D2. FIELD SURVEYS AND INVESTIGATIONS

D2.1 Surveys and Investigations for Master Plan Study

D2.1.1 Installation of Hydrological Gauges and Discharge Measurements

(1) Objectives

Taking into consideration the present critical conditions of hydro-meteorological observation in the LBB basin, it is decided to install the additional hydrological gauges and to execute the discharge measurements. Main work items are as follows:

1) To install automatic rain gauges and automatic float-type water level gauges respectively at four (4) locations.
2) To install staff gauges at ten (10) locations, and to conduct discharge measurement there for six (6) months using current meter at normal flows and float at flood flows.

(2) Installation of Automatic Rain and Water Level Gauges

Few Settlements above 500 m,MSL: Rainfall gauging in the basin above 500 m,MSL is one of the requirement for the gauge installation. However, settlements are few in the highly elevated lands in the basin. Accessibility to the gauge and availability of reliable gauge keeper nearby are the important factors to select a site of rain gauging station. It was acknowledged by available topographical map, interviews with local government officials and site visit that a rain gauge station above 500 m,MSL could be installed only in the uppermost river basin of the Bolango river, where a road system leads to the location and a settlement is situated nearby.

Necessity of Replacement of Existing Gauges: According to the result of site visit to inspect actual conditions of the existing rain and water level gauging stations, it was found that some of the existing gauges are needed for replacement with a new facility. The necessity of replacement, rehabilitation and upgrading of the existing observation system was emphasized by the counterpart agency. There was also a strong request from the counterpart agency to install a new gauge for the ungaged river basin.

Selected Sites: Based on the careful considerations and comprehensive discussion with

counterpart agency as described above, it was concluded that the new automatic rain and water level gauges are to be installed at the following sites in the LBB basin:

(Selected Sites for Installation of Automatic Rain Gauges)

Location	River Basin	Remarks
1. Bongomeme	Pohu River	New installation for ungaged area
2. Kayumerah	Biyonga River	Upgrading of damaged gauge
3. Dulamayo Selatan	Bolango River	New installation for ungaged area (above 500 m,MSL)
4. Alale	Bone River	Upgrading of damaged gauge

(Selected Sites for Installation of Automatic Water Level Gauges)

Location	River Basin	Remarks
1. Satria Bridge	Alo River	New installation for ungaged river
2. Kayubulan Bridge	Biyonga River	New installation for ungaged river
3. Boidu Tapa	Bolango River	New installation for ungaged river
4. Alale	Bone River	Restoration of discarded gauge

Design of Civil Structure: The durability of the civil works of the gauges was also checked by the site survey with counterpart agency. As explained in the previous section, the majority of the automatic water level gauging stations was ruined by the past floods, mainly due to scouring of the foundation and erosion of the riverbank. The durable structure was carefully considered referring to the existing structure and the design standard commonly adapted and undertaken in the Study Area. Standard designs of proposed rainfall gauge and water level gauge are shown in Figures D2.1.1 and D2.1.2.

Installation Works and Operation: The installation of rain gauges and water level gauges was implemented in September and October in 2001 by locally employed personnel who has experience of similar works for Bagpro PDSA, North Sulawesi.

Figure D2.1.3 shows the location of the selected rain and water level gauging sites. All stations are to be operated and maintained initially by the Bagpro PDSA, North Sulawesi Province, then by Gorontalo Province.

(3) Installation of Staff Gauges and Discharge Measurements

Selection of Additional Flow Gauging Sites: The additional flow gauging sites were selected to collect actual flood flow and inundation data in the LBB basin. The

gauging sites were properly placed in the lower reach of the major rivers. Additionally, two staff gauges were located at the river mouth of the Bone River and the south of the Lake Limboto. The following sites were selected for staff gauge installation and discharge measurements in the LBB basin:

River Basin	Location	Purpose
1. Alo River	Satria Bridge	Flood flow of Alo river With an automatic recorder
2. Reksonnegoro River	Titileya	Flood flow of Reksonnegoro river
3. Pohu River	Bontula	Flood flow of Pohu river
4. Biyonga River	Kayubulah Bridge	Flood flow of Biyonga river With an automatic recorder
5. Bolango River	Boidu Tapa	Flood flow of Bolango river With an automatic recorder
6. Bolango River	Bolango Bridge	Flood flow of Bolango river
7. Bolango River	Outlet of Limboto Lake	Flow from the lake
8. Limboto Lake	Limboto Lake	Lake water level
9. Bone River	Alale	Flood flow of Bone river With an automatic recorder
10. Bone River	River mouth	Tidal gauge

Installation Works and Measurement: The installation of staff gauges at ten (10) locations was carried out by the locally employed personnel who conducts discharge measurements and water level recordings for the Study. The staff gauges were installed on October 2001 and the measurements were carried out continuously afterwards.

All stations are to be operated and maintained by the Bagpro PDSA initially and then by Gorontalo Province. Figure D2.1.4 shows the location of the selected staff gauges for discharge measurements.

D2.1.2 Topographic Mapping and River Survey

The topographic mapping including aerial photography were planned for the surrounding areas of Lake Limboto and the flood prone areas of Gorontalo City and river survey for the major rivers in the Study Area.

The survey works were conducted by an Indonesian surveying company PT. Atlas Deltasatya, under a sublet contract with the Study Team. Surveying expert of the Study Team prepared survey plan and specifications and supervised the survey works.

The contract was entered into on August 20, 2001 and the delivery date is October 30, 2001.
Contact prints of the 1/25,000 aerial photographs were used for planning the survey borrowing from Dinas Sumber Daya Air. The photographs were taken in October 1991 covering a part of the Study Area. Available photographs are listed in Table D2.1.1.

In addition, descriptions and previous survey results of the control points and bench marks within the Study Areas were made available from BAKOSURTANAL (Geographical Survey Institute of Indonesia) and Dinas Sumber Daya Air.

(1) Topographic Mapping

Topographic survey was conducted for Lake Limboto and its surrounding areas to provide data for flood flow simulation facility design and flood damage analysis. Total area of topographic survey is 8,000 ha (Figure D2.1.5), including lake area of about 3,500 ha which changes from 2,500 ha in dry season to 5,000 ha in rainy season. The lake was surveyed by sounding, and the surrounding areas were surveyed by means of aerial photo survey. The aerial photo was taken in the scale of 1/25,000 and mapping scale of 1/5,000.

Flood prone areas of Gorontalo City were also subject to the topographic survey by aerial photography. The survey area extends over a total area of 700 ha along the Bolango and Bone rivers for about 7km in length and about 1km in width (Figure D2.1.5). The photo scale was 1/10,000 and the mapping scale 1/1,000.

Monumentation: A total of 20 new monuments were installed along the roads in the survey areas as control points for topographic mapping. The monuments are concrete stones of 15cm x 15cm x 95cm, inscribed respectively the number from LBB-1 to LBB-20 on their sides. These stones were embedded up to the depth of 75cm.

GPS survey: GPS survey was carried out for the control points based on the existing control points N-4002 and BPN18119 which are the national coordinates of Indonesia as shown in Figure D2.1.5. Trimble 4600LS was used for the GPS survey. The accuracy of the GPS survey for the control points was confirmed to be good, and the final results are shown in Table D2.1.2.

Leveling Survey: Leveling survey was conducted for the total length of 71.2km along the road based on the bench marks BPN-18119 and BO-01 relative to the mean-sea-level datum (Figure D2.1.5). Referring to the elevations of the existing bench marks, the sea level in Tomini Bay was measured for 16 hours at 2-hour intervals with a gauge installed in the sea. The maximum tide level on August 10, 2001 was 0.431 at 8:00am and at 20:00pm, and the minimum tide level was -0.371m at 2:00am and at 14:00pm. (See Table D2.1.3)

For direct leveling, the Swiss-made level, WILD NAK 1 was used. The accuracy of leveling was acceptable as shown in Table D2.1.4. The final results of leveling are shown in Table D2.1.2 for the control points.

Pre-marking: Pre-markers were installed before aerial photography. The pre-markers are of cross shaped with the size of 2m x 80cm in Lake Limboto and its surrounding areas and 1.2m x 50cm in the flood prone areas of Gorontalo City. The material of the markers was white thick cloth.

Aerial photography: Aerial photography was conducted in the scale of 1/25,000 in Lake Limboto and its surrounding areas and 1/10,000 in the flood prone areas of Gorontalo City. Monochrome photography was made in both cases. The airplane CESSNA 402-B and the aerial camera Leica RC-30 were used for the aerial photography. The aerial photography was completed for two days on August 24 and 25, 2001 in fair weather. The 1/25,000 photography produces 16 photos on 2 courses and the 1/10,000 photography produces 12 photos on 2 courses as shown in Figure D2.1.5. After the photography, the negative films were annotated as LIMBOTO-BOLANGO-BONE/24-08-01/1:25,000/C1-5/JICA on the start film of each course and LBB/24-08-01/1:25,000/C1-5/JICA on other films.

