CHAPTER VIII ENVIRONMENTAL IMPACT ASSESSMENT

8.1 General

The potential impacts of the proposed project to the environment during both construction and operation phases are predicted and assessed. The construction phase will include riverbed excavation, the construction of earth dikes/river wall, spur dikes, groundsill, sabo dam, drainage sluiceway and related structures such as intake sluiceway/bridge. These structures are all relatively small earth/aggregate/concrete structures along the riverbanks or within the riverbeds. On the other hand, the operation phase will be the use of these passive structures.

Identification of the potential environmental impacts was done by evaluating the project's features and operations against the known list of potential impacts identified by various sources for this type of project. The prediction and assessment present the effects of the unmitigated impacts. The necessary measures to reduce or eliminate the impacts are proposed in the environmental management plan.

8.2 Prediction and Assessment of Impacts

8.2.1 Construction Phase Impacts

The identified potential impacts during the construction phase are water pollution, air pollution, noise generation, soil erosion, fish and wildlife disturbance, vegetation loss, land acquisition/house resettlement, loss of archaeological/historical assets, traffic disturbance and local labor employment. Most of these impacts are short-term in nature. The environmental impacts of the project during the construction phase are summarized in Table II.5.

(1) Water Pollution

The existing average water quality during dry season in the Laoag-Bongo River and at the fan apex of the alluvial fan rivers are estimated based on the tests conducted in the course of the Feasibility Study and shown as follows:

Water Quality Parameter	Laoag- Bongo River	Alluvial Fan River
pH	8.5	8.2
Conductivity	153	162
Total Phosphorus (mg/l)	0.06	0.03
BOD (mg/l)	1.3	1.1
Total Dissolved Solids (mg/l)	152	113
Total Suspended Solids (mg/l)	4.3	0.6
Nitrate (NO^3) (mg/l)	0.48	0.12
Oil and Grease (mg/lq)	1.7	1.1
Dissolved Oxygen (mg/l)	10.4	11.0
Coliforms (MPN/100 ml)	340	450

Note: Water qualities except Coliforms were observed in Feb.-Mar. 1997. Coliforms was observed in June 1997.

Water pollution sources would be the dewatering work for structure foundations, earth work operations adjacent to a stream, and aggregate processing. However, water pollution due to these works is considered not significant since the riverbed

materials of the project sites are mainly composed of sand, gravel and boulder with very little silt and clay.

(2) Air Pollution

Air pollution would come from the use of heavy construction equipment and dust generation activities. However, this will not be a nuisance to the public since houses are far from the construction sites.

(3) Noise Generation

Operation of the various construction equipment will be the major source of noise during construction. However, this noise would not be a nuisance to the public since houses are far from the construction sites.

(4) Soil Erosion

Soil erosion may occur due to earth excavation works on strip vegetation cover at the site. In this project, the earth excavation sites are limited to the riverbeds and abutments of sabo dam. The excavation in the riverbeds will not cause soil erosion. On the other hand, the abutments of the proposed sabo dam are formed of hard rock and there is little soil cover. Hence, the impact to soil erosion is considered minimal.

(5) Fish and Wildlife Disturbance

Inland fishery production in the Laoag River and its tributaries is very low due to the variations in physico-chemical characteristics of the areas and the aggregate/boulder riverbed formation preventing a favorable habitat for fingerling growth. The existing fish species are Hito, Igat (Eel), Gorami, Tilapia, Biya and Bangus.

Only a few wild animals have been identified in the project area.

A limited number of bird population is observed in the primary impact zone. The existing bird species are cuckoo, pigeon, pipit, crow, rails, maya, quail, wild chicken and martinez.

No threatened, endangered or rare species of fish and wildlife are identified in the project area.

During construction, a small number of fishes, wild animals and birds near the construction sites will be affected. However, this impact is expected to be only during construction period and normal condition will be restored after construction. Therefore, affected fishes, animals and birds will be restored in their natural habitat after sometime.

(6) Vegetation Loss

The following 24 species of plants are identified in the project sites.

(a) Non-Dipterocarps (19 species): Mangga, Bayabas, Balimbing, Bogainvilla, Achuete, Yellow Acacia, Corn, Eucalyptus, Sampalok, Kamoteng Kahoy, Banana, Mahogany, Narra, Agoho, Kakawate, Guiho, Ipil-ipil, Takip Asin and Gabi

(b) Bamboo (3 species): Kawayan/Buho and two (2) species of Kawayan

(c) Grass (2 species): Kogon and Marakauayan

These plants are all economic ones which are edible or can be used as firewood/charcoal, animal feeds, additives for food and medicine, construction materials, etc.

Such floating vegetation as water hyacinth and kangkong are identified in some places of the Laoag River and its tributaries.

No threatened, endangered or rare species of plant and vegetation are identified in the project sites.

Although most of the identified plant species in the primary impact zones of the project are considered economically important, the density of the affected species is considerably small as these are found only in patches within the project area. No significant negative impact is expected in terms of vegetation cover since only a small section of the project site will be prepared for the structures.

(7) Land Acquisition and House Resettlement

The required land acquisition and house resettlement for the project are estimated as follows. These land acquisition and resettlement of houses are considered small compared to the beneficial land area and population of the project.

Item	Laoag-Bongo River Impvt.	Alluvial Fan River Impvt.	Sabo Dam	Total
Land Acquisition (ha)	29.0	10.0	1.5	40.5
Farm/Bush Land (ha)	28.2	10.0	1.5	37.9
Residential Land (ha)	0.8	-	-	0.8
House Resettlement (No.)	3	-	-	3

(8) Loss of Archaeological and Historical Assets

No stone age remains have been found in Ilocos Norte. Some Chinese historical properties in Tang, Sun, Yuan and Ming ages have been found along the coastal areas. No historical site in the direct impact area is registered in the National Historical Institute. However, there are fine specimen of Spanish Baroque Churches in the project area. One is Sarrat Church and the other is the ruins of Old Dingras Church. These will not be affected by the construction works.

(9) Traffic Disturbance

The existing traffic volume of the project area is small. Most of the construction works will be performed within the river area. The impact on traffic is considered small.

