

**Final Minimum Technical Standards
Report of Specific Purpose Survey
AERIAL TRIANGULATION REPORT**



**ST. JOHNS COUNTY 2008 – COUNTYWIDE
DIGITAL PHOTOGRAMMETRIC CONTOUR
MAPPING PROJECT**

**ST. JOHNS COUNTY PIGGYBACK CONTRACT ON
THE STATE OF FLORIDA DIVISION OF
EMERGENCY MANAGEMENT (DEM)
CONTRACT NO. 07-HS-34-14-00-22-469**

ST. JOHNS COUNTY, FLORIDA

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LB Number 0006777
Issued: June 30, 2008

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Introduction

This report contains an outline of the photogrammetric aerial triangulation (AT) process that supported the FY2008 St. Johns County, Florida, Countywide Digital Contour Mapping Project. For reference to the ground control supporting aerial triangulation, refer to the MTS Final Report of Photogrammetric Ground Control Survey, issued June 30, 2008.

Project Area

The project area encompasses approximately +/-726 square miles of St. Johns County, Florida.

Purpose of Aerial Triangulation

Aerial triangulation is a method of ground control extension or densification performed mathematically and in conjunction with a limited number of ground control points to control aerial imagery such that it may be utilized to measure 3D information about features on or above the ground.

Dates of Image Acquisition

The aerial imagery was acquired using the Leica ADS40/51 digital sensor. A total of five (5) missions were completed for the entire project area as follows:

Julian Day	Missions	Date
042	1	February 11, 2008
045	1	February 14, 2008
050	2	February 19, 2008
056	1	February 25, 2008

Map Reference

There are no hardcopy maps for the AT process.

Data Sources

Refer to MTS Final Report of Photogrammetric Ground Control Survey, issued June 2, 2008.

Name of Responsible Surveyor

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Woolpert, Inc.
11315 Corporate Blvd, Suite 115
Orlando, Florida 32817-8340
Professional Surveyor and Mapper Number: LS-0005438

Name of Company

Woolpert, Inc.
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Florida Certificate of Authorization Number: LB-0006777

Abbreviations

3D – Three Dimensional
AT – Aerial Triangulation
CP – Certified Photogrammetrist
DOI – Digital Orthophoto Images
DTM – Digital Terrain Model
FCIR – False Color Infrared
ft – United States Survey Feet
MTS – Florida Minimum Technical Standards
NMAS – National Map Accuracy Standards
PSM – Florida Licensed Professional Surveyor and Mapper
QC – Quality Control
RGB – Red, Green, Blue or True Color
RMSE – Root-Mean-Square-Error
RMSE P – Resultant Root-Mean-Square-Error

Sensor Description

All data was acquired using the Leica ADS40/51 digital sensors, serial number 30027 and 30101. Both the RGB and FCIR bands were acquired simultaneously. The maximum acquisition ground sampling distance for flights 1-33 was 0.66-feet; and this imagery was used solely for QC of LiDAR data and breakline development. The band configurations are outlined on the following tables.

Sensor #30027		
Calibration Date: March 13, 2008		
BLUE NADIR	NIR NADIR	PANF02
GREEN NADIR	PANB14	
RED NADIR	PANF27	

Sensor #30101		
Calibration Date: January 8, 2007		
BLUE NADIR	NIR NADIR	PANF02
GREEN NADIR	PANB14	
RED NADIR	PANF27	