Aerial triangulation: Aerial triangulation was carried out in the analytical method using PUG and a comparator after making the positive films from the negative films and copying them to make contact prints. For the 1/25,000 photography areas, the block adjustment method was used.

Topographic mapping: For topographic mapping, the digital plotting method using an analytical plotter was adopted to plot the maps of the 1/5,000 and 1/1,000 scales. As the surveying areas are rather flat, the contour intervals of 1m and the supplemental contour of 0.5m were used for both scales of maps. The map sheet size was 1.5ft x

1.5ft (approx. 55cm x 55cm) for the 1/5,000-scale areas by dividing the existing 1/50,000 topographic maps into 100 equal parts. For the 1/1,000-scale areas, the sheet size of 80cm x 60cm was used. .

(2) River Survey

River survey was conducted for the stretches subject to flood analysis, river planning, and preliminary facility design for the master plan study. The number and approximate width of cross sectional survey are as follows:

1) Primary river such as the Bone and Bolango rivers and rivers flowing into Lake Limboto: 100 sections with width ranging 100~500m
2) Rivers in urban area: 50 sections with width ranging 10~50m

For longitudinal and cross sectional survey of rivers, 20 rivers were selected. The number of cross sections was determined for each river considering the uses for hydraulic analysis. Where there are bridges, weirs and dams, their upstream sections were measured. A total of 201 cross sections were surveyed as shown in Table D2.1.5 and Figure D2.1.6.

Sectional posts were installed on both banks of the river at each cross section. The sectional post has a size of 4cm x 6cm x 50cm. One of the sectional posts was installed at the point of national coordinates obtained from the GPS survey. Elevation of the post was surveyed relative to the mean sea level datum by the direct leveling and GPS leveling. Drawing scales of the cross section are V=1/100 and H=1/300, and those of the longitudinal profile are V=1/100 and H=1/5,000. On the longitudinal profile drawings, water levels at the time of flood and survey and elevation of the lowest riverbed are indicated.

(3) Sounding Survey of Lake Limboto

The sounding survey of Lake Limboto was made using a Raytheon echo sounder combined with a GPS navigator system. The depths of the lake bottom were measured and plotted at the intervals of 100m. For the lakeside portions, the depths were sounded and plotted at the intervals of 100 to 300m using a pole.

A total of 18 measuring sections were set from south to north direction at the intervals

of 400m (Figure D2.1.7). Water level of Lake Limboto was 4.054m above mean sea level during the survey period.

The sounding maps were prepared in the scale of 1/5,000 with intermediate contours of 1m. Where the contour intervals are wider, supplemental contours of 0.5m were inserted. In addition, spot elevations were indicated at the deepest bottoms.

D2.1.3 Investigation of Land Use and Sediment Yield

Land use and sediment yield of the LBB basin were investigated using the satellite images taken in two different years, for an area of about 1,000 km^2 covering the basins of the Bolango river and Lake Limboto basins where devastation of watershed takes place. The results are used as basic data for the study on flood and sediment disasters.

The investigation is carried out in Japan by Kokusai Kogyo Co., Ltd, Japan under the sublet contract with the Study Team. The investigation was completed by the end of September, 2001.

(1) Satellite Images Used

Satellite images used for the analysis were selected from the fine SPOT data with less clouds taken in different years, recently and in around 1990, as follows (Figure D2.1.8):

1) Latest images:
   SPOT (multi-color) K-J: 314-349 taken on Mar. 06, 1998
   SPOT (multi-color) K-J: 315-349 taken on Aug. 29, 2000
2) Images in around 1990:
   SPOT (multi-color) K-J: 314-349 taken on Apr. 22, 1990
   SPOT (multi-color) K-J: 315-349 taken on Sep. 02, 1987

(2) Preparation of Folse Color Image

Two folse color images were prepared in the scale of 1/50,000, joining images K-J: 314-349 and K-J: 315-349, synthesizing data of multi-color bands.

(3) Analysis of Land Use

Land uses of the basin are analyzed on the images taken in 1998/2000 and 1990/1987. Land use is analyzed, in principle, for 8 categories such as forests, bushes, farm lands, grass lands, waste lands, villages, waters, and others. Land use maps are prepared as a result in the scale of 1/50,000. Changes in land use are also mapped in the same scale.

(4) Analysis of Land-Slide Sites

Locations of land-slide sites were also analyzed based on the satellite images taken in 1998/2000 and 1990/1987. Location map of land-slide sites are prepared in the scale of 1/50,000. Land-slide sites smaller than 100 m^2 were disregarded due to the limit of the SPOT data resolution.

D2.1.4 Investigation of Water Quality and Bottom-Sediment

Main objectives of water quality and bottom-sediment investigations are as follows:

1) To evaluate the current conditions of water quality and bottom-sediment as a benchmark,
2) To analyze the effect of sedimentation caused by soil erosion from upstream areas at the entrance to Lake Limboto,
3) To analyze the effect of domestic effluent and agriculture in terms of nutrients and chemical compounds, and
4) To analyze the effect of illegal mining being done in upstream area along the Bone River.

The investigation was conducted by Environmental and Natural Resources Research Center of the Sam Ratulangi University Research Center under the sublet contract in accordance with the technical specifications prepared by the Study Team.

Sampling for water quality test was conducted twice at 15 sites: one in September 2001 during dry season and another in December 2001 during rainy season, aiming to analyze the fluctuation of water quality with run-off discharge over seasons. Sampling for bottom-sediment quality test was planned once at the same 15 sites as water sampling in September 2001 during dry season, because the bottom-sediment quality does not fluctuate with run-off discharge in general.

(1) Sampling Points

A total of 15 sampling sites were chosen commonly for water and bed-sediment samples in the LBB basin, such as Lake Limboto, Bone river including its estuary, Bolango River, Tamalate river, Bionga river, Alo-Pohu river, etc.

Definite locations for water and bottom-sediment sampling points were determined based on the field reconnaissance made on August 6 through 11, 2001, as listed in Table D2.1.6 together with objectives, and illustrated in Figure D2.1.9.

(2) Parameters Measured

Parameters were chosen to meet the purposes and objectives mentioned above. Parameters for water quality are composed of three categories, i.e., fundamental parameters, heavy metals and others. The fundamental parameters were chosen to evaluate the current environmental conditions as ambient water. The heavy metals were chosen to evaluate the suitability for water use and possibility of contamination. The other parameters were chosen to evaluate the suitability as raw water of drinking water.

On the other hand, the parameters for bottom-sediment quality were selected aiming to evaluate the possibility of contamination and its accumulation caused by industrial activities, particularly focusing on an illegal mining undergoing in upland areas of the Bone River. The results at other sampling points than the Bone River can also be used for references.

Parameters for water quality test are as follows:

1) Fundamental parameters: Temperature(℃), pH, BOD_5 (Biochemical Oxygen Demand), COD (Chemical Oxygen Demand), DO (Dissolved Oxygen), SS (Suspended Solid), Coliform Bacillus (Coliform Group Number), T-N (Total Nitrogen), T-P (Total Phosphorus), Electric Conductivity, Color (Chromaticity), and Turbidity.
2) Heavy metals: Cadmium (Cd), Total Mercury (T-Hg), Selenium (Se), Lead (Pb), Arsenic (As), Hexavalent Chromium (Cr^{6+}), Zinc (Zn), Iron (Fe), and Manganese (Mn).

3) Others: Cyanide (CN), Nitrate Nitrogen (NO_3-N), Nitrite Nitrogen (NO_2-N), Fluorine (F), Chloride Ion (Cl^-), Calcium (Ca^{2+}), Magnesium (Mg^{2+}), and Phenolic Substances.

Parameters for bottom-sediment quality test are as follows:

1) Fundamental parameters: Temperature(℃), and pH.
2) Heavy metals: Cadmium (Cd), Total Mercury (T-Hg), Selenium (Se), Lead (Pb), Arsenic (As), Hexavalent Chromium (Cr^{6+}), Zinc (Zn), Iron (Fe), and Manganese (Mn).

(3) Results of Quality Tests

The Sampling in dry season was conducted in September 2001 during dry season for both water quality and bottom-sediment quality tests. The quality tests of those samples were now being undertaken.

D2.1.5 Investigation of Riverbed Materials

Physical properties of the riverbed materials were investigated to obtain basic data for the analysis of sediment transport in the river and sedimentation in the lake. Samples were collected at 50 sites and two riverbed materials at each site, from riverbed sand bar and riverbank, were sampled. A total of 100 samples are subject to laboratory test i.e., grain size analysis and specific gravity test.

The investigation includes the following items:

1) Preparation of work program including a list of key staffs to be assigned for the field works and laboratory test, sequence of works, and time schedule
2) Sampling of river bed materials
3) Grain size analysis
4) Specific gravity test
5) Report.

The investigation was carried out by CV. HEXAMATRA, Manado, under the sublet contract in accordance with the technical specifications prepared by the Study Team. The investigation was completed by the end of October 2001.

