible using global positioning-system (GPS) technology.

In this paper, we present the Real-Time Dynamic (RTD) system and discuss its uniqueness with regards to deformation monitoring. We present several applications utilizing RTD including: 1) monitoring the deformation of a seven story building under seismic deformations; 2) monitoring the subsidence of Venice, Italy; 3) deformation of New York's Verrazano Narrows Bridge during the New York Marathon; and 4) deformation monitoring at the Diamond Valley Lake dam in southern California. We conclude the paper with the design of the slope and landslide monitoring system in Malaysia.

About RTD

Geodetics' Real Time Dynamic (RTD) is a platform independent reference network management and monitoring system based on Geodetics' Epoch-by-Epoch™ technology. This revolutionary advance in high-precision GPS analysis technology provides for robust real-time integrity monitoring and enhanced early warning capabilities. RTD carries out a continuous, simultaneous adjustment of the data modeling the dynamic state of the entire network caused by ionosphere, troposphere and other factors.

The reference network is fully controlled by the RTD software operating on a PC workstation in server mode. The RTD server handles streaming, re-formatting, processing, archiving, and dissemination of data. The RTD server is unique in that it monitors the integrity and network geometry on an Epoch-by-Epoch™ basis and allows the site coordinates to adjust in the event of tectonic/seismic deformation, ground subsidence, site malfunction, etc. It can also be used to monitor tropospheric zenith delays at each site, which can be converted to precipitable water over the region spanned by the network, an important parameter in short-term weather forecasting.

RTD Uniqueness

The central feature of Geodetics' Epoch-by-Epoch™ (EBE) technologies is that a high accuracy relative positioning solution, based on instantaneous integer ambiguity resolution, is achieved for each measurement epoch using only the observations collected at that epoch. Accordingly, each solution is independent of the solutions obtained for the previous and following epochs. Successful resolution of integer-cycle phase ambiguities is a prerequisite for achieving the most precise position estimates with GPS by transforming precise but ambiguous phase measurements into precise unambiguous range measurements.

Current techniques employed by the high end users such as real time kinematic (RTK) surveying require multiple epochs of data in order to resolve phase ambiguities. RTK requires 30-45 seconds for resolving (initializing) integer-cycle phase ambiguities and re-initialization in the event that a receiver experiences loss of lock or cycle slips. This is a severe limitation when trying to position a moving object such as a roving vehicle.
Recent RTK systems have been advertised to reduce the time for initialization/re-initialization and to work at extended ranges. However, Epoch-by-Epoch™ positioning only requires a single epoch for initialization and re-initialization making it extremely suitable for airborne, land and other dynamic applications.

A summary of the unique features of the EBE technology is provided below:

- Integer cycle phase ambiguities are resolved **independently** at each epoch for a network of GPS receivers -- instantaneous initialization and re-initialization compared with up to minutes for Real-Time Kinematic (RTK) positioning.
- Relative site positions estimated to **cm-precision** with only a single epoch of GPS data from 5 or more satellites utilizing dual frequency GPS receivers.
- Designed specifically for **networked environments** (wireless/wired) with multiple platforms and multiple communications options allow for flexibility and seamless operation.
- Special treatment of atmospheric effects allows **extended range** several times the maximum distance achieved by RTK systems.
- Much **less CPU intensive** than typical batch processing methods, allowing for real-time positioning.
- **More flexible** than RTK procedures that require multi-epoch initialization and re-initialization.
- Takes advantage of **very high rate sampling** provided by modern GPS receivers (1- 50 Hz).

Deformation Monitoring Case Studies

The following are four case studies of deformation monitoring utilizing Geodetics' RTD system.

Case Study 1: Seismic Response of a 7-Story Building Utilizing RTD

A 7-story building was instrumented with seven 50 Hz. GPS sensors and tested at the Large High-Performance Outdoor Shake Table at University of California San Diego. The overall objective was to verify the seismic response of reinforced concrete wall systems designed for lateral forces that are significantly larger than those currently specified in building codes in United States. During the tests, which took place between mid-November 2005 and mid-January 2006, a myriad of monitoring sensors covering a to-scale 7-story building were replaced with 7 real-time 50Hz GPS displacement measurement instruments, a novel new application of GPS.