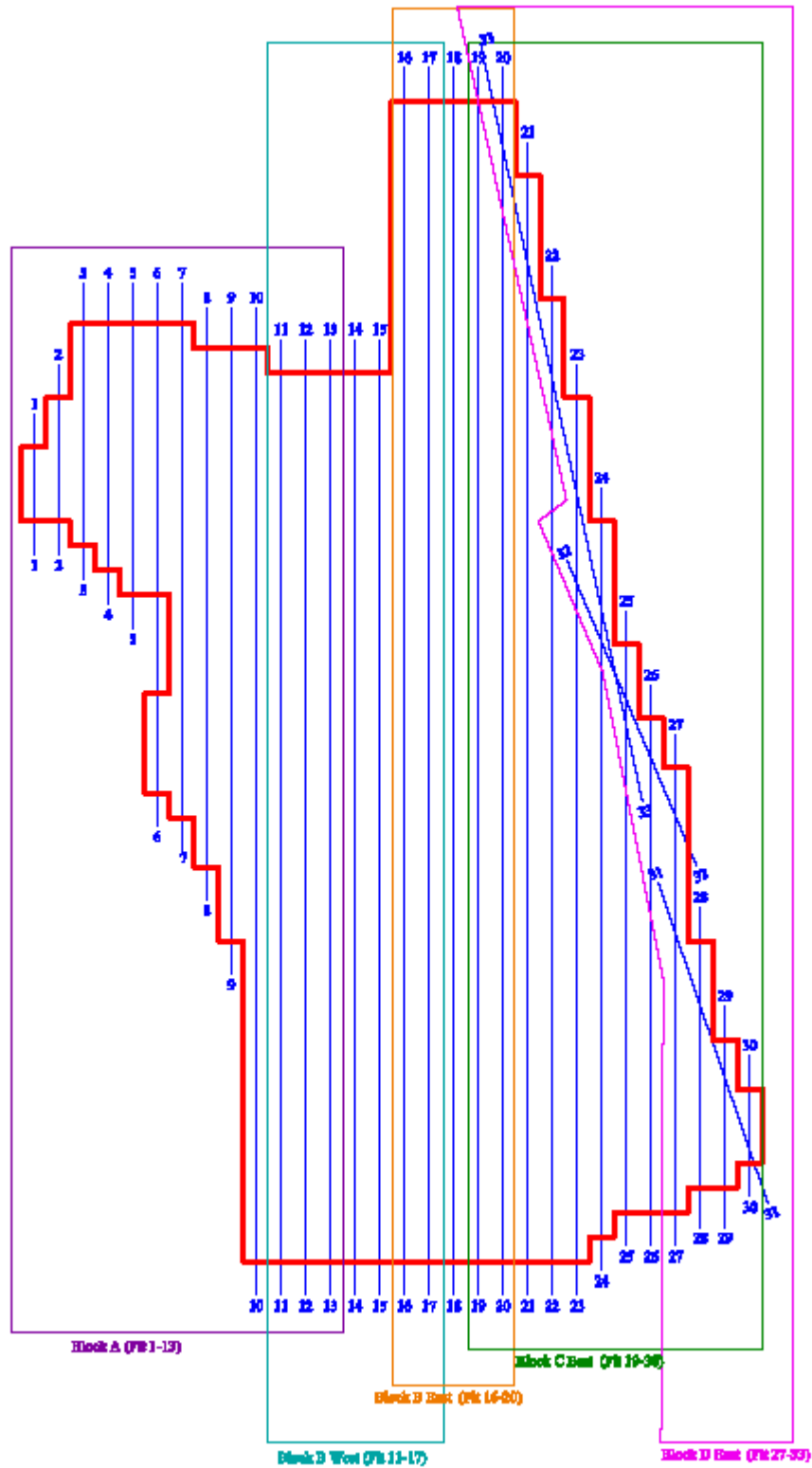
Processing Software

The software utilized for the digital image processing and aerial triangulation, developed by Leica GeoSystems, was: LPS 9.1, ORIMA 9.1, CAP-A 7.5 and GPro 3.2.

Processing Methodology

The project area was divided up into five (5) aerial triangulation blocks (see Diagram “A” shown on the next page). Each block was created using Leica’s GPro software and is based on project specifications, control point locations and a suitable number of lines for our blocks. Each block had a good distribution of control points within its boundaries.

Diagram "A"



Every band for the required flight lines is added to the project applying the processed position and orientation data. This creates metadata files and an orientation data file for each band giving the imagery its raw position and orientation.

Level 0 imagery is created by GPro using the PANB14, PANF28 and the PANF02 bands. The aerial triangulation process is similar to conventional operations, where the Level 0 panchromatic imagery is passed through Automatic Point Measurement, the resulting tie points and ground control is adjusted using CAP-A and ORIMA software. Blunders are removed and the block is analyzed for weak network areas, and if required, manual points are added. The final adjustment output consists of precise orientation data files for each band, calibration parameters, and metadata. The imagery can now be used to QC the LiDAR data and for breakline development, on a digital photogrammetric workstation.

