Survey Report

of the

Portuguese Bend Landslide 2018-2019 Monitoring Surveys

Dated: June 11, 2019, Revised July 9, 2019

for the

City of Rancho Palos Verdes

prepared by

McGee Surveying Consulting

The Portuguese Bend Landslide is monitored on a tri-annual basis beginning with the initial survey of all current monitoring points at the beginning of the rainy season in September-October of each year and two subsequent partial monitoring surveys of a subset of points in mid-winter and mid- spring. The initial survey is addressed in this Report and the partial surveys are addressed as Addendums at the end of this Report. The average date of each survey follows.

Initial Survey - October 10, 2018 Full Monitoring Survey - No. 22
Second Survey - January 29, 2019 Partial Monitoring Survey - No. 23
Third Survey - May 7, 2019 Partial Monitoring Survey - No. 24

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APPENDIX

ATTACHMENT: "PB MOVEMENT DATA POSTING 2007-2018.10.xlsx" (Overall & Annual Movements)

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Survey Report
of the
Portuguese Bend Landslide Monitoring Survey
October 10, 2018 Initial Monitoring No. 22
for the
City of Rancho Palos Verdes
Prepared June 11, 2019, Revised July 9, 2019
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PROJECT OVERVIEW:

McGee Surveying Consulting (MSC) performed a landslide monitoring survey in October 2018, January and May 2019 at Portuguese Bend on behalf of the City of Rancho Palos Verdes. The City of Rancho Palos Verdes assumed responsibility for monitoring the Portuguese Bend Landslide Complex circa 1994 from the County of Los Angeles. The surveys are planned, coordinated and executed by Michael McGee, PLS3945 of MSC who is responsible for the processing of the observations, network adjustments, analysis and reports.

The survey determined precise positions on an array of monitoring points to assess their periodic movements and overall movements since the date of establishment. The results of the initial September-October survey of 65 points are described in this Report and in the attached annual spreadsheet titled "PB MOVEMENT DATA POSTING 2007-2018.10 rev.xlsx". Two subsequent partial monitoring surveys of a sub-set of about 30 points are conducted in the following winter and spring. The results are reported here as addendums.

The Global Navigation Satellite System (GNSS) formerly referred to as GPS is used to measure positions of points because of its high accuracy and cost efficiency. The horizontal and vertical positions of the monitoring points are based on the North American Datum of 1983 (NAD83) and the North American Vertical Datum of 1988 (NAVD 88). The survey is referenced to physical monuments known as California CGPS (Continuous GPS) Stations in the region which are permanently mounted GPS and GNSS receivers tracking satellites 24 hours a day for monitoring seismic activity. The CGPS in California are comparable to the national CORS (Continuously Operated Reference Stations) Network.

The accuracy standard for these surveys follows. Points that move 5 centimeters (0.16 feet or 2 inches) or less per year are surveyed to meet an accuracy standard of one centimeter (0.033 feet) at the 95% Level of Confidence. Where the movements are greater, the accuracy standard is two centimeters (0.066 feet) at the 95% Level of Confidence. Field procedures are designed to accomplish this purpose and Quality Control-Quality Assurance (QAQC) processes discussed hereafter are incorporated to verify these accuracies are attained.

Prior to September 2007, successive coordinate differences were used by others to compute movements; however, arithmetic differences do not provide statistical information about the relative movement accuracies. Beginning with the initial survey by MSC in the 2007 survey, field and office procedures were designed to assure the accuracy and reliability of measurements and provide for queries between epochs that include statistical information and relative precisions of the reported movements. The temporal movements and statistical data are based on a rigorous simultaneous least-squares adjustment of multiple observations at two different epochs.

HISTORY

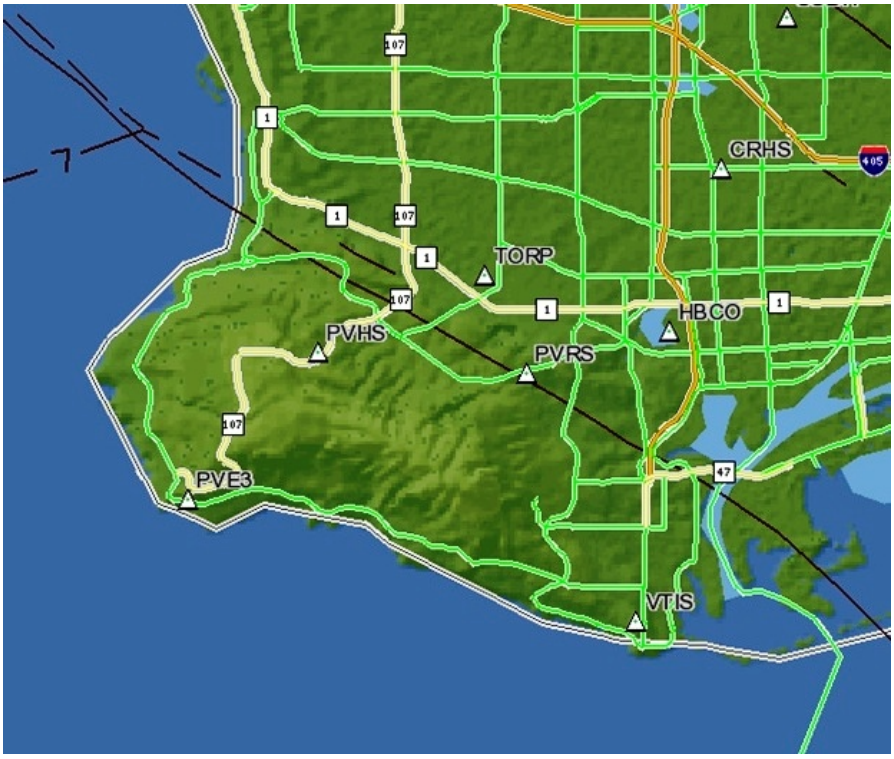
This monitoring survey is a continuation of a program initiated by the County of Los Angeles and taken over by the City of Rancho Palos Verdes circa 1994. McGee Surveying Consulting has conducted the field surveys and reporting since September 2007. The monitoring surveys have occurred annually since 2007, semi-annually since 2012 and three times a year beginning with the September 2014 survey. See the annual Survey Reports on file with the City Engineering Department commencing in 2007. The present status of monitored points is provided in the Appendix under "Monitoring Point Status". See the September 2007 Survey Report for a history of the previous survey process between 1994 and 2007. The historical 1994-2006 positions of all points are listed in the Charles Abbott Associates Inc. file "ALL POINTS MOST RECENT OBSERVED POSITION AS OF SEPTEMBER 15, 2006.xls". This file was attached as an electronic file to the 2007 Survey Report.

PROJECT DATUMS, REFERENCE SYSTEM

Horizontal Datum: The North American Datum of 1983 is the horizontal datum as established by the National Geodetic Survey (NGS) referred to as NAD83 (2007) Epoch 2007.00. The NAD83 (2007) Epoch 2007.00 Adjustment is one of a series of national adjustments of the NAD83 Datum since its adoption in 1986 and is the realization used for these monitoring surveys beginning in 2007. The positions of the CGPS Stations listed below were obtained in September 2007 from the California Spatial Reference Center (CSRC). The CSRC provides California Public Resources Code sanctioned positions for the CGPS Stations. The current national realization of NAD83 is the 2011 Adjustment published by the NGS and referred to as the NAD83 (2011) Epoch 2010.00 Adjustment. The CSRC published an updated adjustment of the CGPS stations in California known as the NAD83(2011) Epoch 2017.50 Adjustment. However, the above referenced NAD83 (2007) Epoch 2007.00 realization is retained by this survey to be consistent with prior reporting and the primary purpose of determining relative movements over time since the difference in epochs causes a 4.4 centimeter shift per year.

Reference Network: This survey is referenced to the CGPS Stations PVE3, PVHS, PVRS & VTIS shown and listed below. For more information see NGS Data Sheets for the PID's listed below and the CSRC website.

