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**Ground Control Survey
Report for Salton Sea 2021
Aerial LiDAR**

For

Dewberry Engineers Inc.

January 2022

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1. Introduction

1.1 Project Summary:

Aero-Graphics Inc. is under contract to Dewberry Engineers to provide surveyed ground control points to support the acquisition of aerial lidar around the Salton Sea in southern California. The survey field work was conducted November 19, 2021, thru December 20, 2021. The ground control point locations were selected by Dewberry and distributed across the project areas as evenly as the terrain would allow.

Existing NGS control points were located and surveyed as part of the field work to verify the accuracy of survey. The results are shown in section 2.4 of this report.

The final horizontal coordinates are referenced to NAD83(2011) UTM Zone 11 meters, EPSG Code 6340. The final vertical elevations are referenced to NAVD88 meters using Geoid model 2018 (Geoid18).

1.2 Surveyor:

Questions regarding this report can be addressed to:

Karl Jensen, PLS, CP
Surveying Manager
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801-487-3273
801-891-2779 direct



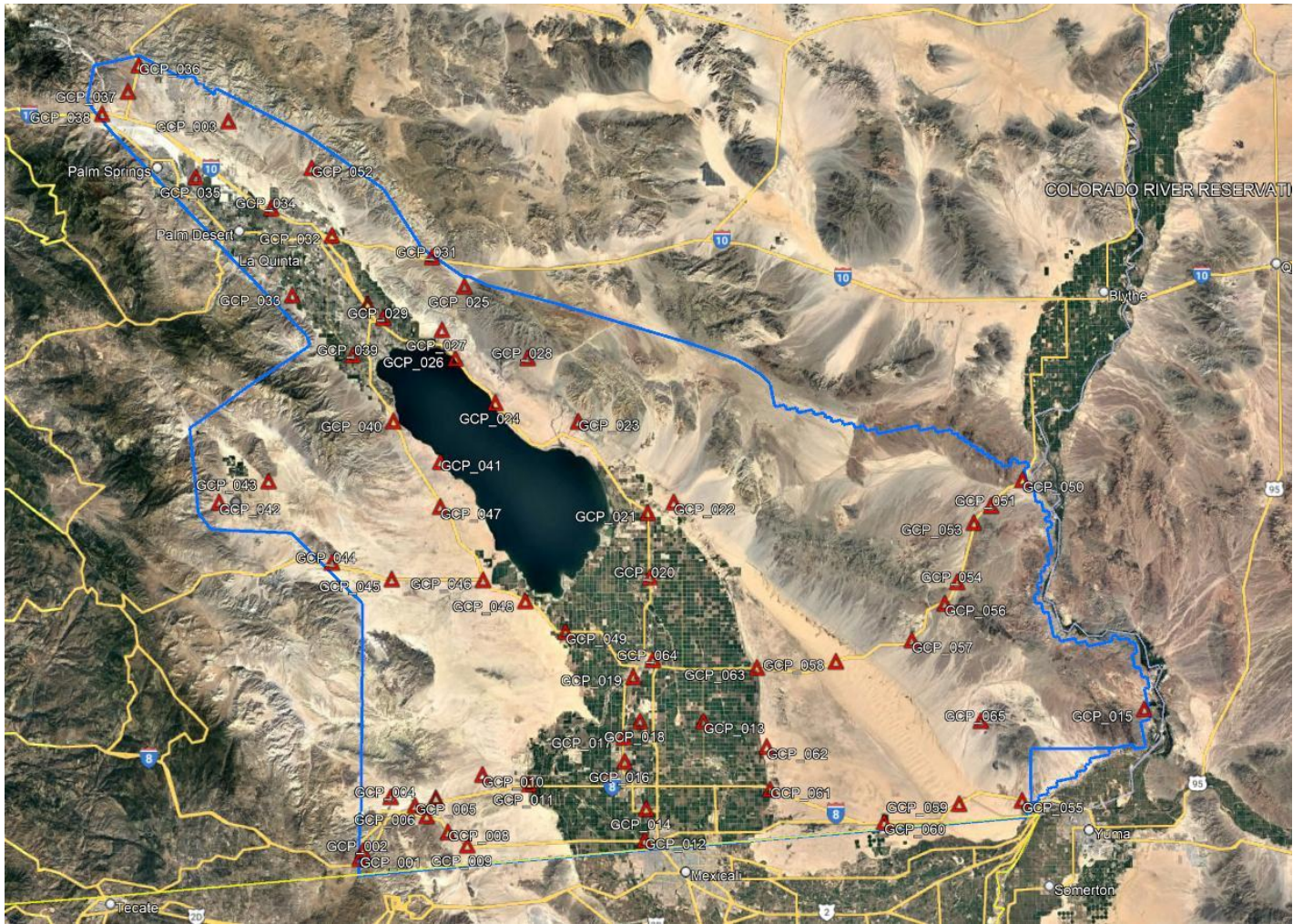
Utah Licensed Professional Land Surveyor #7643406, exp date 3/31/2023

Colorado Licensed Professional Land Surveyor #PLS-0038527, exp date 10/31/2023

ASPRS Certified Photogrammetrist, exp date 9/17/2023

1.3 Project Area:

Salton Sea Control



2. Project Details

2.1 Survey Equipment

The equipment listed below was used to survey the ground points for this LiDAR project.

