Chapter 3. Ground Survey and Aerial Photography

3.1. Ground Control Point Survey

3.1.1. Installation of aerial signals

(1) Preliminary work in the office

Landmarks set up at the existing control points are indicated with red circles in Figure 3.1.1. Some points were altered from the initially-proposed control points due to the accessibility or snow coverage. In doing so, consideration was given that the new ground control points, shifted control points, remain in the vicinity of the edges of the Study Area.



Figure 3.1.1 Landmarks selected at the existing control points

(2) Selection of landmarks

The landmarks were strictly selected at such sites where they were easy to recognize on the aerial photograph. In the field all points were chosen on suitable grounds, open space where there was no obstacle to aerial photograph shooting. Although 35 points were planned in the preliminary selection in the office, 33 points were set up for aerial signals eventually because of snow coverage over the proposed area. The coordinates of the peripheral ground objects from each signal were observed with the use of a total station, a transit compass with measuring tape and/or a handy-type GPS in order to draft the "Point Description" (refer to Figure 3.1.5).

A white-painted aerial signal, which consisted of three rectangles $(3m \times 1m)$ made of stone, wood or other suitable materials and placed in different directions centering the control point, was set up before the aerial photography commencement.



Figure 3.1.2 Specifications and installation of aerial signals (landmarks)

3.1.2. Geodetic control network survey

A geodetic control network survey using GPS was conducted on the entire landmark centers that had been installed previously.

(1) urvey datum

The following datum employed in the Study;

a. Coordinate system:	UTM
	Zone 37 and/or Zone 38
b. Horizontal datum:	WGS 84
c. Vertical datum:	The Baltic mean sea level in the system of 1977
d. Measurement unit	Metric system

(2) GPS observation

GPS observation via long distances within a short time was considered difficult in the light of the vast coverage of areas to be studied, the pavement conditions of access roads, and the complicated topographic conditions. It was impossible to complete observation over the entire planned area by an ideally-planned observation network

within the scheduled study period, and hence it was decided to implement the work by dividing the area into blocks and organizing observation networks with ideal observation methods for respective blocks.

Fortunately, a large number of triangulation points being already present and well-maintained in the country enabled a local GPS observation network combining these control points as reference points given and newly-installed aerial signals as GCPs. By organizing an observation network per block, the accuracy of survey of newly-installed GCPs for topographic map generation was maintained. In other words, the GPS observation over several GCPs was carried out by organizing an independent observation network per session in place of setting up a comprehensive observation network over the entire Study Area. (Refer to Figure 3.1.3)

• Coordinates computation

The loop closing error was designed as not to exceed plus or minus $10mm + 2ppm \times D$ (distance of baseline) in any closed polygonal route on the network after the baseline processing.

The computation results were finalized in the geographical and UTM coordinates (Table 3.1.1). In consideration of the geoid height difference, the elevation based on the M.S.L datum was carefully adjusted as to the new control points through the process of the baseline analysis and the polygonal network adjustment.

• Observation

The following observation method and coordinates computation were applied to the geodetic network with the use of such GPS networks.

- Survey method:	Simultaneous data receiving with three
	observation points or more (static
	observation)
- Type of GPS receiver:	Dual or single frequency type for
	geodetic survey
- Number of GPS receiver:	Not less than 3
- Observation time:	Not less than 2 hours
- Number of satellites received at one time:	More than 5
- Number of existing control points to be	Not less than 2
connected:	



Figure 3.1.3 GPS observ



Figure 3.1.4A sample loop closing error in coordinate computation

0.00

50in

Chapter	r 3
Ground Survey and Aerial Photograp	hy

	Final Coc	ordinates in UTM(V	VGS84)	
Point No.	Ν	E	Ortho Height	Zone
No_1	4,719,397.135	745,782.274	241.371	37
No_2	4,718,936.574	280,292.125	350.405	38
No_3	4,719,304.655	322,614.465	507.000	38
No_4	4,717,012.219	359,786.138	735.275	38
No_5	4,697,595.171	719,543.892	7.930	37
No_7	4,696,279.338	288,069.980	158.089	38
No_8	4,694,785.058	336,438.984	1,195.695	38
No_11	4,677,644.260	267,847.284	21.337	38
No_12	4,677,573.999	316,913.865	161.826	38
No_13	4,673,749.694	361,438.195	718.365	38
No_14	4,671,242.116	420,152.911	846.650	38
No_15	4,672,064.097	473,009.748	896.741	38
No_16	4,670,413.841	525,989.933	682.529	38
No_17	4,652,817.759	730,284.114	7.764	37
No_18	4,656,502.713	290,296.749	151.794	38
No_19	4,649,528.308	419,442.963	598.456	38
No_20	4,650,212.794	479,996.071	588.359	38
No_25	4,644,309.731	360,661.028	520.576	38
No_26	4,627,549.705	381,024.954	1,164.660	38
No_27	4,632,729.490	416,959.495	1,289.500	38
No_28	4,630,584.535	478,672.967	475.540	38
No_29	4,625,536.329	528,249.398	1,590.611	38
No_30	4,627,665.743	563,227.351	373.819	38
No_31	4,637,554.894	582,514.152	367.575	38
No_32	4,607,027.393	720,009.105	19.250	37
No_35	4,613,567.925	334,178.287	1,032.116	38
No_37	4,603,830.079	408,847.055	1,555.923	38
No_38	4,604,765.769	460,669.010	801.573	38
No_40	4,607,959.592	534,846.531	542.733	38
No_41	4,605,532.462	583,328.999	280.569	38
No_42	4,585,584.362	360,172.494	1,243.805	38
No_44	4,583,334.242	450,520.317	737.106	38
No_45	4,583,552.539	499,029.760	312.862	38
1620351	4,608,193.450	279,132.180	1,384.200	38
1165451	4,585,622.930	402,572.920	2,103.230	38

Chapter 3 Ground Survey and Aerial Photography

Table 3.1.2Verification of GPS observation accuracy

Verification of GPS observation accuracy (Loop Closure Check)

Loop No.	Observation Point in Loop	Total Length in Loop (m)	Misclos Vector Length	sure (m) Closure Limit	Diff.	acceptance criteria
1	$No_1 \rightarrow PP5020A \rightarrow No_5 \rightarrow PP5021 \rightarrow No_1$	69,825.582	0.179	0.369	-0.190	0
2	$No_2 \rightarrow PP5051 \rightarrow No_7 \rightarrow PP5081 \rightarrow No_2$	49,271.458	0.118	0.266	-0.148	0
31	$No_3 \rightarrow PP1986 \rightarrow No_8 \rightarrow G_KHOTEV \rightarrow No_3$	77,529.736	0.120	0.408	-0.288	0
32	$No_4 \rightarrow G_KHOTEVI \rightarrow KHUR \rightarrow No_4$	50,086.988	0.059	0.270	-0.211	0
4	$PP1632 \rightarrow No_{11} \rightarrow PP1680 \rightarrow PP1632$	37,078.421	0.019	0.205	-0.187	0
5	$PP1150 \rightarrow No_18 \rightarrow PP1191 \rightarrow No_12 \rightarrow PP1150$	73,956.994	0.020	0.390	-0.370	0
7	$No_14 \rightarrow PP1317 \rightarrow No_19 \rightarrow PP1319 \rightarrow No_14$	46,205.475	0.033	0.251	-0.218	0
8	DJVARI → 1779 → No_28 → DJVARI	4,217.351	0.038	0.041	-0.004	0
9	$No_15 \rightarrow 3370 \rightarrow No_20 \rightarrow 3397 \rightarrow No_15$	57,435.997	0.069	0.307	-0.238	0
10	$No_16 \rightarrow PP4018 \rightarrow PP4038 \rightarrow No_16$	25,782.400	0.071	0.149	-0.078	0
11	$No_17 \rightarrow PP1792 \rightarrow No_32 \rightarrow PP1742 \rightarrow No_17$	102,730.847	0.143	0.534	-0.391	0
12	$No_25 \rightarrow 1886 \rightarrow No_26 \rightarrow PP368 \rightarrow No_25$	61,739.684	0.057	0.329	-0.272	0
13A	$No_2 29 \rightarrow PP1330 \rightarrow PP1340 \rightarrow No_2 9$	25,704.032	0.086	0.149	-0.063	0
13B	$No_29 \rightarrow No_40 \rightarrow PP1340 \rightarrow No_29$	39,800.573	0.012	0.219	-0.208	0
14A	PP1016 \rightarrow gr_rep-0918 \rightarrow No_31 \rightarrow PP1016	32,075.078	0.028	0.180	-0.152	0
14B	$PP1016 \rightarrow No_30 \rightarrow PP1093 \rightarrow No_41 \rightarrow PP1016$	77,370.571	0.036	0.407	-0.371	0
15	$No_35 \rightarrow PP3140 \rightarrow No_42 \rightarrow PP3056 \rightarrow No_35$	80,586.013	0.022	0.423	-0.401	0
16	$No_37 \rightarrow 3342 \rightarrow No_44 \rightarrow 4010 \rightarrow No_37$	106,518.829	0.023	0.553	-0.530	0
17	No_38 KOSALARI \rightarrow No_45 \rightarrow 1396 \rightarrow No_38	89,613.363	0.029	0.468	-0.439	0

O: All accuracy of the GPS observations were less values from the limitation (2cm+5ppm) of Loop Closur Error, and these filled accuracy enough.

• Preparation of point description

A description of each point shown in Figure 3.1.5 was prepared after completion of the observation.