(1) Sampling of Riverbed Materials

Sampling sites of riverbed materials are shown in Figure D2.1.10. Two (2) samples of riverbed materials were collected at each sampling site, from sand bar on riverbed and from nearby riverbank. The sandbar sample was taken near the shore where the riverbed materials are exposed out of water. The sampling site was selected so that the sampled materials should represent those of typical river section.

Sampling of riverbed material was carried out in the following manner at each sampling site:

1) To take photos of river channel at the sampling site for its upstream and downstream views.
2) To remove surface materials by about 30 cm depth and take a photo of sampling spot with scale to show the grain size.
3) To take out bed materials up to 80 cm deep from original surface removing surface materials by about 30 cm deep.
4) The materials taken out are put on a clean vinyl sheet spread over the ground and mixed well. Then, a quarter of the material is sampled.
5) If the maximum grain size is smaller than 10 mm, the sample is kept in a clean container with site name clearly written for the indoor grain size analysis.
6) If maximum grain size is lager than 10 mm, the sample is put on a vinyl sheet and dried up to surface dry conditions in the air for the outdoor grain size analysis at site.

(2) Grain Size Analysis

Grain size analysis was carried out to determine the grain size distribution of the riverbed materials. Indoor sieve analysis was carried out for the samples finer than 10 mm as follows:

1) The sieve set used for indoor analysis consists of 9.52 mm, 4.76 mm, 2.00 mm, 0.84 mm, 0.42 mm, 0.25 mm, 0.105 mm and 0.074 mm or those approved by the Engineer.
2) The balance to be used for weighing the materials remaining on each sieve should be used of sensitivity higher than 0.1 g.

Outdoor grain size analysis at site was carried out in the following procedures:

1) To weigh the whole sample.
2) To screen the sample by a standard sieve set and to weight the weight of materials remained on each sieve and materials passing through the smallest sieve of the set. The total weight of them should be almost equal to the total weight of sample.
3) The standard sieve set shall consist of sieves 50.8 mm, 38.1 mm, 25.4 mm, 19.1 mm and 9.52 mm or those approved by the Engineer.
4) The balance to be used for weighing the material should be of sensitivity higher than 1 g.
5) Each of grain remaining on 50.8 mm sieve should be measured for its grain size and weight. The grain size should be measured by scale for three dimensions of length, width and thickness.
6) The materials remaining on sieves less than 38.1 mm should be mixed after the sieve analysis and about 1 kg of sample is taken out for specific gravity test. The sample should be put in a clean container with its site name clearly written.

(3) Specific Gravity Test

Specific gravity test was carried out indoor for about 1 kg of samples used for the sieve analysis according to ASTM or approved method by the Engineer. Specific gravity test was carried out twice dividing a sample into two.

(4) Report

As a result, a report for the investigation of riverbed materials was prepared covering the following contents:

1) Sampling work which includes the necessary descriptions to interpret the results of bed material tests such as date of sampling, place condition of sampling site and river with photos, characteristics of sample observed by the eye.
2) Sieve analysis including the method of analysis, grading curve of bed material, and other necessary descriptions.
3) Specific gravity test including the method of test, calculation of specific gravity

of bed materials, and other necessary descriptions.

D2.1.6 Geological Investigation

In order to examine subsurface conditions of dams and other structures for the Study, geological investigation was carried out. The investigation includes boring at 18 holes of about 360m in total length, and laboratory tests for 10 core samples.

Geological investigation was carried out by PT. Waja Utama, Gorontalo under the sublet contract in accordance with the technical specifications prepared by the Study Team.

(1) Core Drilling

Core drilling was performed with standard penetration tests and water pressure tests as follows. The core drilling is made for bedrock, soil, gravel deposits, colluvial deposits and talus deposits that may contain boulders. The diameter of the boreholes shall be not less than 60 mm. Every effort should be made for 100 % core recovery.

Standard penetration tests, in accordance with the USBR specification (Earth Manual) or the equivalent, were carried out every 1.5 meters of depth in the sections of the boreholes which are located within soils or un-cemented deposits or intensively weathered rocks, in order to evaluate the mechanical strength of those materials.

Water pressure tests were carried out, following the "Lugeon test" procedure of the descending stage method, for every five meter section, in the parts of boreholes through bedrock in order to evaluate the seepage potential of the foundation rocks. The permeability of the uncemented deposits is also measured by an open-end constant-head test at every three (3) meter of depth starting at the depth of 3 meters.

The quantity of the work and locations of the boreholes are shown in Figure D2.1.11.

(2) Laboratory Tests of Rock

Representative rock specimens selected from the drilling core samples of cylindrical form were sent to the laboratory for the purpose of confirming the basic physical, chemical and mechanical characteristics of the rocks in geotechnical aspects.

The laboratory test work comprises the selection of samples for the laboratory test, their transportation to and testing at the laboratory, geotechnical interpretation and evaluation of the testing results.

Items and envisaged quantities of the laboratory test are as listed below.

1) Water absorption and bulk specific gravity (ASTM C 127): 10 samples
2) Unconfined compression test of rock core specimen (ASTM D2938): 10 samples

(3) Report

As a result of the investigation, an investigation report was prepared at the end of all the investigation work. The investigation report will contain drill logs, records of the water pressure tests, the standard penetration test, photographs of core samples, and results of the laboratory tests with technical interpretation and comments.

D2.1.7 Investigation of Flood Damages and Residents

In order to grasp flood damages and the present living situation of the residents, a social survey by use of questionnaire was conducted. In addition to this, existing government and previous study documents were also examined and reviewed.

The Study Team contracted with a Local Expert (Social Environmentalist) for assisting the Team in the related work. The Expert is a University lecturer and has experience in working for other JICA studies in North Sulawesi as well as for CIDA in the LBB area.

A questionnaire prepared for social survey has two main objectives. One is to collect information on living conditions of the residents of the study area and the other is to investigate their perception on floods. The questionnaire is composed of four parts; questions on (1) general information on the resident's living conditions, (2) past experiences related to floods, (3) residents' perception on the flood, and (4) people's observation on natural environment. Four teams of two persons each were formed to carry out the survey.

The survey sites were selected according to the criteria set up by the Study Team as follows (Bahasa Indonesia in parenthesis):

1) Villages in the flood prone areas (Desa/Kelurahan berada pada wilayah mudah terlanda banjir)
2) Villages invited for the First Public Consultation Meeting (Desa/Kelurahan yang dipilih menjadi peserta pada Pertemuan Konsultasi Masyarakat)
3) Villages situated along the principal rivers/ upstream, midstream, lower reach (Desa/Kelurahan yang berada sepanjang sisi sungai/ atas, menengah, bawah)
4) Villages with a large population (Desa/Kelurahan dengan jumlah penduduk yang besar)
5) Villages with high population density (Desa/Kelurahan dengan kepadatan penduduk yang tinggi)
6) Villages with similar characteristics/situation for comparison (Desa/Kelurahan dengan karakteristik geografi yang sama atau situasi untuk diperbandingkan)

A total of 20 sites were chosen from among villages located in the flood prone areas and also those along the four principal rivers of the area, namely the Bone, Bolango, Biyonga and Alo-Pohu rivers, and their branches. Twenty (20) households are chosen for the interview at each village. Villages selected for the survey are shown in Table D2.1.7 and Figure D2.1.12.

The social survey was started mid August and 20 villages (Desa/ Kelurahan) were investigated to accomplish the interview of a total of 400 households by the middle of September. The last site is Pinogu of the upper Bone River which requires three days for the survey with help of a horse and guides and other preparation.

All the preparation and operation of social survey were done in full collaboration with the Counterpart staff for the Study from Dinas Kimpraswil of Gorontalo Province with technical support of the Local Expert. In the operation, the Counterpart supervises and coordinates the whole survey activities, and the Local Expert provides technical support, processes the collected data for analysis and helps translation between English and Indonesian when needed.

Results of the interview survey are now under processing. Secondary data on present social conditions are also being gathered through direct interviews with relevant government officials and various existing documents such as Desa/Kelurahan Profil (year 2000) and BPS (Badan Pusat Statistik)'s statistics of Kabupaten and Kota Gorontalo. Desa/Kelurahan Profil is collected at the time of teams' visit to the site.

D2.2 Additional Field Surveys for Feasibility Study

D2.2.1 River Survey, Topographic Survey and Topographic Mapping

River survey, topographic survey and topographic mapping were conducted for the priority project areas (the lower Bone River, the lower Bolango River, the Tapodu River and Tamalate Floodway) subject to the Feasibility Study (Figure D2.2.1).

The survey works were conducted by an Indonesian surveying company PT. Atlas Deltasatya, under a sublet contract with the Study Team. Surveying expert of the Study Team prepared survey plan with specifications and supervised the survey works. The contract was entered into on June 17, 2002 and the delivery date is July 31, 2002. The works were carried out based on the following technical items:

Surveying standards: Mean sea level (MSL) was applied to the datum of leveling and National Coordinates (UTM 51 zone) system to the horizontal coordinates.

