Ground Control Point Survey Report

"El Nino Lidar Campaign"

USGS Contract #G16PC00020

Task Order #: T1

Prepared for:

United States Geological Survey (USGS)

Submitted By:

Dewberry

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1. INTRODUCTION

1.1 *Project Summary*

Dewberry is under contract to the United States Geological Survey to provide surveyed control points for the above referenced USGS Task Order. Towill, Inc. was subcontracted by Dewberry to complete this task. The control points will be used to validate the newly acquired lidar and generate both Non-vegetated Vertical Accuracy (NVA) and Vegetated Vertical Accuracy (VVA) reports.

The ground survey was conducted during periods in April and May, 2016. The exclusive source of control for this Lidar campaign and Control survey consisted of Continuously Operating Reference Stations operated by the Plate Boundary Observatory (PBO) branch of UNAVCO (http://www.unavco.org/projects/major-projects/pbo/pbo.html). The western coastal and coast mountain ranges of the United States include hundreds of the PBO CORS that are publically funded and, with coordination in advance, can be operated at a high collection rate (1-hertz) and the data obtained via simple File Transfer Protocol.

The horizontal datum for this project is the latest realization of NAD83, namely NAD83(2011), epoch of 2010.0. The datum is realized by the published horizontal coordinates of the PBO CORS. These values were obtained via the National Geodetic Survey (NGS - www.ngs.noaa.gov/CORS) and the Scripps Orbit and permanent Array Center (SOPAC - sopac.ucsd.edu/processing). See Table 1 for a list of the published coordinate values.

The vertical datum for this project is NAVD88. The datum is realized by the published ellipsoid heights of the PBO CORS and the absolute application of the geoid model GEOID12B. These heights were obtained via the National Geodetic Survey (NGS - www.ngs.noaa.gov/CORS) and the Scripps Orbit and permanent Array Center (SOPAC - sopac.ucsd.edu/processing). See Table 1 for a list of the published ellipsoid heights.

1.2 *Points of Contact*

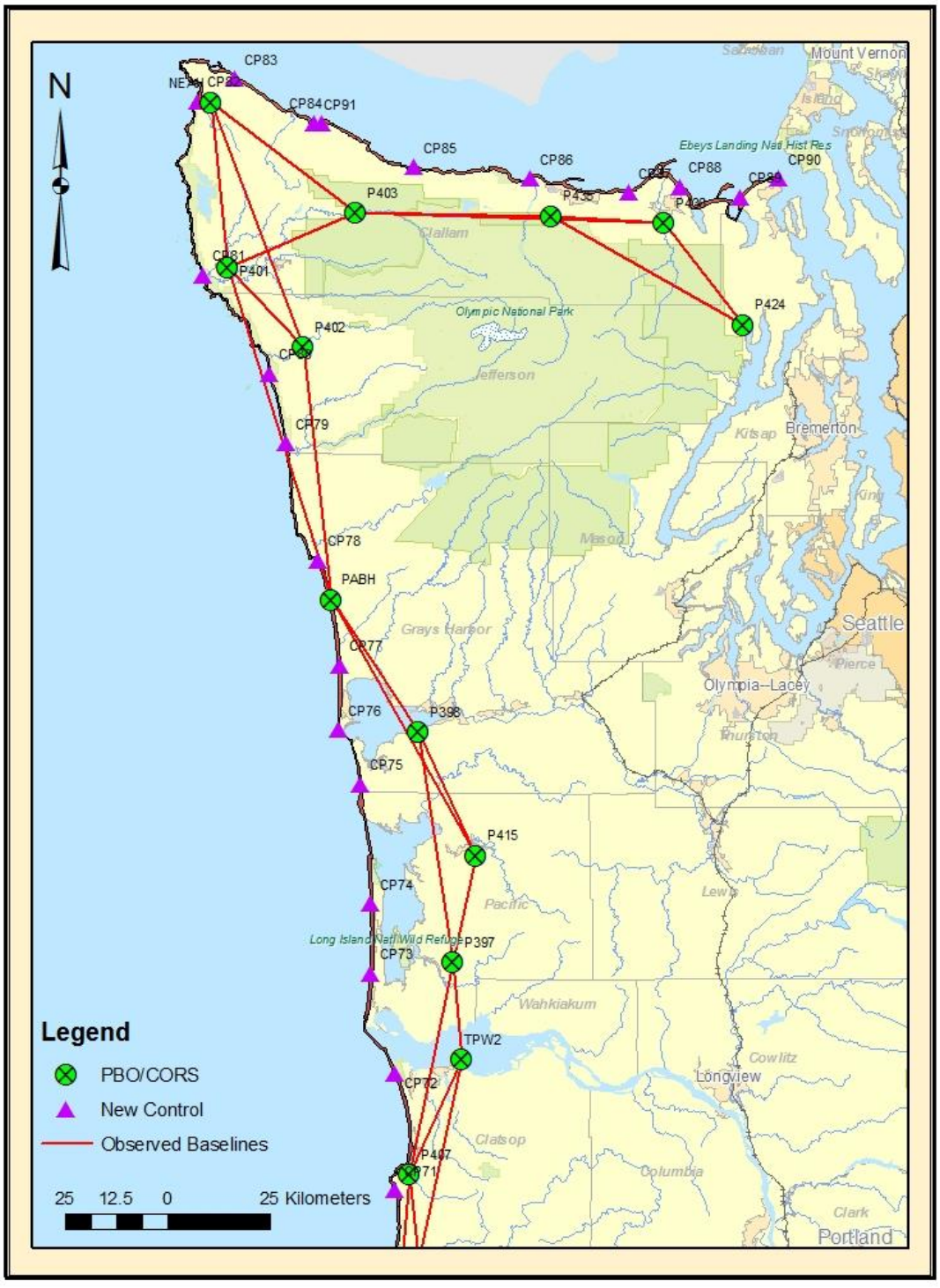
Questions regarding the technical aspects of this report should be addressed to:

