JAPAN INTERNATIONAL COOPERATION AGENCY (JICA)

ELECTRICITY OF VIETNAM
THE SOCIALIST REPUBLIC OF VIETNAM

FEASIBILITY STUDY
ON
DONG NAI NO.3 AND NO.4 COMBINED HYDROPOWER PROJECT
IN
THE MIDDLE REACHES OF THE DONG NAI RIVER
IN
THE SOCIALIST REPUBLIC OF VIETNAM

FINAL REPORT

VOLUME III-2
SUPPORTING REPORT

Appendix B : Topographic Survey
Appendix C : Hydrological Investigation
Appendix D : Environmental Survey
Appendix E : Examination of Project Layout Plan
Appendix F : Data Related to Power Transmission System and Explanation of EGEAS

MARCH 2000

NIPPON KOEI CO., LTD.
TOKYO ELECTRIC POWER SERVICES CO., LTD.

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Composition of the Final Report

Volume I : Executive Summary

Volume II : Main Report

Volume III-1: Supporting Report

Appendix A : Geological Investigation

Volume III-2: Supporting Report

Appendix B : Topographic Survey

Appendix C : Hydrological Investigation

Appendix D : Environmental Survey

Appendix E : Examination of Project Layout Plan

Appendix F : Data Related to Power Transmission System and Explanation of EGEAS

Currency Exchange Rates Adopted for the Study

US$1.00 = VND 13,870
VND 1.00= ¥ 0.008219
(in March 1999)

Appendix B :

Topographic Survey

Appendix B : Topographic Survey

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Appendix B : Topographic Survey

B1 OUTLINE OF TOPOGRAPHIC SURVEY

B1.1 General

The topographic survey for feasibility study on the Dong Nai No.3 and No.4 Combined Hydropower Project was carried out to produce the basic topographic materials required for the feasibility study. The topographic survey works including preparation of the survey products were performed by the local contractor (PECC2) on a local contract basis in a strict accordance with the specifications prepared by the JICA Study Team. The survey works commenced in early June 1999 and finished in the middle of October 1999.

The survey area is located in the middle reach of Dong Nai river which is very steep-sloped with very dense forest. The field works were executed in the rainy season of the year 1999 that lasted almost up to the end of the year. Due to the unexpected bad weather conditions in 1999, the local survey teams encountered the difficulties in completing the survey works as scheduled. In particular, it was too hard to perform the river cross section survey and longitudinal river profile survey in the river portions of rapids where it was quite dangerous to enter into the middle portions of the river over long period during the field work. Moreover, the local survey teams had to access from the right river bank side to the left one at Dong Nai No.4 site by moving hundreds kilometers on the national Road, since it was very dangerous to cross the river by boat due to the very fast rapid. During the rainy season of the year 1999, the floods washed away bridges on road that connects the project site and Gia-Nghia, the nearest major town to the project site. Because of the floods, it was difficult to commute the project site and the town for some time. These natural conditions resulted in a delay of the completion of topographic survey from the originally planned completion time by about three weeks.

Although the smooth execution of the topographic survey works was significantly hampered by the said unusual weather conditions of latter period of 1999, they had been completed satisfactorily in the end of October 1999.

B1.2 Outline of Topographic Survey

The main items of topographic survey are 1:1000 topographic mapping, river cross section and longitudinal profile survey at dam and powerhouse sites of Dong Nai No.3 and No.4 hydropower schemes.

In addition, the control surveys required for the above topographic survey were done by GPS, and the necessary traversing and leveling therefor were also conducted in accordance with the specifications prepared by the JICA Study Team.

B1.3 Survey Instruments and Equipment

The following instruments and equipment were used to perform the topographic survey at the field:

List of Survey Instruments and Equipment Used

Item	Model	Manufacturer	Tech. Specification	Quantity
GPS	SR-9400	Leica, Switzeland	10mm + 2ppm	2 receivers
Total Station	TC-600	Leica, Switzeland	5", 3mm + 3ppm	1 set
	TC-400	Leica, Switzeland	10", 5mm + 5ppm	1 set
	GTS-	Topcon, Japan	5", 5mm + 5ppm	1 set
EDM	RED-2L	Sokkia, Japan	2mm + 2ppm	1 set
Theodolite	Theo 020	Germany	5"	1 set
	T2	Russia	3"	1 set
Level	NA 820	Leica, Switzeland	2.5mm/ double-run km	1 set
	H3T	Russia	4.0mm/ double-run km	2 set

B1.4 Survey Datum

Prior to the start of the regular field survey works, the Survey Expert of the JICA Study Team collected and examined the basic survey datum in collaboration with the surveyors of the local contractor. Besides, the basic survey datum used in the topographic survey for the previous pre-feasibility study was carefully checked. Finally, the following survey datum systems was adopted for topographic survey in the present feasibility study:

- Horizontal datum (coordinate system) : UTM in 48th zone
- Vertical datum (elevation) : Mean sea level at Hatien, national elevation system.

B2 TOPOGRAPHIC SURVEY WORKS PERFORMED

B2.1 Horizontal Control Survey

B2.1.1 GPS Survey

(1) Observation

For the Dong Nai No.3 area, the control point network was established through the topographic survey conducted in the previous pre-feasibility study. Therefore, the GPS survey in the present feasibility study was carried out to extend the control network of Dong Nai No.3 area to the Dong Nai No.4 area because there was no existing control point network in the Dong Nai No.4 area.

In the present feasibility study, it was planned that the GPS net is composed of 8 points, of which 3 points are a reference point (D001, D003 and DN4-4) and 5 points are new point (DN4-1, DN4-2, DN4-3, DN4-5, DN4-6).

The reference points are as follows:

- D001 and D003 belong to the network based on the national triangulation points 61225 and 61228 which had been used for 1:10,000 topographic mapping of the Dong Nai No.3,
- DN4-4 belongs to the network based on D001 and the national triangulation point 61216 which had been used for 1:10,000 topographic mapping of the Dong Nai No.4.

The GPS survey was carried out for 13 sections of observation (13 base lines). The actual survey schedule was shown blow:

Base Line		Observation Date (1999)						
From.	To	Before Jun. 12	June 12	June 13	June 15	July 16	July 17	July 22
D001	D003			x				
D001	DN4-1	x						
D001	DN4-2	x						
DN4-1	DN4-2	x						
DN4-1	DN4-3				x			
DN4-1	DN4-4		x					
DN4-2	DN4-3		x					
DN4-2	DN4-4				x			
DN4-3	DN4-4				x			
DN4-3	DN4-5					x		
DN4-3	DN4-6						x	
DN4-4	DN4-6						x	
DN4-5	DN4-6							x

During the field survey, the observation using GPS could not be continuously performed

because of the rainy condition that took place almost every day.

The minimum observation time was 38 minutes in DN4-4-DN4-6 base line, while the maximum one was 118 minutes in D001-D003 base line. The standard observation time took 30 minutes for baselines within 15 km (static mode).

At least, 5 satellites were simultaneously used for the GPS survey. The GPS network is shown in Figure B2.1.

(2) Processing and computation results

The GPS observation data were processed by the SKI software package attached to the GPS instrument.