Ground Control used in Triangulation

Ground Control Used In Triangulation			
Point ID	X ft.	Y ft.	Z ft.
002	496051.244	1925823.630	24.55
003	485647.878	1925314.622	27.12
004	482184.980	1988099.797	8.89
005	473586.062	2014837.788	6.65
007	471997.200	2042912.389	4.64
008	462783.497	2056628.005	4.34
009	446734.455	2073735.014	14.65
016	528853.646	2105249.434	16.46
017	516814.721	2119695.412	21.36
023	558499.605	1926645.220	33.32
025	488309.051	1956428.609	10.52
08-01	451963.133	2111345.606	20.19
08-02	524901.599	2154189.997	8.05
08-03	535341.573	2154800.141	10.60
08-04	557688.392	2050594.585	16.82
08-05	463401.804	2081978.111	28.91
08-06	535172.038	1963248.021	38.36
08-07	578952.992	1965684.080	3.94
08-08	564979.067	1935966.408	24.37
08-09	535538.894	1933447.473	31.12
08-10	509629.465	2077614.440	28.50
08-11	479645.926	2079976.892	18.61
08-12	485776.417	2106441.159	30.54
08-13	502507.665	2069675.291	33.66
08-14	588029.755	1940354.153	3.56
03_1	445522.439	2083058.691	12.72
03_10	468520.674	2032573.477	4.97
03_11M	468389.654	2094008.308	27.23
03_13	472938.670	2052133.523	7.56
03_15	476807.682	2106154.685	6.99
03_17M	481219.730	2063146.851	28.32
03_20	485636.092	1972085.826	2.47
03_21	486708.803	1939117.447	18.85
03_23M	489149.087	2069089.031	22.59
03_24	489743.732	1922809.199	41.56

Ground Control Used In Triangulation			
Point ID	X ft.	Y ft.	Z ft.
03_25	489604.392	1926297.276	28.95
03_26M	497629.510	1984147.990	15.00
03_27M	497591.341	2056991.535	28.54
03_3	448972.343	2088725.432	19.04
03_30M	510364.980	2027479.081	28.12
03_31	511116.704	2098360.865	35.10
03_36	514681.507	1921939.985	14.32
03_37	514748.633	2152684.175	25.92
03_39	518333.816	2140687.595	21.43
03_41M	519044.838	2056502.849	29.75
03_43M	525564.182	2147444.425	4.59
03_44	527147.660	1925371.001	25.24
03_46M	531329.790	2040839.845	33.95
03_50M	533947.446	2079373.600	5.96
03_51M	535207.023	2128989.111	6.63
03_52M	535420.809	2098331.597	4.52
03_55M	539366.497	2107454.915	2.36
03_57M	543936.261	2019076.306	35.54
03_60M	547613.075	2042840.740	8.28
03_61M	547694.036	1992711.779	29.43
03_64	551766.971	1934909.011	24.97
03_66B	552732.349	1929143.943	27.85
03_68M	555841.254	2029766.587	4.38
03_69M	555954.249	1971453.518	27.02
03_70M	557383.459	2043476.454	4.57
03_73	560126.337	2020736.401	5.04
03_74M	560459.972	1996002.238	11.10
03_77	566356.302	2025087.912	5.79
03_78	568078.559	2007458.318	7.86
03_79M	568060.550	1953924.048	25.93
03_81	569709.792	2016656.774	4.70
03_82M	570691.365	1994045.917	13.40
03_85M	572864.628	1941553.233	23.13
03_86	573436.776	1983594.710	7.12
03_88	576230.816	1940100.060	11.34
03_89	585664.590	1940949.379	5.54
03_8M	460550.608	2090097.506	27.30
03_96M	461534.720	2073674.287	29.66
03_97M	493693.606	1959113.050	7.10
03_9M	465125.730	2062449.162	22.18
3A	505032.321	2046249.962	27.33
4A	464771.490	2109958.799	10.41
6A	542280.259	2064346.092	3.83
A004	497400.221	2097687.192	46.19
A014	540118.758	2131446.250	9.37
A032	554750.290	2064087.807	16.42
A039	563197.872	2031014.813	8.29
CM01	517356.791	2041842.776	31.43
CM02	552402.740	1950794.060	38.42
D002	534950.476	1999305.776	39.15
D322	571956.112	2008137.970	10.11

