

GROUND CONTROL SURVEY REPORT

**GPS SURVEY
FOR LIDAR CONTROL**

**WAUKESHA COUNTY, WI
WROC LIDAR SURVEY**

WAUKESHA COUNTY, WISCONSIN

Services provided by:

AYRES

ASSOCIATES

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ABSTRACT

This report documents the GPS ground surveys conducted in support of FEMA accuracy testing of the lidar data collection for Waukesha County, Wisconsin, in 2012. Surveys were conducted at 8 sites utilizing the base stations established in the static network. These surveys established “ground truth” data at each site on different surface types, including bare earth, low grass, brush lands, low trees, forest, high grass, weeds, crops, and urban areas. Statistical comparisons were made between ground truth points collected from the ground survey and the elevation at the associated horizontal coordinates represented on the LiDAR-derived digital terrain model.

SAMPLE POINTS/TEST POINTS

The ground survey test points were distributed and categorized into sites as shown in the Test Survey Locations map on the next page.

DATA ANALYSIS

To qualify as an acceptable accuracy test, the lidar data must be compared with a dataset of higher accuracy – in this instance ground survey. To develop a comparable dataset of points from the lidar dataset, a utility from proprietary software was used.

The ground control survey results were imported into an ESRI Pointz shapefile with each point’s information as attributes. The utility then accessed the lidar and generated a triangulated irregular network (TIN), which is a continuous digital terrain surface, using the bare-earth lidar points and the compiled breaklines. The utility probed the TIN surface to determine its elevations at each of the survey point’s horizontal locations.

The elevation was then appended as a field to the Pointz shapefile; the attributes for each point were exported to a database; and then statistical analysis was performed. The results can be seen on the following pages.

OVERALL ACCURACY

A comparison of ground survey versus lidar model values indicates a vertical root mean square error (RMSE_z) of 0.293 feet. This is within the FEMA specified vertical accuracy tolerance of 0.6. This RMSE_z equates to a tested 0.574 feet vertical accuracy at 95% confidence level.

GROUND TRUTH ANALYSIS
Comparison of Lidar Points to Ground-Truth Points
Wisconsin State Plane South Coordinate System
NAD 83 HARN / NAVD 88, survey feet

Field definitions

ID– The designation given to the ground survey point to identify it with its coordinates and land cover type

X, Y, and Z – The coordinates that describe the point's horizontal and vertical location within the Waukesha County WISCRS Coordinate System. The X and Y values are shared between the ground control points and lidar comparison points. The Z field shows the elevation of the survey number. The lidar comparison point's elevation is implicit in the analysis' delta Z

Delta Z – The error, the difference between the elevation at a horizontal location as determined by ground survey and as determined by the lidar dataset

Desc– The predominant land cover category at the location of the survey point

Statistic definitions

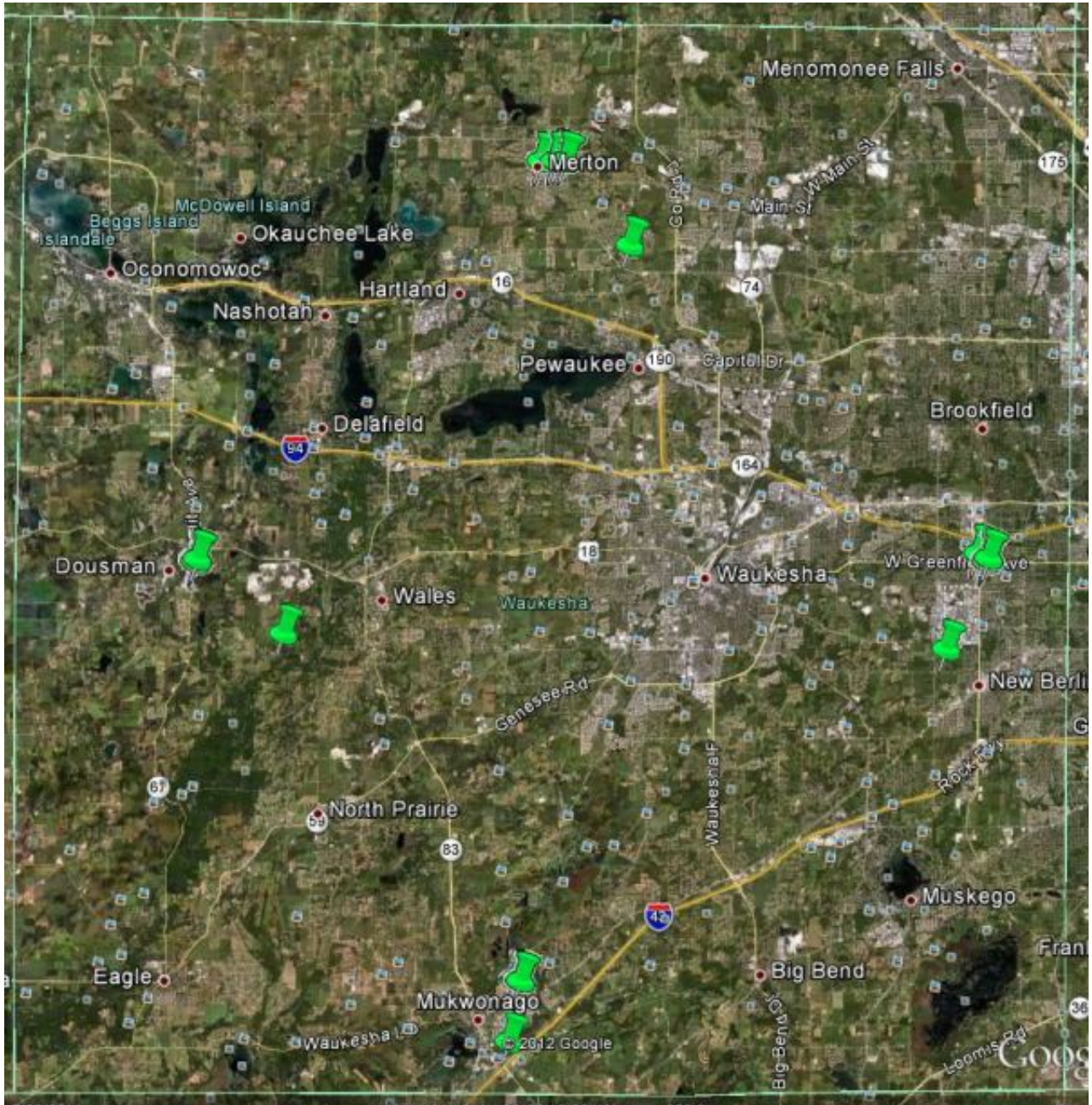
Sum – The sum of the analysis' Delta Z Squared values