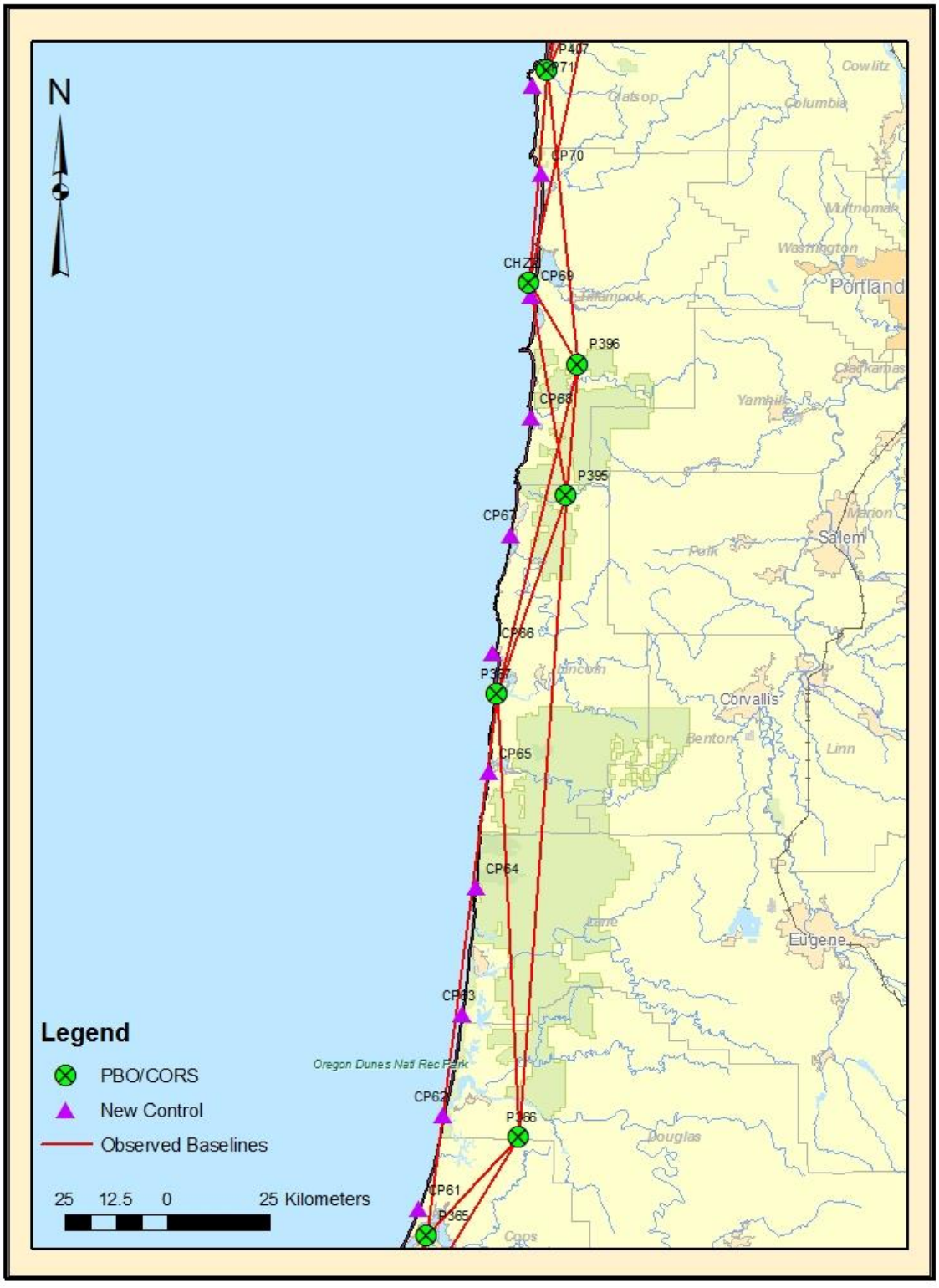
Towill, Inc.

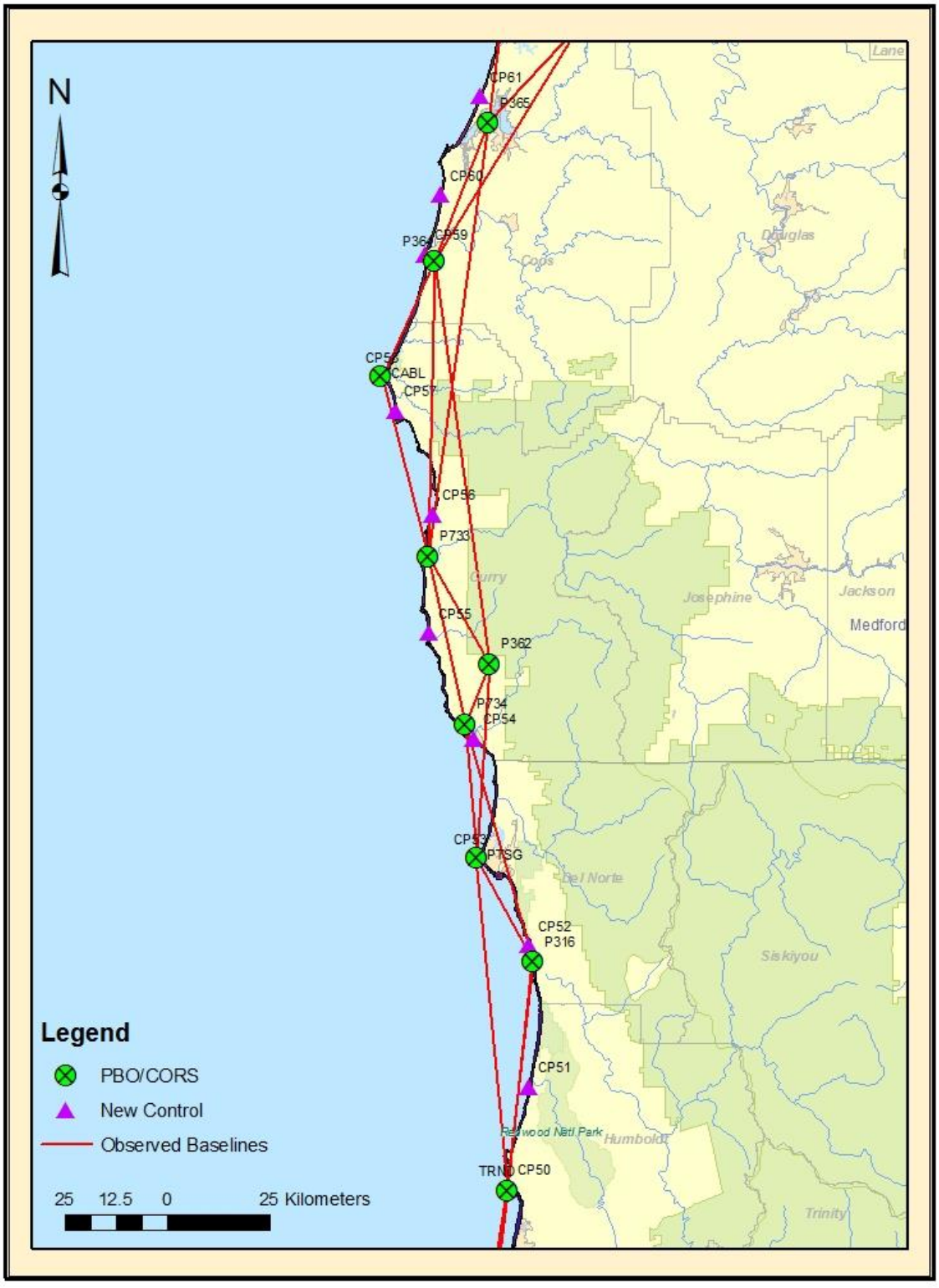
Keith Kirkby, PE
Survey Engineer
7222 Commerce Center Dr.
Suite 230
Colorado Springs, CO 80924
(719) 243-5990