The GPS data were processed in 3 steps, namely observation data processing, network adjustment and transforming coordinates from WGS-1984 to UTM in zone 48th.

1) Observation data processing:

The data processing was made in baseline mode. The baselines of similar length and same observation day were put into same window of processing. The D001 point was used as initial reference point to process baselines. In succession, the processed point was used as reference point to process the next baselines, and the processing was repeated for the remaining baselines.

The results of the observation data processing are shown in the following table:

Reference	Rover	Slope Dist. (m)	$S_{Lat.}$ (m)	$S_{Lon.}$ (m)	S_{Height} (m)
D001	D003	3671.880	0.0005	0.0005	0.0020
D001	DN4-1	6976.032	0.0005	0.0005	0.0019
DN4-1	DN4-2	4372.604	0.0003	0.0003	0.0012
D001	DN4-2	8812.785	0.0005	0.0006	0.0021
DN4-2	DN4-3	4872.605	0.0005	0.0006	0.0016
DN4-1	DN4-4	7129.062	0.0009	0.0007	0.0022
DN4-1	DN4-3	7096.142	0.0005	0.0004	0.0012
DN4-2	DN4-4	4649.428	0.0005	0.0005	0.0011
DN4-3	DN4-4	416.690	0.0004	0.0003	0.0009
DN4-3	DN4-5	5935.082	0.0008	0.0005	0.0022
DN4-4	DN4-6	5973.086	0.0005	0.0004	0.0013
DN4-3	DN4-6	5916.583	0.0005	0.0005	0.0010
DN4-6	DN4-5	240.211	0.0007	0.0004	0.0015

2) Network adjustment

As shown in Figure B2.1, the 3 reference points are those of 2 different networks and they do not have the same accuracy. In case that all of them are used as reference (fixed) point, therefore, the network may be unexpectedly distorted. For the reason, the network was freely adjusted, that is, no points in the network were fixed, to find the most

probable value of vectors of base lines.

The results of network adjustment for the base lines are shown below:

From	To	Length (m)	$d_{Lat.}$ (m)	$d_{Lon.}$ (m)	d_{Length} (m)	Standard (=10+2ppm x I_{Leg})
D001	D003	3672	0.000	0.000	0.000	0.017
D001	DN4-1	6976	0.005	-0.006	0.008	0.024
DN4-1	DN4-2	4373	0.001	-0.002	0.002	0.019
D001	DN4-2	8813	-0.007	0.010	0.012	0.028
DN4-2	DN4-3	4873	-0.004	-0.006	0.007	0.020
DN4-1	DN4-3	7096	0.001	0.001	0.001	0.024
DN4-1	DN4-4	7129	0.004	0.001	0.004	0.024
DN4-3	DN4-4	417	0.002	-0.004	0.004	0.011
DN4-2	DN4-4	4649	-0.003	0.007	0.008	0.019
DN4-3	DN4-5	5935	-0.007	-0.001	0.007	0.022
DN4-6	DN4-5	240	0.001	0.000	0.001	0.010
DN4-4	DN4-6	240	0.001	0.001	0.001	0.010
DN4-3	DN4-6	5917	-0.009	0.006	0.011	0.022

The adjusted Coordinates in WGS-1984 were derived as follows:

No.	Point	Ordinate	Value	Residual (m)
1	D001	Latitude	11°52'52.79048"	0.007
		Longitude	107°51'09.47344"	0.005
		Height	852.164m	0.016
2	D003	Latitude	11°52'03.38490"	0.011
		Longitude	107°52'59.90414"	0.010
		Height	917.381m	0.029
3	DN4-1	Latitude	11°54'22.81594"	0.004
		Longitude	107°47'37.88853"	0.003
		Height	852.755m	0.011
4	DN4-2	Latitude	11°52'23.05556"	0.004
		Longitude	107°46'19.88858"	0.004
		Height	849.512m	0.010
5	DN4-3	Latitude	11°53'23.77881"	0.004
		Longitude	107°43'51.30748"	0.003
		Height	661.653m	0.009
6	DN4-4	Latitude	11°53'10.51441"	0.004
		Longitude	107°43'54.15964"	0.004
		Height	664.966m	0.010
7	DN4-5	Latitude	11°52'55.49976"	0.008
		Longitude	107°40'37.32867"	0.005
		Height	634.848m	0.018
8	DN4-6	Latitude	11°53'03.09302"	0.005
		Longitude	107°40'36.97379"	0.004
		Height	578.838m	0.012

3) Transforming coordinates in WGS-1984 system to those in zone 48th UTM system

The coordinates system of reference points that were computed in the WGS-1984 system were transformed to those in the 48th UTM system in the following steps:

- Adjusting network to WGS-1984 coordinates of reference points D001, D003, DN4-4,
- Transforming to coordinates in the UTM in zone 48.

Using the "Coordinate Transformation Utility of SKI software" and based on coordinates in both systems WGS-1984 and 48th zone UTM of reference points D001, D003, DN4-4, the coordinates of all the points in the network were transformed from WGS-1984 to zone 48th UTM.

The final coordinates in 48th zone UTM system are as follows:

Point	North	East	Elevation
DN4-1	1317406.102	804765.974	736.696
DN4-2	1313699.819	802440.695	732.096
DN4-3	1315522.460	797922.520	544.465
DN4-4	1315115.447	798012.902	547.656
DN4-5	1314595.774	792056.740	516.912
DN4-6	1314829.141	792043.749	460.974

Notes: Elevation above is UTM ellipsoidal height.

The coordinates calculated with distance at actual elevation are summarized below:

Point	North	East	Elevation	Remarks
DN4-3	1315522.212	797922.573	546.444	Fixed for calculation
DN4-4	1315115.447	798012.902	549.746	
DN4-5	1314596.083	792060.253	520.014	
DN4-6	1314829.321	792047.289	463.931	

Note: Elevation above is geoidal height determined by leveling.

B2.1.2 Traverse Survey

The 1st Grade traverse survey and the equivalent control point survey was carried out to install the primary control points for mapping, river cross section and longitudinal profile survey and other surveys at the Dong Nai No.3 and Dong Nai No.4 dam sites and powerhouse sites. For Dong Nai No.3 dam site, no new control points were needed because there were the existing points that were sufficiently available for the purpose of those topographic survey at the site.

1) Observation

At the Dong Nai No.3 powerhouse site, a loop traverse of 5 new points originates from the existing D001 GPS point at the Dong Nai No.3 dam site. These points were I-CP01, I-CP02, I-CP03, I-CP03-1 and I-CP04.

At the Dong Nai No.4 dam site, the 1st grade traverse network was set up based on the two GPS points, namely DN4-3 and DN4-4.

At the right bank area, a loop traverse of 2 new points I-CP01 and I-CP02 originates at GPS point DN4-3 and is closed to the GPS point DN4-4. In addition, 2 points I-CP03 and I-CP04 of 2 one-leg open traverses were radiated from DN4-3 and DN4-4 GPS points.

To make control points in the left bank area, intersection from traverse points in the right bank area were made. There are 2 intersection points, namely I-CP05 and I-CP06, each of which was observed from 2 points DN4-4 and I-CP03 with Total Station (GTS 211D) by two fairs of horizontal angle measurement, one fair of vertical angle measurement and 4 distance readings. In addition, 2 points I-CP07 and I-CP08 of 2 one-leg open traverses were radiated from DN4-4 and I-CP04 points.