Average – The average of the analysis' Delta Z Squared values

RMSE – The root mean squared error, the square root of the average of the squared errors

Accuracyz – The product of multiplying the RMSE with 1.96, a conversion between the RMSE value and a value with a 95% confidence level

Waukesha County LiDAR Check Site Locations



ID	X	Y	Z	Laser Z	Delta Z	DESC
1004	2418241.198	315049.67	820.541	820.96	0.419	MUKWONAGO
1005	2419403.058	322386.593	834.696	835.37	0.674	ASPH
1006	2419407.529	322385.831	834.509	835.35	0.841	ASPH
1007	2419413.449	322385.023	834.353	834.93	0.577	ASPH
1008	2419419.067	322384.265	834.187	834.66	0.473	ASPH
1009	2419423.529	322383.634	833.956	834.93	0.974	ASPH
1010	2419422.698	322378.448	834.122	834.83	0.708	ASPH
1011	2419416.539	322379.025	834.355	834.83	0.475	ASPH
1012	2419409.651	322379.472	834.631	834.91	0.279	ASPH
1013	2419403.109	322379.9	834.844	834.99	0.146	ASPH
1014	2419397.74	322380.273	834.946	835.29	0.344	ASPH
1015	2419396.541	322374.37	835.215	835.56	0.345	ASPH
1016	2419402.43	322373.262	835.08	835.46	0.38	ASPH
1017	2419408.237	322371.995	834.868	835.2	0.332	ASPH
1018	2419415.199	322369.872	834.643	835.11	0.467	ASPH
1019	2419421.017	322368.379	834.397	834.82	0.423	ASPH
1020	2419420.49	322360.935	834.571	835.03	0.459	ASPH
1021	2419412.886	322361.916	834.809	835.23	0.421	ASPH
1022	2419406.052	322362.233	835.007	835.55	0.543	ASPH
1023	2419399.576	322362.392	835.286	835.7	0.414	ASPH
1024	2419392.488	322362.732	835.512	836.1	0.588	ASPH
1025	2419390.893	322355.297	835.763	836.46	0.697	ASPH
1026	2419397.866	322353.905	835.456	835.73	0.274	ASPH
1027	2419404.202	322352.618	835.324	836.02	0.696	ASPH
1028	2419410.297	322351.189	835.134	835.5	0.366	ASPH
1029	2419417.526	322349.74	834.901	835.36	0.459	ASPH
1030	2419483.329	322326.668	834.285	834.82	0.535	TALL GRAS
1031	2419489.036	322325.895	834.338	834.92	0.582	TALL GRAS
1032	2419495.035	322324.709	834.436	835.02	0.584	TALL GRAS
1033	2419500.096	322323.21	834.545	834.97	0.425	TALL GRAS
1034	2419505.518	322321.798	834.618	834.78	0.162	TALL GRAS
1035	2419503.071	322315.935	834.55	834.76	0.21	TALL GRAS
1036	2419497.806	322317.787	834.498	835.01	0.512	TALL GRAS
1037	2419491.332	322319	834.414	834.98	0.566	TALL GRAS
1038	2419486.38	322320.028	834.36	834.77	0.41	TALL GRAS
1039	2419481.079	322321.056	834.278	834.98	0.702	TALL GRAS
1040	2419479.783	322314.705	834.63	835.1	0.47	TALL GRAS
1041	2419485.71	322311.833	834.659	835.21	0.551	TALL GRAS
1042	2419491.063	322310.742	834.578	835.08	0.502	TALL GRAS
1043	2419498.427	322309.429	834.751	835.08	0.329	TALL GRAS
1044	2419503.933	322308.902	834.732	835.08	0.348	TALL GRAS
1045	2419501.647	322302.699	834.746	835.05	0.304	TALL GRAS
1046	2419495.466	322304.587	834.654	835	0.346	TALL GRAS
1047	2419489.615	322306.091	834.502	834.97	0.468	TALL GRAS

1048	2419484.098	322307.383	834.541	835.06	0.519	TALL GRAS
1049	2419477.654	322308.806	834.609	834.99	0.381	TALL GRAS
1050	2419475.811	322302.172	834.68	835.26	0.58	TALL GRAS
1051	2419481.873	322300.902	834.711	835.22	0.509	TALL GRAS
1052	2419487.404	322298.147	834.689	835.25	0.561	TALL GRAS
1053	2419493.494	322295.357	834.779	835.16	0.381	TALL GRAS
1054	2419500.582	322292.65	834.806	835.29	0.484	TALL GRAS
1055	2419348.775	322513.391	835.983	836.19	0.207	MOWED GRA
1056	2419349.164	322519.416	835.843	836.03	0.187	MOWED GRA
1057	2419349.295	322525.313	835.988	836.15	0.162	MOWED GRA
1058	2419349.8	322531.134	835.905	836.1	0.195	MOWED GRA
1059	2419350.589	322537.111	836.024	836.18	0.156	MOWED GRA
1060	2419357.045	322535.911	835.923	835.9	-0.023	MOWED GRA
1061	2419355.694	322529.719	835.925	836.06	0.135	MOWED GRA
1062	2419354.433	322523.358	835.817	836.13	0.313	MOWED GRA
1063	2419353.829	322517.161	835.979	836.09	0.111	MOWED GRA
1064	2419353.129	322511.341	835.988	836.14	0.152	MOWED GRA
1065	2419359.031	322509.594	835.857	836.04	0.183	MOWED GRA
1066	2419360.142	322515.763	835.693	836.04	0.347	MOWED GRA
1067	2419362.362	322521.59	835.808	835.88	0.072	MOWED GRA
1068	2419364.47	322527.499	835.709	835.91	0.201	MOWED GRA
1069	2419366.333	322533.162	835.668	835.74	0.072	MOWED GRA
1070	2419372.559	322532.127	835.62	835.81	0.19	MOWED GRA
1071	2419371.683	322525.474	835.448	835.71	0.262	MOWED GRA
1072	2419370.637	322518.298	835.555	835.75	0.195	MOWED GRA
1073	2419369.705	322511.756	835.419	835.77	0.351	MOWED GRA
1074	2419368.554	322506.039	835.605	835.96	0.355	MOWED GRA
1075	2419374.037	322505.03	835.566	835.69	0.124	MOWED GRA
1076	2419376.637	322510.94	835.249	835.56	0.311	MOWED GRA
1077	2419378.721	322517.889	835.374	835.6	0.226	MOWED GRA
1078	2419381.287	322523.59	835.212	835.45	0.238	MOWED GRA
1079	2419383.899	322530.135	834.991	835.39	0.399	MOWED GRA
1080	2418747.059	322451.098	834.41	834.56	0.15	LOW TREES
1081	2418747.185	322455.293	834.171	834.4	0.229	LOW TREES
1082	2418747.17	322457.721	833.835	834.4	0.565	LOW TREES
1083	2418751.251	322458.174	834.408	834.47	0.062	LOW TREES
1084	2418751.139	322454.17	834.237	834.5	0.263	LOW TREES
1085	2418751.318	322450.89	834.208	834.54	0.332	LOW TREES
1086	2418753.167	322451.21	834.39	834.52	0.13	LOW TREES
1087	2418754.075	322454.616	834	834.47	0.47	LOW TREES
1088	2418754.199	322458.611	834.045	834.43	0.385	LOW TREES
1089	2418757.589	322459.115	833.967	834.44	0.473	LOW TREES
1090	2418758.722	322455.023	834.141	834.45	0.309	LOW TREES
1091	2418759.395	322451.534	834.23	834.51	0.28	LOW TREES
1092	2418763.706	322451.731	834.095	834.46	0.365	LOW TREES