(10) Local Labor Improvement

The proposed project will create opportunities for temporary jobs during the construction period. The requirement for temporary labor during the four (4) years of construction period is estimated below. Besides these temporary workers, a lot of supporting services for the construction works will be required in the Basin. These supporting services will create another job opportunity.

Kind of Labor	Labor Force (man-day)
Skilled Labor	515,000
Unskilled Labor	902,000
Total	1,417,000

8.2.2 Operation Phase Impacts

The identified potential impacts are described below. The environmental impacts of the project during the operation phase are summarized in Table II.5.

(1) Hydrological and River Morphological Change

(a) Groundwater Recharge Reduction

The Labugaon No. 1 and Solsona No. 1 sabo dams will be fixed on rock foundations. Hence, they will block the sub-surface water of the rivers and convert it to surface water. The converted sub-surface water will naturally be taken from the existing downstream irrigation intakes. This will decrease the existing groundwater recharge in the downstream alluvial fan areas. However, the convertible sub-surface water volume is estimated to be as small as 5 l/sec in total. Hence, the reduction of groundwater recharge is considered negligible.

(b) Riverbed Aggradation

Floods of the Cura/Labugaon, Solsona, Madongan and Papa rivers widely deposit sediment on the lands of the alluvial fan area at present. The confinement of the floods by the dike construction will aggradate the riverbeds of the above rivers. On the other hand, the proposed sabo dams will decrease the sediment runoff to the rivers, resulting in decrease of riverbed aggradation.

The average riverbed aggradation of the above rivers after 20 years is predicted to be in the range of nearly zero in Madongan River and 60 cm in Solsona River, averaging 25 cm. However, this aggradation will not cause flood since the proposed dikes are designed to meet this aggradation. Further, the adverse effects of this riverbed aggradation on the existing irrigation intakes are considered minimal.

(c) Reduction of Channel Shifting

Presently, much large size sediments are deposited in the fan apexes of the above rivers at a big flood. This usually disturbs the flood flow and shifts the channel course. However, the proposed sabo dams will decrease the deposition of large size sediments at the fan apexes, resulting in reduction of channel shifting. These positive effects are considered significant.

(d) Increase of Riverbank Erosion

The confinement of floods by the proposed dike will increase the sediment transport capacity in the rivers, resulting in the increase of bank erosion at some critical sites. On the other hand, the proposed spur dike will mitigate the flood flow velocity near the riverbank and induce sediment deposition. Therefore, riverbank erosion will be minimal.

(e) Decrease of Sand Supply to the Coast

The existing sand dunes along the coast are formed by a portion of the sediment supplied from the Laoag River. The existing average annual sediment runoff to the sea is estimated at approximately 100,000 m^3. On the other hand, the proposed sabo dams are expected to reduce the sediment runoff to the sea by 3,000-5,000 m^3 per annum on an average. Therefore, the impact to the sand dune formation is considered minimal.

(2) Water Pollution, Air Pollution and Noise

The project will not generate water pollution loads, air pollution loads and noise during the operation phase.

(3) Geological Destruction

No large scale geological destruction is expected during the operation phases since the sediment storage area and depth of the proposed sabo dams are small.

(4) Ecological Loss and Disturbance

(a) Loss of Wildlife Habitat

There is no wildlife habitat in the proposed sabo dam and river structure sites.

(b) Disruption of Fish Spawning Grounds

The proposed sabo dams will prevent fishes from going up the rivers. However, there are few fishes in the upstream of the alluvial fan rivers and they include no threatened, endangered or rare species. The disruption of spawn grounds of fishes is considered minimal.

(5) Aesthetic Impairment

(a) Aesthetic Impairment of Landscape

The proposed sabo dams and dikes may reduce the aesthetic appeal of landscape in the project sites. On the other hand, the sabo dams will create new landscape with artificial waterfalls. The river water will constantly spill over the crest of the sabo dams. The impairment of total landscape is considered minimal.

(b) Visual Impairment of Historical and Cultural Resources

The objective historical and cultural resources are the Spanish Baroque Church in Sarrat and the ruins in Dingras. No river structures are proposed in Sarrat. The proposed dike in Dingras is small and far from the site of the ruins. The project will not cause adverse impact on the aesthetics of the historical and cultural resources.

(6) Loss of Natural Resources Use

(a) Loss of Fishing Area

Disruption of fishing activity may occur during the construction phase, but fishing may resume during the operation phase.

(b) Impairment of Navigation

There are no navigation activities in the project area.

(c) Damage to Economically Valuable Natural Resources

The project will cause no damage to the other economically valuable natural resources.

(7) Socio-economic Impact

(a) Reduction of Economic Loss

The project will reduce the existing flood damage on house buildings, household effects, commerce and industrial properties, physical and social infrastructures, agricultural products, etc.

(b) Reduction of Heath Risk

Many people in the flood prone area obtain drinking water from dug wells and are provided with unsanitary toilet system. The drinking water is contaminated and toilet wastes overflow at every flood. The project will reduce such health risk.

(c) Increase of Available Farmland

Approximately 50 ha of farmland is washed away every year in the project area under the present situation. This land loss will be prevented by the

project. On the other hand, the project is expected to restore the existing devastated lands of about 1,800 ha for grazing, upland crop cultivation and rice cultivation.

(d) Disruption of Minority's Life

There are some cultural minorities called Isneg in the project area. They are concentrated in the municipality of Carasi which has a total population of 750. Half of the population are Isnegs. Their economy mainly relies on slush and burn farming although they mostly live along the rivers which serve as a main source of food. However, many Isnegs are no longer farmers and many have established themselves in various occupations through formal schooling.

The project will install a sabo dam in Carasi. The construction of the sabo dam may temporarily displace the existing fishing activities. However, in the long term the project will have no impact on their lifestyle.

8.2.3 Environmental Management Plan

Water pollution during the construction phase is considered the only negative impact which shall be eliminated or mitigated as shown in Table II.5. The method of riverbed excavation, excavation of structural foundations, dewatering and aggregate processing will be planned to minimize the generation of turbid water. For this purpose, a settling basin will be provided immediately downstream of the construction site, if necessary.