CGPS Stations (north up)



NAD83 (2007) Epoch 2007.00 - Units: Feet

CGPS	Latitude(dms)	Longitude(dms)	EH(feet)	NGS PID	NAME
PVE3	33 44 35.853290	-118 24 15.269036	235.42	None	PALOS VERDES CORS
PVHS	33 46 46.020150	-118 22 19.741258	853.99	AJ1915	PENINSULA HIGH SCH
PVRS *	33 46 25.891904	-118 19 14.067218	198.63	AJ1916	PALOS VERDES RES
VTIS	33 42 45.489584	-118 17 37.712290	197.52	AJ1936	MARINE EXCHANGE

* Falls in the proximity of a Fault Line as shown above but appears unaffected to date
Note: Some Stations are occasionally off-line during a monitoring campaign as stated in the reports.

Vertical Datum: The North American Vertical Datum of 1988 (NAVD88) established by the NGS.

Reference Network: CGPS Station VTIS is also a Second Order leveled benchmark and the original basis for the elevations in this survey. The Elevations of CGPS stations following.

CGPS	NAVD88 Ht. (Feet)	
PVE3	235.421	Determined by this Survey based on VTIS and agreeing with NGS BM at Hawthorne & PVDS
PVHS	972.1	Based on a Refined Geoid Model
PVRS	316.37	Based on Second Order Leveling by CSRC
VTIS	315.26	Based on Second Order Leveling by CSRC and the basis for NAVD88 for this survey

Geoid Model: Geoid03 was the available model at the time of the initial 2007 survey. The Geoid09 Model became available from the NGS in 2009 and Geoid12B in 2012; however, Geoid03 is retained to be consistent with prior reported heights and the primary purpose of determining relative height changes over time.

Projection: Plane coordinates are NAD83 California State Plane Coordinates Zone 5 in US Feet: The State Plane Coordinate Parameters follow: The average Scale Factor is 1.00007543 and the Height Reduction Factor based on the average ellipsoid heights is 0.99999092, therefore the average Combined Grid Factor is 1.00006635. Distances in this survey are grid. To obtain ground distances divide grid distances by the above Combined Grid Factor. Grid bearings resulting from this survey must be rotated by a Convergence Angle to obtain geodetic (true) bearings. The average convergence angle is -0°12'-30"± (rotate left 0°12'30").

Datum Stability: The City of Rancho Palos Verdes sits on the Pacific Plate which in this vicinity is moving west-northwesterly relative to the North American Plate about 4.4 centimeters (0.14 feet) per year. The area southwesterly of the Fault Line shown on the above map includes the City and is moving at a near constant rate as exhibited by the International Terrestrial Reference Frame (ITRF) north, east and up velocities of the CGPS Stations obtained from SOPAC and listed below.

	ANNUAL VELOCITIES (mtrs)			ANALYSIS PERIOD	
SITE	N	E	Up	START - DATE	- END
PVE3	0.019	-0.040	-0.000	2000.73	2019.36
PVHS	0.019	-0.040	0.000	1999.51	2019.36
PVRS	0.019	-0.039	0.000	1999.09	2019.36
VTIS	0.019	-0.039	-0.001	1998.94	2019.36

These CGPS Stations surround the Portuguese Bend Landslide and provide a rigid reference frame from which to validate the stability of the monitoring network during each survey campaign. See the MSC September 2007 Monitoring Survey Report and the adjustment results below for validation of network stability.

FIELD SURVEYS, DATA COLLECTION, EQUIPMENT & PROCESSING

Two Leica GS15 geodetic GNSS receivers/antennas listed below were mounted on two-meter fixed height poles to collect satellite signal data. The receivers tracked the Global Navigation Satellite Systems (GNSS) consisting of Navstar GPS, GLONASS, and Galileo satellites. A calibration of the poles was conducted to verify their heights and plumb are within 0.003 feet (1 mm) consistent with prior years. There were no equipment failures.

65 monitoring points were occupied and reported in this October 2018 survey. Site photographs and recovery sheets detailing the location, character of the monuments and obstructions were updated. See the Appendix for

"Monitoring Point Status". Point AB61, established in September 2007 sits on Portuguese Point above a stable basalt formation and was used as the primary base station up through October 2018. In January 2019, Point AB20 became the primary base station because of its central location, secured access and no impact on the eco-system; however, future surveys will continue to be referenced to AB61 and PVE3 as described herein.

The October 2018 field survey commenced each day by setting a Leica GS15 GNSS receiver in static mode on a fixed height pole at AB61. A roaming GS15 operating in static mode collected observations on a fixed height pole at the remaining 64 points.

Points with annual movements less than 5 centimeters were measured with two or more independent occupations by each roving receiver resulting in a minimum of two vectors to each point from AB61. An independent occupation means the points were occupied under a different constellation of satellites usually on a different day. Residuals in the measured vectors within 0.03 feet (1 cm) horizontally are accepted, otherwise additional measurements are required. Experience has shown the measurements generally agree less than 0.02 feet. The CGPS stations were connected with nine 2-7 hour observations collected over eight days. Points in the active areas with annual movements greater than 5 centimeters were single occupied by each roving receiver and a comparison with the linear movements from prior years was made to verify the measurement accuracy. AB12 was single occupied due to restricted access. AB12 will be replaced with AB70 in the October 2019 Survey.

Trees and foliage that over-shadow points interfere with signals received from satellites and affect the quality of measurements. To obtain the best possible accuracies, the varying satellite constellation is compared with obstruction diagrams to estimate the best time for observing the greatest number of satellites. To improve the accuracy of the measurements, satellites that are obstructed by trees and foliage are either turned off during the observation or noted for removal in post-processing. Generally, 12 or more un-obstructed satellites are available supporting a static type solution based on 15 minutes of data collection. If the satellite geometry and number of satellites are insufficient then the receiver is moved to another point and returned later when satellite availability improves.

Date of Survey: M22 - 09/12-13/18 and 10/07-13/18 (mean date 10/10/2018) between 0700-1800 PDST (+7 hrs for UTC).
GNSS Survey Parameters:
Constellation: 31 US NAVSTAR GPS satellites, 24 Russian GLONASS and 13 Galileo Satellites.
Observables: L1 & L2 Carrier Waves on GPS and GLONASS, and four Carrier Waves on Galileo Satellites
Epoch Rate - Occupation Times: 15 second epoch rate for 15 minute occupations at monitoring points and nine 2-7 hour occupations at the base station AB61.
Satellites: 15-24; GDOP =< 3; Elevation Mask for Data Collection at 15°
Ephemeris: Precise for Static Post-Processing of CGPS baseline connections and Broadcast for onsite baselines.
Weather: Mostly clear skies, temperature 66°-75° F, no significant weather.
Space Weather: Boulder K Index 2-5 averaging 3 (gauges ionospheric activity on a scale of 0-9; less than 6 preferred)
Equipment:
GNSS Base Receiver Unit No.: M8, Operator: M. McGee, PLS; Occupied Base Station: AB61
Make & Model: Leica GS15 with integrated Antenna; Mount: Fixed Height Pole #1; Antenna Height: 1.801m
GNSS Rover Receiver Unit No.: M9, Operator: M. McGee, PLS
Make & Model: Leica GS15 with integrated Antenna; Mount: Fixed Height Pole #3; Antenna Height: 1.800m