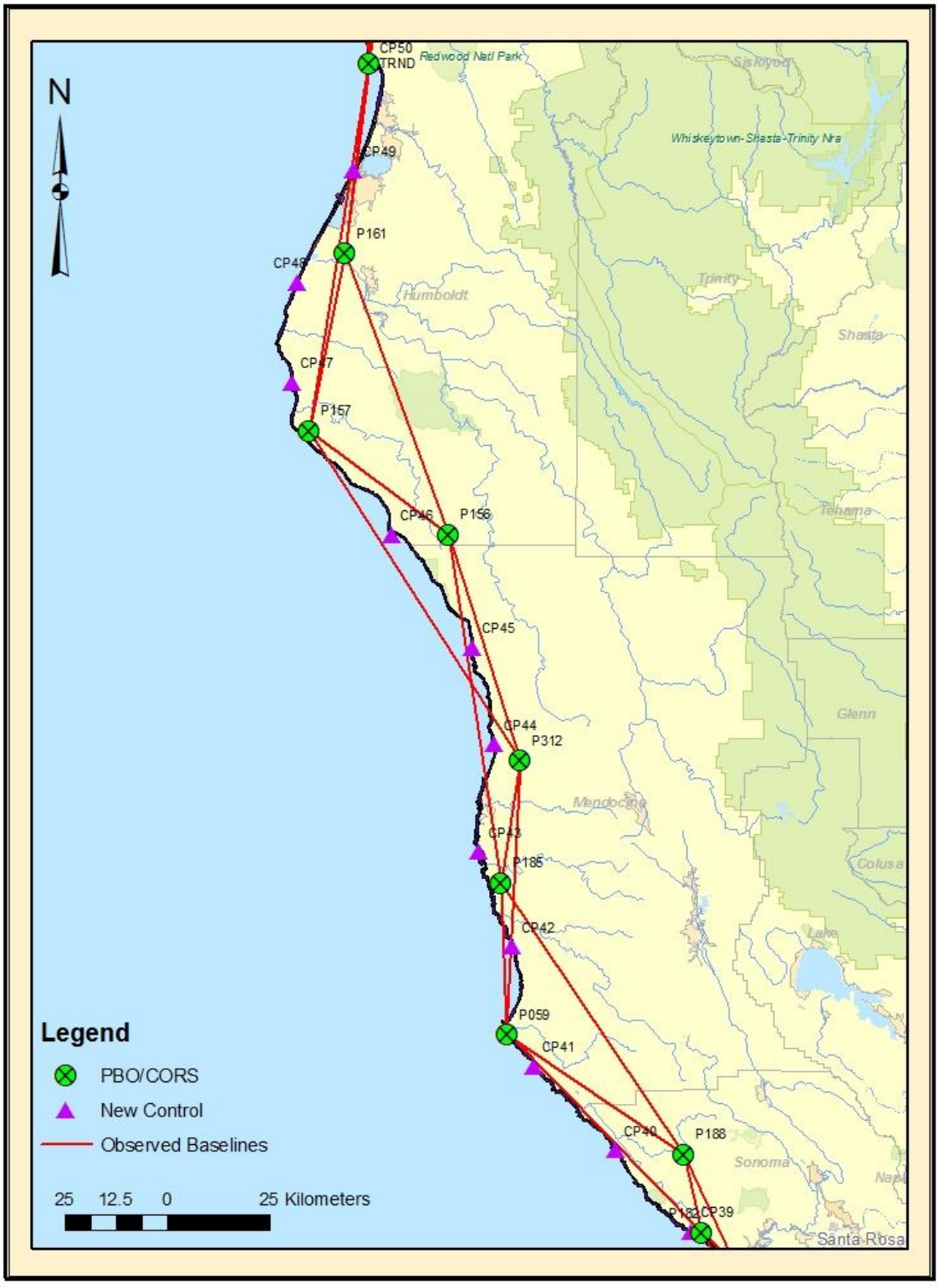
1.3 *Project Area*

The project boundary falls along an approximately 500 meter wide corridor on the coastline between Tijuana, Mexico and Port Townsend, WA as depicted below:




N
P407
P71
CP70
CHZ3
CP69
P396
CP68
P395
CP67
CP66
P367
CP65
CP64
CP63
CP62
P366
CP61
P365
Cowlitz
Clatsop
Columbia
Multnomah
Washington
Portland
Tillamook
Clackamas
Yamhill
Marion
Salem
Polk
Lincoln
Corvallis
Benton
Linn
Lane
Eugene
Douglas
Coos
Oregon Dunes Nat'l Rec Park
Legend
PBO/CORS
New Control
Observed Baselines
25 12.5 0 25 Kilometers


N
CP61
P365
CP60
P364
CP59
CP58
CABL
CP57
CP56
P733
CP55
P362
P734
CP54
CP53
P785
CP52
P316
CP51
TRND
CP50
Lane
Douglas
Coos
Curry
Josephine
Jackson
Medford
Del Norte
Siskiyou
Humboldt
Trinity
Redwood Natl Park
Legend
PBO/CORS
New Control
Observed Baselines
25 12.5 0 25 Kilometers


N
CP50
TRND
Redwood Natl Park
Six Rivers
Whiskeytown-Shasta-Trinity Nra
CP49
P161
CP48
Trinity
Humboldt
Shasta
CP47
P157
CP46
P156
Tehama
CP45
Glenn
CP44
P312
Mendocino
CP43
P185
Colusa
CP42
Lake
P059
CP41
CP40
P188
Sonoma
Napa
P183
CP39
Santa Rosa
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25 12.5 0 25 Kilometers