All the other negative impacts during construction and operation phases are minimal or nil. Hence, no special environmental management plan is proposed for these impacts.

CHAPTER IX IMPLEMENTATION PROGRAM AND OPERATION / MAINTENANCE

9.1 Project Implementation Program

9.1.1 Project Implementation Schedule and Required Funds

(1) General

The proposed project is technically and economically feasible. Environmentally, it will produce no significant adverse effects. Urgent implementation of the project is expected in consideration of the recurrent serious floods in the Basin. The project will be implemented with financing from a foreign financing organization due to the high project cost required.

(2) Implementation Schedule

The project will be implemented from 1997 to 2003 based on the following schedule.

(a) Loan application and agreement to/between foreign financing organization, and other preparations from 1997 to 1998.

(b) Detailed design in1999.

(c) Construction from 2000 to 2003.

(3) Required Funds

The total funds required for the project is estimated at 1,911.3 million pesos at 1997 prices and 2,333.1 million pesos including price contingency. The annual disbursement schedule is shown below.

(Unit : million peso)

Year	Foreign Currency Portion	Local Currency Portion	Total
1999	86.4 (89.9)	16.9 (19.3)	103.3 (109.2)
2000	219.4 (232.8)	245.9 (301.3)	465.3 (534.1)
2001	225.7 (244.2)	241.8 (317.0)	467.5 (561.2)
2002	221.6 (244.6)	238.0 (334.0)	459.6 (578.6)
2003	196.8 (221.6)	218.8 (328.4)	415.6 (550.0)
Total	949.9 (1,033.1)	961.4 (1,300.0)	1,911.3 (2,333.1)

Note: Figures without parentheses are costs at 1997 prices; with parentheses are costs including price contingency

9.1.2 Project Implementation Organization

With the financial aspect taken into consideration, the Laoag River Sabo and Flood Control Project (LRSFCP) is no longer covered by those to be devolved to the Local Government Units as embodied in the Local Government Code 1991. As mandated by Executive Order No. 124, DPWH is the principal agency responsible for the construction, operation and maintenance of flood control projects.

The Project Management Office for Major Flood Control and Drainage Project (PMO-MFCDP) under the DPWH, will be designated as the lead implementing office for this project. This office has direct advisory functions on three (3) project management offices,

i.e., Metro Manila Flood Control Project II, Pampanga Delta Development Project, and Various Flood Control Projects; monitoring and coordination on three (3) others, i.e., Cotabato-Agusan River Basin Project, Small Water Impounding Management Project, and Agno and Allied Rivers Urgent Rehabilitation Project.

For the implementation of the LRSFCP, a new project management field office will be organized to function under the direct supervision of the PMO-MFCDP. The proposed organizational set-up of the PMO-LRSFCP is shown in Fig. II.21. This PMO will be headed by a project manager, and will comprise three (3) sections; namely, Administrative, Right-of-Way Acquisition, and Technical. The staffing requirement is also shown in Fig. II.21.

The construction of the project works will be entrusted to foreign and/or local contractors, which are to be selected through international tendering under the supervision of the PMO-LRSFCP assisted by a selected foreign consultant.

9.2 Operation and Maintenance

9.2.1 Operation and Maintenance Activities

(1) Flood Forecasting and Warning

The flood forecasting and warning in the Basin will be performed based on the data of river water level of nine (9) water gauging stations. Three (3) automatic stream gauging stations were earlier installed during the Study at Gilbert Bridge, Cauplasan Bridge and Solsona Irrigation Dam. Staff gauges were also installed at the piers of Gilbert Bridge, Cauplasan Bridge and Solsona Irrigation Dam. Six (6) other water gauging stations (staff gauges) will be installed at the following sites.

(a) Irrigation dams or intakes at the Cura, Labugaon, Madongan, Papa and Upper Bongo rivers

(b) Guisit River at Poblacion Piddig

A small building will be built near each gauging station and to be provided with a portable telephone. Locations of the above stations are shown in Fig. II.22.

During flood, observed water levels at the nine (9) gauging stations are transmitted by portable telephone to the Provincial Disaster Operation Center (PDOC) through the DPWH District Engineering Office (PWDEO). Flood forecasting on a qualitative basis will be performed by using the collected data of water level along with the typhoon information in the PDOC.

Based on the above, flood forecasting and flood warning will be issued by telephone or portable telephone from PDOC to the people through the MDCC and the BDCC. The flood warning can also be disseminated to the people through local radio broadcasting.

(2) Operation and Maintenance of River Structures

The river structures in the following important river stretches will be managed by PWDEO.

River	Length (km)	River Section
Laoag/Bongo	42	Mouth - Confluence with Papa
Cura/Labugaon	20	Confluence to Laoag - Sabo Dams
Solsona	13	Confluence to Bongo - Sabo Dam
Madongan	10	Confluence to Solsona - Sabo Dam
Papa	8	Confluence to Bongo - Sabo Dam
Total	93	

The objective river structures will include earth dikes, river wall with revetment, spur dikes, groundsills, drainage sluiceway and sabo dam. The quantities of the objective river structures after completion of the proposed sabo and flood control project are estimated as follows.

River Structures	Unit	Existing	Proposed	Total
Earth Dike	km	49.8	33.1	77.9
River Wall/Revetment	km	4.1	0.5	4.6
Spur Dike	unit	80	1,338	1,418
Groundsill	unit	0	4	4
Drainage Sluiceway	unit	0	5	5
Sabo Dam	unit	0	5	5

(3) Hydrological and River Morphological Observation

In addition to the monitoring of river water levels during flood period, the PWDEO will continue to collect data from the river gauging stations located at Gilbert Bridge, Cauplasan Bridge and Guisit River in Poblacion Piddig, following the guidelines prescribed by the Bureau of Research and Standards, DPWH.

Further, it will monitor the riverbed variation of the Cura/Labugaon, Solsona, Madongan and Papa rivers to evaluate the risk of riverbed aggradation or degradation. Cross-sectional survey will be conducted periodically for some river sections. These activities will redound to an effective river management.