TOPCON Dual Frequency/ Dual Constellation GNSS Receivers:

HiPER Ga, S/N: 498-00418	HiPER Ga, S/N: 457-02513
HiPER SR, S/N: 1064-16270	HiPER SR, S/N: 1209-11478
HiPER SR, S/N: 1209-10832	HiPER SR, S/N: 1209-14758
HiPER SR, S/N: 1209-18284	HiPER SR, S/N: 1209-18273

Spectra Precision Ranger 3 Data Collector

Two meter fixed height range pole for each Topcon GNSS HiPER receiver with attached bipod legs for stability.

2.2 Surveyed Point Details

The 65 ground control points were well distributed throughout the project areas. Five (5) photographs were taken of each point, looking north, east, south, west, and close on the occupied point/nail. A mag nail or spike was set at each location where possible.

Control point locations are detailed in the "Control Point Documentation Report" sheets attached to this report.

2.3 Surveyed Point Network

Multiple methods were used during the ground survey to observe the control points. Each method is detailed below.

LiDAR identifiable features or surveyor set\painted targets were used as control points.

STATIC:

Static (or Rapid-Static) Surveying is a method that Aero-Graphics has employed for many years to collect ground control points. A base station location is selected, usually at one or more control locations, and a GNSS receiver is left there for the duration of the day to complete the survey. The other GNSS receivers are then used as rovers to survey the other point locations.

The duration of the rover receivers will vary depending upon the distance from the base receiver. Normally the rover will not be further than 10 km from the base. The greater the distance the rover is from the base receiver, the longer the recording duration of the rover needs to be. Each rover location is surveyed for a minimum of 20 minutes or greater.

Static Surveying was used to collect control points.

The individual point locations are post-processed after the field survey is completed. The GNSS data collected by the receivers is downloaded and processed in NovaTel's Waypoint GravNET software. The base station coordinates are used to differentially correct the other point's locations.

The NGS Online Positioning User Service (OPUS) was used to process the base station location data. A minimum of 2+ hours of GNSS data was collected for base stations to be processed through OPUS.

HEXAGON SMARTNET (VRS):

The HxGN SmartNet Virtual Reference Station (VRS) was used to survey control points where a cell phone data signal was available to provide the necessary real-time correction. The field surveyor's data collector and roving GNSS receiver utilized the real-time broadcast positional correction to observe and survey the points.

The maximum baseline restriction for the roving receiver is 70km while using this method.

2.4 Field Procedures and Analysis

All control points were observed once with a static GNSS receiver or a VRS receiver. Each observation for static surveying occupied the point for a minimum of 20 minutes in duration. Each observation with the VRS occupied the points for a minimum of sixty (60) seconds in duration. Two control points were observed twice each with static and VRS on the same day.

Seven (7) NGS monuments or other benchmarks were surveyed as part of the field procedures for this project. Monuments were researched and located prior to field work commencing. While the highest order of monuments was preferred for surveying it is not always possible to find and use them. Monuments that were surveyed were chosen for accessibility and probable

existence. Although all results are shown below, some are less than desirable due to imprecise data from the NGS datasheets.

The NGS monuments were occupied to provide a QC/QA for the survey methods used. Five (5) of the monuments were occupied twice or more. The observed values and data sheet values are shown below along with the differences. The latitude and longitude from the data sheets were converted to UTM zone 11 meters.