N
P182
CP39
CP38
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CP37
CP36
Point Reyes Natl Seashore
Golden Gate National Rec Area
Marin
San Rafael--Novato
P181
CP35
San Francisco--Oakland
CP34
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CP33
CP32
CP31
P534
CP30
P212
CP29
Santa Cruz
Watsonville
CP28
Salinas
P27
Seaside--Monterey--Marina
CP26
P172
CP25
Yolo
Davis
Sacramento
Napa
Sonoma
Santa Rosa
Vacaville
Fairfield
Solano
Petaluma
Vallejo
Lodi
Stockton
Antioch
Concord
Contra Costa
San Joaquin
Tracy
Livermore
Alameda
Stanislaus
San Jose
Santa Clara
Gilroy--Morgan Hill
San Benito
Monterey
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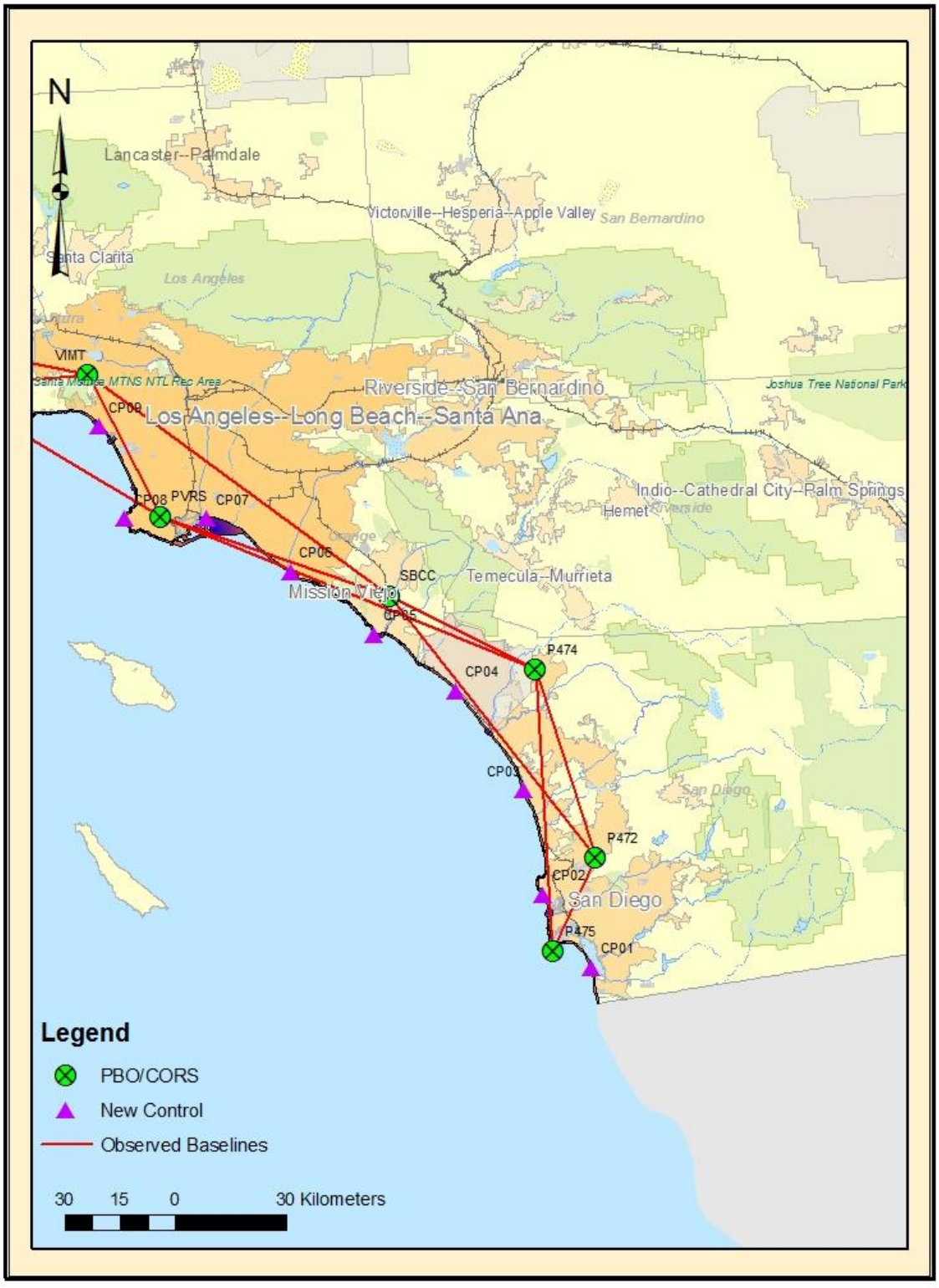
P172
CP25
P173
CP24
CP23
KK23
P067
CP22
CP21
P525
CP20
CP19
CP18
P513
CP17
VNDP
CP16
TIRN
CP15
CP14
Santa Barbara
Santa Maria
Lompoc
Atascadero--Paso Robles
San Luis Obispo
Monterey
Fresno
Kings
Kern
Tulare
San Benito
Santa Barbara
Channel Islands National Park
N
Legend
PBO/CORS
New Control
Observed Baselines
25 12.5 0 25 Kilometers


N
Bakersfield
Kern
San Luis Obispo
San Bernardino
Santa Barbara
Lancaster--Palmdale
Victorville--Hesperia--Apple Valley
Ventura
Santa Clarita
Los Angeles
CP14
CP13
Santa Barbara
VNCO
CP12
Camarillo
Simi Valley
Oxnard
Thousand Oaks
VIMT
CIRX
CP11
CP10
CP09
Santa Monica MTNS NTL Rec Area
Channel Islands National Park
Los Angeles--Long Beach--Santa Ana
Riverside
CP08
PVRS
CP07
CP06
SBCC
Mission Viejo
CP05
San Diego
CP04
Legend
PBO/CORS
New Control
Observed Baselines
30 15 0 30 Kilometers


N
Lancaster--Palmdale
Victorville--Hesperia--Apple Valley
San Bernardino
Santa Clarita
Los Angeles
VIMT
Santa Monica MTNS NTL Rec Area
Riverside--San Bernardino
Joshua Tree National Park
CP09
Los Angeles--Long Beach--Santa Ana
Indio--Cathedral City--Palm Springs
Hemet
P08
PVRS
CP07
CP06
SBCC
Temecula--Murrieta
Mission Viejo
CP05
P474
CP04
CP03
San Diego
P472
CP02
San Diego
P475
CP01
Legend
PBO/CORS
New Control
Observed Baselines
30 15 0 30 Kilometers

PROJECT DETAILS

2.1 *Survey Equipment*

All GPS observations were accomplished using Trimble Navigation R7 dual frequency GPS receivers and accompanying Trimble Zephyr Geodetic antennae. Instrument heights were measured twice in units of feet and meters and the values reduced and compared in the field prior to leaving each station.

