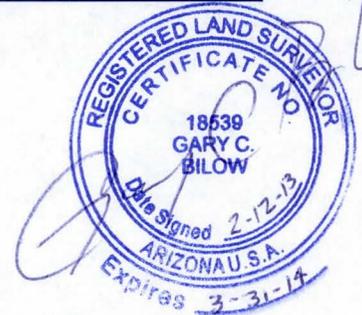


SURVEY REPORT

MCMICKEN OUTFALL CHANNEL AERIAL MAPPING

FLOOD CONTROL DISTRICT CONTRACT 2011C033
ASSIGNMENT NUMBER 1
WOOLPERT PROJECT 72786



Background

This project involves the production of a Digital Terrain Model (DTM), planimetric mapping and ground surface contour mapping of about 4.5 square miles in Surprise, Arizona, as outlined in red on the attached Exhibit A. The DTM and mapping are compiled from aerial imagery and meet American Society of Photogrammetry and Remote Sensing (ASPRS) standards for mapping at a one-foot contour interval. A field survey was performed to establish and position the ground control required to develop the photogrammetric products. The survey was made under the direct supervision of Gary C. Bilow, RLS.

Datum

The survey is based on the North American Datum of 1983, 2011 adjustment (NAD83(2011)), epoch 2010.0 as defined by Continuously Operating Reference Station (CORS) AZPA in Peoria, AZ, CORS AZWA in Wickenburg, AZ and National Spatial Reference System (NSRS) A-order station Q 366.

The vertical datum is North American Vertical Datum of 1988 (NAVD88) established by ties to NSRS bench mark Q 366 and NSRS Height Modernization station 4GA2 which is also a City of Surprise/Maricopa County bench mark. The current geoid model, GEOID12A was used in the data processing.

Coordinate System

Woolpert created a coordinate system specific to the McMicken Dam and Outfall area. The system is designed to minimize the grid and elevation scale factors that must be applied when converting geographic coordinates (latitude and longitude) on an ellipsoidal earth to Cartesian coordinates (Northing and Easting) required by MircoStation and other computer assisted drafting and design software. The goal is to create a grid system where distances measured between points on the ground are the same as distances measured those same points on the grid, within the tolerances associated with the measuring instruments and techniques.

The McMicken Ground Coordinate System was produced by determining the Arizona Central Zone State Plane Coordinates for the photo control points required for the McMicken Outfall and McMicken Dam Aerial Mapping projects. Grid and elevation scale factors are multiplied to produce a combined scale factor for each point. The median values of the combined scale factors was determined and rounded to six places after the decimal. This value is 0.999869. Arizona Central Zone coordinates are multiplied by the reciprocal of the rounded, median,

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combined scale factor to produce McMicken Ground Coordinates.

AZ Central Zone Coordinate x 1.000131 = McMicken Ground Coordinate
McMicken Ground Coordinate x 0.999869 = AZ Central Zone Coordinate

Aerial Photo Targets

Sixty-four target locations were selected by Woolpert photogrammetrists. Photo-identifiable (PID) features were available for seventeen targets. Field surveyors created targets consisting of painted or plastic chevrons with legs one foot wide by four feet long at forty seven locations. Each target was surveyed immediately after it was constructed. Targeting was completed on October 4, 2012 and the aerial photography acquired on October 8, 2012.

Methods

Target positions and elevations were determined using Global Positioning System (GPS) techniques. GPS receivers from Trimble Navigation Limited were used. GPS data were processed and adjusted using Trimble Business Center software.

Initial observations were obtained to verify the control monuments in and around the project area. The project is partially in the West Valley Land Subsidence Feature and NSRS bench mark elevations were determined over 40 years ago. CORS AZPA and AZWA were used with bedrock bench mark Q 366 occupied for four hours. Thirty-minute static GPS sessions were observed at NSRS bench marks Y 23 and N366 and height modernization station 4GA2.

The position and ellipsoid height of Q 366 was held fixed in a minimally constrained least squares adjustment and produced the following comparison with published NAD83(2011) values (in units of International Feet):

Point	PID	Δ North	Δ East	Δ Ell Hgt
Q 366	DV0080	0	0	0
AZPA	DN2121	0.004	0.008	-0.046
AZWA	DL6308	0.005	-0.031	-0.061
4GA2	AJ3856	0.007	0.007	-0.006
N 366	DV0086	n/a	n/a	n/a
Y 23	DV0259	-0.046	-0.149	n/a

Published - surveyed

These results show good agreement between published values and the current positions of the survey marks, with the exception of Y23 which is published as NAD83(1992).