Figure 3.1.5 An example of "point description"



Figure 3.1.6 GPS observation at one of landmark

3.1.3. Leveling

The presence of benchmarks on the existing leveling routes of approximately 920 km within the Study Area was investigated. 63 points of benchmarks confirmed then in the survey were pricked with an eccentric replacement at the apparent position on the aerial photo which was used for height correction in the aerial triangulation. Since most of the existing leveling routes in Georgia are placed along the railroads or were installed during the former Soviet era, they are largely damaged. In particular, those control points alongside the roads are mostly installed under the ground or metal signs riveted on rocks roadsides. The positions of these are not accurately mentioned in the point descriptions, and hence it is hard to find them. Quite a few of these were found already destroyed apparently due to road expansion works, etc.

Verification of the heights of leveling by GPS was not carried out in the Study because they can be corrected by referring to the height values of neighboring benchmarks. (Refer to Figure 3.1.8 and Table 3.1.3)



Figure 3.1.7 Leveling along the existing route

3.1.4. Collection of existing control point coordinate data

The coordinates of existing control points covering the entire area under the Study were collected. The finalized coordinates were compiled into digital files by the Study Team during the first-phase field survey from the existing data book created by the former DGC. The coordinate list contained 1,447 points in total consisting of triangulation points and control points of 1^{st} to 4^{th} orders. These points without exception had altitude values and could be used, as well as the results obtained in the leveling, in height correction in the aerial triangulation. They could also be used for checking the altitudes in the final products.