Ground Control Used In Triangulation			
Point ID	X ft.	Y ft.	Z ft.
DUP2	545533.122	1968084.734	39.91
ELLZ	524684.380	2030457.669	45.59
G002	586977.379	1942423.942	6.15
G004	582960.706	1955756.655	7.87
G006	575534.945	1976416.848	6.51
G010	550860.654	2082997.277	12.59
G012	547130.341	2101369.106	19.97
G014	542319.973	2118709.705	9.44
G017	569396.428	1937400.614	13.93
G019	560302.102	1955673.591	27.76
G022	567468.974	1971615.612	17.37
G027	543103.697	2029666.490	34.78
G032	531784.922	2064969.578	39.23
G033	521372.023	2078454.913	35.34
G037	519036.440	2098267.948	43.21
G042	527043.907	2136827.792	6.42
G047	525726.755	2004884.733	42.82
G052	503290.259	2088138.867	29.92
G055A	538762.038	1923807.000	38.03
G057	519471.807	1943220.226	27.31
G059	520639.129	1960540.667	43.07
G063	521038.530	1983935.560	33.42
G065	504657.479	2006789.401	23.55
G067	499438.216	2018873.706	19.02
G069	499147.692	2034333.931	18.14
G071	488493.597	2050530.591	11.64
G081	504348.786	1939404.284	13.52
G089	488457.292	2005127.118	14.45
G091	488711.605	2034631.877	13.35
G095A	471331.503	2078464.884	28.47
G097	471306.221	2105341.076	15.83
G099	505580.445	1923317.330	17.42
G101	496334.605	1934344.644	21.12
G113	455788.928	2066937.270	13.74
G117	456356.344	2097512.667	15.01
L10	490313.728	2096254.544	16.87
L15	500303.460	2082046.109	24.81
Q323	537715.996	2143173.679	10.48
TID1	479142.388	2003949.601	8.57

AT Block Statistical Summaries

St. Johns Digital Contour Mapping

St. Johns Block A

Control Point Residuals			
Point ID	X ft	Y ft	Z ft
002	-0.041	-0.041	0.042
003	0.097	-0.170	0.070
004	0.061	0.208	0.020
005	0.147	-0.082	-0.063
007	0.050	0.081	0.011
008	0.027	0.121	0.040
009	-0.132	-0.126	0.019
025	-0.018	-0.127	-0.026
08-01	0.038	0.041	0.078
08-05	-0.002	0.097	0.026
08-11	-0.031	0.188	-0.079
08-12	0.024	-0.062	-0.071
03_1	0.040	-0.120	0.079
03_10	-0.010	0.040	-0.007
03_13	-0.045	0.096	-0.033
03_15	-0.049	-0.103	0.024
03_17M	0.020	0.065	-0.036
03_20	-0.006	-0.092	-0.013
03_21	-0.006	-0.076	0.057
03_23M	0.009	0.033	0.016
03_24	0.008	0.104	0.020
03_25	-0.036	0.068	0.076
03_26M	-0.027	-0.075	-0.014
03_27M	-0.040	-0.066	0.009
03_8M	0.043	0.027	-0.040
03_96M	0.029	0.234	0.014
03_97M	0.112	0.116	-0.015
03_9M	-0.006	-0.016	0.018
4A	0.032	-0.036	0.051
A004	-0.056	-0.041	-0.003
G067	0.038	-0.146	-0.072
G069	-0.080	0.032	-0.020
G071	-0.059	-0.091	-0.111
G089	-0.014	-0.062	0.033
G091	-0.035	0.188	-0.088
G095A	-0.011	-0.003	-0.021
G097	0.010	0.001	0.038
G101	-0.058	-0.034	0.043

Control Point Residuals			
Point ID	X ft	Y ft	Z ft
G113	-0.007	-0.139	0.027
G117	0.007	-0.096	0.030
L10	-0.081	0.067	-0.080
L15	0.022	-0.094	-0.060
TID1	0.036	0.090	0.014