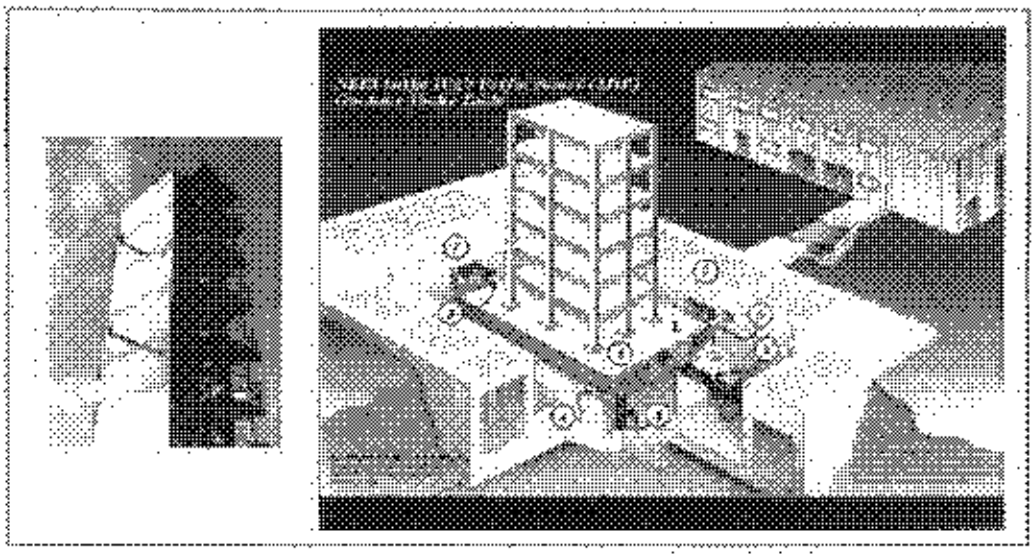

Figure 1: 7-story building at UCSDs NEES Outdoor Shake Table at Camp Elliott instrumented with seven 50 Hz GPS.

The first phase of the program investigated the response of the web cantilever wall configuration to different levels of excitation. This included low amplitude 0.5-25 Hz band-clipped white noise tests, a low intensity earthquake, two medium intensity earthquakes that were somewhat above the site response spectra for the period of the building for 50% probability of exceedance event and a large intensity earthquake whose spectral acceleration in the period range of interest was above the site response spectra for 10% probability of exceedance in 50 years. The intensity earthquake records were taken from the 1971 San Fernando and the 1994 Northridge earthquakes.

During the shake table tests, a high-rate real-time precise Epoch-by-Epoch™ RTD system was deployed. Seven 50 Hz Navcom GPS receivers and Dorne Margolin antennas with choke rings were deployed: 3 on the roof of the 7-story building, 2 cantilevered on the 5th and 3rd floors, one on the shake table itself, and one as a reference just off the shake table. Instantaneous 50 Hz displacements were calculated, using the Geodetics™ RTD software for all tests, and the results were compared with accelerometer data, and with the induced earthquake motions. The results demonstrate consistent mm-level (one-sigma) accuracy for the measured displacements and the usefulness of very high rate GPS displacement measurements for seismic monitoring of structures.