A traverse to connect I-CP08 and I-CP05 points were carried out with closing coordinates error of 1/5800. The traverses were surveyed with Total Station or Theodolite T2 using with EDM by two fairs of horizontal angle measurement, one fair of vertical angle measurement and 4 distance readings. As a result, the closing and different errors were confirmed to be within the limits specified in the Technical Specifications for the topographic survey.

2) Processing and results

The measurement data were carefully checked with respect their accuracy. All the traverses were processed by the Transit method. The calculation was carried out using the software Excel in accordance with the following work flow:

- Calculating closing error of measured angles in traverse based on reference azimuths and then balancing angles.
- Calculating coordinates of points from corrected angles and measured distances, then calculating closing coordinates error from calculated coordinates and reference coordinates.
- Balancing calculated coordinates by closing coordinates error and confirming the precision of traverse.

The closing errors and their limits of the traverses were calculated as shown below:

No	Location	Type	Number of new point	Length (m)	Closing Error			
					Angle	Limits	Coordinate	Limit
1	Dong Nai No.3 P.H. site	Fixed Traverse	5	5,324	28"	27"	1/44,000	1/8,000
2	Dong Nai No.4 Dam site	Fixed Traverse	2	625	-10"	20"	1/36,000	1/8,000
3		Intersection	1	1,266	-	-	1/60,200	1/8,00
4		Intersection	1	1,348	-	-	1/64,400	1/8,00
5		Open	4	1,590	-	-	-	-
	Total		13	10,15				

Note: - Limits on angle is $10"\sqrt{n}$, where n is number of measured angles.

In each survey area, some theodolite traverses were established as second control ones running through the area to provide observation stations and points for survey routes. These theodolite traverses have a closing angle error of less than 60" and a closing coordinates error of less than 1/1000.

B2.2 Vertical Control Survey

B2.2.1 Leveling

The leveling of class 4th or the equivalent leveling was carried out for the purpose of check leveling and link leveling.

A check leveling route to verify elevation of existing benchmarks which were constructed in the previous pre-feasibility study stage was set up to connect the national 2nd class benchmark DN-DL-6A and national 2nd class benchmark DN-DL-3. Besides, some other sectional check leveling routes were established. The check leveling had found some errors of data worked out in the previous pre-feasibility study stage in which an elevation error of approximately 0.1m of benchmarks in Dong Nai No.3 area was found.

The link levelling was done to determine elevations of control points and other points in the survey areas. The levelling routes were set as follows:

- An open leveling route originates from benchmarks IIDN-DL-3 and IIDN-DL-6A to determine elevations of control points I-CP-01, I-CP-03-1, and I-CP-02 at the Dong Nai No.3 powerhouse site,
- An open leveling route originates from benchmarks IIDN-DL-3 and IIDN-DL-6A to determine elevations of control points DN4-1 and DN4-4 in Dong Nai No.4 dam site,
- An open leveling route originates from GPS point DN4-4 to determine elevations of control points I-CP01, I-CP02, DN4-3 at Dong Nai No.4 dam site, and
- A fixed leveling route starts at I-CP08 in the right bank of Dong Nai No.4 dam site to determine elevation of GPS points DN4-5 at Dong Nai No.4 powerhouse site and closes to I-CP05 on the right bank of Dong Nai No.4 dam site.

The open leveling was performed in two directions, namely forward and backward. All the levelling was carried out in the following procedures:

- Sighting length limit is 70m.
- Limit of difference between backsight and foresight lengths is 10m.
- Using two-face scaled staff, main face (black) and auxiliary face (red), were used.
- Readings were taken for two faces of staff, 3 wires on black face and middle wire on red face. These readings were used to check the accuracy of readings mutually.
- Closing error of leveling is $20\sqrt{L}$ km

The technical levelling (or direct leveling) and indirect leveling were used in the levelling.

The levelling was also done to determine elevations of traverse points in the survey area. The technical levelling (or direct levelling) and indirect levelling were used for the purpose. The closing error of these levelling is less than $50\sqrt{L}$ (L: one-way length in km) or $12\sqrt{n}$ (n is number of leveling stations) for technical leveling, and $6cm+\sum S\sqrt{n}$ ($\sum S$ is total length of leveling, n is number of sides) for indirect leveling.

B2.2.2 Cross-River Leveling

The levelling for the river cross section survey was carried out the by indirect levelling to determine elevations of control points on the left bank of Dong Nai No.4 dam site from control points on the right bank, since there was no means to cross the river due to the deep and fast river flow thereat during the topographic survey period.

The elevations of 1st Grade points I-CP05, I-CP06, I-CP07, I-CP08 on the left bank were also measured through traversing from DN4-4, I-CP03 and I-CP04 points on the right bank, of which I-CP05 and I-CP06 points were observed from both DN4-4 and I-CP03 points. Vertical angle was recorded at 2 positions of circle by two times readings for each. While, the distance was measured by 3 times readings.

Telescope height and target height were measured to 0.5 cm accuracy with steel tape.

B2.2.3 Computation and Results.

The measured Levelling data were processed with Excel on computer. The closing error was distributed proportionally to their distances.

The closing error and limits of accuracy and link levelling are shown below:

No	Leveling route	Length (km)	Closing error (mm)	Limits (mm)	Remarks
1	DN-DL-6A ---- DN-DL-	30.50	44	110	Check leveling
2	KM139 ---- T4	4.58	38	43	ditto
3	G15 ---- IV-01	0.30	5	11	ditto
4	G17 ---- IV-02	0.62	12	16	ditto
5	KM148 ---- I-CP01	1.19	6	22	Link leveling
6	I-CP03-1 ---- I-CP02	1.26	10	22	ditto
7	DN-DL-3 ---- DN4-4	10.04	4	63	ditto
8	DN4-3 ---- DN4-4	0.68	29	62	ditto
9	I-CP05 ---- I-CP08	19.79	80	89	ditto
	Total	68.96			

Note: Limits is $20\ mm\sqrt{km}$ (km: one-way length)

The coordinates and elevations of the control points which were determined through the horizontal and vertical control survey mentioned above are tabulated in Table B2.1.

B2.3 River Cross Section Survey

B2.3.1 Measurement

The river cross section was performed for the lines specified in the technical specifications in the contract document of the topographic survey. Concrete posts were installed at the both ends of each cross section. The coordinates of the concrete posts

were connected to those of control points through levelling and traverse survey.

The distance and elevation along cross-sections were determined by stadia and adjusted by coordinates and elevation of ending posts obtained by traverse and leveling survey using Total Stations that were linked to control points.

The ground elevations along cross-section were surveyed at about 5m interval on average.

B2.3.2 Drawing

The river cross sections were drawn to 1:1000 horizontal scale and 1:400 vertical scale using AutoCAD software of the local contractor (PECC2). The figures of river cross sections were laid out diagonally on A0 sized marginal sheet for each survey site.

Drawings were printed on paper for issue and also stored in diskette in DXF files and were compressed to ZIP file to save diskette space.