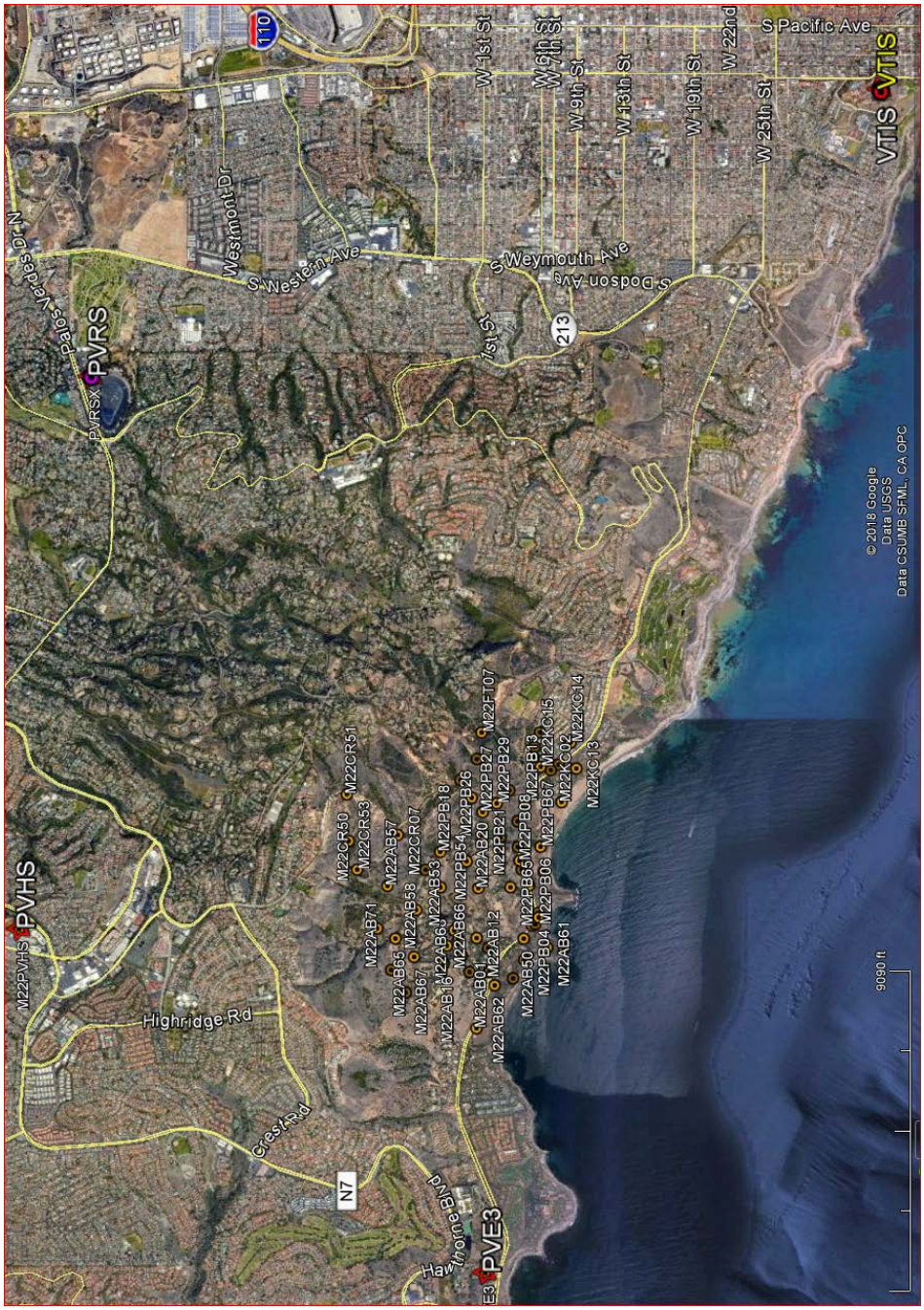
Rinex files (satellite observations) for the CGPS Stations were downloaded from the SOPAC website. Vectors were processed using Leica Infinity v3.0 post processing software with Absolute Antenna Models obtained from the NGS website. Network adjustments and analysis were performed with "Starnet-PRO" version 9.1.4.7868 Software.

NETWORK

AB61 is the primary Base Station situated on Portuguese Point a relatively stable location and the focal point of the network connecting the monitoring points and CGPS Stations. Sixty-five points and four CGPS Stations were connected with 140 measured vectors. See the following Aerial Network Maps.

The monitoring plan utilizes the CGPS Stations to verify the stability of the reference frame. PVE3 is the primary CGPS Station used to control this survey. PVE3 is located south of RPV City Hall and 1.8 miles west-northwest of Base Station AB61. CGPS Stations PVE3, PVRS and VTIS are used to validate the stability of the network. Note: Some Stations are occasionally off-line during a monitoring campaign as stated in the reports.

CGPS Stations & Monitoring Network (north left)



Monitoring Network

MONITORING POINT HISTORY & STATUS

The October 2018 survey is the 22nd Monitoring Survey. For data management purposes during the field survey and data processing, the point names are prefixed with a sequential number to distinguish between monitoring surveys. For example, on the 16th monitoring survey AB61 was named M16AB61 where M16 indicates the sequence number since the initial M01 September 2007 Monitoring Survey. The prefix is stripped in the "COORDINATES LIST" and "PB MOVEMENT DATA POSTING" documents.

2007: Between 1994 and 2006, 149 monitoring points were established to monitor the Portuguese Bend Landslides, many of which were lost or destroyed. Sixty of the original points were recovered in 2007. Eight of the 60 points were deleted because they were near other points better suited for GNSS satellite measurements leaving 52 original points monitored in September 2007 and movements reported between September 2006 and September 2007. Three of the 52 points (AB09, KC11 & PB51) were monitored in September 2007 for the last time and replaced by new points set nearby and better suited for satellite observations. Eighteen new points were set and surveyed in 2007 and had their movements reported for the first time in the following December 2008 survey.
2008: In December 2008, 49 original and 18 new points were surveyed for a total of 67 monitoring points. In December, it was noted that AB05 had been disturbed by a mowing machine. AB05 was found chipped and leaning to southerly about 0.4'. The movement reporting resumed in 2009. Analysis of the movement and historic data made it possible to estimate the disturbance to within 0.05'. The original 1995 position of AB05 was re-referenced S14°E 0.29' to be consistent with the disturbed position, resulting in correct overall reported movements. Note, KC01 was previously reported by others on 9/14/2006 to have moved N 29°E 1.24' from its 12/09/2005 position. In September 2008, this survey found a buried partially illegible brass cap in concrete stamped "COUNTY ENGINEER RE8869 1956 STA ??IELDS" S31°W 1.48 feet from the 1" IP used by on the 2005 and prior surveys. Since the initial September 2007 MSC survey used the 1" IP all subsequent surveys will use said pipe for consistency. The original 1994 position of KC01 (brass cap) was re-referenced to the 1" IP, resulting in a correct overall movement as reported by this survey.
2009: PB64 was set east of the Archery Range to replace PB63 (set in 2007) which had become unsafe to access and was lost in 2010. PB64 was reported for the first time in October 2010.
2010: Points AB03 and BB25 were discontinued. AB03 is on the edge of a cliff 192 feet west-southwest of AB61 making it redundant, and BB25 is on a freestanding rock susceptible to disturbance by wave action. In the summer of 2010, PB62 was destroyed by road construction and in October 2010, PB65 was set 24' south-southwest of PB62's location and reported for the first time in October 2011. The following points may have been disturbed prior to the October 2010 survey: AB05 appears to have been disturbed by mower machinery, AB15 (½" GIP in a meter box) is driven over by vehicles occasionally accessing an adjacent field, and KC02 (½" GIP in a meter box) is occasionally parked on by vehicles accessing the beach.
2011: In October, new points AB62 and AB63 (initially referred to as AB62R and AB63R) were set to replace AB06 and AB07 which were hazardous to occupy due to their location near the traveled way of Palos Verde Drive South.
2012: In September, prior to initiating the survey, eight new monuments AB64, AB65, AB66, AB67, AB68, CR53, KC17 and PB66 were constructed to replace AB54, AB18, AB52, AB55, AB15, CR52, KC04 and PB53 respectively. The monuments were replaced because of poor sky visibility except for KC04 which was difficult to access and AB55 which was destroyed by trenching in the past year. Monuments were set with the following design as noted in the "Point Descriptions". Monuments set in soil are 1" x 5' GIP driven flush and encase in a 6" PVC pipe sitting on a concrete collar down 12-18". Monuments set in asphalt are 1/2" x 2' rebar driven below the surface inside a free floating 2" plastic collar encased in concrete. Points AB15, AB18, AB52, AB54, CR52, KC04 and PB53 were monitored (surveyed and reported) for the last time in 2012 and discontinued.
2013: BB52 is on a freestanding rock susceptible to disturbance by wave action and was monitored for the last time in October and discontinued.
2014: In April PB64 was monitored for the last time due to unsafe access conditions and PB67 (a 5' t-bar steel post driven 3' into the ground) was set north-northwesterly about 250' as a replacement and reported for the first time in September 2014 after 4.5 months whereas all other points in the "PB MOVEMENT DATA POSTING" are reported for 11.5 months since October 2013. In September, AB69 located about 260' NE of AB12 and