NGS Monuments

POINT		OBSERVED VALUES			DATASHEET VALUES			DIFFERENCE		
ID	NGS PID	NORTHING	EASTING	ELEVATION	NORTHING	EASTING	ELEVATION	NORTHING	EASTING	ELEVATION
SDPR12	AF9883	3679901.067	555955.385	233.430	3679900.808	555955.660	233.442	0.259	-0.275	-0.012
SDPR12-1	AF9883-1	3679901.056	555955.384	233.372	3679900.808	555955.660	233.442	0.248	-0.276	-0.070
119	AH9140	3731453.174	557183.677	69.126	3731454.293	557182.293	69.136	-1.119	1.384	-0.010
119-1	AH9140-1	3731453.208	557183.662	69.064	3731454.293	557182.293	69.136	-1.085	1.369	-0.072
119-2	AH9140-2	3731453.204	557183.646	69.097	3731454.293	557182.293	69.136	-1.089	1.353	-0.039
PLS 4152	AH9143	3731247.965	556558.494	76.116	3731246.680	556557.081	76.169	1.285	1.413	-0.053
PLS 4152-1	AH9143-1	3731247.961	556558.508	76.136	3731246.680	556557.081	76.169	1.281	1.427	-0.033
CO J 3	DB1219	3631566.922	653256.703	-1.242	3631566.942	653256.666	-1.212	-0.020	0.037	-0.030
CLR B	DF4133	3666743.423	638376.775	-56.322	3666743.940	638375.950	-55.770	-0.517	0.825	-0.552
A517	DX0609	3714769.995	584836.354	-58.966	3714769.606	584836.408	-58.765	0.389	-0.054	-0.201
A517-1	DX0609-1	3714770.035	584836.414	-58.776	3714769.606	584836.408	-58.765	0.429	0.006	-0.011
G1299	DX3552	3714770.839	582360.352	-55.545	3714771.054	582345.394	-55.426	-0.215	14.958	-0.119
G1299-1	DX3552-2	3714770.874	582360.365	-55.445	3714771.054	582345.394	-55.426	-0.180	14.971	-0.019

NGS Monuments



2.5 Data Processing Procedures

The data from the data collector for the points that were surveyed with VRS was downloaded each day and emailed to the office. The data from the static GNSS receivers was downloaded each day and a copy was uploaded to the office FTP server.

Base station observations were uploaded to OPUS only after the rapid ephemeris was available for processing. Whether the base station was located on an NGS monument or at a new point location, all GNSS data sets with a duration longer than two (2) hours were processed through OPUS.

The static surveyed points were post-processed using NovaTel's Waypoint software. Some of the static control point observations of less than two (2) hours in duration were processed with OPUS Rapid Static (OPUS-RS) as a QA\QC on the static post processing.

After receiving the control points surveyed with the VRS system from the field crew, the points were converted to UTM Zone 11 meters coordinates and merged with the static surveyed control points.

3. Final Coordinates

POINT ID	NAD83(2011) UTM11 NORTHING Meter	NAD83(2011) UTM11 EASTING Meter	ORTHO HGT (Geoid18) Meter
GCP_001	3612597.232	583894.985	929.160
GCP_002	3614017.418	584449.922	842.864
GCP_003	3752465.911	556542.287	386.458
GCP_004	3624254.788	589546.907	196.019
GCP_005	3622683.595	594210.693	116.065
GCP_006	3620708.414	596465.481	109.148
GCP_007	3624207.055	598162.452	78.346
GCP_008	3617691.662	600582.206	113.124
GCP_009	3615228.094	604294.408	110.230
GCP_010	3628722.874	607016.752	31.188
GCP_011	3627069.307	615976.096	-11.475
GCP_012	3616678.180	638226.045	0.516
GCP_013	3639516.165	649111.850	-24.296
GCP_014	3622690.162	638416.818	-4.366
GCP_015	3642956.235	733584.602	101.079
GCP_015V	3642956.271	733584.609	100.992
GCP_016	3631640.311	634175.869	-15.249
GCP_017	3636192.611	633963.639	-19.015
GCP_018	3639346.200	637014.345	-37.334
GCP_019	3647771.863	635612.603	-31.267
GCP_020	3666774.698	638505.884	-54.894
GCP_021	3679018.159	637934.427	-42.893
GCP_022	3681092.381	642848.146	21.981
GCP_023	3696185.538	624373.998	-13.201
GCP_024	3699494.456	608480.339	-58.551
GCP_025	3721552.215	602307.822	317.565
GCP_026	3707833.403	600731.560	-67.403
GCP_027	3713252.387	598087.959	16.786
GCP_027S	3713252.404	598088.079	17.099
GCP_028	3708097.116	614553.007	21.234
GCP_029	3715349.235	586812.828	-49.194
GCP_030	3718018.416	583773.632	-49.320
GCP_031	3727025.515	596033.537	511.063
GCP_032	3730976.323	576696.173	-3.442
GCP_033	3719473.276	569281.576	-7.069
GCP_034	3736022.937	565026.054	32.234
GCP_035	3741802.251	550389.081	109.608
GCP_036	3762880.991	539238.182	535.124
GCP_037	3757903.003	537170.949	483.422