The length of survey lines for those river cross sections are as follows:

No.	Cross-section	Drawing No.	Length (m)		Location
			Surveye	Contra	
1	S-1	CS-DN3-DS-1	704.7	700	Dong Nai No.3 Dam site
2	S-2	CS-DN3-DS-2	1198.0	1200	ditto
3	S-3	CS-DN3-DS-3	637.9	600	ditto
4	S-4	CS-DN3-DS-4	294.6	200	ditto
5	S-5	CS-DN3-DS-5	332.4	200	ditto
6	S-6	CS-DN3-DS-6	356.5	200	ditto
7	S-7	CS-DN3-PH-1	702.9	700	Dong Nai No.3 Powerhouse
8	S-8	CS-DN4-DS-1	600.9	700	Dong Nai No.4 Dam site
9	S-9	CS-DN4-DS-2	988.5	1000	ditto
10	S-10	CS-DN4-DS-3	584.8	700	ditto
11	S-11	CS-DN4-PH-1	1143.2	800	Dong Nai No.4 Powerhouse
	Total		7544.4	7000	

B2.4 River Longitudinal Profile Survey

B2.4.1 Measurement

The river longitudinal profiles were made for the survey lines at the Dong Nai No.3 and No.4 dam and powerhouse sites. The both ends of longitudinal profiles were determined at field based on the design drawing in the technical specifications and they were marked by concrete on shore.

The traverse survey with Theodolite was performed along the river side to set up the coordinates of control points for surveying longitudinal profiles.

A boat equipped with an echo sounder drifts downstream in the river section where longitudinal profile was surveyed and stopped at points of about 50m interval and at featured points for sounding. The coordinates and elevation of these points were simultaneously determined with a Total Station from control points on shore. The water level was also simultaneously recorded at the time of sounding and referred to that at

previous time for interpolation later.

Sounding data were recorded on paper band, and coordinates and elevation were stored in diskette.

B2.4.2 Drawing

Drawing of longitudinal profiles was prepared by AutoCAD and plotted at horizontal scale of 1:2,000, vertical scale of 1:100 on marginal design sheet of A0 size.

The water level interpolated at the same time was also shown on the longitudinal profile, because water levels recorded at different times during the profile survey may have different values.

The drawing data were also stored in diskette in DXF format. The lengths of survey lines for the longitudinal profile survey are shown below:

No.	Longitudinal Profile	Drawing No.	Length (m)		Location
			Surveye	Contract	
1	P-1	LP-DN3-DS-	1700	1700	Dong Nai No.3 Dam site
2	P-2	LP-DN3-PH-	500	500	Dong Nai No.3 Powerhouse site
3	P-3	LP-DN4-DS-	1300	1300	Dong Nai No.4 Dam site
4	P-4	LP-DN4-PH-	500	500	Dong Nai No.4 Powerhouse site
Total			4000	4000	

B2.5 Topographic Mapping

B2.5.1 Measurement

The topographic mapping at 1:1000 scale was carried out for 4 locations, namely Dong Nai No.3 dam site, Dong Nai No.3 powerhouse site, Dong Nai No.4 dam site and Dong Nai No.4 powerhouse site. Most of those mapping areas were surveyed in grid. Some small parts with bit of obstruction were surveyed in radiation.

Before mapping, some traverses survey was done using theodolite so that the traverse lines run across the mapping area. They were used as second control points for mapping.

Some cross-sections with stakes at about 25m interval were placed through the center of the mapping area. The mapping areas were surveyed with Total Stations for both distance and height and connected to control points. This cross sections provide starting points for topographic survey routes on 2 sides. The topographic survey routes were then connected to control points. In addition, survey routes were also set along streams and roads to draw stream and road on the maps in more detail.

Most of topographic survey for the mapping was carried out with Total Station, but it was carried out by stadia in Dong Nai No.4 site due to the rather bad natural conditions. The observed data were recorded onto field book and Total Station card.

B2.5.2 Drawing

The draft drawings for Dong Nai No.4 site were prepared on transparent polyester film by

hand and that of Dong Nai No.3 was prepared by software on computer and then plotted to paper. These are known as original drawing. After preparation of original drawings, they were checked both in office and at field to confirm its accuracy and quality, and aloso for correction if any.

After checking and correction, the fair drawings were made on marginal design sheets at a scale of 1:1,000. The format of marginal design sheets, map symbols, annotation, marginal information and other application were prepared under the approval of Survey Expert of the JICA Study Team before they were applied to prepare the drawings.

The fair drawings were made on A1 size paper. Besides, the draft drawings which were manually prepared were digitised into computer. All of the fair drawings were printed by plotter.

The mapping areas for each structure site are listed in the following table:

No.	Location	Area Surveyed (ha)
1	Dong Nai No.3 Dam site	150
2	Dong Nai No.3 Powerhouse site	24
3	Dong Nai No.4 Dam site	110
4	Dong Nai No.4 Powerhouse site	36
	Total	320

The number of each map sheet is named as follows:

No.	Location	Number of map sheet	Drawing No.
1	Dong Nai No.3 Dam site	9	TM-DN3-DS-1/9 → 9/9
2	Dong Nai No.3 Powerhouse site	1	TM-DN3-PH-1/1
3	Dong Nai No.4 Dam site	7	TM-DN4-DS-1/7 → 7/7
4	Dong Nai No.4 Powerhouse site	3	TM-DN4-PH-1/3 → 3/3
	Total	20	

The above topographic mapping areas are shown in Figures B2.2 to B2.5.

B3 AERO-PHOTO MAPPING FOR DONG NAI NO.4 RESERVOIR AREA

In addition to the topographic survey works mentioned in the foregoing Chapter B2 that were carried out on a local contract basis, EVN produced the 1 to 10,000 scaled topographic maps through aero-photo mapping which covers the whole of the proposed Dong Nai No.4 reservoir area. An index of 1 to 10,000 scaled topographic maps prepared through the aero-photo mapping in 1999 and those prepared in the previous studies are shown in Figure B3.1.

The basic survey outcomes obtained through the topographic survey works mentioned in the foregoing Chapter B2 were used for aero-photo mapping carried out by EVN. Besides, the accuracy of the 1 to 10,000 scaled topographic maps was verified by the Survey Expert of the JICA Study Team in the course of the supervision of the topographic survey works undertaken by the local contractor.

The 1 to 10,000 scaled topographic maps covering the whole Dong Nai No.4 reservoir area that were provided by EVN to the JICA Study Team during the field investigation were effectively utilized for the feasibility study to construct the new Dong Nai No.4 reservoir storage curve. In addition, they were used to examine the waterway routes of the Dong Nai No.3 and No.4 schemes.

The reduced 1 to 10,000 scaled topographic maps produced by EVN are shown in Attachment to Appendix B : Topographic Survey Products.

B4 TOPOGRAPHIC SURVEY PRODUCTS

The following topographic materials that were used for the feasibility-grade design were produced through the topographic survey in the present feasibility study:

- Topographic maps at a scale of 1,000
- River cross sections
- River longitudinal profiles

The above survey products reduced from their original products are shown in Attachment to Appendix B : Topographic Survey Products together with the 1 to 10,000 scaled topographic maps prepared by EVN, that are discussed in the foregoing Chapter B3.