AB70 located about 150' SE of AB12 were set as potential replacements; however, AB69 was destroyed by lot improvements and AB70 proved to be too obstructed for accurate results.
2015: In April, new points PB68, PB69 and PB70 were set to monitor movements of "Palos Verdes Drive South" and reported in October. In October, Monitoring Point AB56 was found disturbed by construction and AB71 (magnetic nail in AC) was set as a temporary replacement. In October, the steel post for PB67 was not found (removed by others) therefore an inconspicuous ½" x 4' rebar was set flush in its place. Because of the large movement in this area a more permanent monument is not necessary.
2016: In October, the temporary point set for AB71 in October 2015 was determined to have been destroyed by road work. AB71 was reset 12' easterly with a 2" screw and brass washer drilled into a granite curb on the south side of Vanderlip Road. Movement information will be available in the fall of 2017.
KC16 was raised about 0.29' to the surface of the road by others between the two occupations in October 2016.
2017: Movement of AB71 (replacement for AB56) reported for the first time in October.
2018: KC14 was raised 0.19' to the surface of the road by others on 11/15/17. PB25 was deleted from the monitoring since PB26 nearby provides the similar movement information.
2019: AB12 is difficult to access because it is in a horse corral and on private land. AB70 was set in 2014 as a future replacement for AB12 in a cul-de-sac at the southeast end of Figtree Road. AB70 is an obstructed site; however, improvements in receiver technology now make accurate measurements possible; therefore, AB70 was measured May 20, 2019 and found to be S33-30E 148.26' and 29.1' lower than AB12. The velocity of AB12 over the last 4.2 years was S24W 0.12' per year and at AB70 was S25W 0.09' per year. AB70 will be substituted on future surveys.

ADJUSTMENTS & ANALYSIS

Adjustment 1: An adjustment to develop NAD83 (2007) 2007.00 Epoch Latitude, Longitude, Ellipsoid Heights and State Plane Coordinates. CGPS Station PVE3 was fixed at its published NAD83 (2007) Epoch 2007.00 position listed above in a Minimally Constrained Adjustment to determine positions of points in this survey and verify its stability relative to other CGPS stations. PVE3 is located 1.8 miles westerly of and outside the influence of the slide area and has been fixed in all adjustments since 2007. The SOPAC published Time Series indicates the horizontal and vertical position of PVE3 is stable. The on-site base station(s) and other operating CGPS Stations are measured relative to PVE3 and used to assess stability of the survey reference frame. The results are listed in the Coordinate List in the Appendix. Differences between surveys for key points are listed in the table below in feet.

Original 9/2007 Positions to 10/10/2018

ID	dN	dE	dZ	
AB01	0.013	-0.084	-0.039	
AB17	-0.025	-0.024	-0.074	
AB61	-0.017	-0.003	-0.008	
CR50	-0.035	-0.017	-0.053	
CR51	-0.033	0.006	-0.183	
KC16	-0.001	-0.004	0.311	
PVE3	-0.000	-0.000	-0.000	< Fixed
PVHS	-0.004	0.010	-0.000	
PVRS	-0.007	0.023	-0.009	
VTIS	0.004	0.001	-0.014	

10/04/2017 Positions to 10/10/2018

ID	dN	dE	dZ
AB01	-0.002	0.004	-0.096
AB17	0.001	-0.010	-0.104
AB61	-0.008	-0.010	-0.083
CR50	-0.002	0.004	-0.060
CR51	0.003	-0.001	-0.096
KC16	0.013	0.003	-0.070
PVE3	-0.000	-0.000	-0.000
PVE3RP	0.008	-0.009	0.003
PVHS	-0.002	-0.006	0.035
PVRS	0.001	0.006	-0.022
VTIS	0.004	-0.009	-0.014

Comments: There are no significant horizontal differences at the Base Station AB61 compared to the October 2017 and 2007 surveys. Given that PVE3 agrees with AB61 and the other CGPS Stations, the survey reference frame is deemed stable and successfully recovered. The vertical differences between 2017 and 2018 will have to be analyzed by the City Geologist; however, this survey included sufficient redundant measurements to assure the differences reported here with the accuracy requirement. An adjustment constrained to the other CGPS Stations is not necessary because the purpose here is to track the relative monitoring point movements over time

and test the stability of the monitoring network reference frame. See the appended "COORDINATE LIST" and prior Survey Reports for prior years coordinate lists.

Adjustment 2: An adjustment to develop NAVD88 Orthometric Heights (Elevations). The CGPS Station PVE3 was fixed horizontally at its NAD83 position and vertically at its NAVD88 Height determined in the September 2007 Survey. The 2007 Height was based on the published 2nd Order NAVD88 Height of CGPS Station VTIS. This Adjustment combines the measured ellipsoid height differences with the NGS Geoid03 Model (models the separation between the ellipsoid and geoid surfaces) to determine the NAVD88 orthometric heights of the CGPS Stations and monitoring points. See the appended Coordinate List for NAVD88 Heights.

ACCURACY

This survey conforms to the intent of the California Spatial Reference Center and California Lands Surveyors Association's "GNSS Surveying Standards and Specifications, 1.1" (2014) and the Federal Geodetic Control Subcommittee (FGCS) "Specifications for GPS Relative Positioning" (1988).

Vector Residuals: The vector lengths, two dimensional residuals and the absolute value of the vertical residuals are listed below in feet. Vectors to single occupied points are excluded to avoid optimistically skewing the results; however, the statistics given below are applicable to all measurements. Analysis of residuals resulting from minimally constrained Adjustment #1 led to the rejection of 10 of 33 vectors connecting the CGPS Stations to the Base Station and 8 out of 107 on-site vectors connecting the Base Station to Monitoring Points.

	Vector Lengths		Two Dimensional Residuals			Vertical Residuals (absolute)		
Network	Vary	Average	Average	Std.Dev.	Maximum	Average	Std.Dev.	_ Range
Mon. Pts	13-9396	3972	0.009	0.006	0.029	0.008	0.008	-0.034 to +0.024
CGPS	9397-26102	16935	0.010	0.007	0.034	0.004	0.016	-0.029 to +0.032

Movement Accuracy: The relative movements reported between October 4, 2017 and October 10, 2018 (12.2 months) statistically attained an average accuracy of 0.03 feet at the 95% Level of Confidence. The actual accuracy of measurements held to the "one-centimeter standard" are estimated to be less than 0.02 feet as demonstrated by the vector residuals, repeatability of measurements at points considered stable, and deflection analysis. Refer to the sections titled ACCURACY and QAQC ANALYSIS in this Report for more information.

As a matter of information, the probability at the 95% level of confidence is that movement (signal) has occurred at a point when the horizontal distance between two epochs is greater than the 95% Error (noise). No movement is considered detected unless the movement exceeds the 95% Error for individual points. See the attached "PB MOVEMENT DATA POSTING 2007-2018.10.xlsx" for the relative movements and the estimated error at the 95% Level of Confidence for individual points.

NAVD88 Heights: The North American Vertical Datum of 1988 orthometric heights resulting from Adjustment #2 are derived from the difference in ellipsoid heights combined with the Geoid03 Model and constrained to the NAVD88 height of PVE3. The NAVD88 Height was determined in 2007 based on the second order orthometric height of CGPS Station VTIS. The relative accuracy of the heights is expected to be 0.03 feet, or greater at obstructed sites. The absolute accuracy of the heights relative to the datum is dependent on the published orthometric height on the Station VTIS. Up until October 2011 there were no specific requirements for vertical accuracies. In October 2011, a 0.03-foot relative vertical accuracy preference was introduced for points AB17, AB57, CR07, CR50 and CR51. In the September 2012 and subsequent surveys, the preference was extended to include all points.