9.2.2 Organization for Operation and Maintenance

During the construction period which is estimated to take four (4) years, the river structures already completed and accepted by the DPWH from time to time will be turned over to the PWDEO.

The PWDEO through its Maintenance Section, will be responsible for the proper operation and maintenance of the existing and new river works. The organizational chart of the PWDEO is shown in Fig. II.23.

Among the above operation and maintenance activities, the maintenance of river structures such as earth dikes, bank protection works, etc., is the largest. The maintenance requirement of sabo dams is considered small.

Technically, PWDEO will be able to attain a satisfactory maintenance of such river structures since it has a long experience in design, construction and repair. However, considering the increase in number of river structures envisioned under the urgent program of the project, the organizational structure of the Maintenance Section of the District Office must be strengthened to carry its assigned task. Further, the appropriate number of equipment needed for the operation and maintenance of the river system should be made available.

Financially, if the present financing level for the flood control of Laoag River Basin is maintained in the future and it can be used for operation and maintenance, the operation and maintenance requirement mentioned above will be satisfactorily met.

DPWH allocated 18.3 million pesos for flood control of the Laoag River Basin during the recent three (3) years from 1994 to 1996. It is equivalent to 6.4 million pesos on the annual average at 1997 prices. This budget was used for the construction of various small river structures on ad hoc basis.

The future annual accountable amount for the operation and maintenance will be 0.24 million pesos as follows:

(Unit: 1,000 pesos)

Operation and Maintenance Activities	Initial Cost (every 10 years)	Annual Cost	Total Annual Cost
Flood Forecasting and Warning	370	40	80
Inspection of River Condition	0	30	30
Hydrological Observation	0	50	50
River Morphological Observation	90	70	80
Total	460	190	240

For the details of operation and maintenance costs, see Volume III-2, Appendix H, River Monitoring, Table H.5.1. The balance of the operation and maintenance budget will be used for the rehabilitation works for the project.

If the above finance can be used for the operation and maintenance activities in the future, the total available funds for the operation and maintenance during 20 years after completion of the project (2004-2023) is estimated to be 270 million pesos by assuming that the above annual financing of 6.4 million pesos will increase in proportion to the annual growth rate of GRDP of the Basin (6.2% up to 2000, 4.65% for 2000-2010 and 3.1% after 2010). This is equivalent to 28% of the total construction cost of 970 million pesos for the proposed river improvement works in the Laoag-Bongo and alluvial fan rivers (see Chapter VI, Construction Plan and Cost Estimate).

CHAPTER X RECOMMENDATIONS

(1) The proposed priority sabo dam and river improvement projects are technically and economically feasible. Environmentally, they will generate no significant adverse effect. Urgent implementation of the projects is recommended in consideration of the recurrent serious floods in the Laoag River Basin. The required financial sources should be arranged as soon as possible.

(2) Hydraulic model tests are considered necessary to check the hydraulic effects of sandbar formation on the riverbanks, to estimate possible local scouring around the spur dikes and to determine the detailed structural dimensions of the spur dikes. Such model tests will be conducted in the detailed design phase.

(3) Monitoring of riverbed variation in the alluvial fan rivers is considered necessary to avert flood risk due to unexpected sediment deposition in the riverbed. For this purpose, periodical cross-sectional survey at fixed river sections shall be conducted. Further, local riverbed scouring around the major structures shall be inspected periodically to prevent structural damage that may cause a catastrophic flood disaster.

(4) The existing temporary dikes built by NIA under INIP-I, which are proposed to be rehabilitated and strengthened under this project, shall now be accepted by DPWH to prevent further deterioration.

(5) Watershed management is a vital non-structural measure for the sediment control of the Basin. The ongoing reforestation projects should be promoted to supplement the sediment control of the proposed sabo dams. The reforestation area should be extended especially in the Madongan and Papa river basins.

(6) Road construction in mountain areas may trigger large failures or landslides, resulting in a sudden increase of sediment runoff to the alluvial fan rivers. Hence, careful attention should be paid on road drainage and spoil disposal in designing the road projects in the watersheds of the Solsona and Upper Bongo rivers.

(7) Flood Fighting is necessary to secure the full capacity of the proposed flood control structures during flood. For this purpose, practical flood forecasting/warning and flood fighting systems should be established and, further, technology transfer on flood fighting including the enhancement of flood fighting capabilities of the local people should be pursued during the construction phase.

TABLES

Table II.1 Breakdown of Project Cost

(Unit : pesos at 1997 price)

Work Items	Unit	Quantity	F.C. Portion	L.C. Portion	Total
1. CONSTRUCTION COST			654,074,234	800,509,346	1,454,583,580
1.1 Preparatory Works (10% of 1.2 and 1.3)			59,461,294	72,773,577	132,234,871
1.2 Main Works			540,557,218	661,577,972	1,202,135,190
1.2.1 Sabo Dams and Alluvial Fan Rivers			464,057,078	604,752,012	1,068,809,090
(1) Cura/Labugaon River			199,329,827	203,134,303	402,464,130
a) Cura Sabo Dam No.1	m3	15,100	21,305,400	24,660,600	45,966,000
b) Labugaon Sabo Dam No.1	m3	16,900	24,834,100	30,941,900	55,776,000
c) River Improvement	km	12.70	153,190,327	147,531,803	300,722,130
(2) Solsona River			77,269,313	114,492,177	191,761,490
a) Solsona Sabo Dam No.1	m3	5,200	7,735,800	9,993,200	17,729,000
b) River Improvement	km	11.00	69,533,513	104,498,977	174,032,490
(3) Madongan River			111,467,506	165,572,024	277,039,530
a) Madongan Sabo Dam	m3	20,800	28,218,300	33,510,700	61,729,000
b) River Improvement	km	9.00	83,249,206	132,061,324	215,310,530
(4) Papa River			75,990,432	121,553,508	197,543,940
a) Papa Sabo Dam	m3	17,000	23,340,600	27,528,400	50,869,000
b) River Improvement	km	7.00	52,649,832	94,025,108	146,674,940
1.2.2 Laoag-Bongo River Improvement	km	13.14	76,500,140	56,825,960	133,326,100
(1) Poblacion Laoag River Improvement	km	3.49	18,151,884	15,523,916	33,675,800
(2) Poblacion San Nicolas River Improvement	km	4.20	23,286,964	15,650,536	38,937,500
(3) Poblacion Dingras River Improvement	km	5.45	35,061,292	25,651,508	60,712,800
1.3 Miscellaneous Works (10% of 1.2)			54,055,722	66,157,797	120,213,519
2. COMPENSATION COST			0	6,440,000	6,440,000
2.1 Land Acquisition	ha	40.5	0	5,990,000	5,990,000
(1) Sabo Dams	ha	1.5	0	150,000	150,000
(2) Alluvial Fan River Improvement	ha	10.0	0	1,000,000	1,000,000
(3) Laoag-Bongo River Improvement	ha	29.0	0	4,840,000	4,840,000
2.2 House Relocation	houses	3	0	450,000	450,000
(1) Laoag-Bongo River Improvement	houses	3	0	450,000	450,000
3. ADMINISTRATION COST (3% of 1 and 2)			0	43,830,707	43,830,707
4. ENGINEERING SERVICES COST (16% of 1)			209,460,036	23,273,337	232,733,373
5. PHYSICAL CONTINGENCY (10% of 1, 2, 3 and 4)			86,353,427	87,405,339	173,758,766
SUB-TOTAL			949,887,696	961,458,730	1,911,346,426
6. PRICE CONTINGENCY (2% for FC and 7% for LC)			83,190,000	338,532,000	421,722,000
TOTAL			1,033,077,696	1,299,990,730	2,333,068,426