GCP_038	3753565.715	532264.819	388.954
GCP_039	3708240.936	581132.484	-41.975
GCP_040	3695753.225	589058.451	-62.992
GCP_041	3688144.488	598138.623	-67.662
GCP_042	3679853.197	555955.834	234.433
GCP_042V	3679853.472	555955.583	234.404
GCP_043	3683978.621	565319.859	184.852
GCP_044	3668684.779	577679.000	109.449
GCP_045	3665671.209	589162.693	12.244
GCP_046	3665769.024	606620.918	-54.058
GCP_047	3679614.040	598225.445	-39.769
GCP_048	3661892.636	614758.031	-49.627
GCP_049	3656172.260	622511.499	-52.570
GCP_050	3686356.334	709520.948	102.359
GCP_051	3681302.149	703508.384	181.867
GCP_052	3743699.245	572715.486	369.910
GCP_053	3678040.928	700245.356	250.118
GCP_054	3666719.673	697214.826	337.776
GCP_055	3625203.410	710369.923	89.977
GCP_056	3662602.830	694904.461	306.667
GCP_057	3655522.225	688717.587	192.789
GCP_058	3651254.862	674275.249	130.001
GCP_059	3624435.577	698293.127	52.762
GCP_060	3620778.796	683987.195	45.467
GCP_061	3626721.703	662066.584	11.986
GCP_062	3634837.949	661288.439	15.903
GCP_063	3649850.586	659192.971	8.303
GCP_064	3651048.690	639297.675	-40.010
GCP_065	3640331.985	702173.536	177.729

4. GNSS Observations

POINT ID	DATE SURVEYED	JULIAN DATE	SURVEY METHOD
GCP_001	December 15, 2021	349	Static
GCP_002	December 15, 2021	349	Static
GCP_003	November 20, 2021	324	VRS
GCP_004	December 15, 2021	349	Static
GCP_005	December 15, 2021	349	Static
GCP_006	December 15, 2021	349	OPUS
GCP_007	December 15, 2021	349	Static
GCP_008	December 16, 2021	350	Static
GCP_009	December 16, 2021	350	Static
GCP_010	December 14, 2021	348	Static
GCP_011	December 14, 2021	348	OPUS
GCP_012	December 13, 2021	347	Static
GCP_013	December 12, 2021	346	VRS
GCP_014	December 13, 2021	347	OPUS
GCP_015	December 13, 2021	347	OPUS-RS
GCP_015V	December 13, 2021	347	VRS
GCP_016	December 13, 2021	347	Static
GCP_017	December 13, 2021	347	OPUS
GCP_018	December 13, 2021	347	Static
GCP_019	December 12, 2021	346	Static
GCP_020	December 11, 2021	345	VRS
GCP_021	December 10, 2021	344	OPUS
GCP_022	December 10, 2021	344	Static
GCP_023	December 3, 2021	337	OPUS
GCP_024	December 3, 2021	337	OPUS
GCP_025	December 1, 2021	335	Static
GCP_026	December 3, 2021	337	Static
GCP_027	December 2, 2021	336	VRS
GCP_027S	December 2, 2021	336	OPUS-RS
GCP_028	December 4, 2021	338	OPUS-RS
GCP_029	December 1, 2021	335	VRS
GCP_030	November 30, 2021	334	VRS
GCP_031	November 22, 2021	326	VRS
GCP_032	November 22, 2021	326	VRS
GCP_033	December 1, 2021	335	VRS
GCP_034	November 22, 2021	326	VRS
GCP_035	November 20, 2021	324	VRS
GCP_036	November 19, 2021	323	VRS
GCP_037	November 19, 2021	323	VRS
GCP_038	November 19, 2021	323	OPUS

GCP_039	December 5, 2021	339	VRS
GCP_040	December 5, 2021	339	Static
GCP_041	December 5, 2021	339	Base
GCP_042	December 9, 2021	343	OPUS
GCP_042V	December 9, 2021	343	VRS
GCP_043	December 9, 2021	343	OPUS
GCP_044	December 8, 2021	342	Static
GCP_045	December 6, 2021	340	OPUS
GCP_046	December 6, 2021	340	OPUS
GCP_047	December 5, 2021	339	OPUS
GCP_048	December 11, 2021	345	OPUS
GCP_049	December 11, 2021	345	OPUS
GCP_050	December 15, 2021	349	OPUS
GCP_051	December 15, 2021	349	OPUS
GCP_052	November 21, 2021	325	VRS
GCP_053	December 14, 2021	348	OPUS
GCP_054	December 14, 2021	348	Static
GCP_055	December 13, 2021	347	VRS
GCP_056	December 14, 2021	348	OPUS
GCP_057	December 16, 2021	350	OPUS
GCP_058	December 16, 2021	350	OPUS
GCP_059	December 13, 2021	347	Static
GCP_060	December 12, 2021	346	VRS
GCP_061	December 12, 2021	346	VRS
GCP_062	December 12, 2021	346	VRS
GCP_063	December 11, 2021	345	VRS
GCP_064	December 12, 2021	346	OPUS
GCP_065	December 14, 2021	348	VRS

5. Deliverables

Along with this report, the deliverables to Dewberry Engineers includes the Control Point Documentation Report sheets and an Excel Spreadsheet including all control point data.