Control point observation data were logged for a minimum of 45 minutes and as much as 60 minutes depending on proximity to operating PBO/CORS.

2.2 *Survey Point Detail*

Ninety-two control points were established along the coastline. The control points were marked with either 12" spikes or PK nails and consisted of a combination of bare-earth, bare-earth/photo-identifiable, and low vegetation ground cover classes. Relative static GPS observation and processing techniques were used for all survey measurements.

The Ground Control Point locations are detailed in section 4 of this document, "Ground Control Point Documentation Reports".

2.3 *Network Design*

A primary geodetic network consisting of 55 PBO/CORS stations was established by downloading several 24-hour data files for each station for multiple days and post-processing the resulting baselines. The resulting network comprises 107 baselines of a minimum 24-hour duration each. Ninety-two new control points were established and subsequently tied into two of the PBO/CORS stations by downloading the appropriate 24-hour RINEX files and post-processing the static observation in Trimble Business Center. The project diagrams above illustrate the primary network connections and the new control point locations.

2.4 *Data Post-processing and Analysis*

Observed relative GPS baselines were processed in Trimble Business Center. All processed observations consist of quasi-independent baselines (i.e. in accordance with the "n-1 baselines" rule where n = number of receivers in a given 'session'). The International GPS Service for Geodynamics (IGS) rapid precise orbits (igr) were used in the processing of all baseline vectors. The 'igr' orbits are published with a latency of approximately 30 hours. These orbits are globally accurate to within ~5cm and are particularly important when processing long baselines.

One temorary base station point (in addition to the PBO/CORS) was established at the Florence Municipal Airport in Florence, OR. This point was tied into two local PBO stations via static GPS data acquired during the campaign.

It is well known that the Earth's crust deforms over time. The geometric variations of the Earth's surface over time must be taken into account for the realization of terrestrial reference systems. It is for this reason that there is inherent inconsistency between the 'published' coordinates of the PBO/CORS and the current survey campaign.

For the purpose of the new control survey, the methodology employed by Towill was to transform the published control coordinates to the mid–epoch of the GPS survey using the National Geodetic Survey software HTDP (Horizontal Time Dependent Positioning) software. The software employs crustal motion models that incorporate both continuous and episodic components of crustal motion. These models assume that points on the Earth's surface move with constant horizontal velocities. This is a generally accepted approach, except for years following the accelerated motion of the plates associated with large earthquakes. The episodic motion (created by earthquakes) is modeled by dislocation theory. The Northridge Earthquake of 1994 is an example. It is modeled by dislocation theory and is incorporated into the HTDP software.

The published geodetic coordinates of the PBO/CORS were transformed using HTDP from the published values (NAD83[2011], epoch 2010.0), to the datum and epoch associated with the new surveys, viz., NAD83[2011], epoch 2016.35. This ensures compatibility between the GPS observations (vectors), and the coordinates used as constraints in the final network adjustment.

2.5 *Adjustments*

A minimally constrained, primary network adjustment was executed to verify the internal integrity of the baseline computations and to derive appropriate a-priori baseline observation weighting factors. In the resulting adjustment, the estimated variance factor ($\sigma_0^2 = 1.0002$) passed the χ^2–test. This indicates appropriate *a priori* estimates of the accuracy of the GPS baseline vectors. None of the 321 vector component residuals or associated standardized residuals were flagged for possible rejection under the τ-max test at the 95 percent level of confidence. The relative horizontal accuracy of the network can be assessed by reviewing the relative 95 percent confidence regions (ellipses) of the adjustment. All station pairings meet the Federal Geodetic Control Subcommittee (FGCS) relative positioning standard for Order B surveys (8mm + 8ppm).

The HTDP-translated latitude and longitude of each PBO/CORS and the published ellipsoid height on the GRS80 ellipsoid were held as weighted observations in a fully constrained primary network adjustment. The estimated variance factor ($\sigma_0^2 = 0.9868$) passed the χ^2–test at the 95 percent level of confidence. This indicates that network was not being unduly distorted by the imposition of constraints. No residuals were flagged for possible rejection.

Ninety-two control points were established and tied into two of the PBO/CORS stations by downloading the appropriate 24-hour RINEX files and post-processing the static observation in Trimble Business Center. These processed vectors were incorporated into a third least-squares adjustment to derive final coordinates and

elevations of each of the newly established control points. The adjusted final coordinates were then run through HTDP to translate the values back to 2010.0 from the mid-epoch of the survey.

2.6 *Published PBO Coordinates / Adjustment Constraints*

The published coordinates of the PBO / CORS stations that were used as control for this survey and, ultimately, constraints (following the HTDP process described above) in the network adjustments is tabulated below:

PBO / CORS Published Coordinates and Ellipsoid Heights

Horizontal Datum: NAD83(2011)
Epoch: 2010.0
Linear Unit: International Meter

Point	Latitude				Longitude				Ellipsoid Height
		º	'	"		º	'	"	
NGS Published Coordinates									
CABL	N	42	50	09.94308	W	124	33	47.98620	38.286
CHZZ	N	45	29	11.44093	W	123	58	41.18376	51.161
LFLO	N	43	59	00.96713	W	124	06	27.69084	-6.042
NEAH	N	48	17	52.26367	W	124	37	29.60004	460.245
P059	N	38	55	42.03419	W	123	43	34.25628	-10.822
P067	N	35	33	06.29824	W	121	00	10.60668	107.594
P157	N	40	14	51.15527	W	124	18	29.00880	696.236
P172	N	36	13	41.05535	W	121	46	02.02944	313.190
P173	N	35	56	44.56712	W	121	17	25.15020	339.828
P181	N	37	54	52.34987	W	122	22	36.26760	72.732
P185	N	39	15	40.67993	W	123	44	57.55488	146.834
P188	N	38	40	04.27069	W	123	13	46.37496	209.358
P210	N	36	48	58.08233	W	121	43	54.58008	3.600
P231	N	36	37	18.02341	W	121	54	19.42416	-25.764
P316	N	41	33	32.86577	W	124	05	10.06188	235.389
P415	N	46	39	21.55259	W	123	43	47.45496	-15.081
P472	N	32	53	21.13976	W	117	06	16.85412	138.603
P474	N	33	21	18.68098	W	117	14	55.24188	183.653
P475	N	32	39	59.01142	W	117	14	38.11776	-24.285
P523	N	35	18	16.00618	W	120	51	36.93060	41.984
P534	N	37	03	40.41997	W	122	14	15.34524	204.804
PABH	N	47	12	46.06456	W	124	12	16.43148	13.277
PTSG	N	41	46	57.85558	W	124	15	18.66132	-9.794