GPS survey: The GPS survey was carried out in order to measure the precise positions (coordinates) of control points for river survey and topographic survey. These horizontal positioning were linked with existing control points which have been installed during the ground survey for this project, or with existing national control points.

Leveling Survey: Leveling survey was carried out in order to check and link with the elevations of control points.

(1) River survey

River survey was conducted for the stretches subject to flood analysis, river planning, and facility design for the Feasibility Study. The number and approximate width of cross sectional survey are as follows:

River	Stretch	Length	Section
Bone	Fr:Estuary To:confliience of Bolango＋500m	1.5km	15sections(Δx=100m, Left/Right bank＋100m)
Bolango	Fr:confluence of Bone To:confluence of Tapodu500m	6.5km	65sections(Δx=100m, Left/Right bank＋100m)
Tapodu	Fr:confluence of Bolango To:Lake Limboto	2.5km	25sections(Δx=100m, Left/Right bank＋100m)
Alopohu	Fr:Lake Limboto To:＋1.5km	1.5km	15sections(Δx=100m, Left/Right bank＋100m)
Biyonga	Fr:Lake Limboto To:＋1.5km	1.5km	15sections(Δ100m, Left/Right bank＋100m)
Tamalate	Fr:Conf. of Tamalate floodway-500m To:Conf. of Tamalate floodway＋500m	1.0km	10sections(Δx=100m, Left/Right bank＋100m)
Bone	Fr:Conf. of Tamalate floodway-500m To:Conf. of Tamalate floodway＋500m	1.0km	10sections(Δx=100m, Left/Right bank＋100m)
Total	-	15.5km	155sections

Sectional posts were installed on both river banks at each cross section. One of the sectional posts was installed at the point of National Coordinates. Elevation of the post was surveyed relative to the mean sea level datum by the direct leveling and GPS leveling. On the longitudinal profile, water levels at the time of flood and survey, and elevation of the lowest riverbed are indicated.

(2) Topographic Survey and Topographic Mapping

Topographic survey and mapping were conducted for the proposed Tamalate Floodway areas to provide data for facility design. Total area of topographic survey is 2.0 km^2 as follows (Figure D2.2.1) and the mapping scale is 1/5,000.

Site	Strech	Length	Width	Area
Proposed Tamalate Floodway	Fr:confluence of Bone-1,000m To:confluence of Tamalate＋200m	4.0km	500m	2.0k ㎡

The areas along the lower Bone River, lower Bolango River and Tapodu River were also subject to the topographic mapping using aerial photography. The survey area extends over a total area of 9.5 km^2 along the lower Bone, lower Bolango and Tapodu rivers for about 9.5 km in length and about 1.0 km in width (Figure D2.2.1). The photo scale is 1/10,000 and the mapping scale is 1/5,000.

Strech	Length	Width	Area
Fr:Estuary-Bone-Bolango-Tapodu To:Lake Limboto	9.5km	1,000m	9.5 k m^2

D2.2.2 Geological Investigation

In order to examine geotechnical subsurface conditions of the sites proposed for weir, floodway, gate, material sources and other important components for the Study, geological investigation was carried out. The investigation includes boring at 16 holes of 245m in total length, and laboratory tests of 12 samples for earth embankment material and 6 samples for concrete aggregate (Figure D2.2.2).

Geological investigation was carried out by Geo ACE Ltd., Makassar under the sublet contract in accordance with the technical specifications prepared by the Study Team.

(1) Core Drilling

Core drilling was performed with standard penetration tests and water pressure tests as follows. The core drilling is made for bedrock, soil, gravel deposits, colluvial deposits and talus deposits that may contain boulders. The diameter of the boreholes shall be not less than 60 mm. Every effort should be made for 100 % core recovery.

Standard penetration tests: In accordance with the USBR specification (Earth Manual) or the equivalent, standard penetration test were carried out at every 1.5 meters of depth in the sections of the boreholes which are located within soils or un-cemented deposits or intensively weathered rocks, in order to evaluate the mechanical strength of those materials.

(2) Laboratory Test of Soil Material

Soil samples for earth embankment and sand-and-gravel samples for filter and concrete aggregates were sent to the laboratory and examined on the physical and mechanical characteristics to meet their utility. Items of soil mechanics test in the laboratory are listed below.

Earth material:

- Particle size analysis by sieve & hydrometer (ASTM D422)

- Liquid limit, plastic limit, plastic index (ASTM D43 1)
- Specific gravity of soil (ASTM D854)
- Natural water content of soil (ASTM D4959)
- Proctor compaction test (ASTM D698)

Concrete aggregates:

- Sieve analysis of aggregates (ASTM C 136)
- Specific gravity and water absorption (fine aggregate) (ASTM C128))
- Specific gravity and water absorption (coarse aggregate) (ASTM C127)

(3) Report

A comprehensive report covering all the results of core drilling and laboratory tests was prepared with technical interpretation and comments.

D2.2.3 Environmental Impact Assessment Study

In order to examine and evaluate the conceivable impacts on both natural and social environment brought from the implementation of the priority projects subject to the Feasible Study, Environmental Impact Assessment (EIA) Study was conducted. The objective of EIA Study also includes the recommendation on necessary countermeasures to make the Projects environmentally sound and sustainable. The EIA Study, including its methodology, was carried out in compliance with the related laws and regulations of the Republic of Indonesia.

The investigation was carried out by Natural Resource Management - Environmental Research Center (PPLH-SDA), Manado, under the sublet contract in accordance with the technical specifications prepared by the Study Team. The investigation was completed by the end of September 2002.

The priority projects targeted for the EIA Study are as follows:

- Lower Bone River Improvement,
- Lower Bolango River Improvement,
- Tapodu River Improvement with Tapodu Gate,
- Tamalate Floodway, and
- Sediment Trap Works in Lake Limboto.

The main components of the EIA Study are:

- To prepare KA-ANDAL, or TOR of the EIA Study, for the Projects;
- To grasp the existing environmental conditions in and around the Project sites by data collection and its analysis focusing on natural and social environments;
- To identify, predict and evaluate the conceivable environmental impacts brought about by the Project implementation;
- To develop and recommend the mitigation measures, environmental management plan (RKL) and monitoring plan (RPL);
- To prepare ANDAL, or EIA report, for the Projects; and
- To support the dissemination and the approval of KA-ANDAL and ANDAL to and/or from the AMDAL Commission, or EIA Appraisal committee, and other relevant organizations and local community.

(1) Collection and Analysis of Data and Information

- Review of the secondary data/information contained in both published and unpublished documents;
- Interpretation and analysis of maps, photographs, and other materials;
- Field reconnaissance and observation, surveying and/or measurement, map development, and laboratory analysis especially for the data collection on physical environment;
- Trekking, sampling, identification, surveying, counting, measurement, calculation, and interview to the local people or other informants especially for the data collection on ecological environment; and
- Field reconnaissance, surveying, map creation, interview to and discussion with the local people, community groups, and representatives of local bodies especially for the data collection on socio-economic and cultural environment.

(2) Impact Assessment

The environmental impacts brought from the project implementation were examined and evaluated corresponding to three stages of project works: pre-construction, construction and operation stages. The magnitude, extent and location of the impacts were predicted quantitatively and concretely as much as possible.

(3) Development and Recommendation of RKL/RPL

After the detailed analysis and the evaluation of the conceivable impacts, practicable mitigation measures were studied in order to enhance the positive impacts and/or to minimize negative impacts. Regarding such impacts as loss of property and/or asset, compensatory measures were proposed. RKL/RPL include how to manage and monitor the environmental status, including parameters, method, schedule or frequency, implementation organization or manpower, and the cost for its execution. Mitigation measures and RKL/RPL were specified for both construction and operational stages.

(4) Report

As a result, a report was prepared as an output of the EIA Study, including all the materials prepared in the course of the EIA Study such as maps and diagrams.