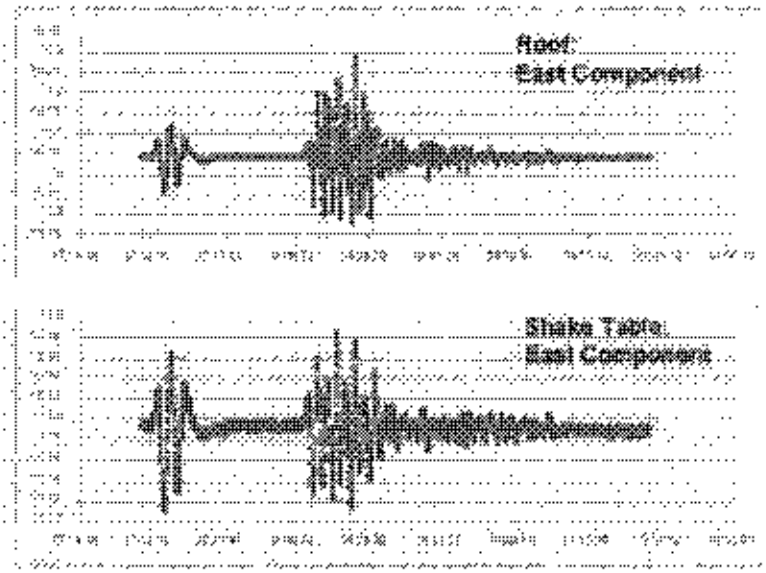

Figure 2: The shake-table induces accelerations in the east-west direction using a powerful hydraulic system. The plots above show the 50 Hz east component displacements of the GPS antennas on the shake-table and on the roof of the 7-story building. Unlike accelerometer measurements, high-rate GPS directly measures displacements, which is highly desirable for structural monitoring.

Case Study 2: Monitoring the Subsidence of the Venice Lagoon, Italy

In order to preserve the City of Venice, the lagoon and the littorals it is fundamental to continue to monitor land subsidence due to anthropogenic (water extraction) and natural (tectonic motion, soil compaction, sediment load) factors, and its contribution to the relative sea level rise. The Venice Water Authority CGPS network is made of a total of 5 GPS stations.

Figure 3: Venice Water Authority CGPS Network

The subsidence of the Venice lagoon is estimated based on CGPS measurements from 2001-2005, and InSAR permanent scatterers data from 1992-2001. The CGPS data show subsidence with respect to ITRF2000 of -4.0±0.4 mm/yr at the northern edge of the lagoon at Cavallino, -1.7±0.3 mm/yr at its southern edge in Chioggia, and 0.1±0.4 mm/yr at a stable inland station near Padua. Using the inland site as a reference, the PSInSAR analysis agrees with the CGPS at the two lagoon sites, but provides much finer spatial resolution and delineates subsidence throughout the area of 1-7 mm/yr, with 1-3 mm/yr of soil motion in the more recent parts of the City of Venice and of the banks exposed to settlement by wave actions. Analysis of the combined 14-year baseline time series indicates a subsidence rate of -2.3 ± 0.05 mm/yr in the southern lagoon and -4.9 ± 0.05 mm/yr in the northern lagoon.