The position and elevation of Q 366 was then held fixed in a minimally constrained adjustment using Geoid12A as the source for geoid heights. Note that use of the current geoid model may introduce some uncertainty when comparing our results with published elevations of stations with orthometric heights determined using earlier models. An exact comparison would require re-processing of historic project measurements used to derive the published data. Our survey produced the following comparison with published elevations:

Point	PID	Δ Elevation
Q 366	DV0080	0
AZPA	DN2121	n/a
AZWA	DL6308	n/a
4GA2	AJ3856	-0.125
N 366	DV0086	0.129
Y 23	DV0259	0.278

Published - surveyed

These results suggest that Y 23 may have subsided. While the checks on N 366 and 4GA2 are slightly poorer than we would like to see, they are equally split above and below published elevations. The published elevation of Q 366 is accepted as accurately defining NAVD88 for this project.

Aerial photo control points were surveyed over seven days using a combination of RTK and static GPS techniques. CORS AZPA and AZWA were used as RTK base stations accessed via the AZCORS network. CORS AZTP was substituted for AZWA for five points when the connection to AZWA became unreliable. Station Q 366 was also occupied each day to provide a direct tie to NAVD88 for each target and PID. Two five-minute RTK GPS sessions were conducted, one using CORS AZPA and the second using CORS AZWA or AZTP. RTK results were compared in the field and the point re-observed if tolerance exceeded 0.25 foot. The results were saved and the setup was checked for level. Photo control points were then occupied for ten minutes in a static GPS session.

All RTK and Static vectors were combined into a least squares adjustment. Measurement data were analyzed and vectors with poor fits were removed from the adjustment. A minimum of two vectors were retained for each photo control point. Seven days of observations at Q 366 were used to establish an adjusted NAVD88 orthometric height for each CORS. These derived elevations were held fixed with the CORS positions, the position and elevation of Q 366 and the elevation of 4GA2 to produce the final adjusted coordinates of the aerial photo control points.

A network diagram is included as Exhibit B. A listing of the aerial photo control point coordinates in the McMicken Ground Coordinate System is Exhibit C.

