

MOKOLO / CROCODILE RIVERS WATER AUGMENTATION PROJECT

SURVEY REPORT

Date of Survey:

- July – October 2009

Staff:

- Professional Land Surveyor, D. Biggert
- Registered Technician, D. van Rensburg
- GPS Instrument operator, G. Ferraro
- Levelling technicians, J. van Rensburg, E. Mbambo, R. Phakathi and L. Bhengu

Equipment:

- Leica System 500 dual frequency receivers
- Leica System 1200 dual frequency receivers
- Topcon and Trimble receivers were used by Southern Mapping Company, and their data was included in our GPS measurements via Rinex transfer files.
- Leica NA2000 and NA3000 digital levels
- Leica Sprinter D100 digital level
- Trimble Digital Levels
- Leica Geomatics Office

General Survey Information:

- The extent of this survey is some 200 kms from North to South and 50 kms East to West.
- Our instruction was to construct survey control beacons, being 12mm iron pegs in concrete, at approximately 2 kilometre intervals along predetermined routes.
- The survey was undertaken in 3 basic phases, these being:
 - Beacon selection and construction
 - Beacon fixing in position
 - Beacon fixing in elevation
- All control had to be fixed and levelled according to TMH11 specifications.
- All control points were fixed in position statically by GPS, and levelled on double level runs by digital levels.
- We were instructed to base all survey information on a previously coordinated point, A084809.
- All stations were occupied to yield an overlap of satellite epochs. The epochs were recorded at 1 second intervals, and the overlap period was determined on the following basis:

0 – 5 kms	5 minutes
5 – 10 kms	10 minutes
10 – 15 kms	15 minutes
15 – 20 kms	20 minutes

Over 20 kms 30 minutes

- All survey information is supplied on coordinate system WG.27.
- We were requested to establish control at the Boschkop Weir. Elevation control was finalised in this vicinity by direct link onto two existing DWAF control beacons, 60DW1 and 60DW2.
- We also located a control point, MKDW2, below the Mokolo Dam wall.

GPS Survey:

- Generally, major base stations were established at approximately 10 kilometre intervals, and intermediate points were then occupied for a period of 10 minutes.
- GPS computations were carried out with Leica Geomatics Office V7.
- Two primary networks were initially computed. The first being termed the “Northern” network and the second the “Southern” network. Once the coordinates of the control points of these networks were finalised, they were then utilised to finalise the coordinates of the secondary control networks.
- Attached to this report is a listing of the GPS Processing Methodology listing the method in calculation of each point.
- Also attached, are final coordinate listing of all control points in both Grid and Geographical formats.
- All station occupations have been exported to Rinex format, and are supplied with the project information.

Level Survey:

- To ensure the accuracy of the survey, we had to close level loops back on themselves. There are 3 major level loops in the project:
 - The farms Sterkfontein 642LQ – Rooipan 357LQ approximately 25 kms (A)
 - The farms Matlabas 94KQ – Sterkfontein 642LQ approximately 60 kms (B)
 - The farms Leliefontein 672LQ - Rooipan 357LQ approximately 15 kms (C)
- Together with data supplied on this project, are all raw level fieldbook files, together with the processed fieldbook files.
- The Level Schedule lists the forward and back runs, together with their height differences and mean difference utilised.
- Where possible, level loops were processed to ensure the integrity of the level loops. All such reductions are listed in the Level Reduction spreadsheet.
- Initially, a major loop around the entire northern section (over 200 kms) was considered, however the misclosure on this loop was in excess of 400mm. When comparing heights to the SAQuasi geoidal model that yields orthometric heights, we were concerned about the large geoidal differences in the very north-eastern sector of the project. We re-established on site, and re-run the section from P1-A09220007 and found a 0,5m difference to our original levels. This was put down to a faulty compensator in a machine used for one day on site before it was discovered and sent away for repairs.
- A selection of additional level legs (some 30 in total) were made where the height difference as derived from the SAQuasi geoidal model was more than

40mm different from that as spirit levelled. With the exception of legs A09220011-A09220012 (30mm different), A09220181-A09220182 (46mm different) and A09220182-A09220183 (81mm different), all other legs agreed with the original level runs perfectly. The difference in the first leg mentioned above could have been due to the inhospitable terrain, and the second and third were definitely due to the one surveyor not balancing his back- and foresights when levelled in steep terrain.

- Some loop misclosures were in the order of:
 - 0,041m over 97 kms
 - 0,069m over 67 kms
 - 0,067m over 14 kms (extremely soft sand)
 - 0,011m over 8 kms
 - 0,010m over 93 kms
 - 0,046m over 33 kms
 - 0,001m over 60 kms
 - 0,034m over 37 kms
- Allowable limits for forward and back runs were limited to 10mm over 1km. If this was not achieved, then the leg was re-levelled. Allowance was made for runs over very soft, sandy terrain.
- A schedule of levelled height differences, with reference to the physical raw data file, is supplied with the survey records.

Photographs:

- There is a landscape photograph of each setup, together with a close-up vertical photograph of each beacon.
- The photographs are stored in date directories, each photo being named according to the beacon name.
- The above photographs are pasted onto each instrument location Booking Sheet.

Base Station Booking Sheets:

- Base station booking sheets exist for every control point.
- If control points were occupied more than once, second and subsequent booking sheets were produced.
- If a control point was occupied more than once, a second set of photographs was not necessarily produced. However, copies of corresponding photographs are supplied in each of the date directories.
- The photograph details on these sheets refer to the photograph name to be found under the date the point was occupied.

General Information:

- We were specifically instructed not to enter onto certain properties. Accordingly, beacons could not be constructed or surveyed on Rhenosterpan 361LQ and Paarl 124KQ.
- Protocol was followed on all other private farms, where land owners were contacted in advance, notified when we would be on their properties, and then personally visited when on site.

- Problems encountered on the project, although being time consuming, were not difficult to overcome. Initially, access to some areas was hampered by having to supply information not originally budgeted for (Exarro and Transnet). Although official access to the Transnet servitude was never supplied, we decided to go ahead and build, survey and level all necessary beacons on these properties. Once again, strict protocol was followed.
- No accidents occurred during the project.

Data Files Supplied:

- Coordinate lists in spreadsheet format.
- GPS raw data files in Rinex format.
- GPS Data Sheets for all stations occupied.
- GPS Booking Sheets for all stations occupied.
- Control point photographs in JPEG format.
- Raw and reduced raw data level files.
- Schedule of levelling information.
- Level reductions.
- Working plan of control point layout.
- Working plan of level routes and misclosures.

Signed at Westville this 19th day of October 2009.

D. J. Biggert.