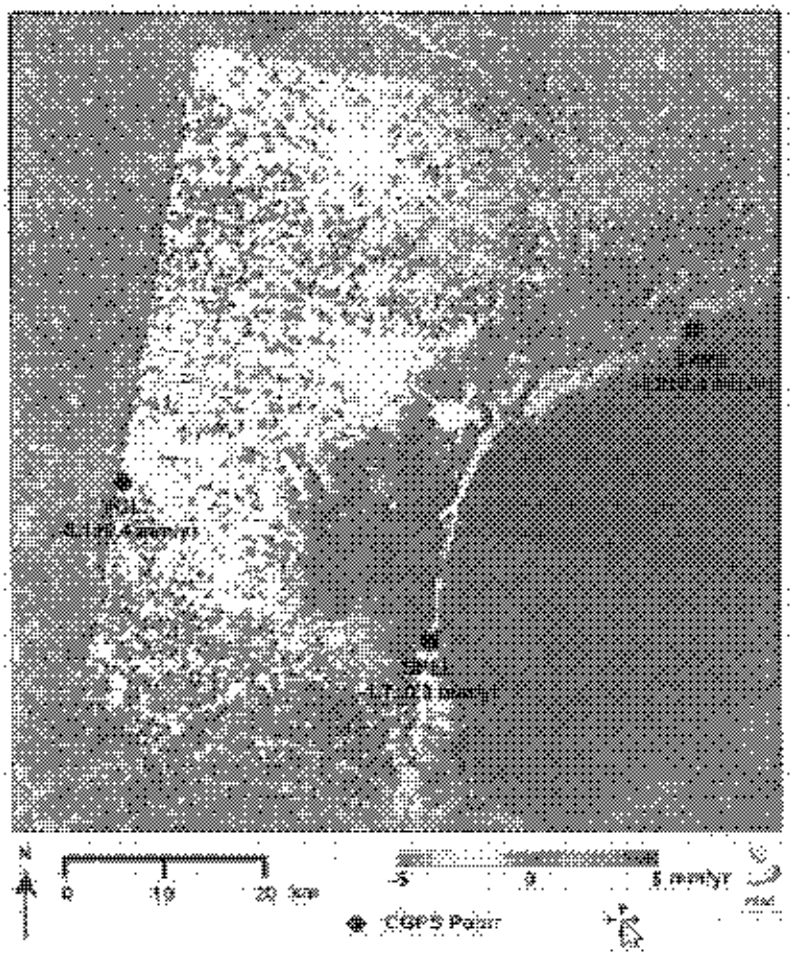

Figure 4: Venice CGPS subsidence rates superimposed on PSInSAR analysis of the Venice Lagoon.

Case Study 3: Monitoring Marathon Runners on the Verrazano Narrows Bridge

The synergy of GPS and accelerometers is demonstrated to provide real-time input on the static and dynamic stress response of critical urban infrastructure.

Combined observations with 5 Hz Global Positioning System (GPS) and 100 Hz force-balance accelerometers (FBA) on the Verrazano Narrows Bridge, New York City allowed the estimation of the load response of the bridge to such factors as marathon runners, regular traffic, and air temperature in the frequency range impossible to span by GPS or FBA alone.

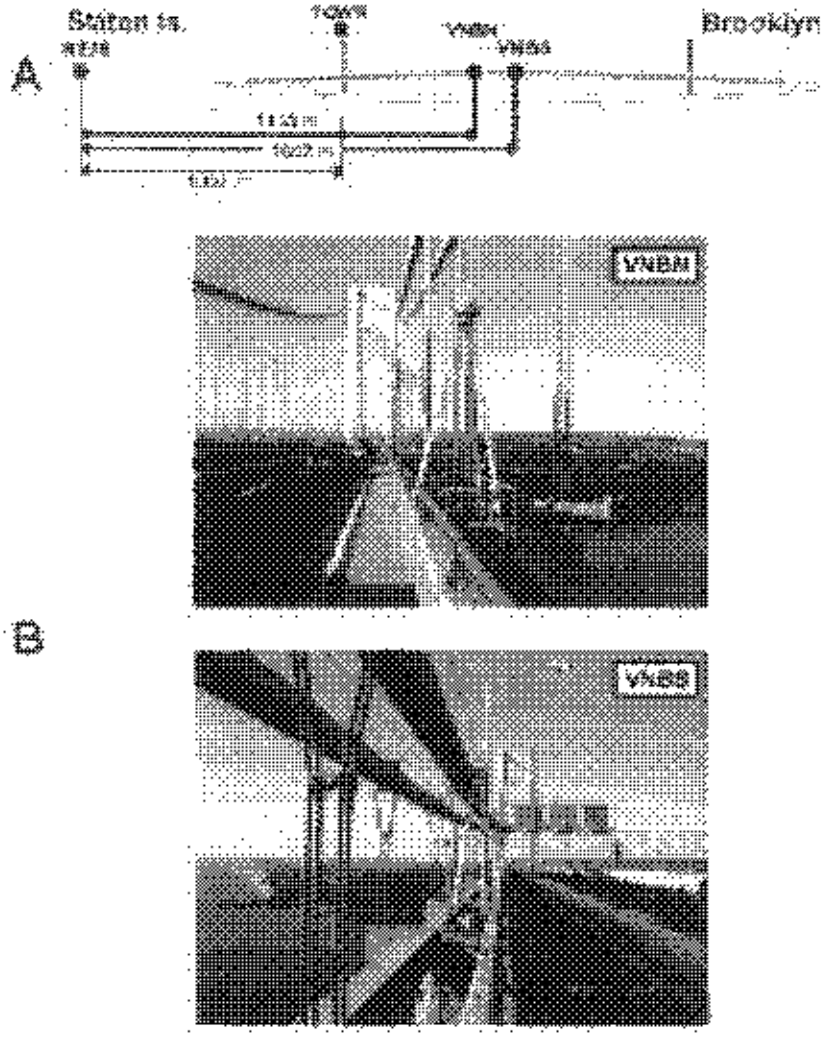

Figure 5: Locations of GPS sensors on the bridge.