1093	2418764.479	322456.165	834.175	834.43	0.255	LOW TREES
1094	2418764.78	322459.396	834.131	834.54	0.409	LOW TREES
1095	2418768.535	322459.998	834.119	834.62	0.501	LOW TREES
1096	2418768.941	322455.333	834.134	834.77	0.636	LOW TREES
1097	2418770.084	322452.596	834.231	834.97	0.739	LOW TREES
1098	2418774.478	322452.487	834.285	834.63	0.345	LOW TREES
1099	2418774.278	322456.572	834.193	834.47	0.277	LOW TREES
1100	2418775.289	322459.157	834.366	834.66	0.294	LOW TREES
1101	2418779.498	322461.638	834.174	834.36	0.186	LOW TREES
1102	2418780.725	322457.426	834.164	834.43	0.266	LOW TREES
1103	2418781.9	322454.274	834.398	834.51	0.112	LOW TREES
1104	2418784.622	322452.925	834.242	834.55	0.308	LOW TREES
1105	2418785.348	322456.989	834.097	834.5	0.403	LOW TREES
1106	2418785.955	322460.31	834.074	834.43	0.356	LOW TREES
100	2419005.77	322618.955	837.64	837.83	0.19	CP
101	2418992.321	322513.643	835.837	836.01	0.173	CP
1107	2419052.253	322606.68	837.957	838.25	0.293	TREE COVE
1108	2419055.98	322605.913	838.03	838.42	0.39	TREE COVE
1109	2419059.327	322605.522	838.064	838.57	0.506	TREE COVE
1110	2419062.349	322605.221	838.315	838.73	0.415	TREE COVE
1111	2419062.788	322608.766	838.214	838.66	0.446	TREE COVE
1112	2419060.492	322609.649	838.139	838.73	0.591	TREE COVE
1113	2419057.898	322610.373	837.976	838.06	0.084	TREE COVE
1114	2419054.327	322611.236	838.065	838.26	0.195	TREE COVE
1115	2419055.337	322614.563	838.14	838.53	0.39	TREE COVE
1116	2419057.574	322613.587	838.18	838.48	0.3	TREE COVE
1117	2419061.028	322612.824	838.148	838.53	0.382	TREE COVE
1118	2419064.118	322611.786	838.182	838.55	0.368	TREE COVE
1119	2419064.839	322614.22	838.342	838.59	0.248	TREE COVE
1120	2419062.106	322614.752	838.193	838.59	0.397	TREE COVE
1121	2419059.169	322614.865	838.175	838.6	0.425	TREE COVE
1122	2419055.657	322615.024	838.082	838.61	0.528	TREE COVE
1123	2419056.7	322618.323	838.2	839.01	0.81	TREE COVE
1124	2419059.678	322617.527	838.244	839	0.756	TREE COVE
1125	2419062.59	322617.018	838.397	838.87	0.473	TREE COVE
1126	2419066.518	322615.547	838.165	838.56	0.395	TREE COVE
1127	2419068.977	322620.539	838.161	838.84	0.679	TREE COVE
1128	2419066.205	322623.362	838.533	838.87	0.337	TREE COVE
1129	2419062.729	322624.863	838.242	839.05	0.808	TREE COVE
1130	2419058.672	322626.428	838.168	838.61	0.442	TREE COVE
1131	2419059.674	322630.256	838.135	838.57	0.435	TREE COVE
1132	2419063.422	322628.438	838.127	838.82	0.693	TREE COVE
1133	2419067.156	322628.42	838.232	839.04	0.808	TREE COVE
1134	2419071.391	322627.949	838.353	839.11	0.757	TREE COVE
1139	2469869.431	363112.309	868.107	868.1	-0.007	NEW BERLI