Point	Latitude				Longitude				Ellipsoid Height
		º	'	"		º	'	"	
SBCC	N	33	33	10.78852	W	117	39	41.30280	89.406
TJRN	N	34	29	00.49571	W	120	07	57.17748	157.816
TRND	N	41	03	13.97729	W	124	09	03.06396	78.680
VNDP	N	34	33	22.71092	W	120	36	59.17428	-9.147
SOPAC SECTOR Published Coordinates									
CIRX	N	34	06	34.38086	W	118	56	14.21628	488.885
P161	N	40	38	14.49384	W	124	12	47.05236	32.868
P177	N	37	31	41.39000	W	122	29	42.13464	72.321
P182	N	38	29	42.04021	W	123	10	52.43052	397.293
P193	N	38	07	22.55902	W	122	54	29.25540	67.104
P312	N	39	31	45.03011	W	123	41	54.09492	255.394
P315	N	39	51	48.88562	W	123	43	00.77268	258.381
P364	N	43	05	25.16694	W	124	24	33.38532	6.807
P365	N	43	23	43.85245	W	124	15	12.47796	27.467
P366	N	43	36	51.50484	W	123	58	46.47828	529.468
P367	N	44	35	06.87286	W	124	03	41.59584	23.277
P395	N	45	01	20.19122	W	123	51	27.03708	53.385
P396	N	45	18	34.23391	W	123	49	22.36332	54.908
P397	N	46	25	17.81465	W	123	47	56.91588	566.625
P398	N	46	55	32.81066	W	123	54	58.05864	23.811
P401	N	47	56	13.86182	W	124	33	25.20540	36.486
P402	N	47	45	58.38217	W	124	18	21.16656	24.010
P403	N	48	03	44.34448	W	124	08	27.08628	284.951
P407	N	45	57	16.72355	W	123	55	51.55968	-12.778
P435	N	48	03	34.36160	W	123	30	11.73996	287.623
P436	N	48	02	43.07377	W	123	08	03.59016	191.191
P437	N	48	00	06.49840	W	122	27	32.90436	12.789
P525	N	35	25	32.74939	W	120	48	29.25720	271.978

Point	Latitude				Longitude				Ellipsoid Height
		º	'	"		º	'	"	
P548	N	34	28	00.48986	W	119	30	14.14980	1135.502
P733	N	42	26	31.24331	W	124	24	47.81268	184.951
P734	N	42	04	35.87203	W	124	17	35.66652	113.718
PVRS	N	33	46	25.89424	W	118	19	14.07036	60.538
VIMT	N	34	07	35.19970	W	118	30	51.84000	554.389
VNCO	N	34	16	32.74244	W	119	14	15.56124	26.345

Notes: Ellipsoid heights are to the Antenna Reference Point (ARP) for the respective PBO/CORS antei

2.7 *Station Reoccupation Comparison*

The allowable tolerance of ± 5cm within the 95% confidence level was specified for the survey accuracy. Forty-six of the control points were occupied a second time at least 4 hours, and in most cases several hours or days, after the initial occupation.

The computed coordinate values and elevations of the re-occupations were compared with those of the initial occupations to evaluate the accuracy of the survey effort. The RMS of the difference in coordinates is 0.007, 0.006 and 0.020 meters for each of northing, easting, and elevation, respectively. The reoccupation results are tabulated below:

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RE-OCCUPATION COMPARISON

Point Name	Re-occupation Name	dNorthing (Meter)	dEasting (Meter)	dElev (Meter)
CP01	CP01_R	0.003	0.009	-0.016
CP03	CP03_R	-0.008	0.000	-0.028
CP05	CP05_R	-0.007	0.001	-0.021
CP06	CP06_R	0.000	0.000	-0.019
CP09	CP09_R	-0.002	0.000	-0.015
CP11	CP11_R	-0.010	0.001	0.019
CP13	CP13_R	0.007	-0.009	0.011
CP15	CP15_R	0.003	0.000	0.001
CP18	CP18_R	0.004	0.000	-0.008
CP20	CP20_R	0.010	0.009	-0.005
CP22	CP22_R	-0.002	0.009	-0.003
CP24	CP24_R	0.008	-0.018	0.019
CP26	CP26_R	0.002	-0.001	-0.011
CP28	CP28_R	-0.003	0.000	0.004
CP30	CP30_R	-0.007	0.009	-0.018
CP32	CP32_R	0.001	0.009	-0.002
CP34	CP34_R	0.013	0.000	-0.015
CP35	CP35_R	0.005	-0.009	0.004
CP38	CP38_R	-0.005	0.000	-0.011
CP40	CP40_R	0.010	0.000	0.023
CP42	CP42_R	-0.009	-0.008	0.000
CP44	CP44_R	0.007	0.009	0.024
CP45	CP45_R	0.004	-0.009	0.024

Point Name	Re-occupation Name	dNorthing (Meter)	dEasting (Meter)	dElev (Meter)
CP48	CP48_R	-0.005	0.009	0.024
CP50	CP50_R	0.001	0.000	0.001
CP51	CP51_R	0.001	0.000	-0.001
CP55	CP55_R	0.003	0.000	0.007
CP57	CP57_R	-0.003	0.000	0.006
CP59	CP59_R	0.002	-0.008	0.007
CP61	CP61_R	0.001	0.000	0.003
CP63	CP63_R	-0.004	0.000	0.044
CP65	CP65_R	0.001	0.000	0.013
CP67	CP67_R	0.002	-0.007	0.005
CP69	CP69_R	-0.002	0.000	0.008
CP71	CP71_R	-0.005	0.000	-0.015
CP73	CP73_R	0.003	-0.007	-0.006
CP75	CP75_R	-0.006	0.000	-0.008
CP77	CP77_R	0.001	-0.007	0.011
CP79	CP79_R	0.005	-0.007	-0.041
CP81	CP81_R	0.014	0.001	-0.037
CP83	CP83_R	0.003	0.000	0.018
CP85	CP85_R	0.013	0.000	-0.038
CP87	CP87_R	0.010	0.000	0.017
CP89	CP89_R	-0.020	-0.007	0.035
CP90	CP90_R	0.021	0.000	0.044

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El Nino Lidar Campaign Control