Sheet No. Location No. No. BM from Catalog No. N E H X Y											_	_
Sheet No. N	1/100,000	Location	-		••		ID	U.T.M	U.T.M	Ortho	Gauss	Gauss
K.38-67 Natusturi 23294 66532 Wall S18.520 2020 4.640.913 477.427 S16.78 6.6428 75.102 75.475 K.38-66 Cixidziri 27383 803 Rock 861.861 2009 4.644.87 75.23 861.88 4.75.233 K.38-66 Cixidziri 2700 4.4 Wall 778.109 2007 4.54.87 75.22 4.65.119 8.75.87 K.38-75 Knishceti 2719 1000 Wall 281.47 2009 4.64.810 38.848 60.22 4.65.027 8.19.90 6.65.027 8.19.90 6.65.027 8.19.90 6.67.027 8.39.027 8.30.207 8.33.99.027 8.30.207 8.33.99.027 8.30.207 8.33.99.027 8.30.207 8.33.99.007 8.33.99.007 8.33.99.007 8.33.99.007 8.33.99.007 8.33.99.007 8.33.99.007 8.33.99.007 8.33.99.007 8.33.99.007 8.33.99.007 8.33.99.007 8.33.99.007 8.33.99.007 8.33.99.007 8.33.99.007 8.33.99.007 <t< td=""><td></td><td></td><td></td><td>No.</td><td></td><td>e</td><td></td><td></td><td></td><td></td><td></td><td></td></t<>				No.		e						
K:38-66 Anamori 27385 6653 673798 87372 818.08 673798 87329 K:38-66 Cixkini 27208 18324 Wall 7762288 2059 4,48170 376,496 75022 4,65117 8375,487 K:38-75 Cixkincti 27206 4 Wall 776,2288 2059 4,464,180 376,496 75022 4,651,178 8375,487 K:38-75 Cirpa 27201 1000 Wall 2381,787 2009 4,464,809 345,843 360,227 337,000 669,797 36,732 36,444,243 358,84 360,227 334,022 36,443 31,000 36,427 33,900 36,7378 36,7378 36,7378 36,7378 36,7378 36,73798 36,73798 36,73798	K-38-78	Mckheta		-								8,476,924
K-38-66 Cixiszbari 27383 801 Rock 801.801 2009 4.457.182 27329 801.85 4.673.279 Kiszbari Xiszbari		Nataxtari										
K-38-76 Likhi 27208 18324 Wall 778.228 2057 4.54.710 376.949 759.20 4.651.129 357.57 K-38-75 Cipa 27201 1000 Wall 771.02 2671.128 375.518 K-38-75 Marchisi 27192 1449 Wall 2831.687 2009 4.643.800 388.841 360.22 83.017 83.1087 K-38-75 Moliti 27195 Nord Wall 501.357 2119 4.640.755 30.482 213.430 23.442.13 23.404.01 K-38-63 Lakabe 27181 1001 Wall 201.586 2129 4.663.213 37.090 102.24 4.643.935 34.900 24.64.738 31.900 102.24 4.64.333 33.930 112.24 4.64.333 33.930 112.24 4.64.333 34.930 4.77.74 37.966 12.64 4.64.393 3.43.1037 4.53.198 4.64.530 33.790 158.67 4.66.331 37.996 12.24 4.61.794 <td< td=""><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td></td<>												
K.38-57 Kvishveti 27206 4.4 Wall 778.109 200p 4.649,102 8.375.10 8.375.1 Moniti 27186 1.973.10 Wall 283.476 208p 4.632,858 51.757 281.09 4.632,668 8.370.10 K.38-55 Moniti 27190 1.449 Wall 50.1323 210p 4.643,80 584.84 300.22 4.650,027 8.364,507 K.38-55 Moliti 27190 1.5406 Wall 50.1323 210p 4.643,80 584.84 300.22 4.650,227 8.364,904 K.38-63 Larshe 27174 1.8516 Wall 120.86 215p 4.660,303 370.90 158.67 4.663,303 370.90 158.67 4.663,303 370.90 18.312.94 4.831,694 8.331.944 K.38-60 Arginizi 28107 31.0 Wall 159.277 14.769,771 14.769,771 14.769,771 14.769,771 14.769,771 14.769,771 14.769,771 14.769,771 14.759,781 483.80 </td <td></td> <td></td> <td></td> <td></td> <td></td> <td></td> <td>-</td> <td></td> <td></td> <td></td> <td></td> <td></td>							-					
K-38-53 Cipa 27201 1006 Wall C31.02 207p 46.04,00 605.79 81.27 82.26,00 8.53.75 K-38-55 Marclisi 27192 14.49 Wall 381.687 200p 4.648,400 358,884 360.22 8.53.75 Moliti 27195 Note 8.33.642 K-38-57 Moliti 27195 Note Wall 504.357 344.89 364.621 8.45.93 32.64.41 4.65.528 8.33.42 8.33.64.23 K-38-63 Carrula 27171 15594 Wall 70.968 215p 4.66.338 41.001 8.34.037 K-38-63 Caratomi 27171 15594 Wall 100.342 215p 4.66.338 41.00.356 84 5.456.64 8.351.09 K.33.642 4.67.574 8.356.89 8.351.08 8.351.08 K.33.642 K.33.642 K.355.698 K.43.643 K.43.643 K.43.643 K.43.643 K.43.643 K.43.643 K.43.643 K.43.643 K.43.643 K.43.64									· · · ·			
K.38-63 Haragauli 27186 1973 Wall 281.476 208p 4652.58 81.757 Zenglia 2463.427 X38.22 K.38-75 Moliti 27105 Noff Wall 501.523 210p 4648.400 58.848 4650.927 8.364.940 K.38-75 Moliti 27105 Noff Wall 501.537 211p 4667.276 4468.928 4650.275 400.43 256.44 8.364.940 K.38-63 Sarapani 27171 15594 Wall 159.66 215p 4.663.231 379.05 18.67 4.667.574 8.337.941 K.38-62 Svin 27160 207.24 Wall 100.12 215p 4.663.231 379.05 18.64 4.858.690 8.435.668 8.435.668 8.435.668 8.435.668 8.435.668 8.435.668 8.435.668 8.435.668 8.435.668 8.435.668 8.445.676 8.435.668 8.445.768 8.435.668 8.445.768 8.435.668 8.445.768 8.435.668 8.445.766 8.455.												
K.38-75 Moliti 27192 1449 Wall 581.84 360.24 358.84 360.24 465.902 463.903 465.925 80.36 82.364.62 K-38-75 Moliti 27196 15406 Wall 504.516 2120 464.930 465.93 499.64 465.923 82.364.32 K-38-63 Zastudi 27171 15594 Wall 201.566 2130 4660.233 41.003 169.36 4663.90 8.31.941 K-38-64 Zastudin 27171 15594 Wall 130.12 216p 4660.703 32.079 102.64 467.97.8 8.31.941 K-38-62 Saturi 21716 167.94 Wall 21.65 72 45.97.71 17.06 102.54 466.97.84 8.31.941 K-38-00 Minickize 28400 32.79 17.4 489.77 37.79 17.96 460.153 4.84.96.08 8.48.95.08 K-38-00 Kinniis 28101 23 Wall 130.123 17.4												
K.38-75 Moliti 27195 No.# Wall 501.232 210p 4648,903 6469,75 501.8 4669,027 48,690,27 8,364,404 K.38-63 Lashe 27181 1001 Wall 216,616 212p 4665,275 496,483 256,44 4655,255 8,349,434 K.38-63 Carapani 27174 18561 Wall 10,866 214p 4662,343 341,000 169,364 8,331,041 K.38-63 Zestarini 27160 20724 Wall 100,112 216p 4663,301 370,900 112,564 485,866 486,876 K.38-60 Chrineul 28102 207 Bridge 341,658 12 4,587,741 8,317,941 486,780 356,88 4,858,608 4,848,976 K.38-90 Orionikdze 28101 23 Wall 41,727 73 4,597,274 483,483 501,59 4,661,754 8,483,935 K.38-90 Nemini 2000 morim-1100 Wall 431,127												
K.38-53 Lone Z111 21.01 24.69.07 36.49.93 205.71 4.66.1023 3.36.49.40 K.38-63 Lose Z1181 1001 Wall 201.566.16 21.29 4.665.573 4.98.82 205.44 4.65.524 3.47.845 K.38-63 Cargami Z7171 15504 Wall 170.986 21.49 4.662.433 317.095 156.74 4.63.630 83.43.09 83.47.845 K.38-62 Admerey Z1166 207.24 Wall 130.312 2169 4.664.791 317.905 156.74 4.65.808 4.8									,			
K-38-63 Lashe 27181 1001 Wall 2326.616 212p 4.65.75 349.482 35.44 4.65.825 8.349.523 K-38-63 Scrapani 271.74 18361 Wall 170.986 214p 4.662.431 341.000 605.217 8.347.845 K-38-62 Swiri 27166 1734 Wall 159.91 215p 4.663.631 37.095 158.67 4.667.748 8.31.097 K-38-62 Adjamety 27166 1734 Wall 100.194 4.777 777 37.066 102.58 4.451.65 8.458.03 56.88 4.851.05 8.458.04 4.707 4.859.89 8.83.93 57.85 8.38.90 8.38.90 8.85.905 8.85.905 8.85.905 8.85.905 8.85.905 8.85.905 8.85.905 8.85.905 8.85.905 8.83.902 8.83.902 8.83.902 8.83.902 8.83.902 8.83.902 8.83.902 8.83.902 8.83.902 8.83.902 8.83.902 8.83.902 8.83.902 8.83.902 8.83.902 </td <td></td> <td>, ,</td>												, ,
K-38-63 dzinula 27181 no/# Wall 201586 213p 4,602,283 347,805 307,253 4,662,473 8,47,845 K-38-63 Zestafoni 27171 15594 Wall 170,986 121p 4,663,631 337,901 158,67 4,665,584 8,337,941 K-38-62 Adjamety 27160 2074 Wall 130,912 216p 4,663,631 337,905 158,67 4,665,584 8,326,825 K-38-60 Opinicidize 28400 320 310 Wall 30,912 71 4,579,74 48,780 356,89 8,488,676 K-38-00 Opinicidize 28401 33 Wall 41,7273 73 4,592,77 43,840 41,723 4,583,78 43,840 44,83,80 45,846,876 K-38-00 Fonicidize 28400 2805 756 Bridge 33,422 74 4,591,092 508,590 50,115 4,849,424 K-38-0 Gardabani 28065/66 322,2032 Wal												
K-38-63 Sorapani 27174 [18361 Wall 170.986 2149 466.243 314.000 66.300 8.344.037 K-38-63 Zestafoni 27116 1734 Wall 130.312 2169 4.669.709 326.794 [29.24] 4.671.754 8.326.825 K-38-62 Adiamety 28107 310 Wall 130.312 2179 4.653.777 317.966 162.54 4.851.925 K-38-00 Orjonikidze 28402 327 Bridge 141.658 T2 4.593.76 485.840 147.07 4.598.24 4.662.83 484.04 14.859.25 4.663.84 845.925 K-38-00 Kumisi 28009 not/t-1910 Wall 502.627 T4 4.599.27 483.450 54.01.666 848.525 K-38-00 Kumisi 28005 not/t-1910 Wall 302.34 T7 4.591.27 4.602.348 43.404 4.885.29 55.19 4.01.568 4.501.66 4.501.474 4.591.294.11 8.456.74 51.												
K-38-63 Zestafoni 21171 15594 Wall 159.931 215p 46.63.611 37.905 188.67 46.65.84 8.337.621 K-38-62 Adjamety 27160 20724 Wall 100.192 217p 46.73.777 317.966 102.50 46.677.34 8.337.994 K-38-00 Opinkidz 284001 33 Wall 417.273 73 4.592.878 485.840 342.93 85.868 8.485.803 85.868 8.485.803 85.868 8.485.820 85.868 8.485.820 85.868 8.485.820 8.58.890 8.485.820 8.738.90 Komisia 28109 8.473.82 8.738.90 8.738.90 8.738.90 8.738.90 8.738.90 8.83.83 8.490.273 8.458.472 18.187 24.04 4.588.394 8.51.98 K-38.90 Radiani 28063 22.25 Wall 301.227 7.20.96 110 4.610.212 493.121 4.63.474 4.588.394 8.51.98 4.53.960 4.643.901 4.643.901 4.643.917							-		,			