Table D2.1.1 EXISTING AERIAL PHOTOGRAPHS TAKEN IN 1991

Course	Photograph	Number
Su-19	15-1	15
Su-19A	2-1	2
Su-18A	1-2	2
Su-18	1-15	15
Su-17	17-1	17
Su-17A	2-1	2
Su-16	1-6	6
Su-16	12-15	4
Su-15	15-1	15
Su-14	9	1
Su-14B	1-6	6
Su-14A	1-7	7
TL-1	11-1	11
TL-2	1-7	7
	Total	110 photographs

Table D2.1.2 RESULT OF CONTROL POINT SURVEY

Name	X(m)	Y(m)	H(m)
BPN-18119	507,229.4032	58,079.4061	3.263
N-4002	503,243.3070	66,866.1200	-
BO-01	-	-	8.716
LBB-01	506,425.1080	58,273.0745	2.564
LBB-02	507,495.8358	58,583.0911	1.991
LBB-03	507,823.6253	58,904.2486	4.043
LBB-04	507,670.1848	59489.8830	4.519
LBB-05	506,474.5976	59,606.0259	3.792
LBB-06	505,559.9265	59,602.4948	4.532
LBB-07	504,947.2862	61,202.4289	5.525
LBB-08	503,598.8151	62,388.0958	8.681
LBB-09	502,990.5830	61,611.8291	7.533
LBB-10	503,659.9173	60,523.7458	5.258
LBB-11	503,375.2276	60,418.7621	8.641
LBB-12	497,873.8245	61,087.3253	10.891
LBB-13	492,713.8520	63,252.7112	19.452
LBB-14	492,037.7156	66,280.9335	9.357
LBB-15	494,643.6256	68,906.0159	7.477
LBB-16	497,622.6223	66,363.1438	6.195
LBB-17	497,748.9012	68,873.2596	11.060
LBB-18	501,811.8679	68,126.2342	16.283
LBB-19	501,423.1600	63,812.9924	6.186
LBB-20	504,804.1878	64,122.1175	12.238

X,Y: national coordinate

H: above mean sea level

Table D2.1.3 OBSERVED TIDE LEVEL OF TOMINI BAY

Time	6:00	8:00	10:00	12:00	14:00	16:00	18:00	20:00	22:00
Elevation	0.231	0.431	0.081	-0.259	-0.371	-0.119	0.251	0.378	0.168

＊ Observation: 10/08/2001

＊ Station: Tomini bay

＊ Elevation(m): From Bench-mark BPN-18119

Table D2.1.4 ACCURACY OF DIRECT LEVELING

Name	Error	Distance	Allowable max. error
From BPN-18119 to BO-01	5.6cm	9.8km	15.7cm
From BPN-18119 to LBB-11	5.1cm	11.4km	16.9cm
From BO-01 to LBB-08	1.9cm	50.0km	35.4cm

Table D2.1.5 LIST OF CROSS SECTION SURVEY

No	Name	Abbreviation	Distance (km)	Number	Width (m)	Bridge	Remark
01	River mouth	RM	1.5	5	500	0	
02	Bone	BNE	17.5	20	125	0	
03	Bolango	BOL	13.65	15	40	1	
04	Bolango	BOL	6.0	7	40	5	
05	Siendeng	SDG	1.5	3	40	1	
06	Limba	LIM	6.25	10	20	6	
07	Bunto	BUN	5.0	10	20	8	
08	Bunto	BUN	4.1	6	20	3	
09	Tapodu	TPD	2.5	5	20	2	
10	Ulanta	ULA	6.0	6	10	5	
11	Pangimba	PGB	4.65	6	10	3	
12	Ratuwangi	RAT	2.0	3	15	1	
13	Rwtenga	RW	8.85	10	15	2	
14	Alo-pohu	APO	10.7	15	15	2	
15	Alo	ALO	3.35	3	15	0	
16	Reksonnegoro	REK	4.0	3	15	1	
17	Pohu	POL	3.25	3	15	0	
18	Marisa	MAR	5.0	5	20	4	
19	Mohupo	MOH	4.2	5	20	5	
20	Biyonga	BYO	7.5	10	20	2	
		Total	117.5	150		51	

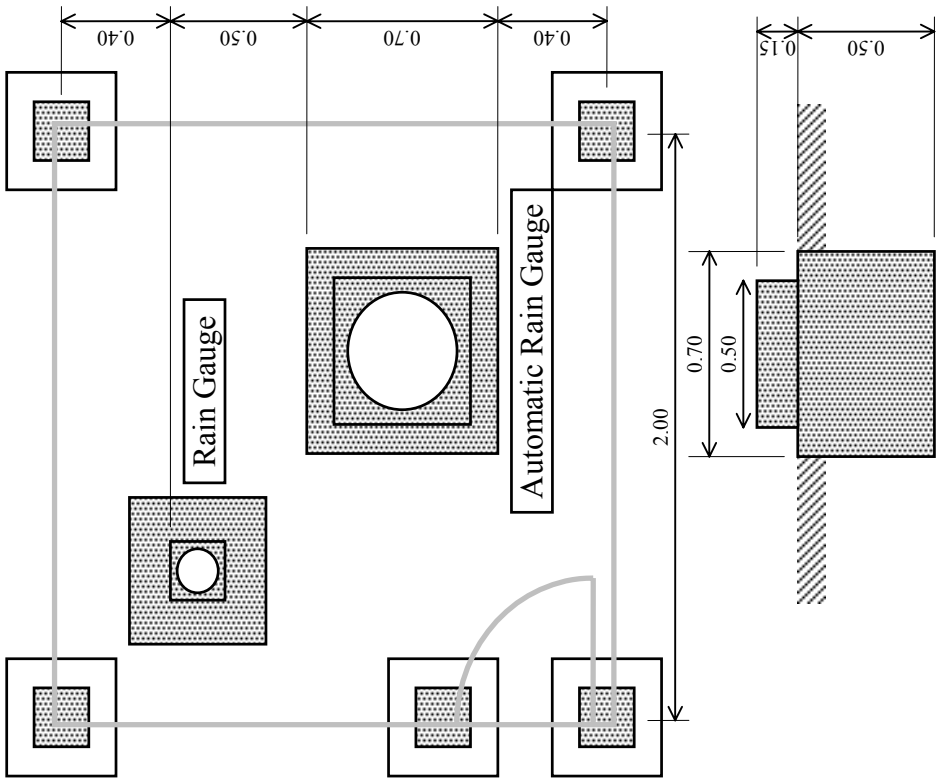
Table D2.1.6 INVESTIGATION OF WATER QUALITY AND BOTTOM-SEDIMENT

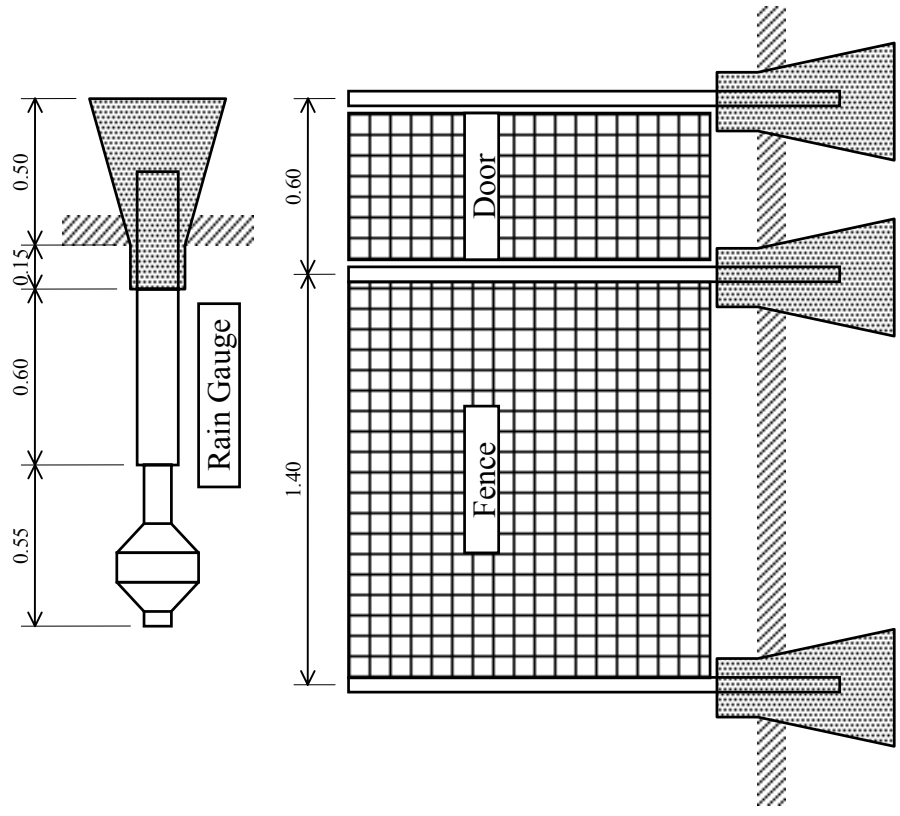
Sampling Point No.	River/Lake and Sampling Point	Objectives
1	Pohu River, at a bridge in Tonuliita.	To analyze the current conditions of water quality and bottom-sediment, sedimentation and nutrient from Pohu river basin.
2	Alo River, at about 50 m above the confluence with Pohu River.	To analyze the current conditions of water quality and bottom-sediment, sedimentation and nutrient from Alo river basin.
3	Alo-Pohu River, at a bridge in Tumbuo in front of a small shop.	To analyze the current conditions of water quality and bottom-sediment, sedimentation and nutrient from Alo-Pohu river basin.
4	Bionga River, at most down stream point in Lahe.	To analyze the current conditions of water quality and bottom-sediment, sedimentation and nutrient from Bionga river basin.
5	Bolango River, at a bridge of Bendung Lomaya.	To measure the water quality and bottom-sediment in upstream area of Bolango river where no big human activities seemed to take place.
6	Bolango River, at about 50 m above the confluence with outlet flow from Lake Limboto.	To analyze the water quality and bottom-sediment in downstream area where the effect of domestic effluent and agricultural drainage take place.
7	Outlet flow of Lake Limboto, at the bridge constructed in Tilote district.	To analyze the current conditions of water quality and bottom-sediment at the 'pipe end' of Lake Limboto.
8	Bolango River, at a bridge in Tenda.	To analyze the current conditions of water quality and bottom-sediment from Limboto and Bolango basin.
9	Ulanta River, at a bridge in Dusun 2.	To measure the water quality and bottom-sediment in upstream area of Tamalate river where no big human activities seemed to take place.
10	Tamalate River, at a bridge in Bugis.	To analyze the water quality and bottom-sediment in downstream area where the effect of domestic effluent and agricultural drainage take place.
11	Bone River, at a bridge in Tulabolo.	To measure the water quality and bottom-sediment in upstream area, focusing to analyze the effect of reported illegal gold mining.
12	Bone River, at Talumolo Bridge.	To analyze the water quality and bottom-sediment in downstream area where the effect of domestic effluent and agricultural drainage take place.
13	Bone River, at river mouth in Tenda.	To analyze the water quality and bottom-sediment from Limboto-Bolango-Bone basin.
14	Lake Limboto, at the center of the lake.	To analyze the water quality and bottom-sediment at the center of Lake Limboto where the deepest point as a benchmark.
15	Lake Limboto, at the north of the lake.	To analyze the water quality and bottom-sediment at the north of Lake Limboto to compare with the result from the center.