1140	2474404.432	373736.79	862.081	862.03	-0.051	ASPH
1141	2474409.979	373737.929	862.281	862.27	-0.011	ASPH
1142	2474415.247	373738.66	862.462	862.45	-0.012	ASPH
1143	2474421.419	373739.13	862.664	862.61	-0.054	ASPH
1144	2474427.639	373740.068	862.878	862.83	-0.048	ASPH
1145	2474428.259	373734.175	862.876	862.82	-0.056	ASPH
1146	2474421.898	373733.945	862.663	862.55	-0.113	ASPH
1147	2474416.515	373733.685	862.451	862.46	0.009	ASPH
1148	2474411.445	373733	862.27	862.24	-0.03	ASPH
1149	2474405.836	373732.643	862.083	862.03	-0.053	ASPH
1150	2474405.287	373727.557	862.037	862.08	0.043	ASPH
1151	2474410.605	373726.696	862.216	862.2	-0.016	ASPH
1152	2474415.732	373726.231	862.388	862.36	-0.028	ASPH
1153	2474420.906	373725.848	862.562	862.55	-0.012	ASPH
1154	2474426.165	373725.425	862.747	862.74	-0.007	ASPH
1155	2474425.93	373719.501	862.708	862.71	0.002	ASPH
1156	2474420.317	373719.38	862.531	862.49	-0.041	ASPH
1157	2474415.062	373718.918	862.374	862.29	-0.084	ASPH
1158	2474409.352	373718.738	862.189	862.18	-0.009	ASPH
1159	2474404.628	373718.591	862.077	862.05	-0.027	ASPH
1160	2474404.437	373713.336	862.094	862.1	0.006	ASPH
1161	2474410.168	373712.849	862.24	862.22	-0.02	ASPH
1162	2474415.975	373712.619	862.409	862.34	-0.069	ASPH
1163	2474421.429	373712.461	862.57	862.61	0.04	ASPH
1164	2474427.093	373712.169	862.749	862.78	0.031	ASPH
1165	2474481.782	373686.491	864.332	864.3	-0.032	MOWED GRA
1166	2474487.779	373685.852	864.375	864.34	-0.035	MOWED GRA
1167	2474492.85	373685.367	864.402	864.38	-0.022	MOWED GRA
1168	2474497.707	373684.586	864.457	864.39	-0.067	MOWED GRA
1169	2474502.358	373684.15	864.446	864.35	-0.096	MOWED GRA
1170	2474502.044	373678.244	864.364	864.25	-0.114	MOWED GRA
1171	2474496.334	373679.22	864.37	864.33	-0.04	MOWED GRA
1172	2474491.32	373680.077	864.454	864.37	-0.084	MOWED GRA
1173	2474485.63	373680.664	864.409	864.32	-0.089	MOWED GRA
1174	2474480.419	373680.927	864.433	864.37	-0.063	MOWED GRA
1175	2474479.579	373674.605	864.401	864.48	0.079	MOWED GRA
1176	2474484.951	373673.478	864.479	864.5	0.021	MOWED GRA
1177	2474490.368	373672.514	864.456	864.5	0.044	MOWED GRA
1178	2474496.065	373671.123	864.359	864.45	0.091	MOWED GRA
1179	2474501.389	373670.205	864.297	864.36	0.063	MOWED GRA
1180	2474501.955	373664.267	864.458	864.45	-0.008	MOWED GRA
1181	2474495.912	373664.75	864.457	864.45	-0.007	MOWED GRA
1182	2474490.279	373665.204	864.47	864.56	0.09	MOWED GRA
1183	2474484.621	373665.834	864.529	864.55	0.021	MOWED GRA
1184	2474479.483	373666.232	864.585	864.57	-0.015	MOWED GRA

1185	2474478.603	373659.883	864.605	864.61	0.005	MOWED GRA
1186	2474483.874	373657.837	864.614	864.64	0.026	MOWED GRA
1187	2474489.061	373656.706	864.707	864.72	0.013	MOWED GRA
1188	2474493.531	373655.422	864.682	864.7	0.018	MOWED GRA
1189	2474499.321	373653.552	864.663	864.71	0.047	MOWED GRA
1190	2474784.592	374078.077	859.313	859.43	0.117	TALL GRAS
1191	2474784.91	374082.993	859.305	859.37	0.065	TALL GRAS
1192	2474785.106	374087.852	859.145	859.34	0.195	TALL GRAS
1193	2474785.055	374092.83	859.086	859.32	0.234	TALL GRAS
1194	2474784.912	374098.088	859.074	859.18	0.106	TALL GRAS
1195	2474790.949	374098.757	859.213	859.36	0.147	TALL GRAS
1196	2474790.621	374091.954	859.319	859.53	0.211	TALL GRAS
1197	2474790.645	374086.841	859.391	859.68	0.289	TALL GRAS
1198	2474790.806	374081.791	859.55	859.62	0.07	TALL GRAS
1199	2474791.019	374076.531	859.682	859.8	0.118	TALL GRAS
1200	2474796.962	374075.379	859.964	860.07	0.106	TALL GRAS
1201	2474797.242	374081.423	859.85	859.9	0.05	TALL GRAS
1202	2474797.275	374086.323	859.689	859.85	0.161	TALL GRAS
1203	2474797.496	374091.67	859.544	859.76	0.216	TALL GRAS
1204	2474797.343	374097.224	859.475	859.69	0.215	TALL GRAS
1205	2474804.257	374097.061	859.733	859.9	0.167	TALL GRAS
1206	2474804.073	374090.34	859.927	860.06	0.133	TALL GRAS
1207	2474804.034	374084.396	860.028	860.28	0.252	TALL GRAS
1208	2474804.063	374079.332	860.186	860.43	0.244	TALL GRAS
1209	2474803.936	374073.415	860.266	860.51	0.244	TALL GRAS
1210	2474810.234	374073.855	860.563	860.75	0.187	TALL GRAS
1211	2474810.638	374079.437	860.576	860.7	0.124	TALL GRAS
1212	2474811.402	374085.183	860.476	860.59	0.114	TALL GRAS
1213	2474811.977	374090.415	860.315	860.43	0.115	TALL GRAS
1214	2474812.398	374095.793	860.303	860.36	0.057	TALL GRAS
1215	2473496.069	374602.016	836.278	836.98	0.702	LOW TREES
1216	2473493.477	374600.62	836.125	836.58	0.455	LOW TREES
1217	2473491.213	374599.179	836.14	836.68	0.54	LOW TREES
1218	2473488.496	374597.435	836.165	836.8	0.635	LOW TREES
1219	2473486.148	374596.056	835.956	836.84	0.884	LOW TREES
1220	2473486.976	374593.141	836.018	836.79	0.772	LOW TREES
1221	2473489.283	374594.008	836.235	836.76	0.525	LOW TREES
1222	2473491.388	374594.922	836.165	836.76	0.595	LOW TREES
1223	2473492.995	374595.917	836.213	836.75	0.537	LOW TREES
1224	2473495.431	374596.846	836.265	836.71	0.445	LOW TREES
1225	2473496.52	374594.797	836.26	836.71	0.45	LOW TREES
1226	2473494.443	374594.121	836.288	836.71	0.422	LOW TREES
1227	2473491.996	374593.383	836.217	836.73	0.513	LOW TREES
1228	2473489.663	374593.289	836.235	836.75	0.515	LOW TREES
1229	2473486.668	374592.653	836.146	836.79	0.644	LOW TREES

