# precision **aerial** surveys

Oceana Gold (New Zealand) Limited
Golden Point Road
RD3 Macraes Flat 9483
East Otago

3rd June 2011

Attn: Marty Hughes

## Re Ground Control Survey and Mapping for Dam Break Analysis

Dear Marty,

Thank you for your email of the 31st May. The following is a record of the survey that was carried out for the Dam break study for Tipperary and Deepdell.

## GROUND CONTROL SURVEY

1. The Equipment used for the GPS survey was Trimble 5800 using RTK and Post Process survey methods.

2. A survey mark was created on the junction of Shag Valley Back Road and Macraes Road  (base1), here a GPS base was setup each survey day and a positional record at 15sec intervals was recorded.

3. During the survey a network of geodetic survey marks, being stations a28u, a3ex, a29p,b42x and afdm were used. These trigs are positioned to the north of the mine site and on the coast at Katiki and Goodwood. In between the coast and the mine site a network of 10 bases was established.

4. All the base points and the trig points were then post processed by Leica Geosystems in the following manner. With the raw rinex observations which delivered us heights in terms of Ellipsoid but not fixed to a known value, we moved the points horizontally to be in terms of Observation Point Circuit 2000, we then took the calculated ellipsoid heights and positions and ran them through the Linz co-ordinate converter, this gave us heights which were in terms of vertical datum 09, (which has a known offset to the Dunedin datum http://www.linz.govt.nz/geodetic/datums-projections-heights/vertical-datums/new-zealand-vertical-datum-2009/nzvd2009-datum-offsets/index.aspx.

A vertical shift was then applied to all the marks based on an average shift between VD09 obtained from the published heights of the known trig marks (Dunedin 1958) to derive our final heights.

5. From our network of base locations we were then able to use RTK GPS to establish our photo control points in a network from the mine to the coast each side of the Shag River and McCormicks Creek.

The accuracy of the control survey +/- 0.1m

## PHOTOGRAMMETRY

1. Aerial Photography was taken at an altitude of 5000ft, 60% overlap and scanned with a Leica scanner at 15 micron.

2. Using BAE Systems Socet Set Software a complete Air Triangulation was completed over the entire area the result of the air trig was:

Run 1


RMS x   ==> 2.360e-002
RMS y   ==> 2.698e-002
RMS z   ==> 1.845e-002
Total RMS ==> 3.804e-002

Run 5

RMS x   ==> 1.124e-002
RMS y   ==> 1.413e-002
RMS z   ==> 1.222e-002
Total RMS ==> 2.180e-002

Run 6

RMS x   ==> 8.101e-003
RMS y   ==> 6.734e-003
RMS z   ==> 9.591e-003
Total RMS ==> 1.425e-002

Run 7-8

RMS x   ==> 2.065e-002
RMS y   ==> 2.270e-002
RMS z   ==> 1.398e-002
Total RMS ==> 3.372e-002

Run 9-10
RMS x   ==> 1.261e-002
RMS y   ==> 1.436e-002
RMS z   ==> 7.818e-003
Total RMS ==> 2.065e-002

Run 11
RMS x   ==> 9.901e-003

RMS y    ==> 1.674e-002
RMS z    ==> 8.485e-003
Total RMS ==> 2.122e-002

Run12
RMS x    ==> 1.324e-002
RMS y    ==> 1.523e-002
RMS z    ==> 1.334e-002
Total RMS ==> 2.419e-002

The complete files can be supplied if required, the above is to be read as follows:

| x-1.324e-002 | = | **0.01324m** |
|---|---|---|
| y-1.523e-002 | = | **0.01523m** |
| z-1.334e-002 | = | **0.01334m** |
| Total RMS ==> 2.419e-002= | | **0.02419m** |

The mapping was then created in NGATE which is also a BAE Systems product. This is an automatic terrain measuring system which is a mass point production over the terrain. From this data we then manually removed trees, buildings and any other structures that were not on the ground. We added breaklines along the road edges, tracks, change of slope and river banks so that the contours accurately represented the ground. The photogrammetrist viewed the ground in 3D at all times and none of the process is interpreted.

The Ortho corrected images are produced from the DTM that is generated from the contour mapping.

A test was carried out by Precision Aerial Surveys before the project was undertaken to ascertain the achievable accuracy.

Each position was measured by a photogrammetrist and an xyz co-ordinate was recorded. We then found and measured the locations with our RTK Trimble GPS, the results are as follows:

| | Photogrammetry Heights | | | GPS Heights | | | Uncorrected Height | Corrected Height | Diff |
|---|---|---|---|---|---|---|---|---|---|
| 1 | 388902.461 | 824446.867 | 55.438 | 260-1 | 388902.529 | 824447.086 | 55.529 | 55.399 | 0.039 |
| 2 | 388864.486 | 824150.43 | 53.562 | 261-1 | 388864.495 | 824150.437 | 53.486 | 53.356 | 0.206 |
| 3 | 388881.058 | 823959.814 | 50.228 | 262-1 | 388881.029 | 823959.77 | 50.186 | 50.056 | 0.172 |
| 4 | 388866.381 | 823829.223 | 49.311 | 263-1 | 388866.503 | 823829.165 | 49.436 | 49.306 | 0.005 |
| 5 | 388773.609 | 823667.859 | 50.561 | 264-1 | 388773.795 | 823667.701 | 50.646 | 50.516 | 0.045 |
| 6 | 388781.678 | 823649.354 | 50.353 | 265-1 | 388781.723 | 823649.225 | 50.337 | 50.207 | 0.146 |
| 7 | 388665.664 | 823307.227 | 49.561 | 266-1 | 388665.766 | 823307.085 | 49.804 | 49.674 | 0.113 |
| 8 | 388563.115 | 823736.056 | 51.478 | 267-1 | 388563.187 | 823735.933 | 51.356 | 51.226 | 0.252 |
| 9 | 388163.359 | 823537.159 | 57.23 | 268-1 | 388163.379 | 823537.085 | 57.399 | 57.269 | 0.039 |
| 10 | 387996.261 | 823573.6 | 63.12 | 269-1 | 387996.09 | 823573.595 | 63.164 | 63.034 | 0.086 |

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| 11 | 387666.678 | 823665.916 | 83.157 | 270-1 | 387666.804 | 823665.78 | 83.189 | 83.059 | 0.098 |
| 12 | 387535.718 | 823558.397 | 96.721 | 271-1 | 387535.376 | 823558.592 | 96.847 | 96.717 | 0.004 |
| 13 | 387424.261 | 824807.509 | 69.428 | 272-1 | 387424.293 | 824807.046 | 69.669 | 69.539 | 0.111 |

The House site elevations were measured in the same way as our test was carried out.

Should you require any further information please do not hesitate to contact me at any time.

Kind Regards

Malcolm Johnson
Director
Precision Aerial Surveys Limited