Table D2.1.7 VILLAGES SELECTED FOR SOCIAL SURVEY

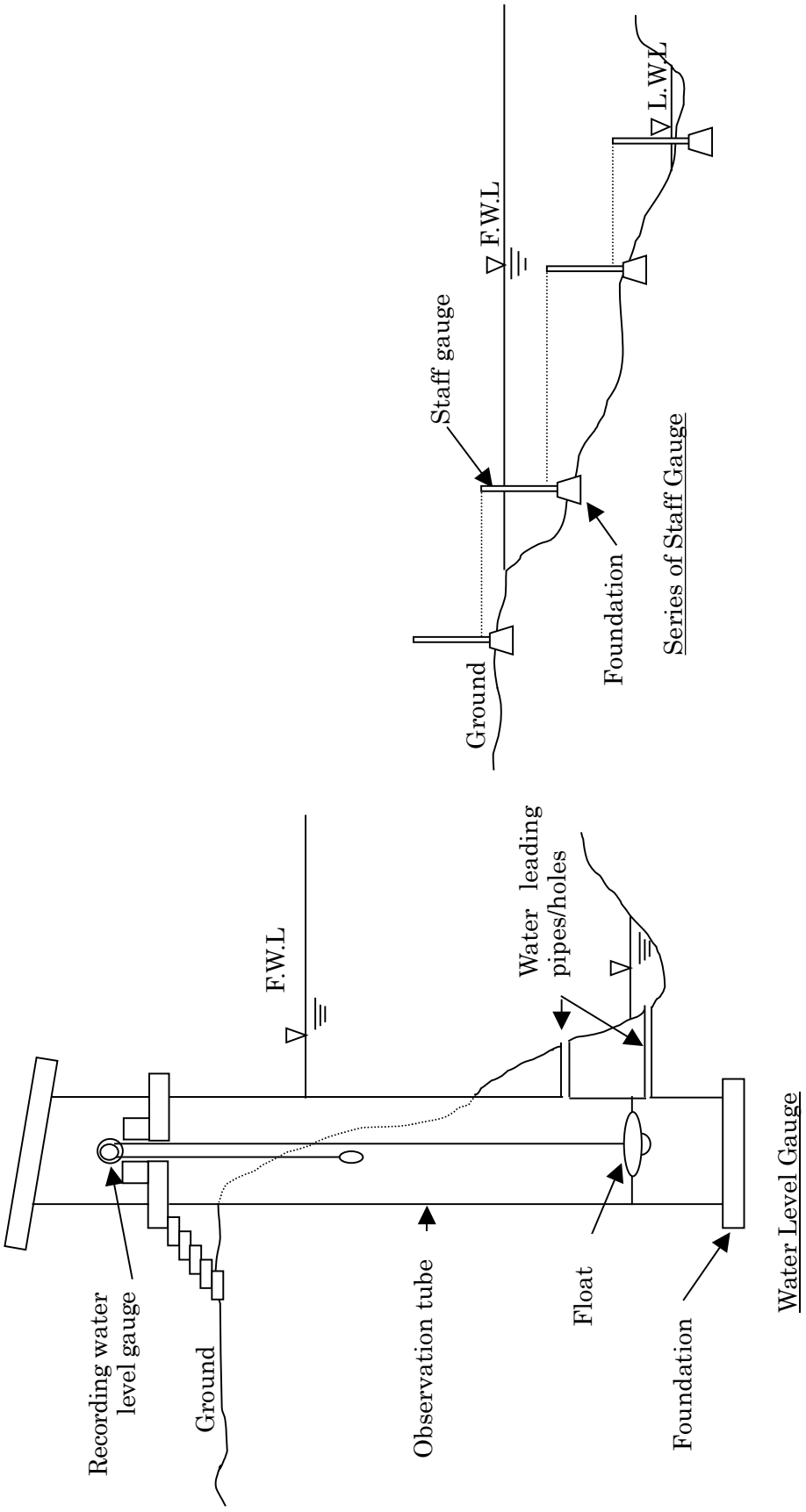
20 households are to be interviewed by site. 20 x 20 = 400 * *flood prone area, ( ) major industry*

Kota / Kecamatan	number of sites village	River Name	Name of villages lower reach	midstream	upper stream	flood prone number	area
Kec. Limboto	1 Hunggaluwa *					1	* 1
		Biyonga	1 Kayumerah	1 Biyonga	1 Bulota	3	
		Alopohu	1 Tunggulo *			1	* 1
Kec. Tibawa	1 Isimu Selatan*					1	* 1
		Alo		1 Datahu	1 Labano	2	
Kec. Batudaa		Pohu		1 Tahupo		1	
		Ambara (Alopohu's branch)			1 Pilolalenga	1	
	1 Payunga					1	
Kec. Suwawa		Bone		1 Lombongo (tourism)	1 Pinogu * or Tulabolo	2	* 1
Kota Utara (Gorontalo)	1 Dulomo (rottan)					1	
Kota Barat (Gorontalo)	1 Molosipat W *	Bolango				1	* 1
Kota Selatan (Gorontalo)	1 Talumolo					1	
		Bolango	1 Siendeng *			1	* 1
Kec. Tapa		Bolango		1 Tupa	1 Longalo	2	
Kec. Telaga	1 Tilote *					1	* 1
TOTAL						20	7 (6)





The Study on Flood Control and Water Management in Limboto-Bolango-Bone Basin in the Republic of Indonesia *Japan International Cooperation Agency*	**Figure D2.1.1** **PROPOSED RAINFALL GAUGING STATION**



The Study on Flood Control and Water Management in Limboto-Bolango-Bone Basin in the Republic of Indonesia *Japan International Cooperation Agency*	**Figure D2.1.2** **PROPOSED WATER LEVEL GAUGING STATION**