The first two miles of the NYC Marathon on November 7, 2004 included over thirty thousand runners traversing the Verrazano Narrows Bridge within the span of about a half hour. A mix of 5 Hz GPS instruments and 100 Hz force-balance accelerometers detected slow vertical

deflections of 0.3-0.4 m and a significant component of the excited vibrations with a dominant period of 0.35 s, compared to regular traffic which deflected the bridge by less than 0.1 m with a dominant period of 7.7 s, the first vertical symmetric flexural mode of the bridge deck.

Case Study 4: Deformation Monitoring at Diamond Valley Lake Earthen Dam

Diamond Valley Lake is the largest water reservoir in southern California. In order to monitor the stability of its three earthen dams, the Metropolitan Water District (MWD) of Southern California has constructed a seven station continuous GPS network. Leica GPS reference stations, sampling at 2 seconds, stream their data by radio modem to a central computer system.

Figure 6: Aerial view of the Diamond Valley Lake.

MWD utilizes continuous GPS (CGPS) sites that were installed (1995 to 2002) for seismic and crustal motion studies and several newly installed (2004) sites from Earthscope's Plate Boundary Observatory project. Each of the approximately 20 CGPS sites chosen for the network (scattered across both Riverside and San Bernardino Counties) are equipped with a wireless LAN (WiLAN) radio, a data buffer and appropriate antenna, cables, etc. The sites communicate with the MWD enterprise communications backbone via the WiLAN radios on an IP-based system. The data are collected at a main server using Geodetics' RTD software, a server/client application providing users with precise instantaneous network positioning through TCP/IP (cell phone modems). The data are collected and analysed in real-time. The software performs a full network analysis, and provides real-time and time-averaged position solutions. Also, the software incorporates motion alarms, and remote status displays.

Malaysia Network Designed for Slope Monitoring

The Malaysia network is designed to allow monitoring and early warning system to detect slope deformations for localized highway areas. The network will consist of multiple GPS base stations placed in a network grid. The final spacing between stations will be determined after a study of the geography and consultation with local experts. Raw satellite measurements from the base stations will be transmitted at 1 Hz to the RTD server, which will perform network integrity and deformation monitoring.