Appendix B

Tables

Table B2.1 Coordinates and Elevation of Control Points and Cross Section Posts (1/2)

Item	Point No.	Coordinates		Elevation (m)	Remarks
		North (m)	East (m)		
GPS Points	D001 *	1,314,702.887	811,201.936	735.747	Height of UTM Spheroid
	D002 *	1,312,950.679	811,713.562	693.340	ditto
	D003 *	1,313,218.081	814,562.354	800.754	ditto
	DN4-1	1,317,406.102	804,765.974	736.696	ditto
	DN4-2	1,313,699.819	802,440.695	732.096	ditto
	DN4-3	1,315,522.460	797,922.520	544.465	ditto
	DN4-4	1,315,115.447	798,012.902	547.656	ditto
	DN4-5	1,314,595.774	792,056.740	516.912	ditto
	DN4-6	1,314,829.141	792,043.749	460.974	ditto
Traverse points	D001 *	1,314,702.887	811,201.936	735.914	Geoidal Height
	D002 *	1,312,950.679	811,713.562	693.507	ditto
	D003 *	1,313,219.045	814,559.973	801.061	ditto
	IV-01 *	1,314,010.359	815,498.459	659.614	ditto
	IV-02 *	1,313,593.879	816,123.180	571.597	ditto
	IV-03 *	1,313,219.045	814,559.973	801.061	ditto
	IV-05 *	1,314,086.807	814,633.434	585.085	ditto
	I-CP01	1,314,667.789	810,049.107	725.837	Geoidal Height, DN3 P.H. Site
	I-CP02	1,314,709.728	809,253.934	659.001	ditto
	I-CP03	1,315,497.741	809,208.182	-	DN3 P.H. Site
	I-CP03-1	1,315,536.800	809,723.893	760.351	Geoidal Height, DN3 P.H. Site
	I-CP04	1,315,526.587	810,922.140	-	DN3 P.H. Site
	DN4-3	1,315,522.212	797,922.573	546.444	Geoidal Height, DN4 Dam Site
	DN4-4	1,315,115.447	798,012.902	549.746	ditto
	I-CP01	1,315,243.363	797,859.260	541.422	ditto
	I-CP02	1,315,240.036	798,063.649	553.012	ditto
	I-CP03	1,314,891.951	798,206.296	537.590	ditto
	I-CP04	1,315,442.937	797,671.785	500.622	ditto
	I-CP05	1,314,666.160	797,544.382	539.172	ditto
	I-CP06	1,314,539.000	797,678.194	523.119	ditto
	I-CP07	1,314,558.984	797,982.460	428.299	ditto
	I-CP08	1,314,835.997	797,447.921	525.982	ditto
	DN4-5	1,314,596.083	792,060.253	520.014	Geoidal Height, DN4P.H. Site
	DN4-6	1,314,829.321	792,047.289	463.931	ditto
Cross-section posts	CS-L01	1,313,329.25	815,189.69	575.76	Dong Nai No.4 dam site
	CS-R01	1,313,889.14	815,617.63	585.28	ditto
	CS-L02	1,313,254.94	814,809.31	655.23	ditto
	CS-R02	1,314,235.25	815,497.84	615.64	ditto
	CS-L03	1,313,597.24	814,692.26	619.74	ditto
	CS-R03	1,314,110.78	815,070.67	614.51	ditto
	CS-L04	1,313,285.60	815,846.96	510.98	ditto
	CS-R04	1,313,553.34	815,969.88	540.28	ditto
	CS-L05	1,313,351.13	815,659.05	524.28	ditto
	CS-R05	1,313,659.07	815,783.95	506.02	ditto
	CS-L06	1,313,432.23	815,474.80	517.61	ditto
	CS-R06	1,313,760.97	815,612.72	567.46	ditto

Table B2.1 Coordinates and Elevation of Control Points and Cross Section Posts (2/2)

Item	Point No.	Coordinates North (m)	Coordinates East (m)	Elevation (m)	Remarks
Cross-section posts	CS-WR07	1,314,347.26	809,224.28	439.50	Water level point on the right bank
	CS-R07	1,314,650.12	809,224.28	641.43	Dong Nai No.3 powerhouse site
	CS-L08	1,314,597.39	797,669.15	523.92	Dong Nai No.4 dam site
	CS-R08	1,314,964.73	798,144.70	508.85	ditto
	CS-L09	1,314,676.29	797,332.92	491.38	ditto
	CS-R09	1,315,279.59	798,116.03	522.30	ditto
	CS-L10	1,314,925.49	797,299.61	487.83	ditto
	CS-R10	1,315,277.75	797,766.44	495.54	ditto
	CS-L11	1,314,346.21	792,418.90	542.96	Dong Nai No.4 powerhouse site
	CS-WL11	1,315,041.65	791,781.73	289.48	Water level point on the left bank

Notes: 1. :* Existing control points on Pre-F/S in 1997/98

2. Water level point: The point on cross-section which is the intersection of cross-section line and the water edge line at surveying time. This point is not installed with concrete mark.