Table II.2 Annual Disbursement Schedule of Project Cost

(Unit : 1,000 pesos)

ITEM	TOTAL			1999			2000			2001			2002			2003		
	F.C.	L.C.	TOTAL	F.C.	L.C.	TOTAL	F.C.	L.C.	TOTAL	F.C.	L.C.	TOTAL	F.C.	L.C.	TOTAL	F.C.	L.C.	TOTAL
1. CONSTRUCTION COST	654,074	800,509	1,454,583	0	0	0	166,561	208,645	375,206	172,488	204,858	377,346	168,760	201,692	370,452	146,265	185,314	331,579
1.1 Preparatory Works	59,461	72,774	132,235	0	0	0	15,142	18,968	34,110	15,681	18,623	34,304	15,342	18,336	33,677	13,297	16,847	30,144
1.2 Main Works	540,557	661,578	1,202,135	0	0	0	137,654	172,434	310,088	142,552	169,304	311,856	139,471	166,688	306,159	120,880	153,152	274,032
1.2.1 Sabo Dams and Alluvial Fan R/I	464,057	604,752	1,068,809	0	0	0	119,502	156,910	276,412	119,265	153,654	272,919	116,097	149,586	265,683	109,193	144,602	253,795
(1) Cura /Labugaon River	199,329	203,135	402,464	0	0	0	46,323	48,136	94,459	53,147	53,182	106,329	53,148	53,183	106,331	46,711	48,634	95,345
a) Cura Sabo Dam No.1	21,305	24,661	45,966	0	0	0	5,326	6,165	11,491	5,326	6,165	11,491	5,327	6,166	11,493	5,326	6,165	11,491
b) Labugaon Sabo Dam No.1	24,834	30,942	55,776	0	0	0	6,209	7,736	13,945	6,209	7,736	13,945	6,209	7,736	13,945	6,207	7,734	13,941
c) Cura/Labugaon R/I	153,190	147,532	300,722	0	0	0	34,788	34,235	69,023	41,612	39,281	80,893	41,612	39,281	80,893	35,178	34,735	69,913
(2) Solsona River	77,270	114,492	191,762	0	0	0	22,692	32,895	55,587	20,265	29,873	50,138	17,156	25,862	43,018	17,157	25,862	43,019
a) Solsona Sabo Dam No.1	7,736	9,993	17,729	0	0	0	4,642	5,996	10,638	3,094	3,997	7,091	0	0	0	0	0	0
b) Solsona R/I	69,534	104,499	174,033	0	0	0	18,050	26,899	44,949	17,171	25,876	43,047	17,156	25,862	43,018	17,157	25,862	43,019
(3) Madongan River	111,467	165,572	277,039	0	0	0	30,063	44,100	74,163	27,175	40,529	67,704	27,116	40,472	67,588	27,113	40,471	67,584
a) Madongan Sabo Dam	28,218	33,511	61,729	0	0	0	7,055	8,378	15,433	7,055	8,378	15,433	7,055	8,378	15,433	7,053	8,377	15,430
b) Madongan R/I	83,249	132,061	215,310	0	0	0	23,008	35,722	58,730	20,120	32,151	52,271	20,061	32,094	52,155	20,060	32,094	52,154
(4) Papa River	75,991	121,553	197,544	0	0	0	20,424	31,779	52,203	18,678	30,070	48,748	18,677	30,069	48,746	18,212	29,635	47,847
a) Papa Sabo Dam	23,341	27,528	50,869	0	0	0	5,836	6,882	12,718	5,835	6,882	12,717	5,835	6,882	12,717	5,835	6,882	12,717
b) Papa R/I	52,650	94,025	146,675	0	0	0	14,588	24,897	39,485	12,843	23,188	36,031	12,842	23,187	36,029	12,377	22,753	35,130
1.2.2 Laoag-Bongo R/I	76,500	56,826	133,326	0	0	0	18,152	15,524	33,676	23,287	15,650	38,937	23,374	17,102	40,476	11,687	8,550	20,237
(1) Poblacion Laoag R/I	18,152	15,524	33,676	0	0	0	18,152	15,524	33,676	0	0	0	0	0	0	0	0	0
(2) Poblacion San Nicolas R/I	23,287	15,650	38,937	0	0	0	0	0	0	23,287	15,650	38,937	0	0	0	0	0	0
(3) Poblacion Dingras R/I	35,061	25,652	60,713	0	0	0	0	0	0	0	0	0	23,374	17,102	40,476	11,687	8,550	20,237
1.3 Miscellaneous Works	54,056	66,158	120,214	0	0	0	13,765	17,243	31,009	14,255	16,930	31,186	13,947	16,669	30,616	12,088	15,315	27,403
2. COMPENSATION COST	0	6,440	6,440	0	6,440	6,440	0	0	0	0	0	0	0	0	0	0	0	0
3. ADMINISTRATION COST	0	43,831	43,831	0	193	193	0	11,256	11,256	0	11,320	11,320	0	11,114	11,114	0	9,947	9,947
4. ENGINEERING SERVICES COST	209,460	23,273	232,733	78,548	8,727	87,275	32,885	3,654	36,539	32,676	3,631	36,306	32,676	3,631	36,306	32,676	3,631	36,306
5. PHYSICAL CONTINGENCY	86,353	87,405	173,759	7,855	1,536	9,391	19,945	22,356	42,300	20,516	21,981	42,497	20,144	21,644	41,787	17,894	19,889	37,783
SUB-TOTAL (1 to 5)	949,887	961,458	1,911,346	86,402	16,897	103,299	219,391	245,911	465,302	225,680	241,790	467,470	221,579	238,080	459,660	196,835	218,781	415,616
6. PRICE CONTINGENCY	83,190	338,532	421,722	3,456	2,450	5,906	13,383	55,330	68,713	18,506	75,197	93,702	23,044	95,946	118,991	24,801	109,609	134,410
TOTAL	1,033,077	1,299,991	2,333,068	89,858	19,347	109,205	232,774	301,241	534,015	244,186	316,986	561,172	244,623	334,027	578,650	221,636	328,390	550,026