Submitted by: _____

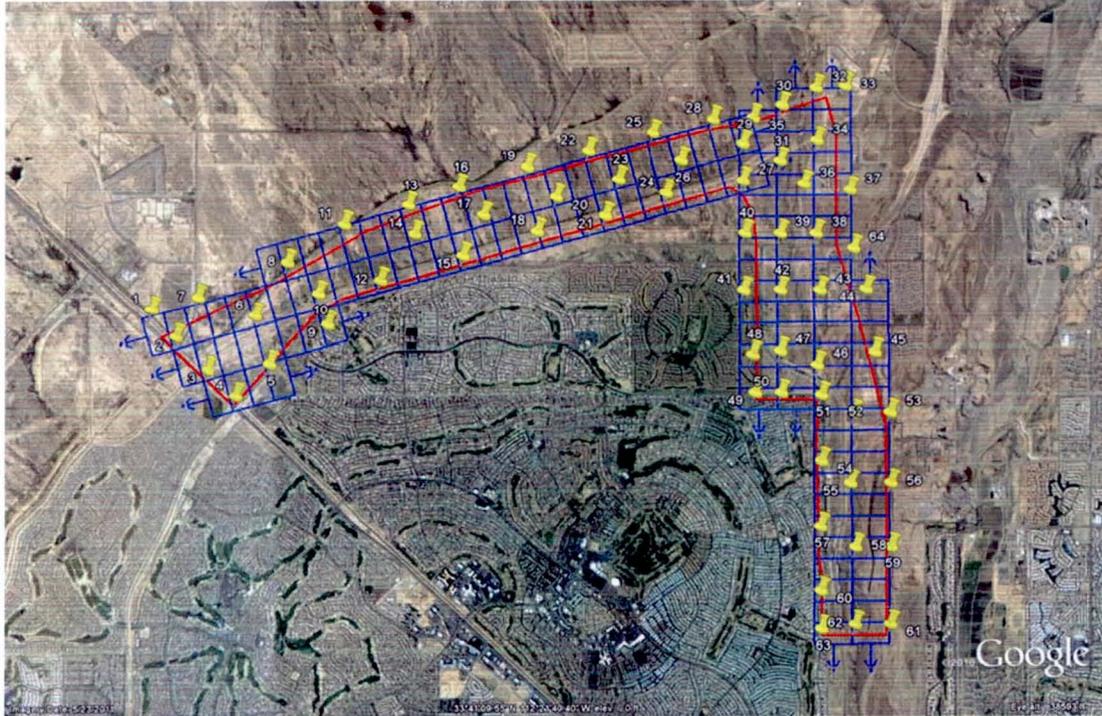
Gary C. Bilow

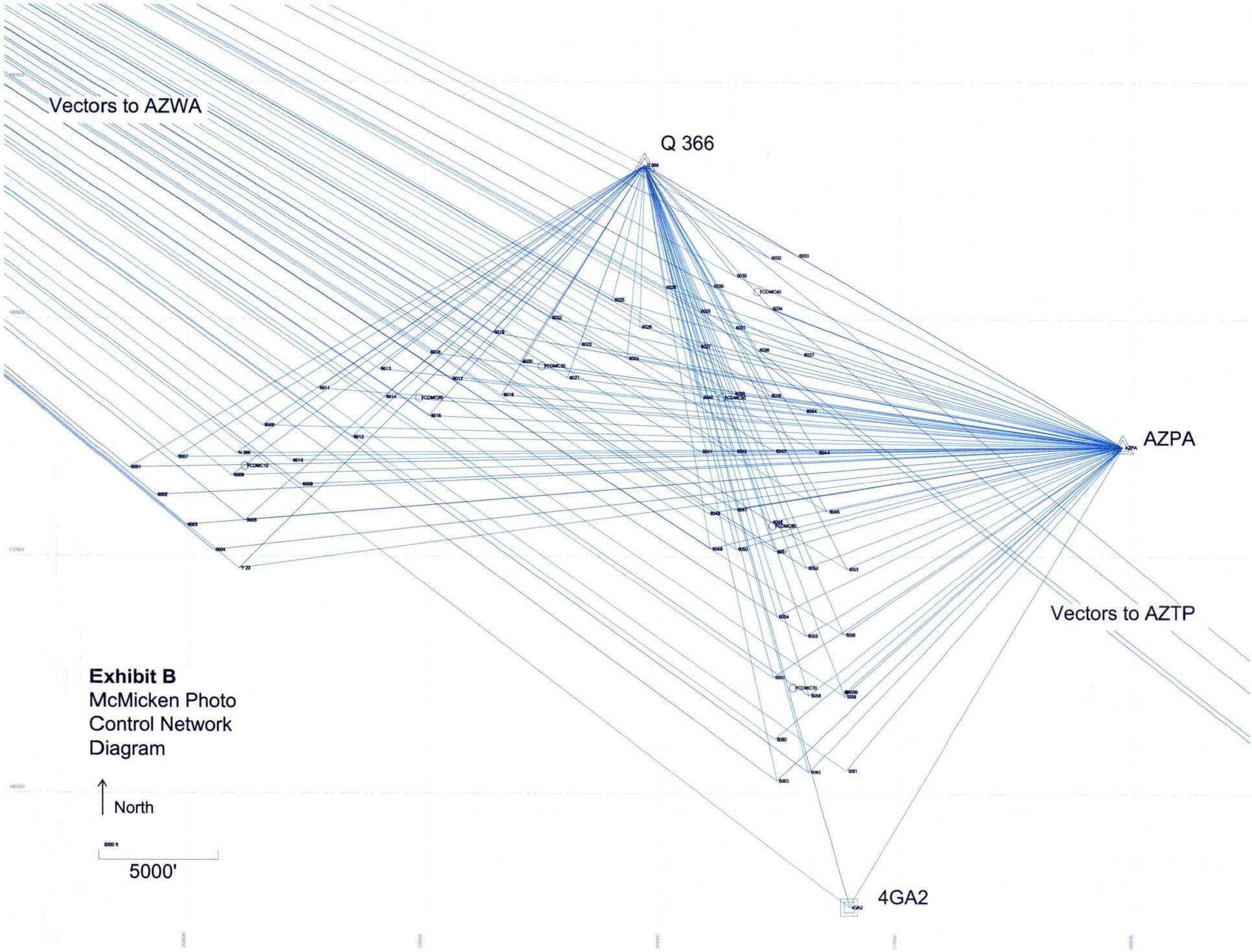
Gary C. Bilow, RLS # 18539



Exhibit A

McMicken Outfall Channel Aerial Mapping Project
1"=240' scale flight and ground control layout.