1230	2473487.083	374589.534	836.351	836.77	0.419	LOW TREES
1231	2473489.087	374590.41	836.296	836.75	0.454	LOW TREES
1232	2473490.823	374591.215	836.262	836.73	0.468	LOW TREES
1233	2473493.825	374592.535	836.206	836.7	0.494	LOW TREES
1234	2473496.701	374593.278	836.333	836.69	0.357	LOW TREES
1235	2473497.453	374590.137	836.449	836.66	0.211	LOW TREES
1236	2473494.365	374589.508	836.348	836.69	0.342	LOW TREES
1237	2473492.293	374588.785	836.208	836.71	0.502	LOW TREES
1238	2473489.485	374588.093	836.284	836.74	0.456	LOW TREES
1239	2473486.75	374587.673	836.285	836.94	0.655	LOW TREES
102	2474612.846	373976.126	859.996	859.98	-0.016	CP
103	2474589.901	373767.118	862.2	862.15	-0.05	CP
1240	2474539.762	373976.813	860.661	860.76	0.099	TREE COVE
1241	2474535.099	373977.73	860.709	860.73	0.021	TREE COVE
1242	2474530.659	373978.613	860.914	860.73	-0.184	TREE COVE
1243	2474526.149	373979.293	861.048	860.76	-0.288	TREE COVE
1244	2474522.283	373979.637	861.093	860.77	-0.323	TREE COVE
1245	2474522.697	373982.976	861.043	860.85	-0.193	TREE COVE
1246	2474526.834	373982.815	860.944	860.84	-0.104	TREE COVE
1247	2474530.501	373982.911	860.935	860.84	-0.095	TREE COVE
1248	2474534.345	373983.039	860.792	860.83	0.038	TREE COVE
1249	2474538.481	373983.087	860.586	860.67	0.084	TREE COVE
1250	2474539.077	373986.677	860.597	860.68	0.083	TREE COVE
1251	2474535.288	373987.482	860.705	860.84	0.135	TREE COVE
1252	2474531.172	373988.067	860.757	860.94	0.183	TREE COVE
1253	2474527.204	373988.396	860.909	860.97	0.061	TREE COVE
1254	2474523.455	373988.948	860.934	860.99	0.056	TREE COVE
1255	2474523.839	373992.055	860.92	861.07	0.15	TREE COVE
1256	2474527.604	373991.852	860.862	861.04	0.178	TREE COVE
1257	2474531.231	373991.62	860.813	861	0.187	TREE COVE
1258	2474535.006	373991.399	860.746	860.85	0.104	TREE COVE
1259	2474539.242	373991.31	860.629	860.76	0.131	TREE COVE
1260	2474541.151	373995.077	860.571	860.79	0.219	TREE COVE
1261	2474537.231	373995.244	860.593	860.77	0.177	TREE COVE
1262	2474532.935	373995.867	860.636	860.81	0.174	TREE COVE
1263	2474528.964	373996.711	860.83	860.9	0.07	TREE COVE
1264	2474525.332	373997.526	860.88	861.04	0.16	TREE COVE
1265	2430814.873	410581.499	973.374	973.41	0.036	LISBON S
1266	2419947.661	420421.939	977.52	977.56	0.04	ASPH
1267	2419951.948	420421.954	977.554	977.58	0.026	ASPH
1268	2419956.387	420421.915	977.582	977.61	0.028	ASPH
1269	2419961.738	420421.836	977.618	977.62	0.002	ASPH
1270	2419967.179	420421.653	977.666	977.68	0.014	ASPH
1271	2419966.634	420416.125	977.716	977.71	-0.006	ASPH
1272	2419960.626	420415.438	977.672	977.7	0.028	ASPH

1273	2419955.897	420415.373	977.673	977.71	0.037	ASPH
1274	2419950.737	420415.4	977.656	977.75	0.094	ASPH
1275	2419945.637	420415.096	977.636	977.63	-0.006	ASPH
1276	2419945.488	420410.034	977.67	977.71	0.04	ASPH
1277	2419951.039	420409.216	977.694	977.75	0.056	ASPH
1278	2419956.152	420408.843	977.727	977.78	0.053	ASPH
1279	2419961.291	420408.43	977.771	977.8	0.029	ASPH
1280	2419966.527	420408.409	977.785	977.81	0.025	ASPH
1281	2419966.04	420402.459	977.862	977.86	-0.002	ASPH
1282	2419960.602	420402.544	977.807	977.85	0.043	ASPH
1283	2419954.934	420402.534	977.789	977.78	-0.009	ASPH
1284	2419949.7	420402.271	977.769	977.76	-0.009	ASPH
1285	2419944.134	420401.962	977.781	977.77	-0.011	ASPH
1286	2419944.09	420396.857	977.787	977.75	-0.037	ASPH
1287	2419949.826	420397.128	977.839	977.78	-0.059	ASPH
1288	2419955.206	420397.459	977.858	977.86	0.002	ASPH
1289	2419960.257	420397.261	977.93	977.92	-0.01	ASPH
1290	2419966.102	420397.127	978.007	977.94	-0.067	ASPH
1291	2419989.93	420466.101	977.357	977.39	0.033	MOWED GRA
1292	2419989.753	420471.229	977.352	977.49	0.138	MOWED GRA
1293	2419989.686	420476.228	977.219	977.38	0.161	MOWED GRA
1294	2419990.144	420481.425	977.494	977.52	0.026	MOWED GRA
1295	2419990.11	420487.155	977.534	977.67	0.136	MOWED GRA
1296	2419996.76	420487.346	977.493	977.53	0.037	MOWED GRA
1297	2419996.336	420480.985	977.472	977.56	0.088	MOWED GRA
1298	2419996.391	420475.436	977.222	977.47	0.248	MOWED GRA
1299	2419996.21	420469.894	977.399	977.49	0.091	MOWED GRA
1300	2419996.163	420464.907	977.399	977.48	0.081	MOWED GRA
1301	2420001.816	420465.059	977.426	977.49	0.064	MOWED GRA
1302	2420002.583	420470.815	977.433	977.58	0.147	MOWED GRA
1303	2420003.408	420475.575	977.374	977.51	0.136	MOWED GRA
1304	2420003.674	420480.925	977.497	977.5	0.003	MOWED GRA
1305	2420003.992	420486.646	977.533	977.58	0.047	MOWED GRA
1306	2420009.523	420486.291	977.587	977.66	0.073	MOWED GRA
1307	2420009.357	420480.391	977.631	977.6	-0.031	MOWED GRA
1308	2420009.131	420475.188	977.425	977.55	0.125	MOWED GRA
1309	2420009.041	420470.178	977.438	977.59	0.152	MOWED GRA
1310	2420008.668	420464.673	977.451	977.52	0.069	MOWED GRA
1311	2420014.475	420463.916	977.439	977.43	-0.009	MOWED GRA
1312	2420014.812	420469.72	977.497	977.55	0.053	MOWED GRA
1313	2420015.039	420475.357	977.544	977.6	0.056	MOWED GRA
1314	2420015.215	420480.402	977.633	977.69	0.057	MOWED GRA
1315	2420015.648	420485.825	977.687	977.72	0.033	MOWED GRA
1316	2421615.629	420495.016	1000.859	1001.01	0.151	TALL GRAS
1317	2421620.615	420494.894	1000.903	1001.06	0.157	TALL GRAS