FINAL ADJUSTED COORDINATES

Horizontal Datum: NAD83(2011)
Epoch: 2010.0

Point	Latitude				Longitude				Ellipsoid Height (Meter)	Projected (Meter)		Ortho. Height (Meter)	Description	Re-Occupied
	°	'		"	°	'		"		N	E			
Control Points - UTM Zone 11														
CP01	N	32	37	20.17499	W	117	08	05.18370	-31.462	3609421.133	487356.700	3.825	PID / Bare Earth	X
CP02	N	32	48	27.26921	W	117	15	40.96908	-7.266	3629985.235	475530.070	27.900	Low Vegetation	
CP03	N	33	03	51.75671	W	117	18	09.13176	-18.614	3658464.484	471758.807	16.183	Bare Earth	X
CP04	N	33	18	51.88187	W	117	28	57.71136	11.111	3686247.479	455068.821	45.717	Low Vegetation	
CP05	N	33	27	42.42985	W	117	42	41.78232	34.618	3702708.923	433872.508	69.622	PID / Bare Earth	X
CP06	N	33	37	29.83037	W	117	56	48.96240	-31.826	3720974.700	412168.712	3.521	Low Vegetation	X
CP07	N	33	45	48.18946	W	118	11	02.53104	-32.172	3736550.900	390351.568	3.588	Bare Earth	
CP08	N	33	46	21.92646	W	118	25	21.46116	9.471	3737869.464	368269.371	45.734	Low Vegetation	
CP09	N	33	59	59.64832	W	118	29	07.13580	-30.955	3763139.519	362828.378	4.864	PID / Bare Earth	X
CP10	N	34	01	48.86375	W	118	45	16.46820	-2.243	3766897.193	338016.754	33.590	Low Vegetation	
CP11	N	34	05	08.08363	W	119	02	12.81696	-24.179	3773517.429	312071.298	11.753	PID / Bare Earth	X
CP12	N	34	14	25.13674	W	119	15	56.68740	-29.749	3791124.412	291334.175	6.420	Low Vegetation	
CP13	N	34	23	35.91188	W	119	31	23.76534	-32.723	3808653.053	268033.741	2.805	PID / Bare Earth	X
CP14	N	34	25	02.20087	W	119	49	40.65492	-31.509	3812051.689	240089.549	4.434	Low Vegetation	
Control Points - UTM Zone 10														
CP15	N	34	28	26.21402	W	120	08	12.06096	3.366	3818429.812	762983.115	39.387	PID / Bare Earth	X
CP16	N	34	30	36.62078	W	120	30	03.93768	-30.987	3821560.589	729406.082	5.194	Low Vegetation	
CP17	N	34	40	56.64072	W	120	36	17.73252	-19.721	3840433.867	719418.300	16.377	PID / Bare Earth	
CP18	N	34	57	54.11821	W	120	39	00.71496	-28.223	3871687.284	714535.253	7.506	PID / Bare Earth	X
CP19	N	35	10	49.63166	W	120	44	05.15292	-33.110	3895404.942	706269.857	2.066	Low Vegetation	
CP20	N	35	22	17.28597	W	120	51	50.68098	-29.145	3916332.960	694036.432	5.832	PID / Bare Earth	X

Point	Latitude				Longitude				Ellipsoid Height	Projected		Ortho. Height	Description	Re-Occupied
		°	'	"		°	'	"		N	E			
CP21	N	35	27	32.30089	W	120	57	42.40116	-21.746	3925852.275	684959.475	13.173	Low Vegetation	
CP22	N	35	32	31.87770	W	121	05	31.96014	-22.099	3934846.461	672943.218	12.829	Low Vegetation	X
CP23	N	35	42	13.64951	W	121	18	15.36048	-19.083	3952420.495	653409.087	15.708	Bare Earth	
CP24	N	35	55	16.61781	W	121	28	00.04296	12.615	3976303.729	638337.011	47.007	PID / Bare Earth	X
CP25	N	36	08	20.00551	W	121	39	02.16216	54.524	4000196.840	621407.995	88.567	Low Vegetation	
CP26	N	36	19	38.46961	W	121	53	39.45372	12.967	4020824.970	599243.144	47.520	Bare Earth	X
CP27	N	36	33	21.90650	W	121	55	41.15352	-6.433	4046163.777	595926.814	28.139	Low Vegetation	
CP28	N	36	39	37.35131	W	121	49	14.86992	-6.446	4057845.356	605387.780	27.827	PID / Bare Earth	X
CP29	N	36	55	56.84783	W	121	51	40.72752	-19.069	4087985.261	601407.291	14.348	Low Vegetation	
CP30	N	36	59	29.47250	W	122	09	55.18926	-3.137	4094257.208	574274.602	30.579	Bare Earth	X
CP31	N	37	11	00.24878	W	122	23	33.67608	-16.809	4115390.783	553906.465	16.715	Low Vegetation	
CP32	N	37	18	01.09532	W	122	24	19.09530	-27.082	4128352.701	552705.122	6.157	PID / Bare Earth	X
CP33	N	37	26	22.04243	W	122	26	34.37160	-10.816	4143770.156	549283.726	22.231	Low Vegetation	
CP34	N	37	39	57.03383	W	122	29	40.46064	28.868	4168860.774	544575.938	61.696	Bare Earth	X
CP35	N	37	51	48.12835	W	122	35	08.90466	115.004	4190736.529	536432.497	147.600	Low Vegetation	X
CP36	N	38	01	34.99453	W	122	52	38.10144	-22.365	4208749.869	510773.226	10.300	PID / Bare Earth	
CP37	N	38	04	36.51622	W	122	58	29.95104	-18.147	4214337.607	502193.835	14.630	Low Vegetation	
CP38	N	38	18	52.02004	W	123	01	55.80192	-29.548	4240705.328	497187.908	2.714	Bare Earth	X
CP39	N	38	29	55.79336	W	123	12	31.98600	114.752	4261184.436	481785.369	146.836	Low Vegetation	
CP40	N	38	40	35.25857	W	123	25	18.99300	2.896	4280958.534	463297.377	34.974	PID / Bare Earth	X
CP41	N	38	51	33.40879	W	123	39	09.71532	0.275	4301363.329	443369.632	32.517	Bare Earth	
CP42	N	39	07	18.14156	W	123	42	57.24162	24.390	4330526.523	438114.933	55.983	Low Vegetation	X
CP43	N	39	19	44.28365	W	123	48	34.18740	-6.090	4353595.893	430229.559	25.392	PID / Bare Earth	
CP44	N	39	33	58.22323	W	123	46	06.95442	-3.159	4379890.558	433978.994	27.702	Low Vegetation	X
CP45	N	39	46	38.03380	W	123	50	06.62694	53.879	4403366.107	428478.198	84.496	Bare Earth	X
CP46	N	40	01	22.44374	W	124	04	08.79708	-14.964	4430846.417	408770.633	15.928	PID / Bare Earth	