QUALITY CONTROL - QUALITY ASSURANCE (QAQC) ANALYSIS

To ensure the accuracy and validity of the measurement systems used in these GNSS monitoring surveys, an independent test was conducted in 2007 using conventional terrestrial based instruments as reported in the "QAQC ANALYSIS" section of the September 2007 Monitoring Survey Report. Comparing the results of the GNSS systems with conventional instrumentation found horizontal measurements agreed 0.01 feet on average. In November 2011, the GNSS instruments and fixed height poles used in this survey were calibrated on the National Geodetic Survey's Santa Maria Baseline and found to agree 0.003 to 0.006 feet with the published distances. In February 2018, the GNSS instruments and fixed height poles were calibrated on the NGS Camarillo Baseline and found to agree 0.003 feet with the published distances.

To validate the radial survey method used in these surveys to position points from base stations AB61 and/or AB20, independent GNSS intra-net cross connections were measured and compared with the stand alone computed inverse distances in the 2007, 2008 and 2009 surveys. The results found the two-dimensional accuracy to agree 0.01 feet on average, indicating the radial method of measurements is reliable. Therefore, the additional labor cost of measuring cross connection between points is of no benefit when it comes to the integrity or accuracy of these surveys. See the "QAQC ANALYSIS" section of the September 2007 and the December 2008 Monitoring Survey Reports for detailed analysis.

Deflection Analysis is a method established by this surveyor to assess the consistency of the direction of movements reported from period to period with the overall. Assuming that movements are generally linear, the separation or the deflection from the overall direction to the present direction is an implication of the accuracy obtained with these procedures since the expectation is zero (no deflection). Analysis of the individual movement deflections finds the implied accuracy varies 0.01 to 0.02 feet.

SUMMARY

Point movement ranges by landslide zones are listed below in feet:

(AB##) 0.00 to 0.11
(CR##) 0.00 to 0.06
(FT##) 0.02 to 0.12
(KC##) 0.01 to 0.08
(PB##) 0.07 to 1.34 and 3.94 at PB67
(UB02) 0.97

See the Appendix for a graphic of the horizontal movements depicted by 1" and 1' contours.

See the attached " PB MOVEMENT DATA POSTING 2007-2018.10.xlsx " spreadsheet for overall and periodic movements of each point. The movements are given in north, east and up or down as well as a vector of distance and direction relative to north. The direction is given as an azimuth in degrees where 0° is north and increases clockwise (90° East, 180° South, 270° West). The overall movements listed in the spreadsheet are from the date when a point was established to the present survey.

RECOMMENDATION

Re-locating obstructed monuments has long term benefits resulting in better accuracy and lower cost surveys due to improved sky visibility for tracking satellites; however, alternate locations are not always suitable for geological analysis. Points AB16, AB17, AB24, AB58 and PB18 have limited sky visibility and would benefit from tree trimming. PB18 was completely overgrown in May 2019 and the adjacent shrubbery and Pepper Tree must be cleared.

ATTACHMENTS

The following document is attached to this Report: "PB MOVEMENT DATA POSTING 2007-2018.10.xlsx" listing the coordinates of the initial positions and all subsequent monitoring surveys with the overall and periodic movements of monitoring points since 2007.

SURVEYOR'S STATEMENT

This is a Report on the procedures, criteria and results of the City of Rancho Palos Verdes Portuguese Bend Landslide Monitoring Surveys. This Report includes the Initial Fall Survey, the Second Winter (Addendum No.1) and the Third Spring Survey (Addendum No.2). This survey was conducted and the report prepared by me at the request of Ron Dragoo, Principal Engineer of the City of Rancho Palos Verdes.

Michael R. McGee P.L.S. 3945 — Date 6/11/2019

APPENDIX

13- Table of Horizontal and Vertical Movements
14- Aerial Photo of Monitoring Points with Movements and Contours
15- Monitoring Point Status
16- Coordinate List for the Oct. 10, 2018 Survey: NAD83 (2007) Epoch 2007.00 Geodetic, Grid, NAVD88
17- ADDENDUM No. 1: Second Survey – January 29, 2019 Partial Monitoring Survey No. 23
17- ADDENDUM No. 2: Third Survey – May 7, 2019 Partial Monitoring Survey No. 24
18- Table of Partial Monitoring Survey Horizontal and Vertical Movements

Table of Annual Movements of Monitoring Points

Portuguese Bend Landslide Monitoring

Horizontal and Vertical Movements in Feet

October 4, 2017 to October 10, 2018 - 12.2 Months

Listed below are the horizontal movements and vertical (elevation) changes during the above annual period. See the attached spreadsheet titled "PB MOVEMENT DATA POSTING 2007-2018.10.xlsx" for more details and a history of movements. Note: The measurement confidence is 0.02' (1/4"); therefore, movements of 0.02' or less are deemed to have not moved.

Point ID	Horizontal Movements	Vertical Changes	Point ID	Horizontal Movements	Vertical Changes
AB01	0.00	-0.10	KC01	0.08	-0.10
AB02	0.01	-0.07	KC02	0.04	-0.09
AB04	0.11	-0.11	KC05	0.03	-0.09
AB05	0.09	-0.10	KC06	0.03	-0.08
AB12	0.08	-0.09	KC07	0.01	-0.07
AB13	0.05	-0.15	KC13	0.02	-0.12
AB16	0.02	-0.13	KC14	0.01	-0.05
AB17	0.01	-0.10	KC15	0.03	-0.09
AB20	0.06	-0.09	KC16	0.01	-0.07
AB24	0.06	-0.09	KC17	0.02	-0.10
AB50	0.05	-0.11	PB04	0.34	-0.21
AB51	0.04	-0.14	PB06	0.42	-0.11
AB53	0.05	-0.11	PB07	0.54	-0.11
AB57	0.07	-0.12	PB08	0.44	-0.07
AB58	0.06	-0.14	PB09	0.62	-0.20
AB59	0.08	-0.16	PB12	1.34	-0.39
AB60	0.04	-0.11	PB13	0.94	-0.16
AB61	0.01	-0.08	PB18	0.07	-0.15
AB62	0.11	-0.08	PB20	1.18	-0.38
AB63	0.07	-0.12	PB21	0.60	-0.27
AB64	0.02	-0.12	PB26	0.11	-0.10
AB65	0.02	-0.16	PB27	1.27	-0.34
AB66	0.04	0.02	PB29	0.92	-0.37
AB67	0.02	-0.09	PB54	0.08	-0.12
AB68	0.04	-0.11	PB55	0.54	-0.32
AB71	0.04	-0.12	PB59	0.55	-0.31
CR07	0.06	-0.14	PB65	0.13	-0.12
CR50	0.00	-0.06	PB67	3.94	-0.69
CR51	0.00	-0.10	PB68	0.29	-0.24
CR53	0.01	-0.09	PB69	0.30	-0.20
FT06	0.12	-0.15	PB70	0.26	-0.37
FT07	0.08	-0.06	UB02	0.97	-0.08
FT08	0.02	-0.08			