1318	2421626.286	420494.926	1000.939	1001.11	0.171	TALL GRAS
1319	2421631.782	420494.74	1001.022	1001.16	0.138	TALL GRAS
1320	2421637.327	420494.736	1001.101	1001.3	0.199	TALL GRAS
1321	2421637.443	420488.972	1001.099	1001.39	0.291	TALL GRAS
1322	2421631.627	420489.882	1000.958	1001.3	0.342	TALL GRAS
1323	2421626.597	420489.881	1000.85	1001.26	0.41	TALL GRAS
1324	2421621.404	420490.118	1000.857	1001.07	0.213	TALL GRAS
1325	2421615.985	420491.408	1000.779	1001.1	0.321	TALL GRAS
1326	2421615.872	420486.042	1000.843	1001.13	0.287	TALL GRAS
1327	2421621.402	420485.771	1000.927	1001.1	0.173	TALL GRAS
1328	2421626.898	420485.575	1000.986	1001.28	0.294	TALL GRAS
1329	2421632.126	420485.866	1001.084	1001.25	0.166	TALL GRAS
1330	2421637.275	420486.088	1001.112	1001.38	0.268	TALL GRAS
1331	2421636.147	420480.658	1001.069	1001.45	0.381	TALL GRAS
1332	2421630.715	420481.103	1001.092	1001.46	0.368	TALL GRAS
1333	2421625.569	420481.404	1000.969	1001.29	0.321	TALL GRAS
1334	2421620.218	420481.616	1000.987	1001.16	0.173	TALL GRAS
1335	2421614.692	420482.213	1000.848	1001.02	0.172	TALL GRAS
1336	2421615.06	420476.38	1000.85	1001.26	0.41	TALL GRAS
1337	2421620.897	420475.733	1001.007	1001.44	0.433	TALL GRAS
1338	2421626.076	420475.683	1001.08	1001.57	0.49	TALL GRAS
1339	2421631.607	420475.351	1001.095	1001.53	0.435	TALL GRAS
1340	2421637.546	420474.967	1001.249	1001.64	0.391	TALL GRAS
1341	2422206.92	420691.616	1010.108	1010.35	0.242	LOW TREES
1342	2422206.647	420695.195	1010.513	1010.71	0.197	LOW TREES
1343	2422206.688	420698.516	1010.528	1010.68	0.152	LOW TREES
1344	2422206.81	420701.514	1010.45	1010.5	0.05	LOW TREES
1345	2422207.237	420704.603	1010.1	1010.28	0.18	LOW TREES
1346	2422210.915	420704.275	1010.095	1010.12	0.025	LOW TREES
1347	2422210.931	420701.317	1009.93	1010.15	0.22	LOW TREES
1348	2422210.904	420698.809	1010.031	1010.22	0.189	LOW TREES
1349	2422210.617	420695.925	1010.047	1010.33	0.283	LOW TREES
1350	2422211.32	420693.117	1010.068	1010.24	0.172	LOW TREES
1351	2422213.561	420692.478	1010.037	1010.18	0.143	LOW TREES
1352	2422214.068	420695.404	1009.985	1010.2	0.215	LOW TREES
1353	2422213.845	420697.482	1009.886	1010.22	0.334	LOW TREES
1354	2422213.898	420699.938	1009.997	1010.13	0.133	LOW TREES
1355	2422214.153	420702.126	1009.966	1010.07	0.104	LOW TREES
1356	2422216.652	420701.874	1009.948	1010.18	0.232	LOW TREES
1357	2422216.94	420699.348	1010.037	1010.2	0.163	LOW TREES
1358	2422217.199	420696.587	1009.971	1010.17	0.199	LOW TREES
1359	2422217.895	420693.743	1009.846	1010.11	0.264	LOW TREES
1360	2422218.662	420691.28	1009.894	1010.08	0.186	LOW TREES
1361	2422220.522	420691.572	1009.961	1010.06	0.099	LOW TREES
1362	2422220.749	420694.835	1009.807	1010.1	0.293	LOW TREES

1363	2422220.284	420697.252	1009.946	1010.12	0.174	LOW TREES
1364	2422220.239	420700.405	1009.952	1010.08	0.128	LOW TREES
1365	2422220.57	420703.148	1009.925	1010.05	0.125	LOW TREES
104	2422732.202	420576.807	1005.119	1005.16	0.041	CP
105	2422588.483	420574.586	1005.686	1005.7	0.014	CP
1366	2422858.945	420562.732	1004.933	1005.11	0.177	TREE COVE
1367	2422859.097	420559.517	1004.989	1005.25	0.261	TREE COVE
1368	2422859.34	420556.509	1005.179	1005.38	0.201	TREE COVE
1369	2422859.432	420553.349	1005.184	1005.54	0.356	TREE COVE
1370	2422864.14	420552.61	1005.144	1005.62	0.476	TREE COVE
1371	2422864.23	420555.282	1005.011	1005.45	0.439	TREE COVE
1372	2422864.13	420557.801	1004.883	1005.3	0.417	TREE COVE
1373	2422864.2	420561.175	1004.807	1005.1	0.293	TREE COVE
1374	2422868.451	420561.188	1004.789	1005.15	0.361	TREE COVE
1375	2422867.942	420558.42	1004.929	1005.18	0.251	TREE COVE
1376	2422867.22	420555.857	1005.042	1005.35	0.308	TREE COVE
1377	2422866.968	420552.77	1005.142	1005.55	0.408	TREE COVE
1378	2422869.96	420553.646	1005.275	1005.43	0.155	TREE COVE
1379	2422870.035	420555.894	1005.155	1005.29	0.135	TREE COVE
1380	2422870.091	420558.288	1004.955	1005.15	0.195	TREE COVE
1381	2422870.093	420560.784	1004.848	1005.16	0.312	TREE COVE
1382	2422873.864	420560.778	1004.757	1005.12	0.363	TREE COVE
1383	2422873.496	420558.532	1004.91	1005.12	0.21	TREE COVE
1384	2422873.422	420556.251	1005.161	1005.2	0.039	TREE COVE
1385	2422873.382	420553.954	1005.119	1005.34	0.221	TREE COVE
1386	2422878.268	420554.35	1005.068	1005.12	0.052	TREE COVE
1387	2422878.807	420557.077	1004.95	1005.05	0.1	TREE COVE
1388	2422878.783	420560.121	1004.826	1004.9	0.074	TREE COVE
1389	2422878.918	420562.588	1004.756	1004.99	0.234	TREE COVE
1390	2422883.107	420562.217	1004.683	1004.91	0.227	TREE COVE
1391	2422882.603	420558.951	1004.841	1005	0.159	TREE COVE
1392	2422882.623	420555.873	1004.989	1005.12	0.131	TREE COVE
1393	2422882.636	420552.822	1005.026	1005.14	0.114	TREE COVE
1396	2390153.392	363330.408	1003.326	1003.25	-0.076	OTTAWA E
1397	2379249.82	371912.116	896.068	895.99	-0.078	ASPH
1398	2379253.466	371911.984	896.061	895.95	-0.111	ASPH
1399	2379257.361	371911.915	895.925	895.82	-0.105	ASPH
1400	2379261.048	371911.999	895.827	895.76	-0.067	ASPH
1401	2379264.904	371911.896	895.798	895.7	-0.098	ASPH
1402	2379265.216	371906.986	895.829	895.66	-0.169	ASPH
1403	2379260.778	371907.091	895.863	895.69	-0.173	ASPH
1404	2379256.673	371907.035	895.899	895.77	-0.129	ASPH
1405	2379253.219	371906.992	895.938	895.81	-0.128	ASPH
1406	2379249.518	371906.872	896.02	895.84	-0.18	ASPH
1407	2379248.89	371902.504	896.001	895.81	-0.191	ASPH