Point	Latitude				Longitude				Ellipsoid Height	Projected		Ortho. Height	Description	Re-Occupied
		°	'	"		°	'	"		N	E			
CP47	N	40	21	13.83610	W	124	21	39.92508	-21.761	4467920.598	384417.874	9.717	Low Vegetation	
CP48	N	40	34	21.06894	W	124	20	59.74602	-22.436	4492179.976	385736.885	9.074	Bare Earth	X
CP49	N	40	49	14.02464	W	124	11	24.74988	-23.490	4519519.624	399629.622	7.240	Low Vegetation	
CP50	N	41	03	26.76371	W	124	08	54.42720	-23.424	4545768.153	403496.420	6.638	PID / Bare Earth	X
CP51	N	41	17	02.11735	W	124	05	30.86772	-22.451	4570850.714	408563.356	7.002	Low Vegetation	X
CP52	N	41	35	37.24829	W	124	05	53.57076	-22.809	4605246.942	408471.547	5.958	PID / Bare Earth	
CP53	N	41	47	00.18694	W	124	15	09.03636	-12.308	4626484.284	395918.095	16.543	PID / Bare Earth	X
CP54	N	42	02	42.64325	W	124	16	06.92868	-22.474	4655570.846	395011.734	5.656	Low Vegetation	
CP55	N	42	16	31.32728	W	124	24	18.08820	-21.290	4681306.538	384141.112	6.691	Bare Earth	X
CP56	N	42	32	09.55003	W	124	23	59.80452	-13.043	4710238.546	385036.855	14.175	PID / Bare Earth	
CP57	N	42	45	40.55636	W	124	30	59.34096	-6.718	4735419.350	375915.297	20.549	Low Vegetation	X
CP58	N	42	50	07.28059	W	124	33	29.12328	31.991	4743708.906	372662.896	59.335	Bare Earth	
CP59	N	43	06	17.69641	W	124	26	03.64794	-3.995	4773464.005	383287.053	22.831	PID / Bare Earth	X
CP60	N	43	14	09.07170	W	124	23	27.39768	-21.146	4787945.602	387060.361	5.538	Low Vegetation	
CP61	N	43	27	14.09855	W	124	16	35.47344	-20.613	4812014.777	396721.634	5.411	PID / Bare Earth	X
CP62	N	43	39	35.06954	W	124	12	27.76320	-18.206	4834790.803	402620.774	7.250	Low Vegetation	
CP63	N	43	52	56.26139	W	124	09	12.39372	-20.811	4859446.280	407340.877	4.279	PID / Bare Earth	X
CP64	N	44	09	37.43503	W	124	07	01.25976	-9.766	4890294.787	410685.631	14.459	Low Vegetation	
CP65	N	44	24	50.71095	W	124	05	00.45888	-11.682	4918436.985	413740.802	12.387	PID / Bare Earth	X
CP66	N	44	40	33.73781	W	124	04	38.06688	3.501	4947527.748	414619.804	27.503	Low Vegetation	
CP67	N	44	56	08.31077	W	124	01	23.06370	16.217	4976310.139	419275.945	39.471	PID / Bare Earth	X
CP68	N	45	11	32.70494	W	123	58	03.00720	-15.851	5004781.230	424001.720	7.145	Low Vegetation	
CP69	N	45	27	38.08796	W	123	58	12.45756	-14.965	5034574.766	424154.255	8.303	PID / Bare Earth	X
CP70	N	45	43	33.33061	W	123	56	32.23500	-13.350	5064028.358	426677.169	9.530	Low Vegetation	
CP71	N	45	55	10.28977	W	123	58	22.69884	38.708	5085566.442	424551.497	62.072	PID / Bare Earth	X
CP72	N	46	10	38.05529	W	123	58	41.70468	-12.890	5114205.189	424494.105	11.097	Low Vegetation	

Point	Latitude				Longitude				Ellipsoid Height	Projected		Ortho. Height	Description	Re-Occupied
		°	'	"		°	'	"		N	E			
CP73	N	46	23	43.24504	W	124	03	34.37010	-18.373	5138520.068	418543.306	6.026	PID / Bare Earth	X
CP74	N	46	32	53.76282	W	124	03	36.13428	-17.818	5155512.475	418733.586	6.526	Low Vegetation	
CP75	N	46	48	34.51516	W	124	05	57.24384	-18.289	5184591.198	416133.956	6.227	Bare Earth	X
CP76	N	46	55	42.13970	W	124	10	18.43788	-18.531	5197870.813	410795.543	6.286	PID / Bare Earth	
CP77	N	47	04	13.95547	W	124	10	18.05970	-19.080	5213669.419	411039.857	5.637	Bare Earth	X
CP78	N	47	17	56.19059	W	124	14	46.72680	-17.018	5239138.461	405778.708	7.306	Low Vegetation	
CP79	N	47	33	18.97528	W	124	21	24.14178	-0.492	5267764.194	397929.937	23.261	Bare Earth	X
CP80	N	47	42	26.96638	W	124	24	52.14384	11.773	5284758.814	393891.755	35.312	Low Vegetation	
CP81	N	47	55	14.37109	W	124	38	15.59256	-18.872	5308779.769	377652.065	4.442	PID / Bare Earth	X
CP82	N	48	18	04.29808	W	124	39	49.04352	1.169	5351115.071	376627.234	22.632	Low Vegetation	
CP83	N	48	21	10.61134	W	124	32	43.68408	0.991	5356684.107	385505.203	21.721	Bare Earth	X
CP84	N	48	15	31.76996	W	124	15	16.43112	-14.727	5345828.918	406885.053	5.947	Low Vegetation	
CP85	N	48	09	53.62330	W	123	57	04.81788	-12.788	5335065.501	429261.236	7.596	Bare Earth	X
CP86	N	48	08	30.42881	W	123	34	11.27964	-15.884	5332216.305	457612.162	4.227	Low Vegetation	
CP87	N	48	06	44.54977	W	123	14	55.40424	22.996	5328820.270	481486.688	43.641	PID / Bare Earth	X
CP88	N	48	07	29.99035	W	123	04	52.95288	-17.806	5330196.512	493944.410	3.288	Low Vegetation	
CP89	N	48	06	12.07210	W	122	53	04.65846	-17.834	5327794.062	508589.077	3.806	PID / Bare Earth	X
CP90	N	48	08	36.09983	W	122	45	22.11192	-18.821	5332263.165	518140.234	3.367	Low Vegetation	X
CP91	N	48	15	27.26654	W	124	16	59.23020	-10.463	5345724.904	404763.367	10.271	Low Vegetation	
KK23	N	35	42	13.36241	W	121	18	15.23556	-19.274	3952411.703	653412.379	15.517	Bare Earth	