Appendix B

Figures

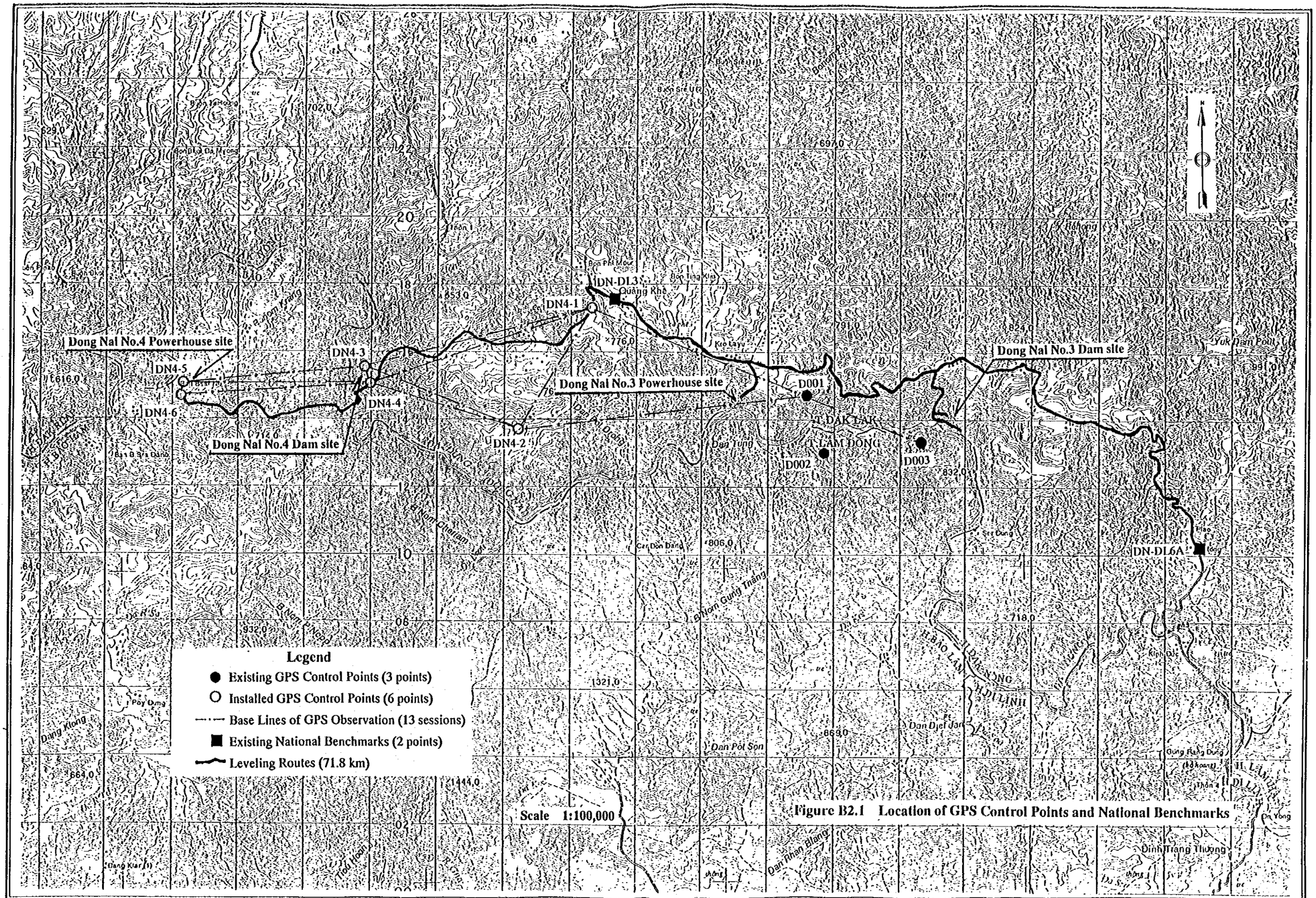

Figure B2.1 Location of GPS Control Points and National Benchmarks

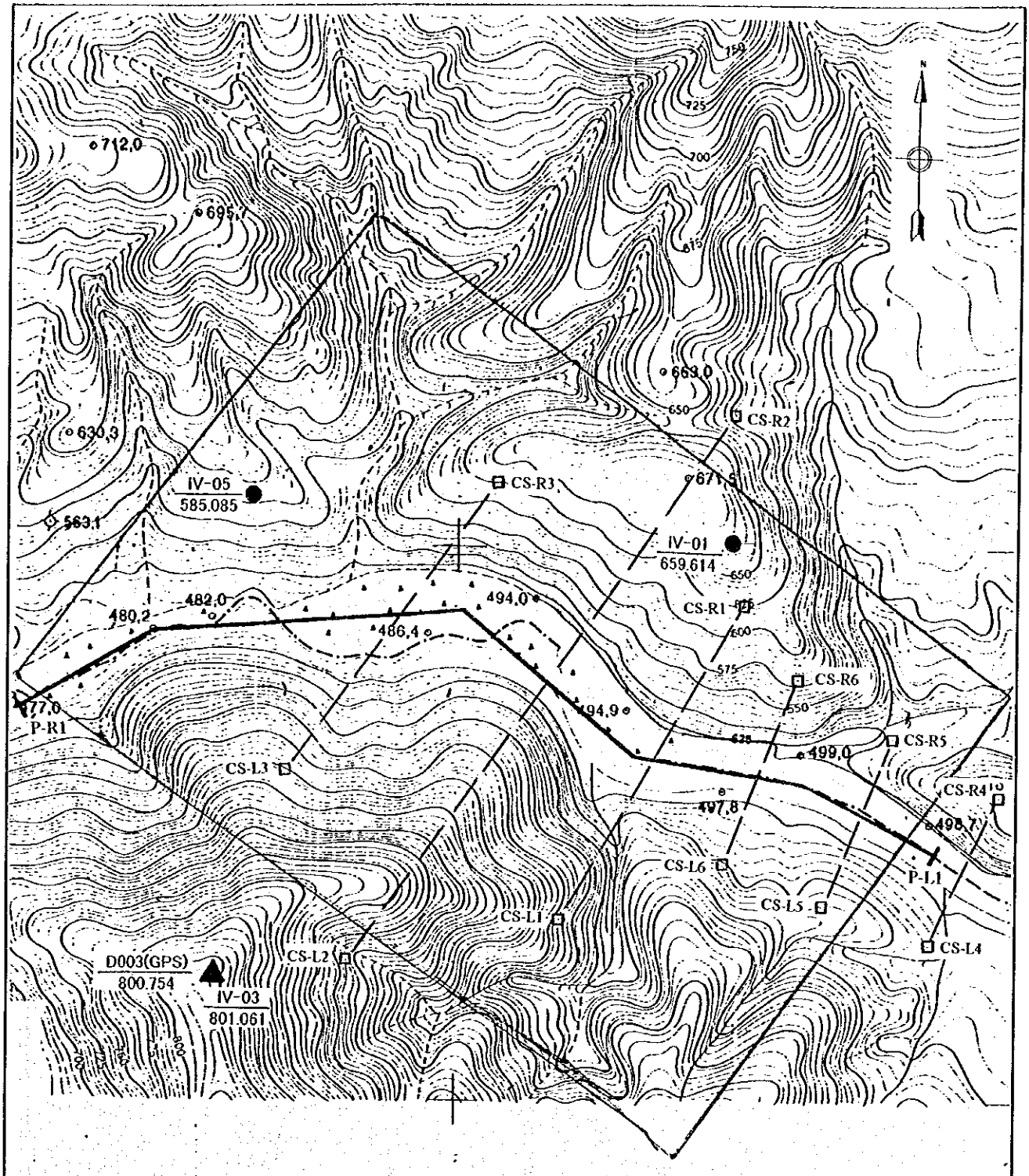

Figure B2.2 **Topographic Survey Area at Dong Nai No.3 Dam Site**