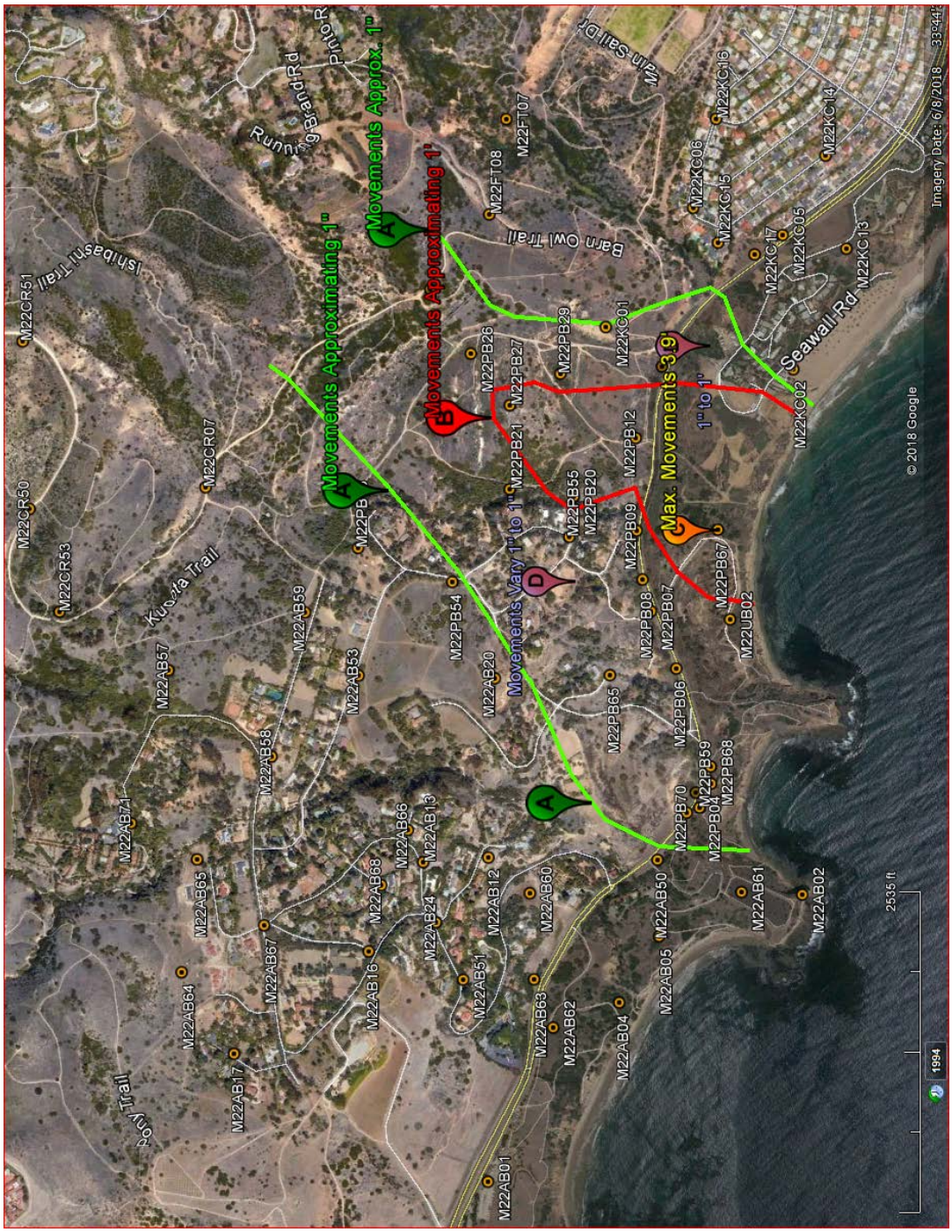
Aerial Photo of Monitoring Points with Movements

(north is left)

General Depiction of Horizontal Movements - October 4, 2017 to Oct. 10, 2018

(Generalized depiction of movements and not to be used for planning or development purposes)

A = Approximate 1-inch Contour Movement Line
B = Approximate 12-inch (1 foot) Contour Movement Line
C = Maximum Measured Movement of 3.9 feet
D = Movements Vary 1 inch to 1 foot between Contours Lines A & B, 1 inch or less outside of A



MCGEE SURVEYING CONSULTING

RANCHO PALOS VERDES - PORTUGUESE LAND SLIDE MONITORING POINT STATUS -Updated 06/11/19

Annual Obs. Date	Comments
09/01/07	71 Points Surveyed 60 old points found with 52 monitored plus 19 new points
12/01/08	67 Points Surveyed AB09, KC11, PB51 discontinued; BB53 destroyed; AB05 disturbed
11/01/09	68 Points Surveyed Set PB64 to replace PB63 destroyed subsequently
10/01/10	65 Points Surveyed Discontinued AB03, BB25; set PB65 to replace PB62 destroyed by paving
10/03/11	69 Points Surveyed; Set AB62 & AB63 to replace AB06 & AB07
09/14/12	72 Points Surveyed; Discontinued AB06, AB07; AB55 destroyed by trenching; Added 8 new points
10/06/13	65 Points Surveyed; Discontinued AB15, AB18, AB52, AB54, CR52, KC04, PB53
09/19/14	64 Points Surveyed; Discontinued BB52, PB67 set in April 2014; Added PVE3RP (reference to PVE3 antenna)
10/08/15	66 Points Surveyed; AB56 Destroyed & Replaced by AB71A; PB68, PB69, & PB70 Set in April 2015
10/05/16	66 Points Surveyed; AB71A Destroyed & Replaced by AB71;
10/04/17	66 Points Surveyed; 30 Points to Survey in Feb 2018 and April 2018
10/10/18	65 Points Surveyed; 30 Points to Survey in Jan 2019 and May 2019

Pt ID	Comments	GNSS	Pt ID	Comments	GNSS
AB01	Base Station 1994-2006	G	KC01	NE'ly/2 monuments 1.5' apart, Access Issues	G
AB02		G	KC02		G
AB04		G	KC05		G
AB05		G	KC06		G
AB12	To be replaced by AB70 Oct. 2019	G	KC07		G
AB13		F	KC13		G
AB16		P	KC14	Raised 0.19’ by others 11/2018	G
AB17		F	KC15		F
AB20	Base Sta.. 2018->	G	KC16	Raised 0.29’ by others 10/2016	G
AB24		F	KC17	Replaced KC04	G
AB50		G	PB04		G
AB51		G	PB06		G
AB53		F	PB07		G
AB57		G	PB08		G
AB58		P	PB09		G
AB59		G	PB12		G
AB60		G	PB13		G
AB61	Base Sta.. 2007-2018	G	PB18	Overgrown	P
AB62		G	PB20	S'ly/ 2 monuments 5.3' apart	G
AB63		G	PB21		F
AB64		G	PB25	Deleted Oct. 2018	G
AB65		G	PB26		F
AB66		G	PB27		G
AB67		G	PB29		G
AB68		G	PB54		F
AB71	Replaced AB56 10/2016	F	PB55		F
CR07		G	PB59		G
CR50		F	PB65		G
CR51		G	PB67		G
CR53		G	PB68		G
FT06		F	PB69		G
FT07	Access Issues	G	PB70		G
FT08		G	UB02		G
			PVE3RP	Reference to CGPS Sta. PVE3	G

GNSS column indicates site is Good, Fair or Poor for Satellite Visibility Conditions

McGEE SURVEYING CONSULTING
5290 Overpass Road, Ste#107, Santa Barbara, CA 93111

10/10/2018 COORDINATE LIST

Portuguese Bend Landslide 10/10/2018 Monitoring Survey No. 22
Prepared by McGee Surveying Consulting: Document Date 06/11/2019, Revised Ortho Hts 07/09/19

Datum: Horizontal & EH are NAD83 (2007) 2007.00 Epoch; California State Plane Zone 5; Vertical: NAVD88
Note, Fixed CGPS Station PVE3 at Record 3D Position & NAVD88 Height per September 2007 Survey;
See 2007 and subsequent Survey Reports