Note: R/I means River Improvement.

Table II.3 Economic Cost and Benefit Stream of Project under Present Condition

(Unit : Million Pesos)

Serial Year	Year	Cost			Benefit					Balance
		Const-ruction	O&M	Total	Flood Control	Land Loss Prevention	Land Use Restration	Negative	Total	
1	1999	104.38		104.38					0.00	-104.38
2	2000	382.00		382.00				0.04	-0.04	-382.04
3	2001	384.90	1.18	386.07	31.56			0.04	31.52	-354.55
4	2002	378.63	2.38	381.01	71.86			0.04	71.82	-309.19
5	2003	342.34	3.59	345.94	129.34			0.04	129.30	-216.64
6	2004		4.65	4.65	203.77	2.91	1.05	0.04	207.68	203.04
7	2005		4.65	4.65	203.77	5.82	2.10	0.04	211.64	206.99
8	2006		4.65	4.65	203.77	8.73	3.14	0.04	215.60	210.95
9	2007		4.65	4.65	203.77	11.64	4.19	0.04	219.56	214.91
10	2008		4.65	4.65	203.77	14.54	5.24	0.04	223.51	218.87
11	2009		4.65	4.65	203.77	17.45	5.24	0.04	226.42	221.77
12	2010		4.65	4.65	203.77	20.36	5.24	0.04	229.33	224.68
13	2011		4.65	4.65	203.77	23.27	5.24	0.04	232.24	227.59
14	2012		4.65	4.65	194.05	26.18	5.24	0.04	225.43	220.78
15	2013		4.65	4.65	194.05	29.09	5.24	0.04	228.34	223.69
16	2014		4.65	4.65	171.09	32.00	5.24	0.04	208.29	203.64
17	2015		4.65	4.65	171.09	34.91	5.24	0.04	211.20	206.55
18	2016		4.65	4.65	171.09	37.82	5.24	0.04	214.11	209.46
19	2017		4.65	4.65	171.09	40.72	5.24	0.04	217.02	212.37
20	2018		4.65	4.65	171.09	43.63	5.24	0.04	219.93	215.28
21	2019		4.65	4.65	171.09	46.54	5.24	0.04	222.84	218.19
22	2020		4.65	4.65	171.09	49.45	5.24	0.04	225.75	221.10
23	2021		4.65	4.65	171.09	49.45	5.24	0.04	225.75	221.10
24	2022		4.65	4.65	171.09	49.45	5.24	0.04	225.75	221.10
25	2023		4.65	4.65	171.09	49.45	5.24	0.04	225.75	221.10
26	2024		4.65	4.65	155.13	49.45	5.24	0.04	209.78	205.14
27	2025		4.65	4.65	155.13	49.45	5.24	0.04	209.78	205.14
28	2026		4.65	4.65	155.13	49.45	5.24	0.04	209.78	205.14
29	2027		4.65	4.65	155.13	49.45	5.24	0.04	209.78	205.14
30	2028		4.65	4.65	155.13	49.45	5.24	0.04	209.78	205.14
31	2029		4.65	4.65	155.13	49.45	5.24	0.04	209.78	205.14
32	2030		4.65	4.65	155.13	49.45	5.24	0.04	209.78	205.14
33	2031		4.65	4.65	155.13	49.45	5.24	0.04	209.78	205.14
34	2032		4.65	4.65	155.13	49.45	5.24	0.04	209.78	205.14
35	2033		4.65	4.65	155.13	49.45	5.24	0.04	209.78	205.14
36	2034		4.65	4.65	155.13	49.45	5.24	0.04	209.78	205.14
37	2035		4.65	4.65	155.13	49.45	5.24	0.04	209.78	205.14
38	2036		4.65	4.65	155.13	49.45	5.24	0.04	209.78	205.14
39	2037		4.65	4.65	155.13	49.45	5.24	0.04	209.78	205.14
40	2038		4.65	4.65	155.13	49.45	5.24	0.04	209.78	205.14
41	2039		4.65	4.65	155.13	49.45	5.24	0.04	209.78	205.14
42	2040		4.65	4.65	155.13	49.45	5.24	0.04	209.78	205.14
43	2041		4.65	4.65	155.13	49.45	5.24	0.04	209.78	205.14
44	2042		4.65	4.65	155.13	49.45	5.24	0.04	209.78	205.14
45	2043		4.65	4.65	155.13	49.45	5.24	0.04	209.78	205.14
46	2044		4.65	4.65	155.13	49.45	5.24	0.04	209.78	205.14
47	2045		4.65	4.65	155.13	49.45	5.24	0.04	209.78	205.14
48	2046		4.65	4.65	155.13	49.45	5.24	0.04	209.78	205.14
49	2047		4.65	4.65	155.13	49.45	5.24	0.04	209.78	205.14
50	2048		4.65	4.65	155.13	49.45	5.24	0.04	209.78	205.14
51	2049		4.65	4.65	155.13	49.45	5.24	0.04	209.78	205.14
52	2050		4.65	4.65	155.13	49.45	5.24	0.04	209.78	205.14
53	2051		4.65	4.65	155.13	49.45	5.24	0.04	209.78	205.14
54	2052		4.65	4.65	155.13	49.45	5.24	0.04	209.78	205.14
55	2053		4.65	4.65	155.13	49.45	5.24	0.04	209.78	205.14