St. Johns Block B East

Control Point Residuals			
Point ID	X ft	Y ft	Z ft
016	0.179	0.074	-0.433
017	0.015	-0.062	-0.101
08-02	-0.118	0.047	0.100
08-03	0.101	-0.121	0.220
08-06	-0.023	-0.047	0.304
08-09	-0.072	0.229	0.111
03_39	-0.049	-0.073	-0.010
03_41M	0.062	-0.039	-0.093
03_43M	-0.066	0.062	0.047
03_44	-0.085	0.055	-0.025
03_46M	0.090	0.143	-0.649
03_50M	0.091	-0.152	0.184
03_51M	0.094	-0.214	0.238
03_52M	0.036	-0.083	0.090
03_55M	-0.066	0.415	-0.028
CM01	0.055	-0.181	0.019
D002	-0.020	-0.185	0.185
ELLZ	-0.066	0.056	0.055
G032	0.168	-0.088	0.020
G033	0.057	-0.004	-0.145
G037	0.039	-0.034	-0.114
G042	-0.176	0.138	-0.071
G047	-0.072	0.100	0.186
G055A	-0.153	0.164	-0.025
G057	0.045	-0.243	0.045
G059	0.103	-0.107	0.025
G063	0.090	-0.063	-0.062
Q323	-0.261	0.213	-0.070

St. Johns Block B West

Control Point Residuals			
Point ID	X ft	Y ft	Z ft
002	-0.149	-0.220	0.164
017	0.006	-0.072	-0.092
08-02	-0.053	-0.056	-0.095

Control Point Residuals			
Point ID	X ft	Y ft	Z ft
08-10	0.027	0.072	0.000
08-13	-0.022	0.012	0.034
03_23M	-0.095	0.005	0.012
03_24	-0.146	0.030	0.016
03_25	-0.209	0.019	0.013
03_26M	-0.064	-0.272	0.045
03_27M	-0.042	-0.203	0.062
03_30M	0.191	0.495	-0.036
03_31	0.002	0.024	-0.091
03_36	0.080	0.206	0.028
03_39	-0.042	-0.125	-0.014
03_41M	0.100	0.033	-0.135
03_43M	-0.047	-0.016	-0.087
03_97M	0.009	-0.105	0.130
3A	0.057	-0.125	-0.020
A004	-0.053	-0.274	0.096
CM01	0.083	-0.090	0.002
ELLZ	0.036	0.114	-0.102
G033	0.061	0.023	-0.215
G037	0.080	0.006	-0.137
G047	0.030	0.202	-0.066
G052	-0.076	0.067	0.059
G057	0.072	0.017	0.017
G059	0.130	0.132	-0.016
G063	0.138	0.142	-0.131
G065	0.072	-0.063	0.114
G067	0.001	-0.041	0.085
G069	0.009	0.194	0.024
G081	-0.001	-0.002	0.083
G091	-0.064	0.119	-0.077
G099	0.007	-0.052	0.045
G101	-0.122	-0.235	0.179
L10	-0.021	0.039	0.053
L15	0.015	-0.001	0.056

St. Johns Block C

Control Point Residuals			
Point ID	X ft	Y ft	Z ft
016	0.098	-0.118	-0.110
023	-0.008	0.214	-0.022
08-03	-0.122	-0.152	0.283
08-04	-0.070	0.112	-0.033
08-06	-0.068	-0.053	0.348
08-07	0.076	0.078	-0.148
08-08	-0.065	-0.043	0.110
08-09	0.032	-0.015	0.348