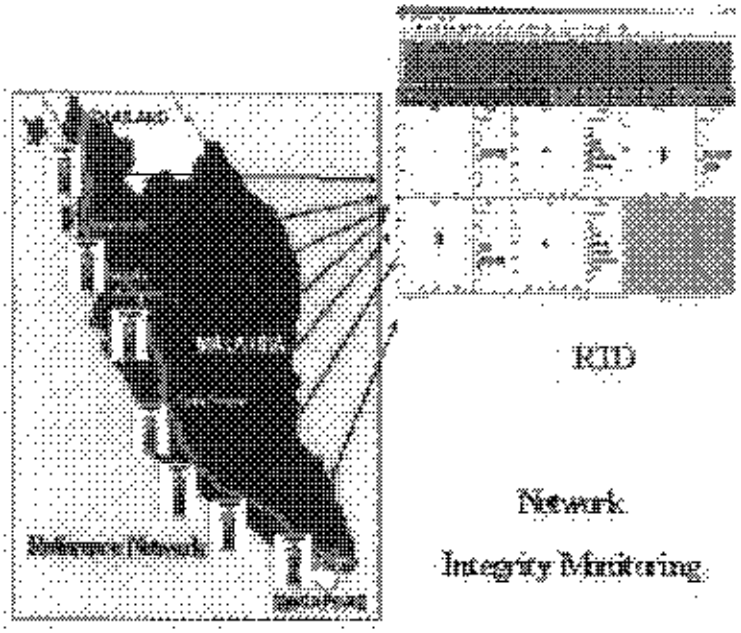

Figure 7: Schematic diagram of the Malaysian network

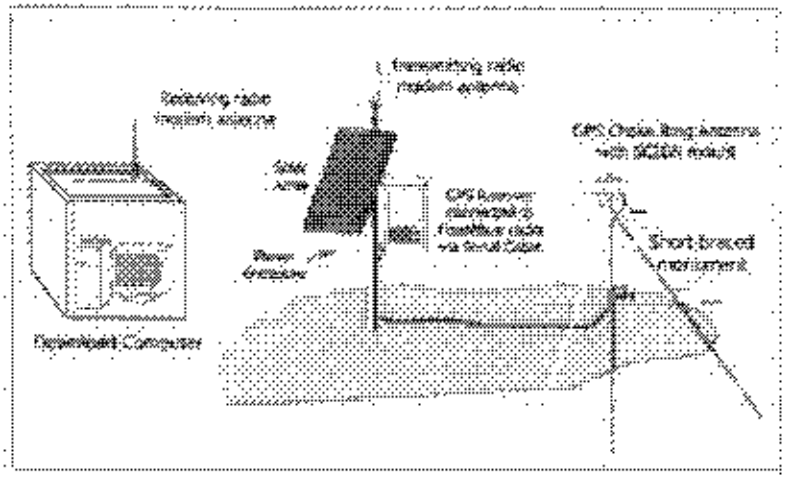

Figure 8: A typical site configuration in the Malaysian Network

Conclusions

In this paper, we have presented the Real-Time Dynamic (RTD) system for real-time integrity monitoring and enhanced early warning capabilities. We have presented four case studies in which RTD is used for various monitoring applications. Finally, we presented a system for slope monitoring on the Malaysian highways designed to detect precursors to slope failures as an early warning capability.

References

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[2] Bock, Yehuda, Paul J. de Jonge, David Honcik and Jeff Fayman (2003). Wireless Instantaneous Network RTK: Positioning and Navigation. *Proceedings of the Institute of Navigation (ION), ION GPS 2003.* Portland, Oregon, September 9-12, 2003, pp. 1397-1405.

[3] Bock, Yehuda, Fan Yang, 50 Hz GPS to outdoor shake table tests of a 7-story building at Camp Elliott, http://www.igpp.ucsd.edu/ne/2006/01/30.html

[4] Bock, Yehuda, Shimon Wdowinski, Alessandro Ferretti, Giovanni Cecconi, and Giuliano Savio, Subsidence of the Venice Lagoon from Continuous GPS and InSAR Permanent Scatterers (2006), in review, Geophysics Research Letters

[5] Kogan, Mikhail G., Won-Young Kim, Yehuda Bock, and Andrew W. Smyth (2006), Load Response on the Verrazano Narrows Bridge during NYC Marathon Revealed by GPS and Accelerometers, unpublished manuscript.

Volume 2
Cost Proposal

RFP No: G0 09-036
Purchase of GPS Real-Time Network
Software, Installation, Support and Training

Offeror's Name:	Geodetics Inc.
Mailing Address:	2649 Ariane Drive San Diego, CA 92117
Phone:	(858)729-0872
Fax:	(858)729-0874
Submission Date:	15 May 2009
Submitted to:	City of Long Beach Purchasing Division Attn: Peggy Chambers 333 W Ocean Blvd/7th Floor Long Beach CA 90802

Points of Contact:

Contractual		Technical	
Name :	Dr. Lydia Bock	Name:	Dr. Jeffrey Fayman
Address:	2649 Ariane Dr., San Diego San Diego, CA 92117	Address:	2649 Ariane Dr. San Diego, CA 92117
Phone:	(858)729-0872	Phone:	(858)729-0872
Fax:	(858)729-0874	Fax:	(858)729-0874
Email :	lydia@geodetics.com	Email :	jfayman@geodetics.com

Ge•detics

"Quality Products Based on State of the Art Technologies"

2649 Ariane Drive, San Diego, CA 92117
Phone 858.729.0872 Fax 858.729.0874
CAGE Code: 1UDB4
DUNS Code: 02-509-2052
Info@geodetics.com

Quote

Date: May 15, 2009

Quote Number: 0515-01

To City of Long Beach, Public Works
Kimberly A. Holtz, PLS
Senior Surveyor
(562) 570-6992
Cell (562) 754-9874

Quote for RTD-Pro for 12 Sites
For The City of Long Beach.