1408	2379253.209	371902.094	895.911	895.77	-0.141	ASPH
1409	2379256.616	371901.67	895.892	895.76	-0.132	ASPH
1410	2379260.422	371901.411	895.783	895.67	-0.113	ASPH
1411	2379264.293	371901.061	895.771	895.59	-0.181	ASPH
1412	2379264.705	371895.644	895.726	895.67	-0.056	ASPH
1413	2379260.057	371896.36	895.798	895.75	-0.048	ASPH
1414	2379256.515	371896.692	895.838	895.76	-0.078	ASPH
1415	2379252.125	371896.49	895.839	895.87	0.031	ASPH
1416	2379248.231	371896.334	895.986	895.81	-0.176	ASPH
1417	2379247.692	371891.703	896.069	895.97	-0.099	ASPH
1418	2379252.309	371890.649	896.02	895.87	-0.15	ASPH
1419	2379256.248	371890.138	896.043	895.87	-0.173	ASPH
1420	2379259.982	371889.657	895.938	895.8	-0.138	ASPH
1421	2379264.158	371888.941	895.858	895.63	-0.228	ASPH
1422	2379336.954	371863.145	895.259	895.31	0.051	MOWED GRA
1423	2379341.304	371863.148	895.299	895.26	-0.039	MOWED GRA
1424	2379345.469	371863.157	895.418	895.31	-0.108	MOWED GRA
1425	2379349.805	371863.259	895.473	895.37	-0.103	MOWED GRA
1426	2379354.414	371863.46	895.598	895.57	-0.028	MOWED GRA
1427	2379354.91	371857.756	895.535	895.59	0.055	MOWED GRA
1428	2379349.363	371857.607	895.412	895.46	0.048	MOWED GRA
1429	2379344.951	371857.471	895.387	895.31	-0.077	MOWED GRA
1430	2379340.595	371857.528	895.28	895.21	-0.07	MOWED GRA
1431	2379336.465	371857.372	895.33	895.32	-0.01	MOWED GRA
1432	2379336.566	371852.173	895.248	895.29	0.042	MOWED GRA
1433	2379341.727	371851.258	895.254	895.28	0.026	MOWED GRA
1434	2379346.451	371850.845	895.335	895.44	0.105	MOWED GRA
1435	2379350.711	371850.259	895.346	895.47	0.124	MOWED GRA
1436	2379355.043	371849.894	895.538	895.65	0.112	MOWED GRA
1437	2379355.702	371844.682	895.572	895.61	0.038	MOWED GRA
1438	2379350.221	371844.925	895.413	895.46	0.047	MOWED GRA
1439	2379346.014	371845.309	895.374	895.48	0.106	MOWED GRA
1440	2379341.698	371845.257	895.312	895.43	0.118	MOWED GRA
1441	2379336.966	371845.273	895.316	895.44	0.124	MOWED GRA
1442	2379336.836	371839.618	895.299	895.36	0.061	MOWED GRA
1443	2379342.494	371838.85	895.393	895.44	0.047	MOWED GRA
1444	2379347.265	371838.223	895.473	895.46	-0.013	MOWED GRA
1445	2379352.42	371838.073	895.502	895.56	0.058	MOWED GRA
1446	2379358.035	371836.944	895.725	895.73	0.005	MOWED GRA
1447	2379397.408	371674.547	897.647	898.05	0.403	TALL GRAS
1448	2379402	371674.838	897.612	897.98	0.368	TALL GRAS
1449	2379406.102	371675.37	897.522	897.81	0.288	TALL GRAS
1450	2379410.649	371675.279	897.453	897.84	0.387	TALL GRAS
1451	2379414.721	371675.709	897.41	897.68	0.27	TALL GRAS
1452	2379414.827	371670.336	897.304	897.53	0.226	TALL GRAS