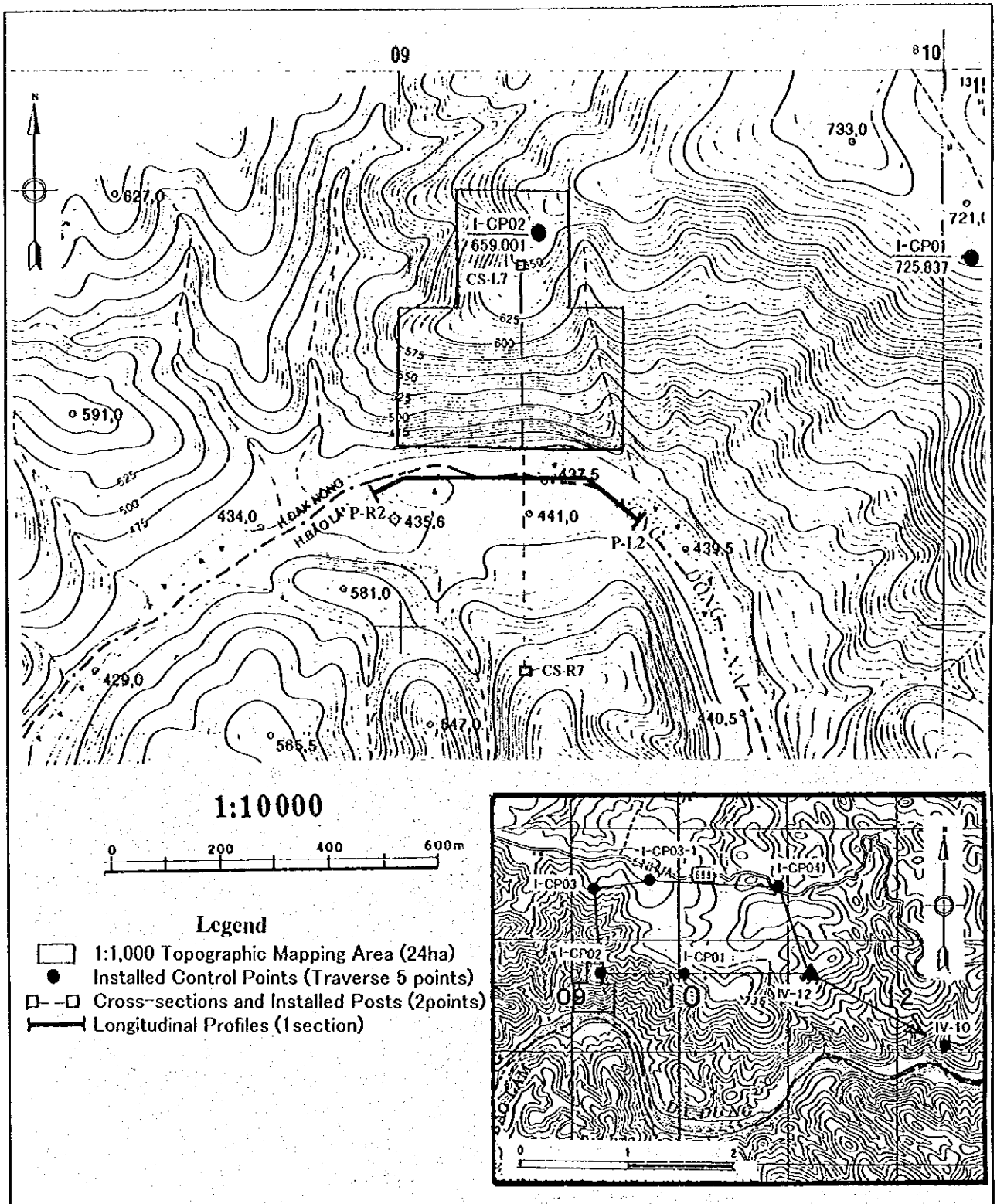

Figure B2.3 Topographic Survey Area at Dong Nai No.3 Powerhouse Site

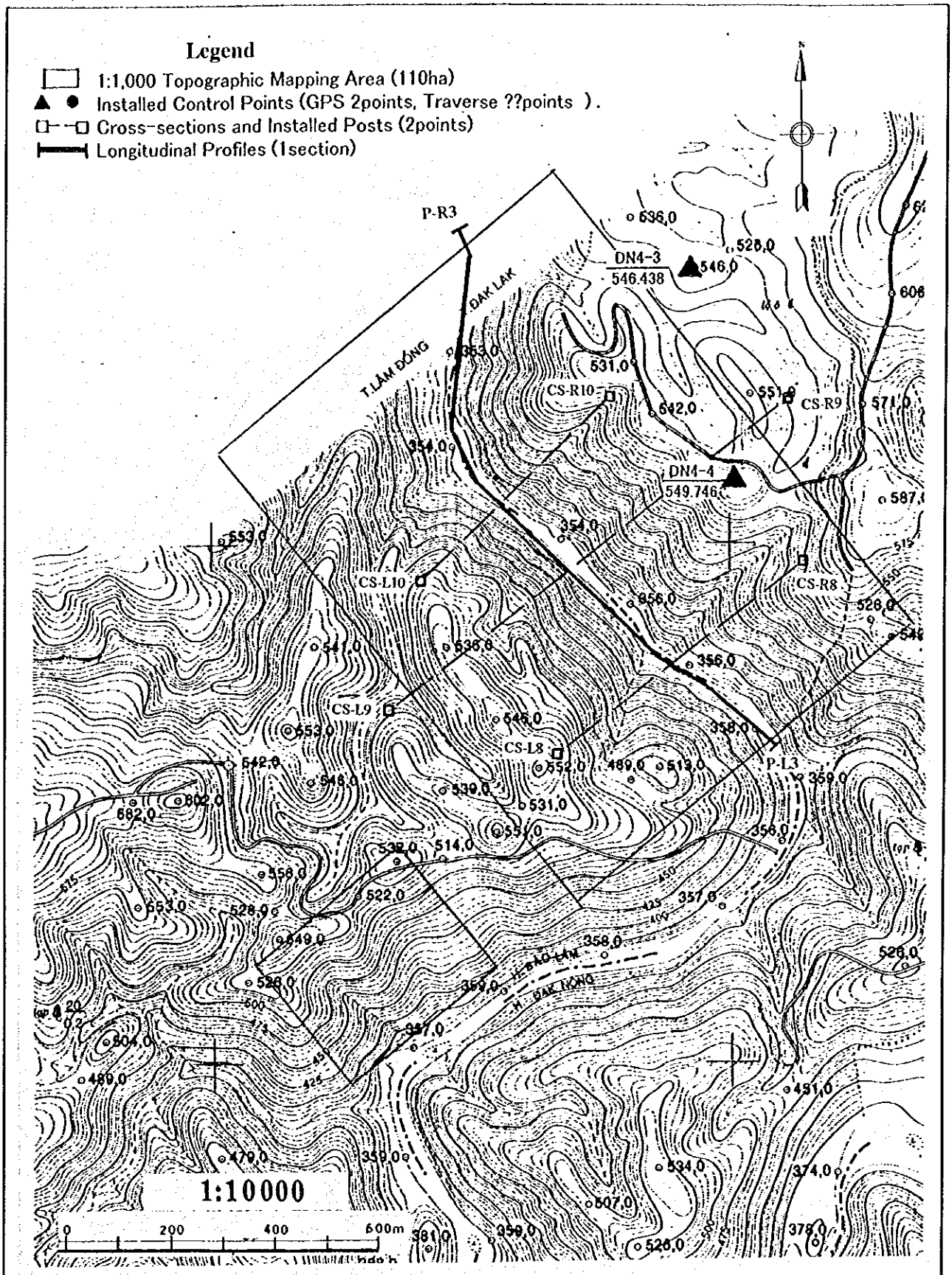

Figure B2.4 Topographic Survey Area at Dong Nai No.4 Dam Site