NPV: -190.2 B/C: 0.82 EIRR : 12.4%

Table II.4 Economic Cost and Benefit Stream of Project under Future Condition

(Unit : Million Pesos)

Serial Year	Year	Cost			Benefit					Balance
		Const-ruction	O&M	Total	Flood Control	Land Loss Prevention	Land Use Restration	Negative	Total	
1	1999	104.38		104.38					0.00	-104.38
2	2000	382.00		382.00				0.04	-0.04	-382.04
3	2001	384.90	1.18	386.07	82.10			0.04	82.05	-304.02
4	2002	378.63	2.38	381.01	143.06			0.04	143.01	-238.00
5	2003	342.34	3.59	345.94	205.67			0.04	205.62	-140.31
6	2004		4.65	4.65	280.88	3.71	1.38	0.04	285.93	281.29
7	2005		4.65	4.65	292.50	7.66	2.76	0.04	302.87	298.23
8	2006		4.65	4.65	304.59	11.84	4.27	0.04	320.66	316.01
9	2007		4.65	4.65	317.19	16.28	5.87	0.04	339.29	334.65
10	2008		4.65	4.65	330.31	20.98	7.56	0.04	358.81	354.16
11	2009		4.65	4.65	343.97	25.96	7.80	0.04	377.68	373.03
12	2010		4.65	4.65	358.20	31.22	8.04	0.04	397.41	392.77
13	2011		4.65	4.65	369.26	36.79	8.29	0.04	414.30	409.65
14	2012		4.65	4.65	362.21	42.67	8.54	0.04	413.38	408.73
15	2013		4.65	4.65	373.40	48.89	8.81	0.04	431.05	426.40
16	2014		4.65	4.65	338.83	55.44	9.08	0.05	403.31	398.66
17	2015		4.65	4.65	349.28	62.36	9.36	0.05	420.96	416.31
18	2016		4.65	4.65	360.06	69.65	9.65	0.05	439.32	434.67
19	2017		4.65	4.65	371.17	77.33	9.95	0.05	458.41	453.76
20	2018		4.65	4.65	382.62	85.42	10.26	0.05	478.26	473.61
21	2019		4.65	4.65	394.43	93.95	10.58	0.05	498.91	494.26
22	2020		4.65	4.65	406.60	102.91	10.58	0.05	520.04	515.40
23	2021		4.65	4.65	406.60	102.91	10.58	0.05	520.04	515.40
24	2022		4.65	4.65	406.60	102.91	10.58	0.05	520.04	515.40
25	2023		4.65	4.65	406.60	102.91	10.58	0.05	520.04	515.40
26	2024		4.65	4.65	369.79	102.91	10.58	0.05	483.24	478.59
27	2025		4.65	4.65	369.79	102.91	10.58	0.05	483.24	478.59
28	2026		4.65	4.65	369.79	102.91	10.58	0.05	483.24	478.59
29	2027		4.65	4.65	369.79	102.91	10.58	0.05	483.24	478.59
30	2028		4.65	4.65	369.79	102.91	10.58	0.05	483.24	478.59
31	2029		4.65	4.65	369.79	102.91	10.58	0.05	483.24	478.59
32	2030		4.65	4.65	369.79	102.91	10.58	0.05	483.24	478.59
33	2031		4.65	4.65	369.79	102.91	10.58	0.05	483.24	478.59
34	2032		4.65	4.65	369.79	102.91	10.58	0.05	483.24	478.59
35	2033		4.65	4.65	369.79	102.91	10.58	0.05	483.24	478.59
36	2034		4.65	4.65	369.79	102.91	10.58	0.05	483.24	478.59
37	2035		4.65	4.65	369.79	102.91	10.58	0.05	483.24	478.59
38	2036		4.65	4.65	369.79	102.91	10.58	0.05	483.24	478.59
39	2037		4.65	4.65	369.79	102.91	10.58	0.05	483.24	478.59
40	2038		4.65	4.65	369.79	102.91	10.58	0.05	483.24	478.59
41	2039		4.65	4.65	369.79	102.91	10.58	0.05	483.24	478.59
42	2040		4.65	4.65	369.79	102.91	10.58	0.05	483.24	478.59
43	2041		4.65	4.65	369.79	102.91	10.58	0.05	483.24	478.59
44	2042		4.65	4.65	369.79	102.91	10.58	0.05	483.24	478.59
45	2043		4.65	4.65	369.79	102.91	10.58	0.05	483.24	478.59
46	2044		4.65	4.65	369.79	102.91	10.58	0.05	483.24	478.59
47	2045		4.65	4.65	369.79	102.91	10.58	0.05	483.24	478.59
48	2046		4.65	4.65	369.79	102.91	10.58	0.05	483.24	478.59
49	2047		4.65	4.65	369.79	102.91	10.58	0.05	483.24	478.59
50	2048		4.65	4.65	369.79	102.91	10.58	0.05	483.24	478.59
51	2049		4.65	4.65	369.79	102.91	10.58	0.05	483.24	478.59
52	2050		4.65	4.65	369.79	102.91	10.58	0.05	483.24	478.59
53	2051		4.65	4.65	369.79	102.91	10.58	0.05	483.24	478.59
54	2052		4.65	4.65	369.79	102.91	10.58	0.05	483.24	478.59
55	2053		4.65	4.65	369.79	102.91	10.58	0.05	483.24	478.59