K-38-62 Sviri 27166 1774 Wall 130.212 216p 4669.799 326.794 129.24 4671.754 8,317.994 K-38-62 Addiamety 2160 20724 Wall 159.939 T1 4,579.741 485.703 356.88 4581.660 8485.875 K-38-00 Marneuli 28401 32 Wall 502.627 T4 4,599.277 483.345 407.14 8,483.935 K-38-00 Kumisi 28009 normichal 28099 normichal 8,485.935 487.355 492.09 4,604.134 8,485.935 K-38-90 Fonichala 28095 756 Bridge 384.291 T6 4,611.734 491.192 585.05 461.366 8,491.271 K-38-90 Fonichala 28053 140 Wall 283.013 T8 4,586.472 511.878 284.00 4,588.394 8,510.944 K-38-90 Caciablani 2205.68 132.0205.66 1392.0205.62 14.41 4,51.744 4,500.54 <td></td> <td></td> <td></td> <td></td> <td></td> <td></td> <td></td> <td></td> <td>,</td> <td></td> <td></td> <td></td>									,			
K-38-62 Adjamety 21100 20724 Wall 102.194 217p 64.073.777 317.960 102.50 4.675.774 8,316.90 K-38-90 Orjenikidze 28402 32.7 Bridge 341.058 T2 4.583.768 485.840 342.95 4,585.668 8,485.698 8,485.929 K-38-90 Munisi 28401 3 Wall 417.273 73 4.592.878 483.345 501.59 4,601.154 8,485.529 K-38-90 Kumisi 28009 roff-101 Wall 493.123 17 4,591.022 505.59 301.05 4,593.016 8,508.695 K-38-90 Gardabani 28055 899 Wall 301.234 17 4,591.092 505.590 301.05 4,593.016 8,508.695 K-38-90 Raishoid 28065 Vall Vall 233.227 91.609.21 405.120 464.116 469.123 4,41.14 4,573.77 Kaspi 22.22 4,61.214 8,45.674 8,45.674 8,45.674 <td></td>												
K-38-102 Shulaverin 28107 310 Wall 359.539 Ti 4579.741 486.780 356.88 4581.600 8458.670 8485.693 K-38-90 Marneuli 28401 3 Wall 417.273 T3 4,592.878 483.840 417.07 4,593.68 845.869 8485.903 845.869 8485.903 8455.688 4585.669 8,485.903 845.903 845.869 845.869 845.869 845.869 845.869 845.903 845.903 845.903 845.903 845.903 845.903 845.903 845.903 845.903 845.903 845.903 845.935 845.913 845.923 845.933 845.935 845.933 845.935 845.933 845.935 845.933 845.935 845.933 845.943 845.913 845.943 845.914 845.915 845.944 843.933 845.945 845.943 845.943 845.943 845.943 845.943 845.943 845.943 845.943 845.943 845.943 845.945.944 845.944 845.943												
K:38-90Orjonikidze 28402 327 $Bridge$ $341, 12, 73$ 172 $4, 583, 768$ $485, 840$ $472, 93$ $4, 585, 689$ $6, 488, 933$ $K:38-90$ Kumisi 28101 23 Wall $417, 273$ 173 $4, 592, 878$ $483, 840$ $417, 073$ $4, 592, 878$ $483, 840$ $170, 4, 594, 820$ $4, 604, 138$ $8, 843, 529$ $K:38-90$ Kumisi 28009 $n, of -1910$ Wall $493, 154$ 175 $4, 602, 388$ $487, 355$ $492, 097$ $4, 604, 138$ $8, 847, 529$ $K:38-90$ Gardabani 28065 899 Wall $301, 234$ 176 $4, 591, 092$ $595, 390, 106$ $8, 590, 895$ $K:38-90$ Gashiani 28063 2255 Wall $332, 027, 372, 961$ 110 $4, 610, 212$ $493, 143$ $122, 464, 143$ $24, 243$ $8, 499, 243$ $K:38-70$ Cargeri 27422 740 Wall $520, 018$ 122 $4, 614, 214$ $8, 492, 443$ $8, 492, 443$ $K:38-77$ Kaspi 27422 740 Wall $520, 011$ 123 $4, 644, 143$ $32, 075, 254$ $643, 300$ $K:38-77$ Graciali 27426 20531 Wall $550, 011$ 123 $4, 644, 145$ $440, 007$ $561, 25$ $4, 647, 760$ $8, 435, 947$ $K:38-77$ Graciali 27426 20531 Wall $550, 011$ 123 $4, 644, 145$ $410, 007$ $561, 25$ $4, 647, 760$ $8, 435, 947$ $K:38-76$ Hashuri 2												
K:38-90Marneuli284013Wall417.273T34,592,87483,405417.074,594,8028,483,525 $K:38-90$ Kumisi2810123Wall502,627T44,599,227483,435501.594,601,1548,483,529 $K:38-90$ Fonichala28095756Bridge384,291T64,611,734491,15458,50958,9096,809,125 $K:38-91$ Gardabani28055899Wall201,234T44,509,207508,509511,57554,631,6668,490,257 $K:38-90$ Gardabani28053140Wall283,013T84,586,472511,875284,404,588,3948,511,984 $K:38-90$ Vei2806561392,20362Wall73,027,172,961104,610,21493,1714,671,8448,499,813 $K:38-77$ Kaspi274,22740Wall259,108T214,641,161451,759528,664,634,0088,456,714 $K:38-77$ Kaspi274,22740Wall500,011T234,644,161440,067590,254,646,1108,450,744 $K:38-77$ Kaspi274,22YdoWall500,011T234,644,1433,017561,254,646,1088,456,744 $K:38-77$ Kaspi274,2420531Wall500,011T234,644,1433,017561,254,646,1088,457,444 $K:38-77$ Garcia274,4420621Wall705,888T2												
K-38-90Kumisi 28101 23 Wall $502c77$ 74 $4,599.27$ 48.355 501.59 $4,601,154$ $8,487,55$ $K-38-90$ Kumisi 28099 no/#-1910Wall 493.154 T5 $4,602,385$ 492.09 $4,604,313$ $8,487,451$ $K-38-91$ Gardabani 28055 899 Wall 301.234 17 $4,591,092$ $508,500$ 301.05 $4,693,016$ $8,508,695$ $K-38-91$ Gardabani 28055 899 Wall 323.013 17 $4,591,092$ $508,500$ 31.108 $8,508,466$ $K-38-90$ Gashiani 28065.66 $1392/20362$ Wall $73.027.732.967$ 110 $4,612,21$ $495,143$ 372.22 $4,612,418$ $4,634,818$ $8,469,181$ $K-38-77$ Kaspi 27422 740 Wall 520.108 724 $4,641,116$ $41,065$ 54.025 $4,643,408$ $8,456,714$ $K-38-77$ Garakiani 27442 20534 Wall 500.11 723 $4,644,165$ 440.675 54.602 $64.61,108$ $8,450,714$ $K-38-77$ Garakiani 27443 20621 Wall 550.516 724 $4,648,918$ 400.126 $64.61,018$ $8,450,714$ $K-38-64$ Kareli 27448 20426 Wall 560.2306 729 $4,644,713$ 401.654 $4.654,713$ 40.657 $4.645,197$ $8,418,810$ $K-38-64$ Kareli 27448 899 Wall 622.251 $74.649,909$ <td></td> <td></td> <td></td> <td></td> <td><u> </u></td> <td></td> <td></td> <td></td> <td></td> <td></td> <td></td> <td></td>					<u> </u>							
											, ,	
K-38-90 Fonichala 28095 899 Wall 301.234 T7 4,511,734 91159 385.05 4,613,666 8,911,257 K-38-91 Ruisbolo 28053 140 Wall 283.013 T8 4,586,472 511,878 284.40 4,888,94 8,511,944 K-38-90 Gashiani 28063 225 Wall 3302,221 T9 4,605,914 9,412 343.17 4,607,844 8,499,243 K-38-70 Ozasini 27412 20584 Wall 487,027,707 10 4,612,116 44,415,14 4,451,44 4,463,282 486.29 4,644,488 8,451,841 K-38-77 Carkishevi 27418 1753 Wall 500,011 723 4,644,164 440,007 540,228 4,645,184 K-38-77 Grad 27434 200621 Wall 500,011 723 4,644,164 440,007 549,257 4,644,079 8,429,446 K-38-77 Skra 27434 200421 Wall 633,516 127 4,647,368 4,641,078 4,641,078 4,641,078 4,641,078 </td <td></td>												
K.38-91Gardabani28055899Wall301.234T74.591,002508,509501.054.593,0168.508,695K.38-90Ruisbolo28053140Wall283,013T84.586,472511.878284.404.588,3948.511,984K.38-90Veli28063225Wall343,222T94.660,5914499,142331.714.607,8448.499,243K.38-70Dergeyi27422740Wall529,108T214.661,116451,759528.664.643,0608.451,841K.38-77Karsipi27422740Wall529,108T214.641,116451,759528.664.640,2088.456,774K.38-77Grakali2742620531Wall550,011T234.644,1165440,067540.224.641,0164.640,2088.456,774K.38-76Hashuri2744220621Wall550,011T234.644,165440,067540.224.644,7088.33,001K.38-76Hashuri2743420621Wall603,516T274.649,804430,173261,1084.649,4788.33,90,907K.38-76Hashuri2744815741Wall632,201T294.654,1700.31,216661,216,662,3087304.652,799304,418601,564.651,9378.418,410K.38-64Gomi27451,52572,067Wall661,216,662,3087304.652,799394,448607,488.934,472K.38-60									· ·			
K-38-90 Ruisbolo 28053 140 Wall 283.013 T8 4,586,79 211,878 284.40 4,588,394 8,511,984 K-38-90 Okashiani 28063/66 132/20362 Wall 343.222 T9 4,605,914 499,142 343.17 4,607,844 8,499,243 K-38-78 Dzegyi 27412 20584 Wall 487,857 T20 4,632,540 468,829 463,480 8,451,841 K-38-77 Kaspi 27412 20584 Wall 500,011 T23 4,641,161 451,755 54,640,908 8,456,941 K-38-77 Garia 27425 27426 20531 Wall 500,011 T23 4,644,161 433,017 561.25 4,644,108 8,413,041 K-38-77 Gori 27434 20621 Wall 603,516 T27 4,644,914 438,07 4,644,907 8,432,09 K-38-64 Kareli 27443 889 Wall 623,201 T28 64,61,914 8,402,44 8,394,707 K-38-64 Kareli 27448 1571 Wall </td <td></td> <td></td> <td></td> <td></td> <td></td> <td></td> <td></td> <td></td> <td>· · · ·</td> <td></td> <td></td> <td></td>									· · · ·			
K-38-90 Gashiani 28063 225 Wall 543.222 T9 4,605,914 499.142 343.71 4,607,844 8,499,243 K-38-70 Dergyi 27412 2005/66 1392/20362 Wall 873.027/372.966 110 4,610,212 499,714 372.22 4,612,143 8,495,813 K-38-77 Kaspi 27422 740 Wall 529,108 721 4,641,116 451,759 528.66 4,643,060 8,458,71 K-38-77 Kavishevi 27412 20051 Wall 500,011 723 4,644,165 440,075 54,640,928 8,456,77 K-38-76 Hashuri 27455 512 Wall 500,516 727 4,645,101 8,440,144 K-38-76 Hashuri 27443 20426 Wall 603,516 727 4,647,909 418,743 601.56 460,197 8,418,811 K-38-64 Kareli 27448 1571 Wall 632,203 729 464,90,403 84,64,747 8,30,707 K-38-66 Gomi 2745,5 512 Wall 6											· · ·	
K-38-90 Veli 28065/66 1392/20362 Wall \$73.027/372.96 T10 4.610.212 495.714 372.22 4.612.143 8.498.813 K-38-78 Dzegvi 27412 20584 Wall 487.857 T20 4.632.540 465.264 4668.829 4664.3060 8.451.841 K-38-77 Kaspi 27412 7040 Wall 508.016 T22 4.638.985 456.690 507.55 4.640.306 8.451.841 K-38-77 Garal 27425 512 Wall 705.888 724 4.645.814 430.01 512.55 4.647.706 8.433.091 K-38-77 Gori 27434 20621 Wall 586.038 T22 4.645.181 430.105 62.218 4.649.079 8.426.265 K-38-74 Kareli 27443 889 Wall 62.217 78 4.652.098 409.128 62.118 64.654.464 8.409.246 K-38-64 Kareli 27443 859 Wall 62.217 78												