Control Point Residuals			
Point ID	X ft	Y ft	Z ft
08-14	-0.082	0.110	0.006
03_46M	0.111	-0.053	-0.090
03_50M	0.086	-0.131	0.219
03_51M	-0.089	-0.261	0.332
03_52M	-0.108	-0.142	0.284
03_55M	0.261	0.323	-0.372
03_57M	0.060	-0.192	0.138
03_60M	-0.131	0.162	0.030
03_61M	-0.088	0.101	0.022
03_64	-0.005	-0.025	-0.015
03_66B	-0.065	-0.127	0.055
03_68M	0.003	-0.043	-0.011
03_69M	-0.013	-0.156	0.041
03_70M	0.025	0.156	-0.031
03_73	-0.013	0.026	-0.135
03_74M	-0.031	0.029	-0.060
03_77	0.022	-0.083	-0.037
03_78	-0.126	0.179	0.021
03_79M	-0.014	0.164	-0.018
03_81	0.013	0.054	-0.166
03_82M	-0.042	0.097	-0.138
03_85M	-0.057	-0.196	0.111
03_86	0.019	0.084	-0.050
03_88	-0.015	-0.063	-0.027
03_89	-0.014	-0.070	-0.049
A014	0.372	0.098	-0.289
A032	-0.032	-0.017	-0.067
A039	0.045	-0.156	-0.058
CM02	-0.051	-0.057	0.019
D002	-0.064	-0.194	0.222
D322	0.010	-0.066	0.003
DUP2	-0.001	-0.067	0.097
G002	-0.033	0.110	-0.005
G004	-0.073	-0.086	0.000
G006	-0.075	-0.026	0.086
G010	-0.091	0.144	-0.349
G012	-0.035	0.270	0.045
G014	0.283	-0.145	-0.116
G017	-0.024	0.087	-0.088
G019	-0.044	0.205	-0.039
G022	-0.058	0.127	-0.059
G027	0.146	-0.164	0.000
G032	0.095	-0.166	0.079
G055A	0.047	0.138	-0.318

St. Johns Block D

Control Point Residuals			
Point ID	X ft	Y ft	Z ft
08-03	-0.138	-0.098	-0.064
08-04	-0.174	0.056	-0.128
08-07	0.226	0.051	-0.100
08-14	0.113	0.086	0.111
03_70M	-0.089	-0.153	0.041
03_77	-0.153	0.416	-0.232
03_78	-0.299	0.182	-0.083
03_81	0.082	0.032	-0.133
03_82M	0.084	-0.020	-0.144
03_85M	0.133	-0.253	0.159
03_86	0.193	0.072	0.029
03_88	0.220	-0.139	0.062
03_89	0.191	-0.001	0.161
A014	-0.148	-0.085	0.003
A032	-0.203	-0.065	0.039
A039	-0.153	0.165	-0.067
D322	0.120	-0.039	0.111
G002	0.115	0.086	0.060
G004	0.090	-0.008	0.158
G006	0.058	-0.070	0.261
G010	-0.182	-0.043	-0.073
G012	-0.167	-0.057	-0.010
G014	-0.047	-0.111	-0.071
G017	0.132	-0.062	-0.088
Q323	-0.005	0.058	-0.004

St. Johns Summary

The final RMSE (Root Mean Square Error) residuals on the ground control points are as follows:

	X	Y	Z
RMS	0.098	0.133	0.128
RMS P	0.165		

The RMSE values fall well within the MTS/NMAS requirements for DTM/contour mapping at 1"=100' scale at +/-0.4-foot RMSE vertical accuracy. The DTM will be used as the basis to support the generation of 2-foot contours with supplemental 1-foot contours at +/- 0.75 foot accuracy in un-obscured areas.


THIS REPORT IS NOT VALID WITHOUT THE SIGNATURE AND RAISED SEAL OF A FLORIDA LICENSED SURVEYOR AND MAPPER.

Surveyor and Mapper in Responsible Charge:

Savo Slijepcevic, CP, PSM
Woolpert, Inc.
11315 Corporate Blvd, Suite 115
Orlando, Florida 32817-8340

Professional Surveyor and Mapper Number: LS-0005438

THIS PHOTOGRAMMETRIC MAPPING DATA AND REPORT IS CERTIFIED TO ST. JOHNS COUNTY, FLORIDA, AS MEETING OR EXCEEDING, IN QUALITY AND PRECISION, THE STANDARDS APPLICABLE FOR THIS WORK, AS SET FORTH IN CHAPTER 61G17-6, FLORIDA ADMINISTRATIVE CODE.

 6-30-08
Savo Slijepcevic, CP, PSM Date
Professional Surveyor and Mapper No. LS-0005438

Seal