Vectors to AZWA

Q 366

AZPA

Vectors to AZTP

4GA2

Exhibit B
 McMicken Photo
 Control Network
 Diagram



5000'

Exhibit C
 McMicken Outfall Aerial Mapping
 Photo Control Point Coordinates

NAD83(2011) 2010.0 McMicken Ground Coordinates				
Divide Northing and Easting by 1.000131 to convert to Arizona				
Central Zone State Plane Coordinates				
NAVD88	Int'l Feet	Geoid12A		
Point ID	Northing	Easting	Elevation	Feature Code
6001	979182.31	548150.48	1354.50	PP
6002	978010.85	549269.76	1347.67	PID
6003	976740.52	550532.10	1334.94	PID
6004	975675.54	551715.47	1326.22	PP
6005	976925.32	553051.38	1332.38	PP
6006	978841.75	552510.12	1335.20	PP
6007	979612.06	550157.31	1350.35	PP
6008	980947.13	553820.79	1338.26	PP
6009	978437.62	555420.53	1321.40	PID
6010	979452.28	555013.95	1326.36	PP
6011	982498.35	556156.93	1339.68	PP
6012	980436.29	557589.57	1323.99	PP
6013	983314.70	558758.36	1332.51	PP
6014	982125.71	558976.93	1326.61	PP
6015	981326.21	560866.70	1317.14	PP
6016	984011.78	560858.79	1333.81	PP
6017	982886.60	561788.86	1325.07	PP
6018	982198.07	563934.82	1315.85	PP
6019	984844.08	563566.60	1332.47	PP
6020	983608.29	564745.35	1321.67	PP
6021	982914.27	566723.27	1312.89	PP
6022	985449.35	566010.36	1331.34	PP
6023	984325.02	567250.89	1321.62	PP
6024	983721.54	569240.18	1311.59	PP
6025	986193.74	568654.38	1329.53	PP
6026	985049.98	569793.89	1317.40	PP
6027	984220.37	572290.29	1306.19	PP
6028	986722.43	570839.29	1324.90	PP
6029	985713.65	572291.15	1313.88	PP
6030	987206.76	573834.13	1324.58	PP
6031	985001.53	573779.11	1310.35	PP
6032	987952.63	575305.74	1322.05	PP
6033	988035.08	576467.42	1326.65	PID
6034	985815.31	575338.73	1314.46	PP
6035	986770.81	572856.15	1323.91	PP
6036	984064.75	574768.67	1300.54	PP
6037	983853.79	576658.53	1304.97	PP
6038	982125.74	575258.23	1295.43	PP
6039	982217.21	573728.83	1292.12	PP
6040	982059.62	572374.83	1301.49	PP
6041	979785.87	572318.93	1285.65	PID
6042	979797.09	573784.84	1282.70	PP
6043	979795.42	575441.93	1277.63	PID
6044	979716.40	577249.83	1284.04	PID
6045	977214.52	577652.14	1271.99	PID
6046	976788.93	575287.27	1262.20	PP
6047	977311.71	573790.13	1265.98	PP
6048	977165.65	572639.36	1264.73	PID
6049	975666.17	572724.90	1261.16	PID
6050	975650.74	573807.81	1255.73	PID
6051	975541.20	575466.72	1252.07	PID
6052	974843.49	576780.84	1264.64	PP
6053	974784.99	578451.21	1219.24	PP
6054	972789.91	575523.12	1237.76	PID
6055	971971.09	576739.76	1245.58	PP
6056	972006.58	578299.42	1192.64	PP
6057	970220.54	575334.92	1227.73	PID
6058	969447.61	576846.75	1218.18	PP
6059	969398.59	578315.81	1182.56	PP
6060	967612.09	575387.92	1218.27	PID
6061	966283.48	578349.85	1173.00	PP
6062	966231.12	576810.04	1203.28	PP
6063	965866.77	575466.39	1205.95	PID
6064	981471.16	576747.32	1291.61	PID