1453	2379408.989	371670.584	897.25	897.6	0.35	TALL GRAS
1454	2379404.605	371670.708	897.45	897.71	0.26	TALL GRAS
1455	2379400.727	371670.498	897.614	897.89	0.276	TALL GRAS
1456	2379396.881	371669.948	897.664	897.91	0.246	TALL GRAS
1457	2379397.056	371665.502	897.577	897.96	0.383	TALL GRAS
1458	2379401.703	371665.48	897.423	897.68	0.257	TALL GRAS
1459	2379405.965	371665.323	897.292	897.62	0.328	TALL GRAS
1460	2379410.12	371665.54	897.162	897.47	0.308	TALL GRAS
1461	2379414.536	371665.143	897.031	897.48	0.449	TALL GRAS
1462	2379414.08	371659.728	897.104	897.39	0.286	TALL GRAS
1463	2379408.871	371660.538	897.194	897.58	0.386	TALL GRAS
1464	2379404.371	371661.021	897.381	897.62	0.239	TALL GRAS
1465	2379400.15	371661.081	897.571	897.76	0.189	TALL GRAS
1466	2379395.795	371660.794	897.645	897.84	0.195	TALL GRAS
1467	2379395.842	371655.883	897.465	897.81	0.345	TALL GRAS
1468	2379400.762	371655.55	897.3	897.7	0.4	TALL GRAS
1469	2379405.048	371655.318	897.188	897.56	0.372	TALL GRAS
1470	2379409.377	371655.031	897.141	897.48	0.339	TALL GRAS
1471	2379413.759	371654.948	897.116	897.46	0.344	TALL GRAS
1472	2379168.779	371988.668	897.21	897.22	0.01	LOW TREES
1473	2379168.452	371991.144	897.372	897.52	0.148	LOW TREES
1474	2379168.19	371993.009	897.444	897.58	0.136	LOW TREES
1475	2379165.833	371992.697	897.386	897.58	0.194	LOW TREES
1476	2379166.096	371991.082	897.296	897.48	0.184	LOW TREES
1477	2379166.801	371988.381	897.231	897.25	0.019	LOW TREES
1478	2379163.248	371987.587	897.241	896.96	-0.281	LOW TREES
1479	2379163.999	371989.635	897.467	897.19	-0.277	LOW TREES
1480	2379164.354	371991.803	897.502	897.43	-0.072	LOW TREES
1481	2379160.46	371987.472	897.177	897	-0.177	LOW TREES
1482	2379159.86	371989.709	897.401	897.16	-0.241	LOW TREES
1483	2379159.49	371991.441	897.614	897.29	-0.324	LOW TREES
1484	2379156.667	371986.123	897.374	896.97	-0.404	LOW TREES
1485	2379157.09	371988.225	897.446	897.1	-0.346	LOW TREES
1486	2379156.905	371990.066	897.517	897.23	-0.287	LOW TREES
1487	2379155.072	371990.08	897.456	897.26	-0.196	LOW TREES
1488	2379155.078	371988.46	897.362	897.15	-0.212	LOW TREES
1489	2379154.885	371985.922	897.351	896.98	-0.371	LOW TREES
1490	2379152.288	371985.512	897.356	897	-0.356	LOW TREES
1491	2379152.697	371987.963	897.333	897.16	-0.173	LOW TREES
1492	2379152.249	371989.403	897.434	897.3	-0.134	LOW TREES
1493	2379150.717	371989.977	897.446	897.48	0.034	LOW TREES
1494	2379150.066	371988.517	897.559	897.41	-0.149	LOW TREES
1495	2379149.198	371986.384	897.47	897.18	-0.29	LOW TREES
1496	2379147.501	371986.539	897.49	897.16	-0.33	LOW TREES
1497	2379148.283	371989.138	897.415	897.43	0.015	LOW TREES

1498	2379147.587	371991.226	897.466	897.62	0.154	LOW TREES
106	2379594.883	372016.383	897.188	897	-0.188	CP
107	2379454.75	372011.264	897.027	896.81	-0.217	CP
1499	2379602.642	372084.756	897.299	897.37	0.071	TREE COVE
1500	2379605.107	372084.222	897.464	897.41	-0.054	TREE COVE
1501	2379607.458	372083.899	897.449	897.45	0.001	TREE COVE
1502	2379610.076	372083.299	897.506	897.33	-0.176	TREE COVE
1503	2379612.561	372083.362	897.412	897.24	-0.172	TREE COVE
1504	2379612.839	372085.566	897.399	897.28	-0.119	TREE COVE
1505	2379610.171	372086.485	897.511	897.32	-0.191	TREE COVE
1506	2379607.127	372086.824	897.41	897.3	-0.11	TREE COVE
1507	2379604.237	372086.925	897.349	897.28	-0.069	TREE COVE
1508	2379601.162	372086.921	897.341	897.32	-0.021	TREE COVE
1509	2379601.058	372090.938	897.299	897.19	-0.109	TREE COVE
1510	2379603.983	372091.046	897.265	897.21	-0.055	TREE COVE
1511	2379606.568	372091.577	897.324	897.21	-0.114	TREE COVE
1512	2379609.736	372091.571	897.294	897.13	-0.164	TREE COVE
1513	2379612.212	372091.511	897.312	897.12	-0.192	TREE COVE
1514	2379612.816	372094.896	897.255	897.06	-0.195	TREE COVE
1515	2379610.395	372095.333	897.209	897.08	-0.129	TREE COVE
1516	2379607.807	372095.836	897.258	897.09	-0.168	TREE COVE
1517	2379604.124	372096.046	897.201	897.07	-0.131	TREE COVE
1518	2379601.51	372096.235	897.195	897.1	-0.095	TREE COVE
1519	2379601.947	372100.52	897.207	897.17	-0.037	TREE COVE
1520	2379604.414	372100.211	897.283	897.09	-0.193	TREE COVE
1521	2379607.557	372100.074	897.346	897.12	-0.226	TREE COVE
1522	2379610.812	372100.257	897.377	897.08	-0.297	TREE COVE
1523	2379614.091	372100.535	897.284	897.04	-0.244	TREE COVE

Average dz	0.169
Minimum dz	-0.404
Maximum dz	0.974
Average magnitude	0.226
Root mean square	0.293
Std deviation	0.24

FIELD NOTES

Project FEMA ground survey notes

Contains point number and descriptions

Includes Control and Check Points left out of statistical analysis

E - Ground Truthing

- shot 1,139 is check on New Berlin C GPS
- shots 1,140 - 1,164 are Asphalt
- shots 1,165 - 1,189 are Mowed Grass
- shots 1,190 - 1,214 are Tall Grass / Weeds
- shots 1,215 - 1,239 are Low Trees / Brush

- set CP# 102 - 60d nail

- set CP# 103 - 60d nail

T	H1	B5	SH
102	5:09	103	5:04

- shots 1,240 - 1,264 are Tree Cover

N - Ground Truthing

- shot 1,265 is check on Lisbon S GPS
- shots 1,266 - 1,290 are Asphalt
- shots 1,291 - 1,315 are Mowed Grass
- shots 1,316 - 1,340 are Tall Grass / Weeds
- shots 1,341 - 1,365 are Low Trees / Brush

- set CP#104 - 60d nail

- set CP#105 - 60d nail

T	H	B	S
104	5.24	105	5.04

- shots 1,366 - 1,393 are Tree Cover

W - Ground Truthing

- shot 1,396 is check on Ottawa E GPS
- shots 1,397 - 1,421 are Asphalt
- shots 1,422 - 1,446 are Mowed Grass
- shots 1,447 - 1,471 are Tall Grass / Weeds
- shots 1,472 - 1,498 are Low Trees / Brush

- set CP# 106 - 60d nail

- set CP# 107 - 60d nail

π	H1	BS	SH
106	5.25	107	5.04

- shots 1,499 - 1,523 are Tree Cover

S - Ground truthing 10/4/11

- 1,004 is check shot on Mukwonago GPS
- shots 1,005 - 1,029 are asphalt
- shots 1,030 - 1,054 are Tall Grass / Weeds
- shots 1,055 - 1,079 are Mowed Grass
- shots 1,080 - 1,106 are Low Trees / Brush

- set CP#100 - 60d nail

- set CP#101 - 60d nail

π	H1	B5	SH
100	5.23	101	5.50

- shots 1,107 - 1,134 are Tree cover