Point	Latitude	Longitude	EH(ft)	North(ft)	East(ft)	OrthoHt(ft)	Description
AB01	33-44-38.30262	118-22-53.05186	60.104	1729427.561	6445709.557	178.586	Punched 1/2" GIP in meter box
AB02	33-44-13.84878	118-22-26.19243	-2.027	1726946.974	6447968.685	116.468	4" BC "SAN PEDRO 1936" on conc. block
AB04	33-44-28.08740	118-22-36.29136	-51.326	1728389.556	6447121.139	67.131	BC "CO ENG STA Q2.." on 2"GIP in mass of conc.
AB05	33-44-24.98778	118-22-30.09445	-38.009	1728074.255	6447643.327	80.437	BC "CO ENG STA Q3.." on 2"GIP in mass of conc.
AB12	33-44-38.27207	118-22-22.72226	164.812	1729414.862	6448270.932	283.156	BC "CO ENG STA 7A.." in mass of conc.
AB13	33-44-43.34312	118-22-23.16215	246.062	1729927.637	6448235.685	364.383	Punched 1/2" GIP in meter box
AB16	33-44-47.57859	118-22-31.51215	258.044	1730358.430	6447532.124	376.381	Punched 1/2" GIP in meter box
AB17	33-44-58.06059	118-22-41.08432	324.389	1731421.095	6446727.749	442.722	Punched 1/2" GIP in meter box
AB20	33-44-37.77169	118-22-05.96679	277.933	1729359.059	6449685.775	396.204	BC "CO ENG STA W. FIX 1956.." in mass of conc.
AB24	33-44-42.35164	118-22-28.79605	217.345	1729829.177	6447759.527	335.697	Cotton spindle in conc. In road
AB50	33-44-25.10987	118-22-22.94795	63.567	1728084.352	6448246.934	181.986	Nail in conc. collar of well
AB51	33-44-40.22836	118-22-34.15244	186.685	1729616.222	6447306.374	305.068	PK mag nail in plastic plug "LS6957" in 1"GIP
AB53	33-44-48.36522	118-22-05.70084	234.552	1730429.887	6449712.158	352.773	Chiseled + on s edge conc. Vault
AB57	33-45-03.16768	118-22-05.20509	446.464	1731926.129	6449759.504	564.621	6" mag nail & washer in conc. in 2"x 36" GIP
AB58	33-44-55.14168	118-22-13.27639	287.290	1731117.277	6449074.935	405.515	Punched RR spike on s side road
AB59	33-44-52.53717	118-21-59.79470	315.889	1730849.811	6450212.464	434.066	6" mag nail & washer in conc. in 2"x 36" GIP
AB60	33-44-35.03927	118-22-26.06645	60.946	1729089.104	6447987.294	179.322	6" mag nail & washer in conc. in 2"x 28" GIP
AB61	33-44-18.57302	118-22-25.95810	21.990	1727424.479	6447990.253	140.458	6" mag nail & washer in conc. in 2"x 24" GIP
AB62	33-44-33.22730	118-22-38.63351	24.518	1728909.896	6446925.285	142.957	6" mag nail & washer in conc. in 1"x 24" GIP
AB63	33-44-34.71525	118-22-34.12239	62.288	1729058.887	6447306.826	180.698	Punched 1/2 x 48" rebar
AB64	33-45-02.13621	118-22-33.46040	413.879	1731830.688	6447373.101	532.160	2" mag nail on NE side 2' conc. Collar/Well B12
AB65	33-45-00.93065	118-22-22.90363	340.232	1731705.496	6448264.115	458.474	2" mag nail & washer in conc. in 1"x 60" GIP
AB66	33-44-44.53342	118-22-20.15045	255.993	1730047.022	6448490.470	374.296	1/2"x 24" punched rebar 1" below AC/collar
AB67	33-44-55.71620	118-22-29.06610	286.975	1731180.298	6447741.758	405.267	1/2"x 24" punched rebar 1" below AC/collar
AB68	33-44-46.61069	118-22-25.31254	275.041	1730258.633	6448055.312	393.357	1/2"x 24" punched rebar 1" below AC/collar
AB71	33-45-06.07024	118-22-19.51922	453.196	1732224.002	6448551.837	571.402	2"screw&brass washer"PLS3945" on VanderlipDr.
CR07	33-45-00.26674	118-21-48.09396	513.776	1731627.613	6451203.390	631.873	6" mag nail & washer in conc. in old 1" IP
CR50	33-45-13.97072	118-21-50.11950	754.551	1733013.580	6451037.357	872.607	Tack & shiner on lower rock wall
CR51	33-45-14.49684	118-21-34.43628	858.075	1733062.000	6452361.867	976.068	Tack & shiner on conc. pad
CR53	33-45-11.63350	118-21-59.73965	662.552	1732780.260	6450224.153	780.654	2" mag nail & washer in conc. in 1"x 60" GIP
FT06	33-44-42.78113	118-21-29.58706	370.304	1729854.366	6452759.917	488.389	6" mag nail & washer in conc. in 2"x 36" GIP
FT07	33-44-36.86787	118-21-13.66370	470.487	1729251.825	6454102.549	588.530	6" mag nail & washer in conc. in 2"x 36" GIP
FT08	33-44-38.19499	118-21-22.57468	540.327	1729388.643	6453350.473	658.401	6" mag nail & washer in conc. in 2"x 36" GIP
KC01	33-44-29.13021	118-21-33.11100	194.041	1728475.441	6452457.387	312.217	6" mag nail & washer in conc. in old 1" IP
KC02	33-44-14.54586	118-21-37.05776	-104.533	1727002.286	6452118.782	13.734	Punched 1/2" GIP in meter box
KC05	33-44-15.36968	118-21-24.51039	109.253	1727081.787	6453178.808	227.454	Punched 1/2" GIP in meter box
KC06	33-44-22.33144	118-21-21.96762	181.634	1727784.797	6453396.059	299.790	Punched 1/2" GIP in meter box
KC07	33-44-22.09042	118-21-18.55895	195.305	1727759.414	6453683.857	313.447	Punched 1/2" GIP in meter box
KC13	33-44-10.41116	118-21-25.78304	72.835	1726580.906	6453069.541	191.067	Cotton spindle in AC turnout
KC14	33-44-12.03469	118-21-17.07086	141.912	1726742.425	6453805.947	260.097	Brass pin&washer "LS8773" set above spike in CL
KC15	33-44-20.39681	118-21-25.21860	168.797	1727590.198	6453120.798	286.976	Cotton spindle in cul-de-sac
KC16	33-44-20.55016	118-21-13.64610	209.087	1727602.245	6454098.230	327.215	Brass pin&washer "LS8773" set above spike in Xn
KC17	33-44-17.54890	118-21-26.32512	97.017	1727302.632	6453026.322	215.216	2" mag nail & washer in conc. in 1"x 50" GIP
PB04	33-44-20.94634	118-22-15.81599	47.124	1727661.226	6448847.713	165.533	Nail & tag "RCE26120" in conc. in 3" pipe
PB06	33-44-23.64938	118-22-05.05432	58.330	1727931.138	6449757.607	176.676	Punched cap on 2" GIP
PB07	33-44-25.62730	118-21-59.69421	78.757	1728129.433	6450211.029	197.069	Brass tag "LA CO DPW" in conc. in 2" GIP
PB08	33-44-26.27316	118-21-56.72562	76.035	1728193.812	6450461.980	194.331	Punched cap on 2" GIP
PB09	33-44-26.72963	118-21-52.15220	69.568	1728238.553	6450848.396	187.841	Punched cap on 2" GIP in cable box
PB12	33-44-26.80852	118-21-43.48951	63.459	1728243.884	6451580.032	181.693	Punched cap on 2" GIP in cable box
PB13	33-44-24.76021	118-21-36.79748	87.873	1728034.787	6452144.465	206.088	Punched cap on 2" GIP in cable box
PB18	33-44-48.40713	118-21-53.76901	244.605	1730430.449	6450719.804	362.774	Punched 1/2" GIP in meter box
PB20	33-44-31.61892	118-21-48.93357	111.831	1728731.832	6451122.013	230.056	Punched cap on 2" GIP in cable box
PB21	33-44-36.60570	118-21-48.27840	153.263	1729235.751	6451179.167	271.462	Punched cap on 2" GIP in cable box
PB26	33-44-39.63236	118-21-35.58808	164.722	1729537.863	6452251.988	282.851	Brass tag "LA CO DPW" in conc. in 2" GIP
PB27	33-44-36.59731	118-21-40.42530	151.299	1729232.512	6451842.376	269.462	Punched cap on 2" GIP in cable box
PB29	33-44-32.65891	118-21-37.47877	49.947	1728833.482	6452089.789	168.116	Brass tag "LA CO DPW" in conc. in 2" GIP
PB54	33-44-41.07534	118-21-56.95141	239.384	1729690.248	6450448.356	357.599	PK mag nail in plastic plug "LS6957" in 1"GIP
PB55	33-44-31.97349	118-21-52.73767	120.236	1728768.840	6450800.873	238.476	PK mag nail in plastic plug "LS6957" in 1"GIP
PB59	33-44-21.83751	118-22-18.06146	37.880	1727752.017	6448658.401	156.294	PK mag nail in plastic plug "LS?" in 1" GIP
PB65	33-44-28.81264	118-22-05.67003	169.206	1728453.288	6449707.519	287.529	2"alum.cap "PLS3945" on 5/8"x 24"rebar flush/AC
PB67	33-44-20.41096	118-21-52.06211	-47.648	1727599.765	6450853.688	70.657	1/2" x 3' rebar
PB68	33-44-20.97329	118-22-14.21575	53.928	1727663.452	6448982.873	172.330	2" Alum Cap "PLS3945" in 1"x 30" GIP
PB69	33-44-22.12891	118-22-16.64848	45.470	1727781.034	6448777.845	163.877	2" Alum Cap "PLS3945" in 1"x 30" GIP
PB70	33-44-22.83743	118-22-18.53442	35.609	1727853.247	6448618.830	154.021	2" Alum Cap "PLS3945" in 1"x 30" GIP
UB02	33-44-19.46177	118-22-00.45747	-55.762	1727506.389	6450144.293	62.586	PK mag nail in plastic plug "?" in 1"GIP
PVE3	33-44-35.85329	118-24-15.26904	235.421	1729207.091	6438765.184	354.360	CGPS Pos. Fixed in 2007 and subsequent surveys
PVE3RP				1729195.880	6438764.665	346.877	PK in Conc. Base, RP to PVE3
PVHS	33-46-46.02015	118-22-19.74135	854.021	1742328.079	6448570.488	972.037	CGPS Pos. Determined as by this Survey
PVRS	33-46-25.89196	118-19-14.06707	198.587	1740239.295	6464237.900	316.295	CGPS Pos. Determined as by this Survey
VTIS	33-42-45.48970	118-17-37.71231	197.499	1717933.689	6472307.221	315.244	CGPS Pos. Determined as by this Survey