K-38-78Dzegvi2741220584Wall487.857T204.632,540468.29466.294.634,4808.468,918K-38-77Kavitshevi27422740Wall529.108T214.641,161451.79528.664.643,0008.451.841K-38-77Kavitshevi2742620531Wall550.011T234.644,164440.067549.254.640,7088.456.774K-38-76Hashuri27455512Wall705.888T244.645,814430.01561.054.647,7008.433.091K-38-76Gori27434204261Wall603.516T274.649,990418.73601.564.651,978.418.611K-38-64Kareli27443889Wall602.521T284.652,799994.648600.484.654,1148.409.246K-38-64Kareli2744815741Wall603.201T294.651,107403.23163.668.465,1148.94.02.26K-38-64Gomi2745/5512Wall705.88T324.652,0984.4728.30.744K-38-64Gomi2745/5512Wall705.88T324.652,0584.418704.784.652,038.384,472K-38-60Gumati269941763Wall705.88T324.650,2688.30.61352.964.690,2988.30.664K-38-50Tvishi269911271Rock317.74T414.685,7688.30.61352.96 <td></td>												
K-38-77Kaspi 27422 740Wall529.108T21 $4,641,116$ $451,759$ 528.66 $4,643,060$ $8,451,841$ K-38-77Grakali 27426 20531 Wall $508,466$ T22 $4,638,984$ $456,000$ 507.55 $4,640,108$ K-38-77Gori 27426 20531 Wall $500,011$ T23 $4,641,165$ $440,007$ $54,252$ $4,641,108$ K-38-77Gori 27434 20621 Wall $586,038$ T25 $4,647,104$ $588,07$ $4,640,079$ $8,426,256$ K-38-77Skra 27434 20621 Wall $602,516$ T27 $4,649,090$ $418,733$ $601,56$ $6,651,937$ $8,438,091$ K-38-64Kareli 27434 889 Wall $622,521$ T28 $4,652,098$ $409,182$ 622.18 $4,654,478$ $8,490,246$ K-38-64Kareli 27443 889Wall $662,208$ T30 $4,652,098$ $4,654,747$ $8,394,707$ K-38-76Hashuri 27455 512 Wall $705,888$ T32 $4,650,665$ $384,418$ $704,78$ $4,652,603$ $8,308,685$ K-38-76Hashuri 27455 512 Wall $702,683$ $1469,680,488$ $702,648$ $600,488$ $60,928$ $8,309,776$ $8,310,744$ K-38-50Goumati 26993 13Rock $311,774$ T44 $4,658,266$ $335,444$ $4,711,576$ $8,319,016$ K-38-50Chrebalo 26979 1055 <td></td>												
K-38-77Kavtishevi274181753Wall508.466T224,638,985456,690507.554,640,2888,456,774K-38-77Grakali2742620531Wall550.011T234,641,165440,067549.254,646,1108,440,144K-38-76Hashuri2743420621Wall705.888T244,645,113426,194538.974,649,0798,432,6265K-38-77Skra2743320426Wall603.516T274,649,990418,743601.564,651,9378,418,811K-38-64Kareli27443889Wall622.521T284,652,698409,182622.184,654,7478,94,0246K-38-64Kareli2744815741Wall612.16/662.308T304,652,799394,648660.484,654,7478,94,707K-38-76Hashuri27455512Wall705.888T324,650,55584,418704.784,652,6038,344,72K-38-50Gumati2699313Rock351.774T414,687,814310,71222,44,689,7768,310,744K-38-50Joneti269911271Rock31.774T414,687,814310,4144,1758,310,192K-38-50Sinti269791055Rock347.76T444,710,91318,988347.294,712,9638,310,92K-38-50Samtredia2704115846Wall24,905T464,674,348 <td></td> <td>~~~</td> <td></td> <td></td> <td></td> <td></td> <td></td> <td></td> <td>· · ·</td> <td></td> <td></td> <td></td>		~~~							· · ·			
K-38-77Grakali2742620531Wall550.011T234.644,165440,067549.254.646,1108.440,144K-38-76Hashuri27435512Wall705.888T244.643,184433.017561.254.647,7088.433.091K-38-77Skra27434200621Wall603.516T274.649,990418,743601.564.651,9378.418,811K-38-64Kareli27443889Wall622.521T284.652,089409,182622.184.654,4668.409,246K-38-64Gomi27451/5257/2067Wall639.203T294.654,170409.231637.684.654,4778.394,707K-38-76Hashuri27455512Wall705.888T324.650,655384,418704.784.652,6038.384,472K-38-60Gumati269941763Wall202143T404.687,81410,719202.414.689,7668.310,744K-38-50Joneti269911271Rock21.861T424.655,58310,16821.124.607,3248.310,192K-38-50Tvishi269806542Wall342.177T434.709,551319,386341.144.711,5768.310,192K-38-50Tvishi269806542Wall24.905T464.674,348310,2748.302,748.330,192K-38-50Tvishi269751336Wall12.995T464.674,348									456,690			
K-38-76 Hashuri 27455 512 Wall 705.888 T24 4.645,814 433,017 561.25 4,647,700 8,433,091 K-38-77 Gori 27434 20621 Wall 586,038 T27 4,647,133 426,194 538,97 4,649,079 8,432,055 K-38-77 Skra 27439 20426 Wall 622,521 T28 4,652,698 409,182 622.18 4,654,646 8,409,246 K-38-64 Kareli 27443 889 Wall 632,201 T29 4,654,170 403,231 637.68 4,654,648 4,654,477 8,409,246 K-38-64 Kareli 27451 512 Wall 705.888 T32 4,654,170 403,231 637.68 4,654,701 4,652,603 8,384,472 K-38-62 Kutaisi 26994 1763 Wall 202143 T40 4,687,814 310,719 202.41 4,659,758 8,310,442 K-38-50 Joneti 26991 13 Rock 317.74 T41 4,688,965 308,661 321.12 4,677,328 8,310,1							T23	4,644,165	440,067	549.25	4,646,110	8,440,144
K.38-77 Gori 27434 20621 Wall 586.038 T25 4,647,133 426,194 538.97 4,649,079 8,426,265 K-38-64 Kareli 27443 889 Wall 602,521 T28 4,652,098 409,182 622.18 4,654,107 403,231 637.68 4,655,119 8,418,811 K-38-64 Kareli 27444 15741 Wall 630,203 T29 4,654,170 403,231 637.68 4,654,174 8,403,293 K-38-64 Gomi 27451/52 57/2067 Wall 61.216/662.308 T30 4,650,655 384,418 107.19 202.41 4,659,776 8,310,744 K-38-50 Gumati 26993 13 Rock 351.774 T41 4,688,965 308,661 352.96 4,690,928 8,308,685 K-38-50 Joneti 26991 1271 Rock 212.861 T42 4,695,588 310,168 211.12 4,697,608 8,310,944 K-38-50 Tvishi 26996 6542 Wall 342.177 T43 4,700,901 318,988 <							T24	4,645,814	433,017		4,647,760	8,433,091
K-38-77 Skra 27439 20426 Wall 603.516 T27 4,649,990 418,743 601.56 4,651,937 8,418,811 K-38-64 Kareli 27443 889 Wall 622.521 T28 4,652,698 409,182 622.18 4,654,104 8,409,246 K-38-64 Gomi 274451/52 57/2067 Wall 561.21/6/62.308 T30 4,652,799 394,648 60.48 4,654,107 8,394,707 K-38-62 Kutaisi 26994 1763 Wall 202143 T40 4,687,814 10/19 202.41 4,687,814 310,179 202.41 4,689,776 8,310,744 K-38-50 Gumati 26991 1271 Rock 212.861 T42 4,695,558 310,168 211.12 4,697,524 8,310,92 K-38-50 Tvishi 26990 6542 Wall 342.177 T44 4,710,905 313,84 475.88 4,712,963 8,319,916 K-38-50 Tvishi 26979 1055 Rock 347.176 T44 4,710,901 318,984 4,712,963							T25	4,647,133	426,194	538.97	4,649,079	8,426,265
K-38-64Kareli27443889Wall 622.521 T28 $4,652,698$ $409,182$ 622.18 $4,654,646$ $8,409,246$ K-38-64Kareli2744815741Wall 639.203 T29 $4,654,170$ $403,231$ 637.68 $4,654,174$ $8,304,707$ K-38-64Hashuri27451/5257/2067Wall $561.216/662.308$ T30 $4,652,699$ $394,648$ 660.48 $4,654,747$ $8,394,707$ K-38-62Kutaisi269941763Wall202143T40 $4,687,814$ $310,719$ 202.41 $4,689,776$ $8,310,744$ K-38-50Gumati2699313Rock 351.774 T41 $4,688,965$ $306,661$ 352.96 $4,690,928$ $8,308,665$ K-38-50Joneti269911271Rock 212.861 T42 $4,695,558$ $310,168$ 211.12 $4,697,524$ $8,310,192$ K-38-50Tvishi269791055Rock 347.76 T44 $4,710,991$ $318,988$ 347.29 $4,716,828$ $8,330,192$ K-38-50Chrebalo26975336Wall $24,905$ T46 $4,674,348$ $301,274$ 83.70 $4,676,305$ $8,301,295$ K-37-72Djumati27127no/#Nall17.541T47 $4,662,158$ $70,263$ $4,676,305$ $8,301,295$ K-37-72Poti27146 $63-49$ Wall24,905T48 $4,671,033$ $206,542$ $4,670,908$ $7,733,494$ K-37-72 </td <td></td> <td></td> <td>27439</td> <td></td> <td></td> <td></td> <td>T27</td> <td>4,649,990</td> <td>418,743</td> <td>601.56</td> <td>4,651,937</td> <td>8,418,811</td>			27439				T27	4,649,990	418,743	601.56	4,651,937	8,418,811
K-38-64 Gomi 27451/52 57/2067 Wall 661.216/662.308 T30 4,652,799 394,648 660.48 4,654,747 8,394,707 K-38-76 Hashuri 27455 512 Wall 705,888 T32 4,650,655 384,418 704.78 4,652,603 8,384,472 K-38-60 Gumati 26994 1763 Wall 202143 T40 4,688,965 363,661 352,796 4,690,928 8,308,485 K-38-50 Gumati 26991 1271 Rock 312,777 T43 4,709,605 319,386 341.14 4,711,576 8,319,016 K-38-50 Tvishi 26979 1055 Rock 347.76 T44 4,710,910 318,988 347.29 4,716,832 8,33,578 K-38-50 Sumtrodia 27041 15846 Wall 24,905 T46 4,671,333 200,548 23,61 8,310,295 K-38-51 Samtrodia 27041 15846 Wall 24,905 T48 4,671,033 200,548 22,61 4,662,303 7,730,30 K-37-72			27443				T28	4,652,698	409,182	622.18	4,654,646	8,409,246
K-38-76Hashuri27455512Wall705.888T324,650,655384,418704.784,652,6038,384,472K-38-62Kutaisi269941763Wall202143T404,687,814310,719202.414,689,7768,310,744K-38-50Gumati2699313Rock351,774T414,688,965308,661352.964,690,9288,308,685K-38-50Joneti269911271Rock212.861T424,695,558310,168211.124,697,5248,310,192K-38-50Tvishi269791055Rock347.76T444,710,991318,988347.294,712,9638,319,414K-38-50Chrebalo26975336Wall24,905T444,714,893333,544475.884,716,8328,333,578K-38-61Samtredia2704115846Wall24,905T484,671,033280,54822.614,664,1177,740,740K-38-61Samtredia2704115846Wall24,905T484,671,033280,54822.614,672,9898,280,560K-37-72Poti2714663-49Wall24,905T484,671,033280,54822.614,670,9898,280,560K-37-72Kvalovani27138No numberWall15.285102p4,681,650743,33514.144,683,6177,73,349K-37-72Ureki2721420145Wall10.159104p<	K-38-64	Kareli	27448	15741	Wall	639.203	T29	4,654,170	403,231	637.68	4,656,119	8,403,293