Contact Person	Payment Terms
Kimberly A. Holtz Kimberly_Holtz@longbeach.gov	See Schedule Below

We are pleased to provide you with the following quote

Year 1 thru 3

Item #	Qty	Description	Unit Price	Total
YEAR 1				
Software:				
RTD-Pro Server	1	RTD-Pro server License (including 3 sites license)	$47,500.00	$47,500.00
RTD-Pro Site	9	RTD-Pro Site License	$3,000.00	$27,000.00
RTD-Post Processing	1	RTD-Post Processing License	$6,000.00	$6,000.00
CommLinkProxy	1	CommLink Proxy (CLP)	$1,700.00	$1,700.00
Installation and Configuration:	1	Configuration and Setup (2 days) including travel expenses to Long Beach	$2,500.00	$5,000.00
Training	1	Training at Geodetics, Inc. (half a day)	$2,000.00	$2,000.00
Technical Support		Data Analysis 4 days ($250/hr)	$2,000.00	$8,000.00
Software Maintenance (One year)				
RTD-Pro Server	1	RTD-Pro (including 3 sites)	$7,800.00	$7,800.00
RTD-Pro Site	9	RTD-Pro (9 additional sites)	$600.00	$5,400.00
RTD-PP	1	RTD-Post Processing	$2,000.00	$2,000.00
			TOAL YEAR 1	**$112,400.00**
YEAR 2				
Software Maintenance (One year)				
RTD-Pro Server	1	RTD-Pro (including 3 sites)	$8,073.00	$8,073.00
RTD-Pro Site	9	RTD-Post (9 additional sites)	$621.00	$5,589.00
RTD-PP	1	RTD-Post Processing	$2,070.00	$2,070.00
Technical Support		Data Analysis 4 days ($262.5/hr)	$2,100.00	$8,400.00
			TOTAL YEAR 2	**$ 24,132.00**
YEAR 3				
Software Maintenance (One year)				
RTD Pro Server	1	RTD-Pro (including 3 sites)	$8,356.00	$8,356.00
RTD Pro Site	9	RTD-Post (9 additional sites)	$645.00	$5,805.00
RTD-PP	1	RTD-Post Processing	$2,142.00	$2,142.00
Technical Support		Data Analysis 4 days ($275/hr)	$2,200.00	$8,800.00
			TOTAL YEAR 3	**$25,103.00**

Summary: Year 1 thru 3

TOTAL YEAR 1		**$112,400.00**
TOTAL YEAR 2		**$ 24,132.00**
TOTAL YEAR 3		**$ 25,103.00**
		$161,635.00
	Tax	$13,268.06
	GRAND TOTAL	**$174,903.06**

Option YEAR 4				
Software Maintenance (One year)				
RTD Pro Server	1	RTD-Pro (including 3 sites)	$8,650.00	$8,650.00
RTD Pro Site	9	RTD-Post (9 additional sites)	$668.00	$6,012.00
RTD-PP	1	RTD-Post Processing	$2,217.00	$2,217.00
Technical Support		Data Analysis 4 days ($287.5/hr)	$2,300.00	$9,200.00
			TOTAL YEAR 3	**$26,079.00**

Option YEAR 5				
Software Maintenance (One year)				
RTD Pro Server	1	RTD-Pro (including 3 sites)	$8,950.00	$8,950.00
RTD Pro Site	9	RTD-Post (9 additional sites)	$691.00	$6,219.00
RTD-PP	1	RTD-Post Processing	$2,295.00	$2,295.00
Technical Support		Data Analysis 4 days ($300/hr)	$2,400.00	$9,600.00
			TOTAL YEAR 3	**$27,046.00**

Payment Schedule		
Year 1-3	Upon signage of agreement	**$174,903.06**
Option Year 4	At the start of Year 4	**$26,079.00**
Option Year 5	At the start of Year 5	**$27,046.00**

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GEODETICS, INC., a California corporation

July 23rd, 2009

By _____
President

Dr. Lydia Bock
Type or Print Name

July 23rd, 2009

By _____
Secretary

Dr. Lydia Bock
Type or Print Name

"LICENSOR"

CITY OF LONG BEACH, a municipal corporation

August 6, 2009

By _____
Assistant City Manager

City Manager

EXECUTED PURSUANT TO SECTION 301 OF THE CITY CHARTER.

"LICENSEE"

This Agreement is approved as to form on July 29, 2009.

ROBERT E. SHANNON, City Attorney

By _____
Deputy

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