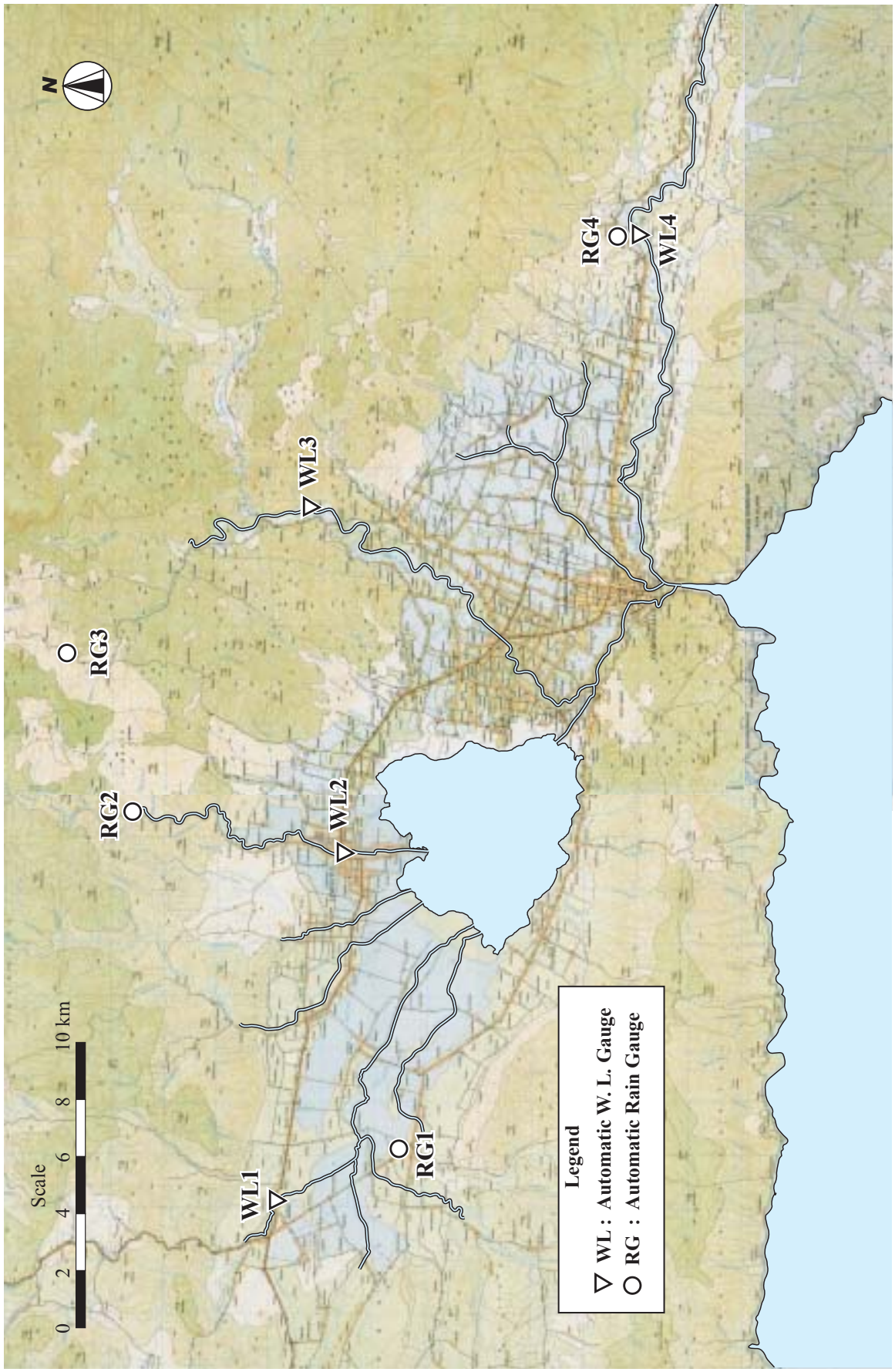


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Figure D2.1.3
LOCATION OF RAINFALL AND WATER LEVEL GAUGES NEWLY INSTALLED

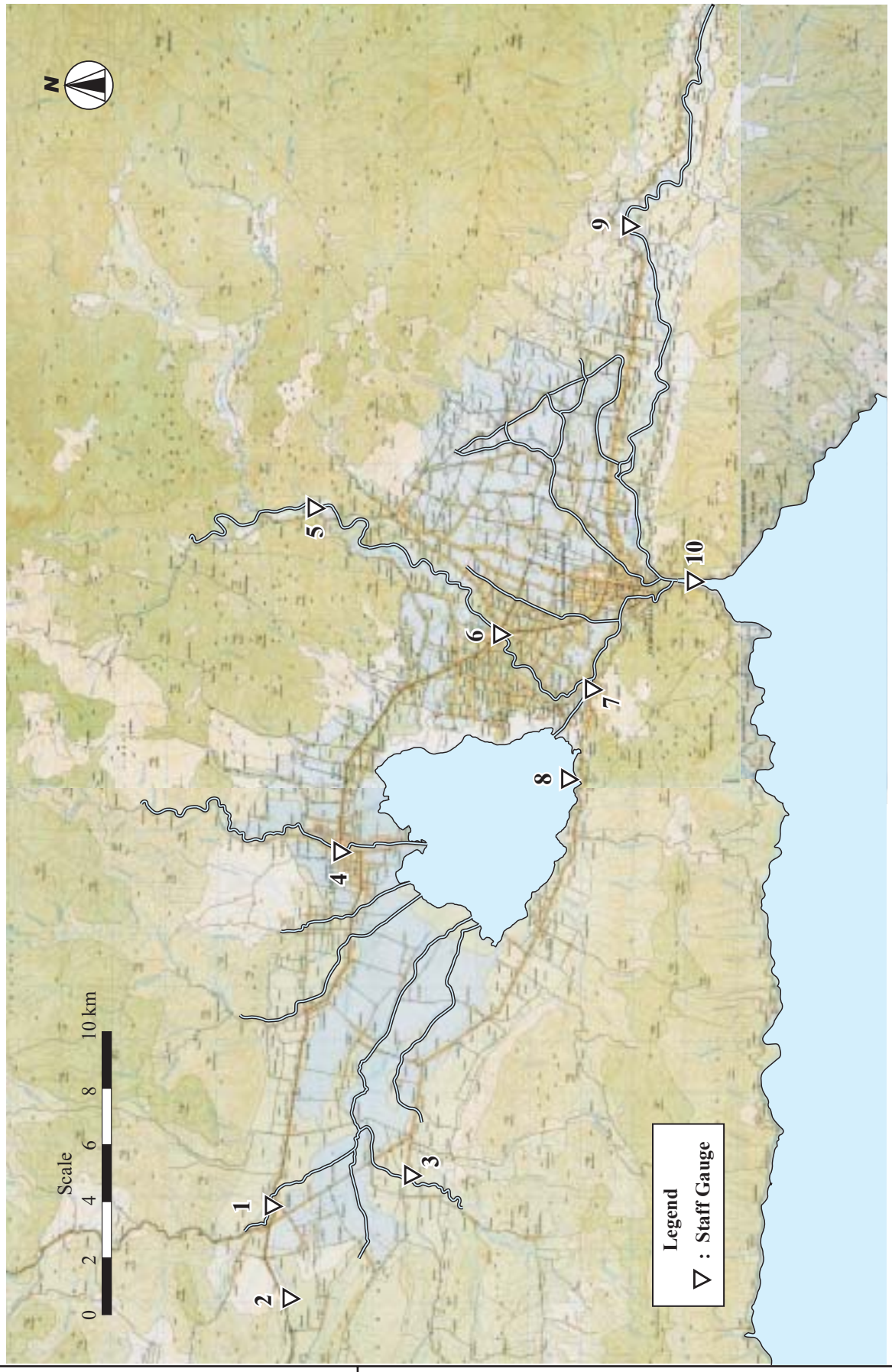

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Figure D2.1.4
LOCATION OF STAFF GAUGES FOR DISCHARGE MEASUREMENT SITES

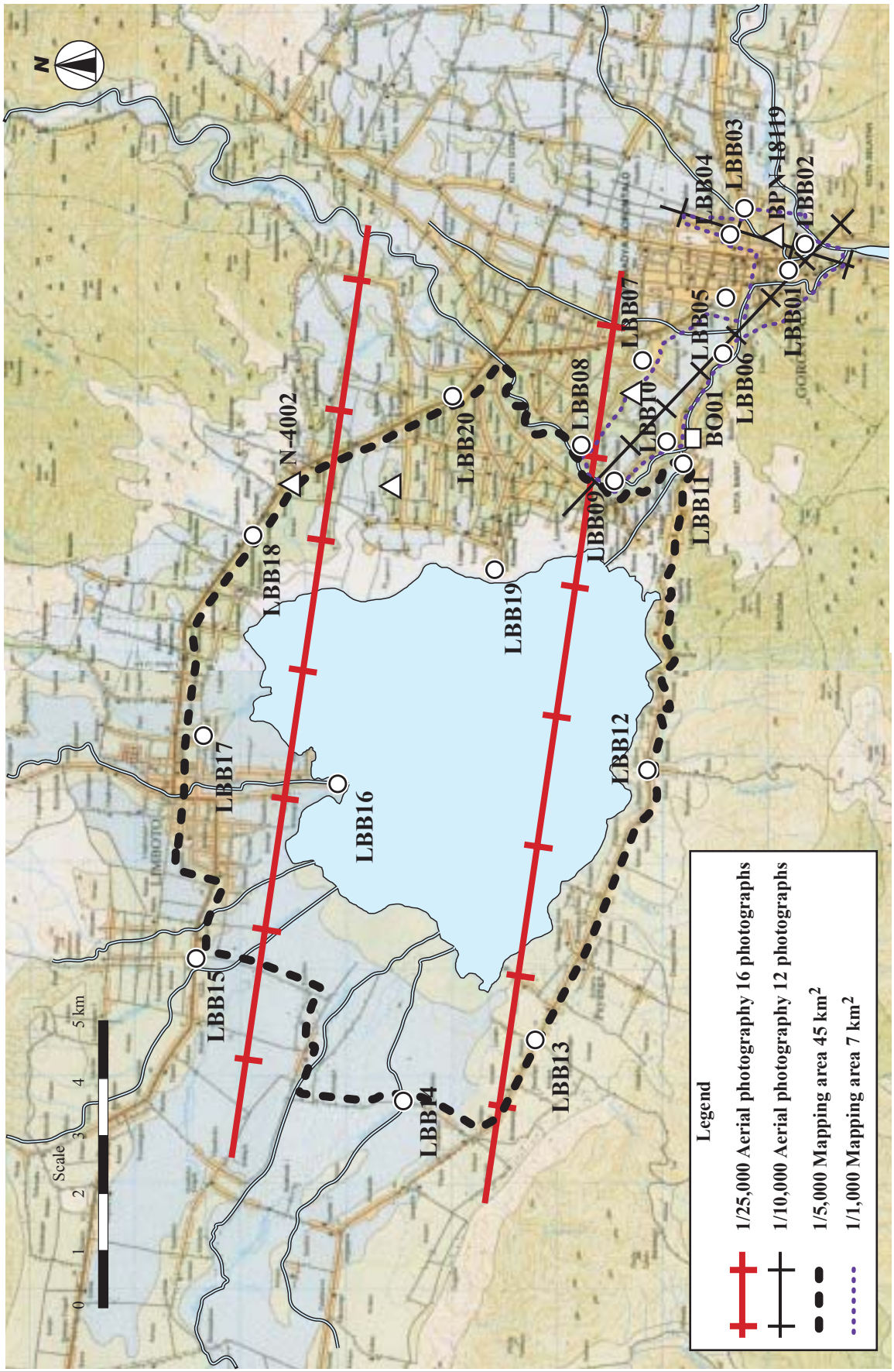

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Figure D2.1.5
LOCATION OF CONTROL POINTS FOR AERIAL PHOTOGRAPHY