K-38-62Kutaisi269941763Wall202143T404,687,814310,719202.414,689,7768,310,744K-38-50Gumati2699313Rock351.774T414,688,965308,661352.964,690,9288,308,685K-38-50Joneti269911271Rock212.861T424,695,558310,162211.124,697,5248,310,192K-38-50Tvishi269971055Rock347.76T444,710,991318,988347.294,712,9638,319,414K-38-50Chrebalo26975336Wall459,338T454,714,859333,544475.884,716,8328,333,578K-38-61Samtredia2704115846Wall24,905T464,674,348301,27483.704,676,3058,301,295K-37-72Poti2714663-49Wall17.541T474,669,036720,8032.834,670,9898,280,560K-37-72Kvalovani27138No numberWall15.285102p4,681,650743,33514.144,683,6177,743,540K-37-72Kvalovani271422518Ground0,587103p4,675,065723,6520.894,677,0307,22,849K-37-72Kvalovani2721420145Wall10.159104p4,634,833727,2617.004,654,3637,730,373K-37-72Kvalovani2714220145Wall12.864105p	K-38-64	Gomi	27451/52	57/2067	Wall	661.216/662.308	T30	4,652,799	394,648	660.48	4,654,747	8,394,707
K-38-50Gumati2699313Rock351.774T414,688,965308,661352.964,690,9288,308,685K-38-50Joneti269911271Rock212.861T424,695,558310,168211.124,697,5248,310,192K-38-50Tvishi269791055Rock347.76T444,709,605319,386341.144,711,9768,319,414K-38-50Chrebalo26975336Wall459,338T454,710,991318,988347.294,712,9638,319,106K-38-50Chrebalo26975336Wall459,338T454,714,859333,544475.884,716,8328,330,1295K-38-61Samtredia2704115846Wall24,905T464,674,348301,27483.704,676,3088,301,295K-37-72Djumati27127no/#Wall17.541T474,662,158740,53616.874,664,1177,740,740K-37-72Poti2714663-49Wall3.664101P4,669,036720,8032.834,670,9987,720,999K-37-72Kvalovani27138No numberWall15.285102p4,681,650743,35514.144,683,6177,743,540K-37-72Verki271422518Ground0.587103p4,675,055731,6260.884,677,0307,223,849K-37-72Verki2721420145Wall10.159104p <td< td=""><td>K-38-76</td><td>Hashuri</td><td>27455</td><td>512</td><td>Wall</td><td>705.888</td><td></td><td>4,650,655</td><td>384,418</td><td>704.78</td><td>4,652,603</td><td>8,384,472</td></td<>	K-38-76	Hashuri	27455	512	Wall	705.888		4,650,655	384,418	704.78	4,652,603	8,384,472
K-38-50Joneti269911271Rock212.861T424,695,558310,168211.124,697,5248,310,192K-38-50Tvishi269806542Wall342.177T434,709,605319,386341.144,711,5768,319,414K-38-50Tvishi269791055Rock347.76T444,710,991318,988347.294,712,9638,319,016K-38-50Chrebalo26975336Wall459,338T454,714,859333,544475.884,716,8328,331,578K-38-61Samtredia2704115846Wall24.905T464,674,348301,27483.704,676,0588,301,295K-37-72Djumati27127no/#Wall17,541T474,667,133280,54822.614,672,9898,280,560K-37-72Poti2714663-49Wall24,905T484,671,033280,54822.614,670,9987,720,999K-37-72Kvalovani27138No numberWall15.285102p4,681,650743,33514.144,683,6177,743,540K-37-72Urcki2721420145Wall10.159104p4,654,407730,1739.394,656,6337,730,373K-37-84Oczhamuri2722020684Wall12.864105p4,63,902734,94210.844,639,8527,735,144K-37-84Czahwiti2722420578Wall5.851106p <td>K-38-62</td> <td>Kutaisi</td> <td>26994</td> <td>1763</td> <td>Wall</td> <td>202143</td> <td>T40</td> <td>4,687,814</td> <td>310,719</td> <td>202.41</td> <td>4,689,776</td> <td>8,310,744</td>	K-38-62	Kutaisi	26994	1763	Wall	202143	T40	4,687,814	310,719	202.41	4,689,776	8,310,744
K-38-50Tvishi269806542Wall342.177T434,709,605319,386341.144,711,5768,319,414K-38-50Tvishi269791055Rock347.76T444,710,991318,988347.294,712,9638,319,016K-38-50Chrebalo26975336Wall459,338T454,714,859333,544475.884,716,8328,333,578K-38-61Samtredia2704115846Wall24,905T464,674,348301,27483.704,676,3058,301,295K-37-72Djumati27127no/#Wall17.541T474,662,158740,53616.874,664,1177,740,740K-37-72Poti2714663-49Wall24.905T484,671,033280,54822.614,672,9898,280,560K-37-72Kvalovani27138No numberWall15.285102p4,681,650743,33514.144,683,6177,743,540K-37-72Urcki2721420145Wall10.159104p4,637,002734,94210.844,639,8527,730,373K-37-84Oczhamuri2722020684Wall12.864105p4,637,002734,94210.844,634,9477,714,240K-37-84Czahsuri2722420578Wall12.864105p4,626,670728,21321.314,628,6157,728,412K-37-84Czahsuri2722420578Wall2.2.4311	K-38-50	Gumati	26993	13	Rock	351.774	T41	4,688,965	308,661		4,690,928	8,308,685
K-38-50Tvishi269791055Rock347.76T444,710,991318,988347.294,712,9638,319,016K-38-50Chrebalo26975336Wall459,338T454,714,859333,544475.884,716,8328,333,578K-38-61Samtredia2704115846Wall24,905T464,674,348301,27483.704,676,3058,301,295K-37-72Djumati27127no/#Wall17,541T474,662,158740,53616.874,664,1177,740,740K-38-61Samtredia2704115846Wall24,905T484,671,033280,54822.614,672,9898,280,560K-37-72Poti2714663-49Wall3.664101P4,669,036720,8032.834,670,9987,720,999K-37-72Kvalovani27138No numberWall15.285102p4,681,650743,33514.144,683,6177,743,540K-37-72Ureki271420145Wall10.159104p4,654,07730,1739.394,656,3637,730,373K-37-84Oczhamuri2722020684Wall12.864105p4,637,902734,94210.844,639,8527,735,144K-37-84Czakvi27022No numberWall5.831106p4,632,550731,0264.064,634,4977,712,266K-37-84Czakvi27022No numberWall5.656109	K-38-50	Joneti	26991	1271	Rock	212.861			310,168		4,697,524	8,310,192
K-38-50Chrebalo26975336Wall459,338T454,714,859333,544475.884,716,8328,333,578K-38-61Samtredia2704115846Wall24.905T464,674,348301,27483.704,676,3058,301,295K-37-72Djumati27127no/#Wall17.541T474,662,158740,53616.874,664,1177,740,740K-38-61Samtredia2704115846Wall24.905T484,671,033280,54822.614,672,9898,280,560K-37-72Poti2714663-49Wall3.664101P4,669,036720,8032.834,670,9987,720,999K-37-72Kvalovani27138No numberWall15.285102p4,681,650743,33514.144,683,6177,743,540K-37-72Ureki2712420145Wall10.159104p4,654,407730,1739.394,656,3637,733,734K-37-84Oczhamuri2722020684Wall12.864105p4,637,902734,94210.844,639,8527,731,144K-37-84Czakvi27022No numberWall5.831106p4,632,550731,0264.064,634,4977,712,266K-37-84Czakvi27022No numberWall5.656109p4,613,700719,4924.284,615,6688,276,286K-37-96Batumi272420578Wall5.656109	K-38-50		26980		Wall						4,711,576	8,319,414
K-38-61Samtredia2704115846Wall24,905T464,674,348301,27483.704,676,3058,301,295K-37-72Djumati27127no/#Wall17.541T474,662,158740,53616.874,664,1177,740,740K-38-61Samtredia2704115846Wall24,905T484,671,033280,54822.614,672,9898,280,560K-37-72Poti2714663-49Wall3,664101P4,669,036720,8032.834,670,9987,720,999K-37-72Kvalovani27138No numberWall15.285102p4,681,650743,33514.144,683,6177,743,540K-37-72Kolhida271422518Ground0.587103p4,675,065723,6520.894,670,3037,723,849K-37-72Ureki2722020684Wall10.159104p4,637,902734,94210.844,639,8527,735,144K-37-84Oczhamuri272221368Wall12.864105p4,637,002734,94210.844,639,8527,735,144K-37-84Czakvi27022No numberWall22.431107p4,626,670728,21321.314,628,6157,728,412K-37-84Czakvi27022No numberWall5.656109p4,613,700719,4924.284,615,6688,266,53K-38-85Dandalo27248754Ground327,231 <td< td=""><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td>, ,</td><td></td><td></td><td></td><td></td></td<>								, ,				
K-37-72Djumati27127no/#Wall17.541T474,662,158740,53616.874,664,1177,740,740K-38-61Samtredia2704115846Wall24.905T484,671,033280,54822.614,672,9898,280,560K-37-72Poti2714663-49Wall3.664101P4,669,036720,8032.834,670,9987,720,999K-37-72Kvalovani27138No numberWall15.285102p4,681,650743,33514.144,683,6177,743,540K-37-72Kolhida271422518Ground0.587103p4,675,065723,6520.894,677,0307,723,840K-37-72Ureki2721420145Wall10.159104p4,654,407730,1739.394,656,3637,730,373K-37-84Oczhamuri2722020684Wall12.864105p4,637,902734,94210.844,639,8527,735,144K-37-84Kobuletti272221368Wall22.431107p4,626,670728,21321.314,628,6157,728,412K-37-84Czakvi27022No numberWall5.656109p4,613,700719,4924.284,615,6407,719,688K-37-86Dandalo27248754Ground327.231110p4,614,475258,649327.734,616,6088,258,653K-38-85Dandalo27248754Ground327.231 <td< td=""><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td></td<>												
K-38-61Samtredia2704115846Wall24.905T484,671,033280,54822.614,672,9898,280,560K-37-72Poti2714663-49Wall3.664101P4,669,036720,8032.834,670,9987,720,999K-37-72Kvalovani27138No numberWall15.285102p4,681,650743,33514.144,683,6177,743,540K-37-72Kolhida271422518Ground0.587103p4,675,065723,6520.894,677,0307,723,849K-37-72Ureki2721420145Wall10.159104p4,654,407730,1739.394,656,3637,730,373K-37-84Oczhamuri2722020684Wall12.864105p4,637,902734,94210.844,639,8527,735,144K-37-84Kobuletti2722420578Wall22,431107p4,626,670728,21321.314,628,6157,728,412K-37-84Czakvi27022No numberWall8.289108p4,633,33772,2617.204,625,7777,727,460K-37-86Dandalo27248754Ground327.231110p4,613,700719,4924.284,615,6607,719,688K-38-85Dandalo27248754Ground327.231110p4,614,475258,649327.734,616,4088,258,653K-38-85Dandalo27274408Ground964.102<												