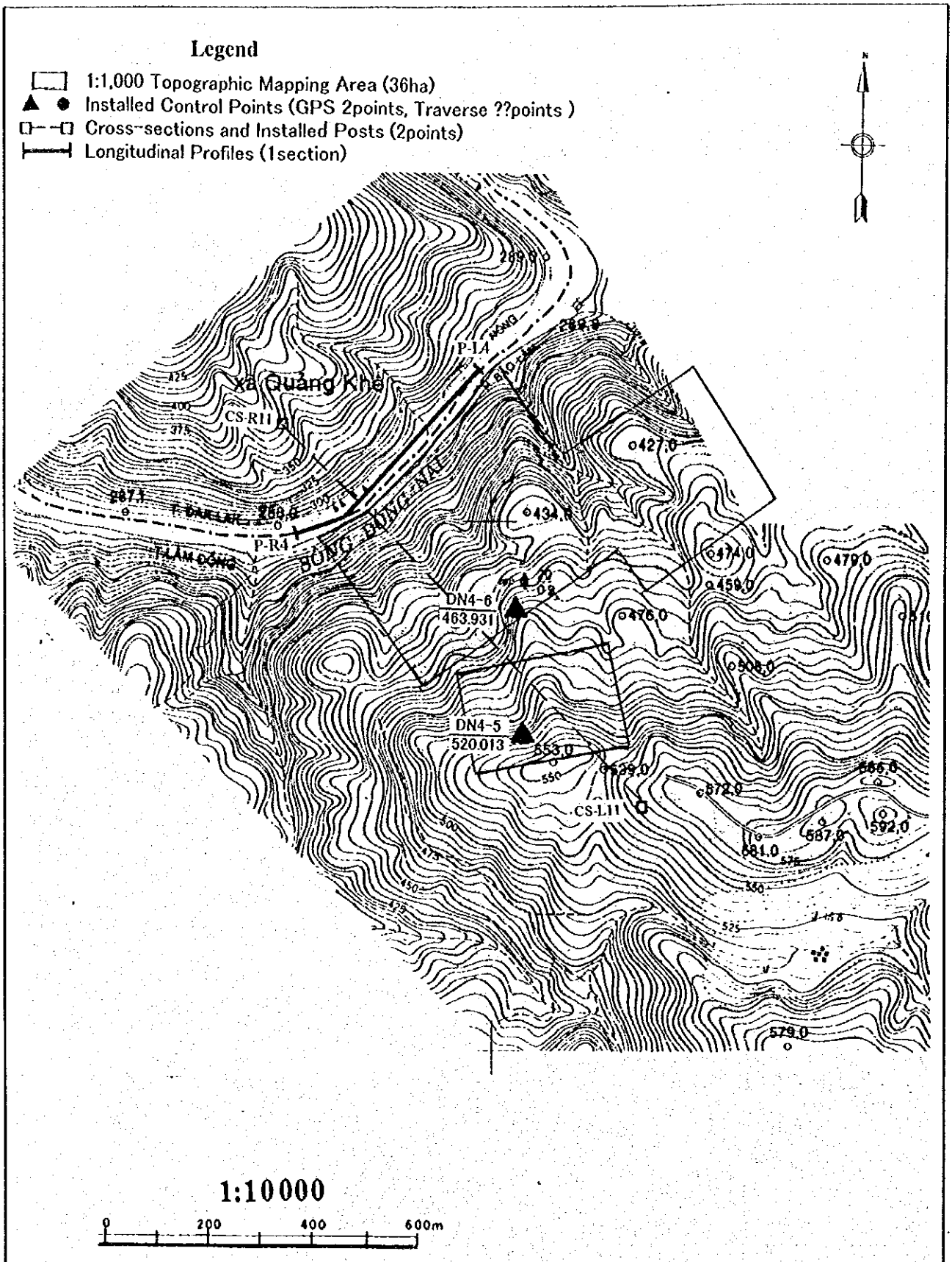

Figure B2.5 Topographic Survey Area at Dong Nai No.4 Powerhouse Site

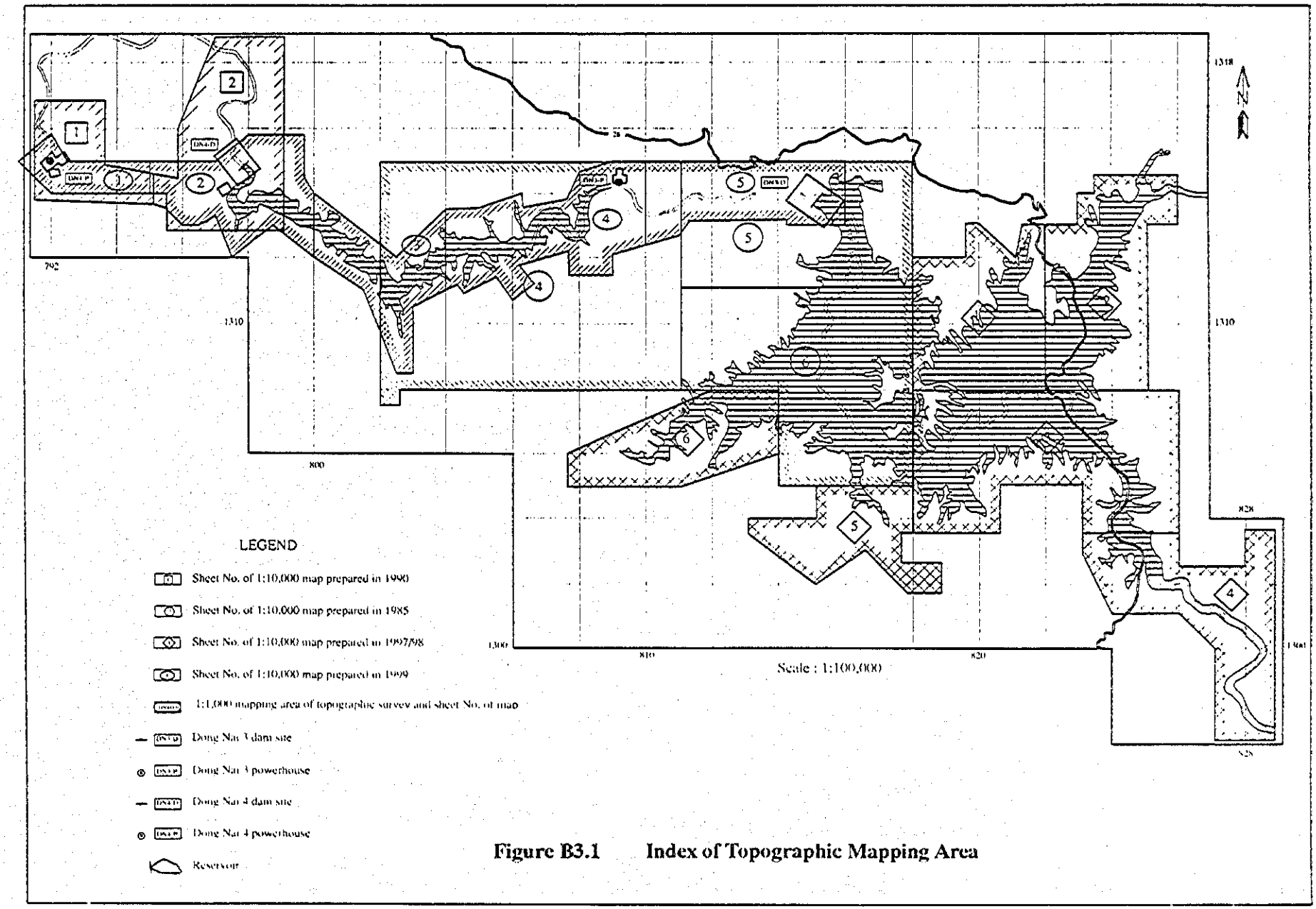

Figure B3.1 Index of Topographic Mapping Area