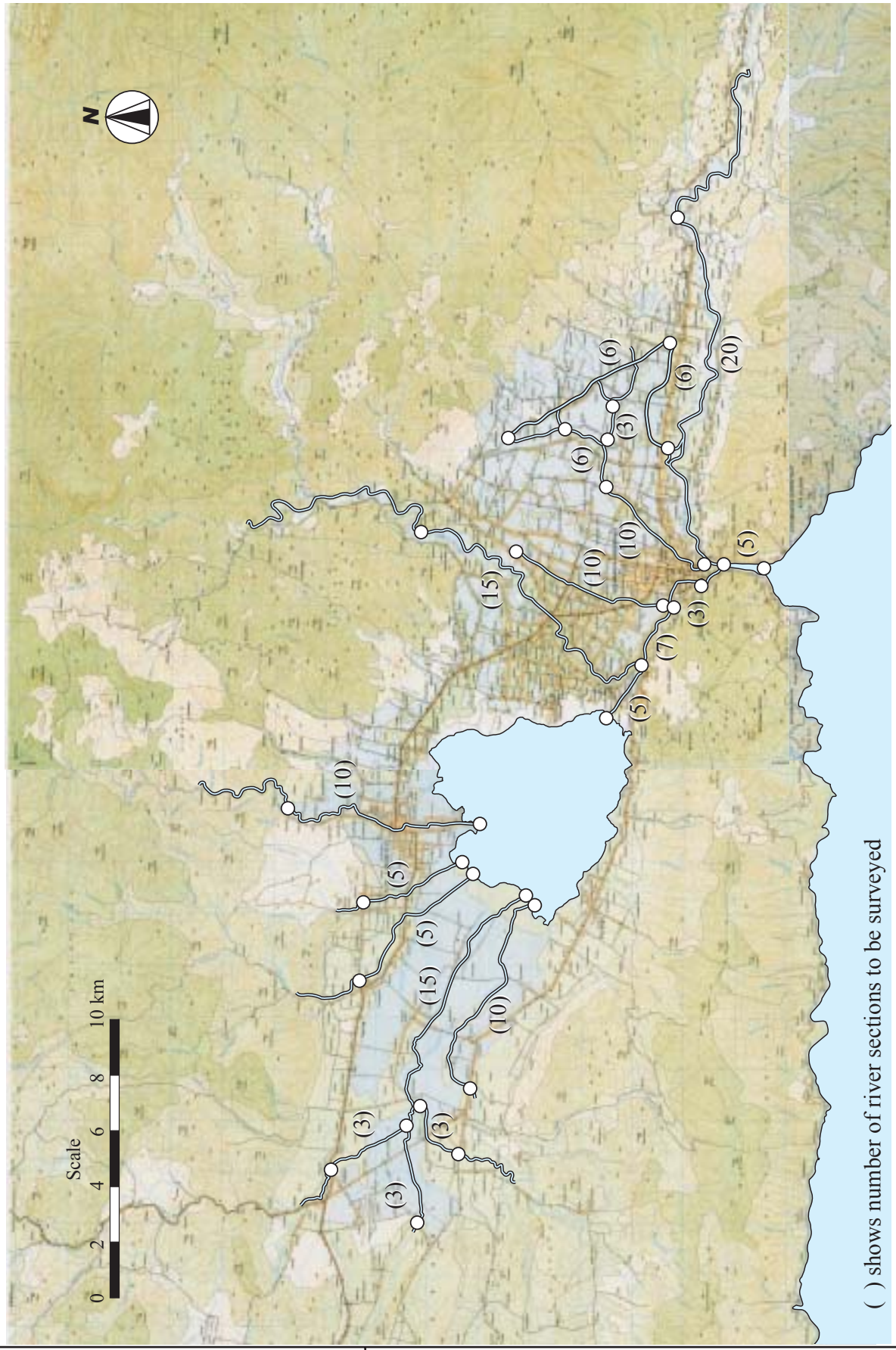

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Figure D2.1.6

LOCATION MAP OF RIVER SURVEY

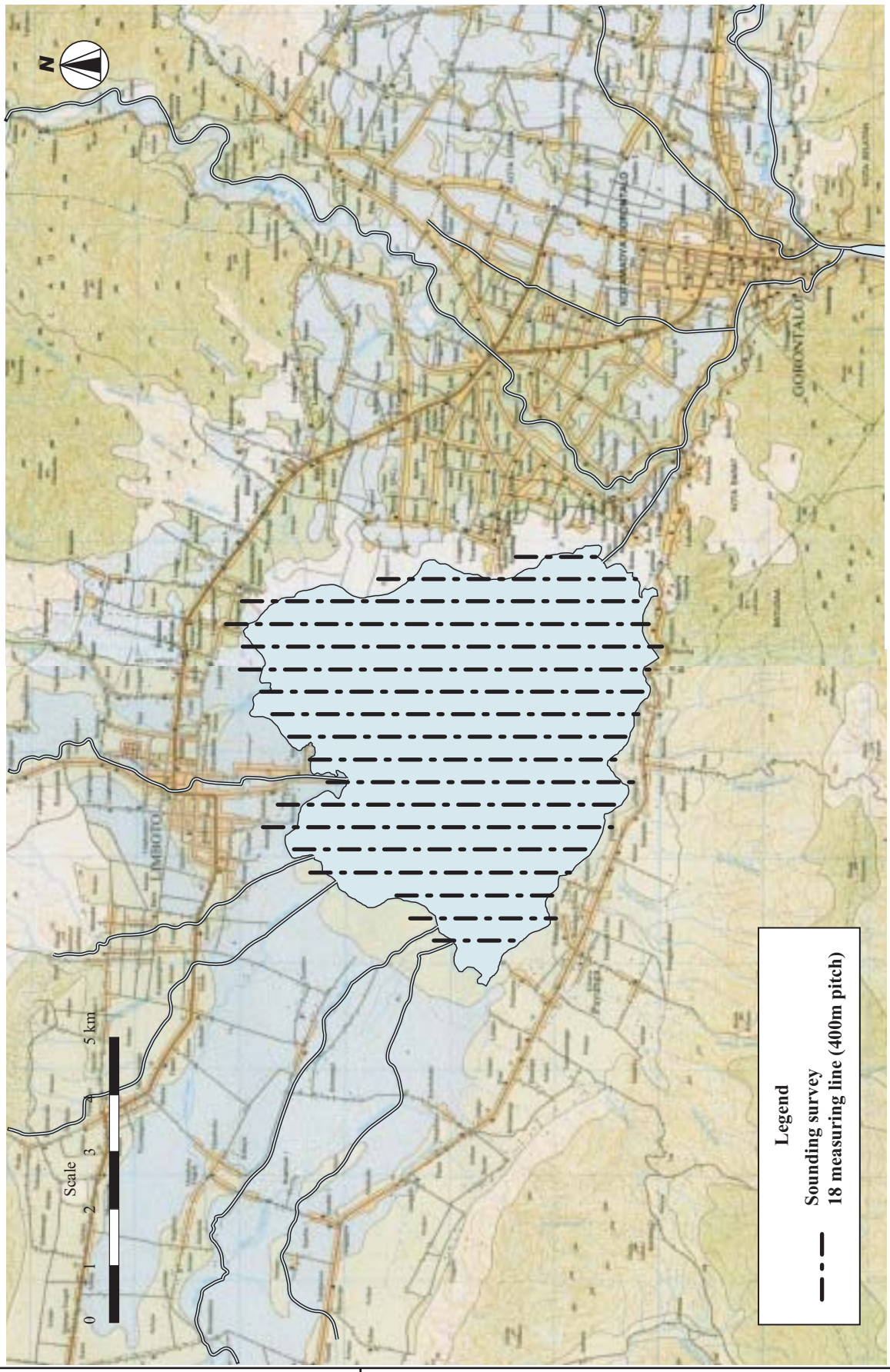

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Figure D2.1.7
LOCATION MAP OF SOUNDING SURVEY OF LAKE LIMBOTO