K-37-72Poti2714663-49Wall3.664101P4.669,036720,8032.834,670,9987,720,999K-37-72Kvalovani27138No numberWall15.285102p4,681,650743,33514.144,683,6177,743,540K-37-72Kolhida271422518Ground0.587103p4,675,065723,6520.894,677,0307,723,849K-37-72Ureki2721420145Wall10.159104p4,654,407730,1739.394,656,3637,730,373K-37-84Oczhamuri2722020684Wall12.864105p4,637,902734,94210.844,639,8527,735,144K-37-84Czahamuri2722420578Wall5.831106p4,632,650731,0264.064,634,4977,712,268K-37-84Czakvi27022No numberWall8.289108p4,623,833727,2617.204,625,7777,727,460K-37-96Batumi2723154Wall5.656109p4,613,700719,4924.284,615,6407,719,688K-38-85Dandalo27248754Ground327,231110p4,614,475258,649327,734,616,4088,258,653K-38-85Hulo27309468Wall874.202111p4,613,63036,369964,404,615,5688,36,416K-38-76Kvishheti27292539Wall782.965114p<		•/										
K-37-72Kvalovani27138No numberWall15.285102p4,681,650743,33514.144,683,6177,743,540K-37-72Kolhida271422518Ground0.587103p4,675,065723,6520.894,677,0307,723,849K-37-72Ureki2721420145Wall10,159104p4,654,407730,1739.394,656,3637,730,373K-37-84Oczhamuri2722020684Wall12,864105p4,637,902734,94210.844,639,8527,731,1226K-37-84Kobuletti272221368Wall5.831106p4,636,670728,21321.314,628,6157,728,412K-37-84Czakvi27022No numberWall8.289108p4,638,333727,2617.204,664,6407,719,688K-37-96Batumi2723154Wall5.656109p4,613,700719,4924.284,615,6407,719,688K-38-85Dandalo27248754Ground327,231110p4,614,475258,649327.734,616,4088,258,653K-38-6227274408Ground964,102112p4,636,3036,308964,404,615,5688,364,105K-38-75Borjomi27287No numberWall782,965114p4,646,203376,958781.914,663,038,36,415K-38-76Kvishheti27292539Wall782,965114p <t< td=""><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td></t<>												
K-37-72Kolhida271422518Ground0.587103p4,675,065723,6520.894,677,0307,723,849K-37-72Ureki2721420145Wall10.159104p4,654,407730,1739.394,656,3637,730,373K-37-84Oczhamuri2722020684Wall12.864105p4,637,902734,94210.844,639,8527,731,126K-37-84Kobuletti272221368Wall5.831106p4,632,550731,0264.064,634,4977,731,226K-37-84Czihisdziri2722420578Wall22.431107p4,626,670728,21321.314,628,6157,728,412K-37-84Czakvi27022No numberWall8.289108p4,633,83372,2617.204,625,7777,727,460K-37-96Batumi2723154Wall5.656109p4,613,700719,4924.284,615,6407,719,688K-38-85Dandalo27248754Ground327,231110p4,614,475258,649327.734,616,4088,258,653K-38-85Hulo27309468Wall874.202111p4,613,630336,380964.404,615,5688,364,15K-38-75Borjomi27287No numberWall782.965114p4,634,089367,958781.914,636,0308,368,006K-38-76Kvishheti27292539Wall724.88711												
K-37-72Ureki2721420145Wall10.159104p4,654,407730,1739.394,656,3637,730,373K-37-84Oczhamuri2722020684Wall12.864105p4,637,902734,94210.844,639,8527,735,144K-37-84Kobuletti272221368Wall5.831106p4,632,550731,0264.064,634,4977,731,226K-37-84Czihisdziri2722420578Wall22.431107p4,626,670728,21321.314,628,6157,728,412K-37-84Czakvi27022No numberWall8,289108p4,633,833727,2617.204,625,7777,727,460K-37-96Batumi2723154Wall5.656109p4,613,700719,4924.284,615,6407,719,688K-38-85Dandalo27248754Ground327,231110p4,614,475258,649327.734,616,4088,258,653K-38-85Hulo27309468Wall874.202111p4,613,630365,808964.404,615,6688,276,286K-38-76Z2724408Ground964.102112p4,634,089367,958781.914,636,0308,368,006K-38-76Kvishheti27292539Wall724.887115p4,646,203376,28374.734,648,1498,376,334K-38-91280572160Wall317.1P34,596,059504,892<												
K-37-84Oczhamuri2722020684Wall12.864105p4,637,902734,94210.844,639,8527,735,144K-37-84Kobuletti272221368Wall5.831106p4,632,550731,0264.064,634,4977,731,226K-37-84Czihisdziri2722420578Wall22.431107p4,626,670728,21321.314,628,6157,728,412K-37-84Czakvi27022No numberWall8.289108p4,633,833727,2617.204,625,7777,727,460K-37-96Batumi2723154Wall5.656109p4,613,700719,4924.284,615,6407,719,688K-38-85Dandalo27248754Ground327.231110p4,614,475258,649327.734,616,4088,258,653K-38-85Hulo27309468Wall874.202111p4,613,636276,275873.984,615,6688,276,286K-38-75Borjomi27287No numberWall782.965114p4,634,089367,958781.914,636,3008,368,006K-38-76Kvishheti27292539Wall724.887115p4,646,203376,283724.734,648,1498,376,334K-38-91280572160Wall317.1P34,596,059504,892317.764,597,9858,504,995												
K-37-84Kobuletti27221368Wall5.831106p4,632,550731,0264.064,634,4977,731,226K-37-84Czihisdziri2722420578Wall22.431107p4,626,670728,21321.314,628,6157,728,412K-37-84Czakvi27022No numberWall8.289108p4,623,833727,2617.204,625,7777,727,460K-37-96Batumi2723154Wall5,656109p4,613,700719,4924.284,615,6407,719,688K-38-85Dandalo27248754Ground327,231110p4,614,475258,649327.734,616,4088,258,653K-38-85Hulo27309468Wall874.202111p4,613,630363,08964.404,615,5688,276,286K-38-76Derjomi27274408Ground964.102112p4,634,089367,958781.914,636,0308,366,066K-38-76Kvishheti27292539Wall724,887115p4,646,203376,283724.734,648,1498,376,334K-38-91280572160Wall317.1P34,596,059504,892317.764,597,9858,504,995												
K-37-84Czihisdziri2722420578Wall22.431107p4,626,670728,21321.314,628,6157,728,412K-37-84Czakvi27022No numberWall8.289108p4,623,833727,2617.204,625,7777,727,460K-37-96Batumi2723154Wall5,656109p4,613,700719,4924.284,615,6407,719,688K-38-85Dandalo27248754Ground327,231110p4,614,475258,649327.734,616,4088,258,653K-38-85Hulo27309468Wall874.202111p4,613,630336,80964.404,615,5688,326,455K-38-6227274408Ground964.102112p4,613,630367,958873.984,615,6588,336,415K-38-75Borjomi27287No numberWall722,4857114p4,634,089367,958781.914,636,0308,368,006K-38-76Kvishheti27292539Wall724,887115p4,646,203376,283724.734,648,1498,376,334K-38-91280572160Wall317.1P34,596,059504,892317.764,597,9858,504,995												
K-37-84Czakvi27022No numberWall8.289108p4,623,833727,2617.204,625,7777,727,460K-37-96Batumi2723154Wall5.656109p4,613,700719,4924.284,615,6407,719,688K-38-85Dandalo27248754Ground327,231110p4,614,475258,649327.734,616,4088,258,653K-38-85Hulo27309468Wall874.202111p4,613,630276,275873.984,615,5688,276,286K-38-6227274408Ground964.102112p4,613,63036,380964.404,615,5688,364,15K-38-75Borjomi27287No numberWall782.965114p4,634,089367,958781.914,636,0308,368,006K-38-76Kvishheti27292539Wall724.887115p4,646,203376,28372.4734,648,1498,376,334K-38-91280572160Wall317.1P34,596,059504,892317.764,597,9858,504,995												
K-37-96Batumi2723154Wall5.656109p4.613,700719,4924.284.615,6407,719,688K-38-85Dandalo27248754Ground327.231110p4.614,475258,649327.734.616,4088,258,653K-38-85Hulo27309468Wall874.202111p4.613,636276,275873.984,615,5688,276,286K-38-6227274408Ground964.102112p4,613,630336,380964.404,615,5638,336,415K-38-75Borjomi27287No numberWall782,965114p4,634,089367,958781.914,636,0308,368,006K-38-76Kvishheti27292539Wall724.887115p4,646,203376,283724.734,648,1498,376,334K-38-91280572160Wall317.1P34,596,059504,892317.764,597,9858,504,995												
K-38-85Dandalo27248754Ground327.231110p4,614,475258,649327.734,616,4088,258,653K-38-85Hulo27309468Wall874.202111p4,613,636276,275873.984,615,5688,276,286K-38-6227274408Ground964.102112p4,613,630336,380964.404,615,5638,336,415K-38-75Borjomi27287No numberWall782.965114p4,634,089367,958781.914,636,0308,368,006K-38-76Kvishheti27292539Wall724.887115p4,646,203376,283724.734,648,1498,376,334K-38-91280572160Wall317.1P34,596,059504,892317.764,597,9858,504,995	K-5/-84											
K-38-85Hulo27309468Wall874.202111p4,613,636276,275873.984,615,5688,276,286K-38-6227274408Ground964.102112p4,613,630336,380964.404,615,5638,336,415K-38-75Borjomi27287No numberWall782.965114p4,634,089367,958781.914,636,0308,368,006K-38-76Kvishheti27292539Wall724.887115p4,646,203376,283724.734,648,1498,376,334K-38-91280572160Wall317.1P34,596,059504,892317.764,597,9858,504,995												
K-38-62 27274 408 Ground 964.102 112p 4,613,630 336,380 964.40 4,615,563 8,336,415 K-38-75 Borjomi 27287 No number Wall 782,965 114p 4,634,089 367,958 781.91 4,636,030 8,368,006 K-38-76 Kvishheti 27292 539 Wall 724,887 115p 4,646,203 376,283 724.73 4,648,149 8,376,334 K-38-91 28057 2160 Wall 317.1 P3 4,596,059 504,892 317.76 4,597,985 8,504,995												
K-38-75Borjomi27287No numberWall782.965114p4,634,089367,958781.914,636,0308,368,006K-38-76Kvishheti27292539Wall724.887115p4,646,203376,283724.734,648,1498,376,334K-38-91280572160Wall317.1P34,596,059504,892317.764,597,9858,504,995		Hulo										
K-38-76 Kvishheti 27292 539 Wall 724.887 115p 4,646,203 376,283 724.73 4,648,149 8,376,334 K-38-91 28057 2160 Wall 317.1 P3 4,596,059 504,892 317.76 4,597,985 8,504,995		Devi					-	, ,				
K-38-91 28057 2160 Wall 317.1 P3 4,596,059 504,892 317.76 4,597,985 8,504,995											· · ·	
		Kvishheti										
κ -30-102] 28110 380 Wall 380.104 P3 [4,5/2,956 [482,911] 384.89 [4,5/4,8/2] 8,483,005												
	к-38-102		28110	380	Wall	386.104	РЭ	4,572,956	482,911	584.89	4,574,872	8,483,005