Addendum No. 1

Monitoring Survey No. 23 Report
Portuguese Bend Landslide Monitoring
January 29, 2019 Partial Monitoring Survey
for the
City of Rancho Palos Verdes
by
McGee Surveying Consulting

Addendum No. 1 Report briefly describes the second tri-annual Portuguese Bend Monitoring Survey M23. The field survey took place January 28-31, 2019 (average date 01/29/19). This partial survey included 30 points which are a sub-set of the full monitoring array reported in October 2018. A Minimally Constrained Adjustment was processed to develop NAD83 (2007) Epoch 2007.00 Geodetic and State Plane Coordinates in feet. The adjustment fixed CGPS Station PVE3 and included two other CGPS Stations PVRS and VTIS with three 3-9 hour observations (PVHS not operating). The CGPS stations are known to be stable over time and indicated the survey reference frame was stable and successfully recovered.

For a detailed history of the program and surveys see “History” above and the Monitoring Survey Reports by MSC dating back to 2007. The Field Surveys, Equipment, Data Collection and Network Design were as described in the above Report with the following addition.

A new Leica GS18T GNSS Receiver was acquired for this project with the future expectation of improving productivity. The GS18 was used to duplicate the survey effort by double occupying all points as a test to compare the accuracy of the GS18 with GS15 Receivers used since 2010. The GS18 incorporates an advanced algorithm with an Inertial Measurement Unit (IMU) to eliminate the need for leveling the instrument. Comparing the results of the two independent surveys found an increase in production with the GS18 with a small loss in accuracy. The results will be addressed in the October 2019 Survey Report. Movements are summarized in the “Periodic Horizontal & Vertical Movement in Feet” below.

Addendum No. 2

Monitoring Survey No. 24 Report
Portuguese Bend Landslide Monitoring
May 7, 2019 Partial Monitoring Survey

Addendum No. 2 Report briefly describes the second tri-annual Portuguese Bend Monitoring Survey M24. The field survey took place May 5-8, 2019 (average date 05/07/19). This partial survey included 28 points which are a sub-set of the full monitoring array reported in October 2018. Points AB04, FT07, PB12 and PB18 were overgrown and not accessable. AB12 has access issues as it is located on private land used for a horse corral with guard dogs. AB70 established in 2014 was recovered and will be used as a future substitute for AB12 as noted in “History” above. A Minimally Constrained Adjustment was processed to develop NAD83 (2007) Epoch 2007.00 Geodetic and State Plane Coordinates in feet. The adjustment fixed CGPS Station PVE3 and included two other CGPS Stations PVHS and VTIS with four 3-7 hour observations. The CGPS stations are known to be stable over time and indicated the survey reference frame was stable and successfully recovered.

For a detailed history of the program and surveys see “History” above and the Monitoring Survey Reports by MSC dating back to 2007. The Field Surveys, Equipment, Data Collection and Network Design were as described in the above Report with the following addition.

The Leica GS18T GNSS Receiver discussed above was used to double and triple occupy all points in this survey utilizing a GS15 receiver as a base station. The results of the January 2018 survey with the GS18 were found to be similar to past results with the GS15. Based on the January test results, the GS18 Receiver was substituted on this survey for the roaming GS15 Receiver used since 2010. On the next monitoring survey in October 2019 the application of the GS18 will be fully implemented which will increase production with little loss in precision resulting in an accumulated cost savings for the City over the next few years. Movements are summarized in the "Periodic Horizontal & Vertical Movement in Feet" below.

Note: Columns 4-7 revised 07/09/19

PORTUGUESE BEND LANDSLIDE "PARTIAL MONITORING" MOVEMENTS						
Oct. 2018 to May 2019 Periodic Horizontal & Vertical Movements in Feet						
	10/10/2018 (M22) to 01/29/2019 (M23) = 3.6 mo		01/29/2018 (M23) to 05/07/2019 (M24) = 3.3 mo		10/10/2018 (M22) to 05/07/2019 (M24) = 6.9 mo	
Mon.Pt.	Movement Distance	Elevation Change	Movement Distance	Elevation Change	Movement Distance	Elevation Change
AB04	0.12	0.09	Not Observed	Not Observed	Not Observed	Not Observed
AB12	0.05	0.07	0.10	-0.09	0.16	-0.01
AB13	0.06	0.07	Not Observed	Not Observed	0.09	0.00
AB16	0.02	0.11	0.00	-0.06	0.03	0.05
AB17	0.03	0.16	0.01	-0.06	0.02	0.10
AB20	0.08	0.07	0.12	-0.09	0.17	-0.02
AB50	0.05	0.08	0.04	-0.06	0.07	0.02
AB59	0.05	0.17	0.12	-0.12	0.16	0.04
AB60	0.07	0.10	0.08	-0.13	0.15	-0.02
AB61	0.02	0.12	0.01	-0.14	0.00	-0.02
AB65	0.05	0.12	0.03	-0.08	0.08	0.04
CR07	0.02	0.08	0.06	-0.15	0.08	-0.07
CR50	0.02	0.07	0.01	-0.13	0.03	-0.05
FT06	0.04	0.05	0.13	-0.15	0.17	-0.10
FT07	0.02	0.06	Not Observed	Not Observed	Not Observed	Not Observed
KC06	0.04	0.09	0.01	-0.13	0.02	-0.04
KC07	0.05	0.11	0.02	-0.12	0.03	0.00
KC13	0.03	0.11	0.03	-0.09	0.06	0.02
KC16	0.04	0.10	0.03	-0.11	0.00	-0.01
KC17	0.01	0.06	0.03	-0.09	0.04	-0.03
PB04	0.29	0.01	0.45	-0.27	0.77	-0.26
PB12	0.50	0.00	Not Observed	Not Observed	Not Observed	Not Observed
PB13	0.36	0.07	0.44	-0.13	0.86	-0.06
PB18	0.02	0.14	Not Observed	Not Observed	Not Observed	Not Observed
PB26	0.07	0.11	0.15	-0.14	0.21	-0.02
PB55	0.28	0.26	0.34	-0.20	0.63	0.05
PB59	0.45	-0.08	0.68	-0.37	1.15	-0.46
PB67	1.14	-0.13	1.96	-0.44	3.18	-0.57
PB68	0.24	0.02	0.37	-0.26	0.62	-0.25
PB69	0.25	-0.02	0.43	-0.25	0.70	-0.27
PB70	0.23	-0.22	0.36	-0.55	0.61	-0.77
Note: Movements of 0.03 feet (3/8") or greater are deemed to have actually moved.						
See "PB MOVEMENT DATA POSTING 2007-(Present).xlsx" for the Oct. 2017 to Oct. 2018 annual summary						