Table 3.1.3List of existing benchmarks



Figure 3.1.8 Existing leveling route with benchmarks

3.2. Aerial Photography

Aerial photography took place in May 2005 under the control of Pasco Europe. An area of approximately 30,000 km2 was completely photographed with a scale of 1: 40,000. A total of 1,447 black and white aerial photographs were taken during this mission.



Figure 3.2.1 Aircraft used for the aerial photography

The aerial photography in this study adopted the GPS Kinematic method so that surveying works on the ground, including surveying GCPs, was drastically reduced



compared with traditional methods. The method to install GPS benchmarks on the ground around the photography stations and perform observation simultaneously with the GPS receivers installed onboard the aircraft was adopted to derive the photo center coordinate.

Figure 3.2.2Diagram of aerial photography by GPS Kinematic Method

3.2.1. Planning and implementation

- **Preparation:** The tentative flight plan was checked and necessary adjustment was made prior to the installation of data in the navigation system.
- Flight Plan : All the flight lines were planned using the Tracker flight planning software.
- Shooting : All the aerial shootings took off from Tbilisi International Airport. The first flight was carried out on May 21, 2005 and photography of the entire project area was completed on May 24, 2005.
- **Condition of photography**: The aerial photography was performed only when the angle of the sun above the horizon was 30 degrees or more.
- Security Check: All the films were checked by Security Officer, Colonel Zurab Tateshvili, the Ministry of Defense, the Government of Georgia to remove the confidential objects.

3.2.2. Specifications

The shooting was made on the following specifications. The aerial photographs were inspected if required specifications were fulfilled after the shooting.

I	F				
Scale of Photography	1:40,000				
Camera specifications:	LaicaRC-30 or equivalent (f= 152 mm, 23 cm \times 23				
	cm)				
Flight altitude to planned	within $6,000m \pm 5\%$ from the ground				
elevation:					
Overlan	Overlap $60 \pm 5\%$				
Overlap	Sidelap $30 \pm 10\%$				
Tolerable cloud cover:	Within 3% of successive 5 frames of photographs				
	(excluding parts necessary for plotting orientation)				
Condition	The coordinates of the principal points were measured				
	using ADGPS.				

• Used specification for aerial photography

• Used equipment, materials and navigation system:

Aircraft	Camera type	Lens type	Calibration Date	Navigation system
Piper PA31-T	ZEISS RMK	PLEOGON- A3	03.03.2003	Tracker
N700RG	TOP 15			

• Film type used: KODAK LX 2405 black and white aerial photography film was used for the entire project.

Location	Model	Options	Recording interval	Cut off angle
Base station Afrika	Leica	10 mb memory	1 second	10 degrees
Aircraft N700RG	Ashtech	16 mb	1 second	0 degrees
	Z-Surveyor	memory		

Airborne GPS: Differential GPS registration is as follows.

The reference station was located in the vicinity of the Tbilisi International Airport. All the data were downloaded daily after the aerial photography flights. Leica SKI-Pro V3.0 software was used for photo center coordinate computations using the backward and forward processing method. The processed data and final coordinates of each photo center, were saved on CD-ROM.

3.2.3. Inspection of Photographs

The Study Team carried out a quality control of the photographs using the rush prints. All the photographs were inspected and checked for overlapping and image quality in accordance with Specification. As the results of inspection, all photographs were found satisfied with the above-mentioned specifications. A flight index map was prepared in the AutoCAD format and saved on CD-ROM for a total number of 73 strips with 1,447 photographs (Figure 3.2.3).



Figure 3.2.3 Flight index map

3.2.4. Scanning of aerial photographic films

All the frames of aerial film were scanned according to the following conditions.

Mode	:	Grayscale
Resolution	:	20 micrometer
File format	:	Tiff (un-tiled, uncompressed)
Scanner	:	Vexcel Ultrascan5000



Figure 3.2.4 Scanning of a roll film by Ultrascan 5000

Scanning direction was designed in such a way that the film rotation with respect to the ground was reversed in alternate strips because the airplane was flying in the

Chapter 3 Ground Survey and Aerial Photography



Figure 3.2.5Rotation needed for reversed flight direction

Each scanned aerial photo was opened with Adobe Photoshop 8.0 for checking on the brightness and contrast and also for deletion of confidential objects such as military facilities.



Figure 3.2.6 Scanned image opened with Adobe Photoshop



Figure 3.2.7 Scanning process of aerial photographs

3.3. Aerial Triangulation

3.3.1. Outline of the work (Scope of the aerial triangulation)

Aerial triangulation was carried out over the entire Study Area of 30,000km². All the works were implemented using the MST model in the Socet Set software.

All 1,447 images were split into two blocks, east and west.

The triangulation was done based on WGS84 and coordinate system UTM, Zone 38. Computation was successfully processed, and the results were used in digital plotting of maps to be newly created.

3.3.2. Method of triangulation

The scanned images of aerial photographs and the results of GCP observation and leveling were used in the aerial triangulation. Adjustment computations were carried out employing the bundle method by dividing the whole Study Area into two blocks, A and B.



Figure 3.3.1 Process flow of adjustment



Figure 3.3.2 Allocation of control points in each block

3.3.3. Results

In the Multi-Sensor Triangulation Residual table, each control or tie point had a residual error less than one pixel, except a few points that were located in mountains or whose image quality is poor.

The average residual errors (RMS errors) and its maximum residual values, in the horizontal and vertical directions, of the control points used in the calculation are as follows:

In the Multi-Sensor Triangulation Residual table, each control or tie point had a residual error less than one pixel, except a few points that were located in mountains or whose image quality was poor.

In the horizontal and vertical directions, the resulted standard deviation of residual error computed as "RMS" and maximum residual errors of the control points are presented in Table 3.3.1 below :

		9	I			
Block No.	X (Longitude)		X (Longitude) Y (Latitude)		Z (Elevation)	
	Standard	Max.	Standard	Max.	Standard	Max.
	deviation		deviation		deviation	
B1	0.237	+0.846	0.213	-0.643	0.088	-0.340
B2	0.358	+1.327	0.293	-0.866	0.047	+0.124
						(\cdot, \cdot, \cdot)

 Table 3.3.1
 Results of adjustment computation of residual error

(in meter)

With the bundle method, the thresholds (accuracy standards) for the residual errors of control points in aerial triangulation were within the limitation values of 0.02% (1.2m), and 0.04% (2.4m) for average and maximum, respectively of aerial photography flight height, as mentioned in the Manual of Overseas Basic Map Production issued by the JICA, refer to Table 3.3.2,. Thus, the above adjustment computation results could be deemed as a satisfactory level of accuracy.

Table 3.3.2	Accuracy standards for standard deviation of residual errors
X:	less than 1.2 m ("altitude above ground level" x 0.02 %)
Y:	less than 1.2 m ("altitude above ground level" x 0.02 %)
Z:	less than 1.2 m ("altitude above ground level" x 0.02 %)

Table 3.3.3	Accuracy standards for maximum of residual errors
X:	less than 2.4 m ("altitude above ground level" x 0.04 %)
Y:	less than 2.4 m ("altitude above ground level" x 0.04 %)
Z:	less than 2.4 m ("altitude above ground level" x 0.04 %)

3.4. Creation of orthphotographs

3.4.1. Objective of the work

Considering the difficulty in field identification of the aerial photograph images, to avoid misinterpretation of information, Semi orthophotographs (produced at larger scale, 1:20,000) were prepared for the counterpart to conduct field verification speedily and efficiently.

More specifically, it is easier in this way, for the surveyors to confirm their position by referring to the positional information acquired using a handy GPS device as the 1:20,000 scaled orthophotographs displays the GPS coordinates "2 times enlargement compared to the original aerial photographs so taken at 1:40,000", which is traditionally used for field verification.

3.4.2. Method of creating orthophotos

Orthophotographs were created with ERDAS Imagine V.8.6. First, importing the SocetSet projects, DEM data was generated from the automatic DTM. This DEM data was employed to derive, semi orthophotographs covering the entire Study Area. These photos were mosaicked per four images and output as 49 scenes were carried at the surveys. All these data were saved in Geo-Tiff files. Followings are the major

steps involved in this work:



Figure 3.4.1 The process of generating semi orthphotos





Figure 3.4.3 Output files, Geo Tiff, cutting off into the format of newly designed map sheet