NPV: 441.8 B/C: 1.43 EIRR : 20.3%

Table II.5 Scaling Checklist for Environmental Impacts

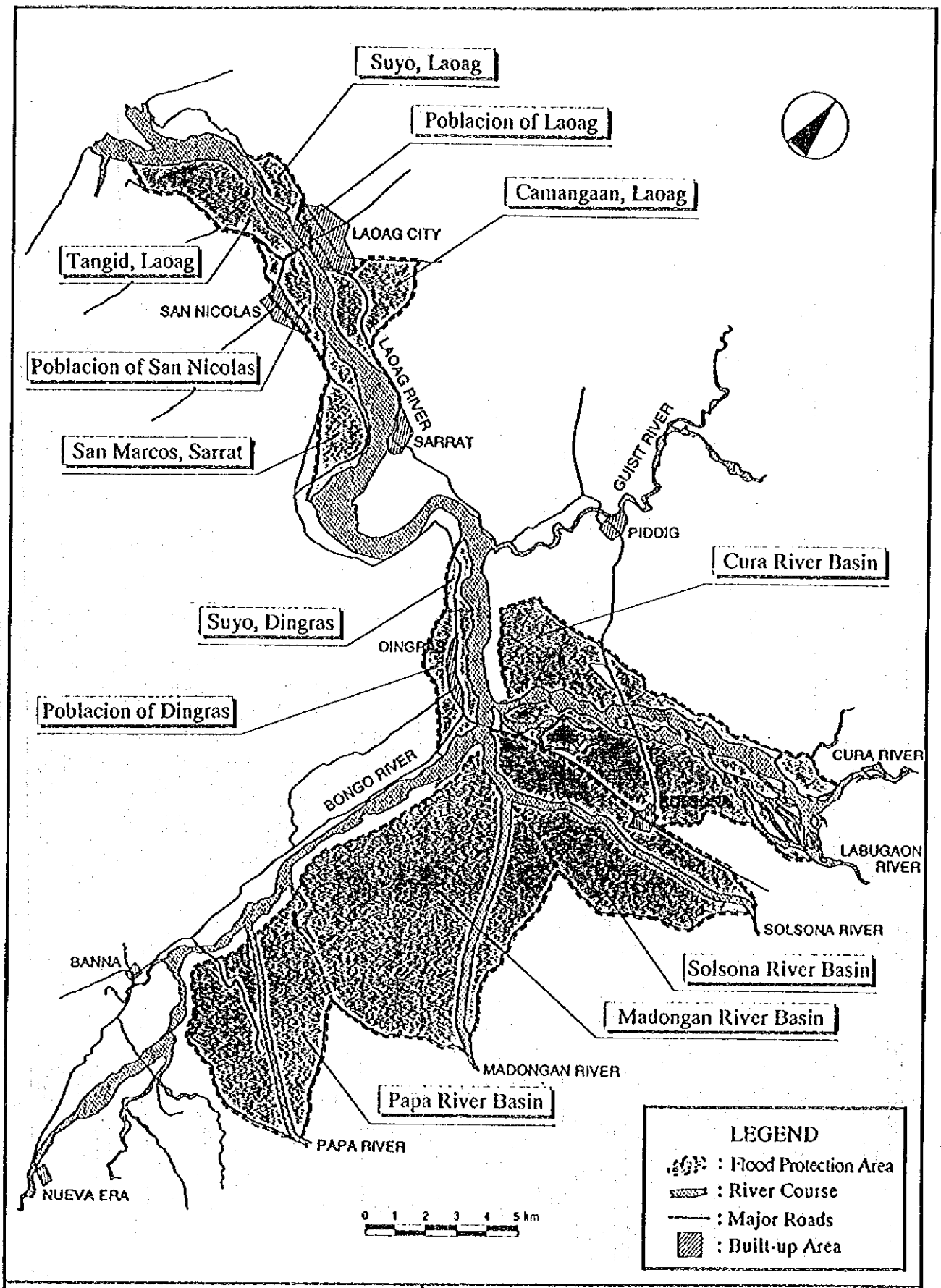
(Construction Phase)

Impact Area	Direct Impact	Nature	Magnitude
Water Quality/Air Quality/ Noise	Water Pollution	Negative	Moderate
	Air Pollution	Negative	Minimal
	Noise Generation	Negative	Minimal
Geology	Soil Erosion	Negative	Minimal
Ecology	Fish/Wildlife Disturbance	Negative	Minimal
	Vegetation Loss	Negative	Minimal
Socio-Economy	Land Aquisition/House Relocation	Negative	Minimal
	Archaeological/Historical Asset Loss	Negative	No Effect
	Traffic Disturbance	Negative	Minimal
	Local Labor Employment	Positive	Significant

(Operation Phase)

Impact Area	Direct Impact	Nature	Magnitude
Hydrology/River Morphology	Groundwater Recharge Reduction	Negative	Minimal
	Riverbed Aggradation	Negative	Minimal
	Reduction of Channel Shifting	Positive	Significant
	Increase of River Bank Erosion	Negative	Minimal
	Decrease of Sand Supply to Coast	Negative	Minimal
Water Quality/Air Quality/ Noise	Generation of Water Pollutants	Negative	No Effect
	Generation of Air Pollutants	Negative	No Effect
	Generation of Noise	Negative	No Effect
Geology	Geological Destruction	Negative	No Effect
Ecology	Loss of Wildlife Habitat	Negative	No Effect
	Disruption of Fish Spawning Grounds	Negative	Minimal
Aesthetics	Aesthetic Impairment of Landscape	Negative	Minimal
	Visual Impairment of Historical/ Cultural Resources	Negative	No Effect
Natural Resources Use	Loss of Fishing Area	Negative	No Effect
	Impairment of Navigation	Negative	No Effect
	Damage to Economically Valuable Natural Resources	Negative	No Effect
Socio-Economy	Reduction of Economical Loss	Positive	Significant
	Reduction of Health Risk	Positive	Significant
	Increase of Available Farmland	Positive	Significant
	Disruption of Minorities' Life	Negative	No Effect

FIGURES

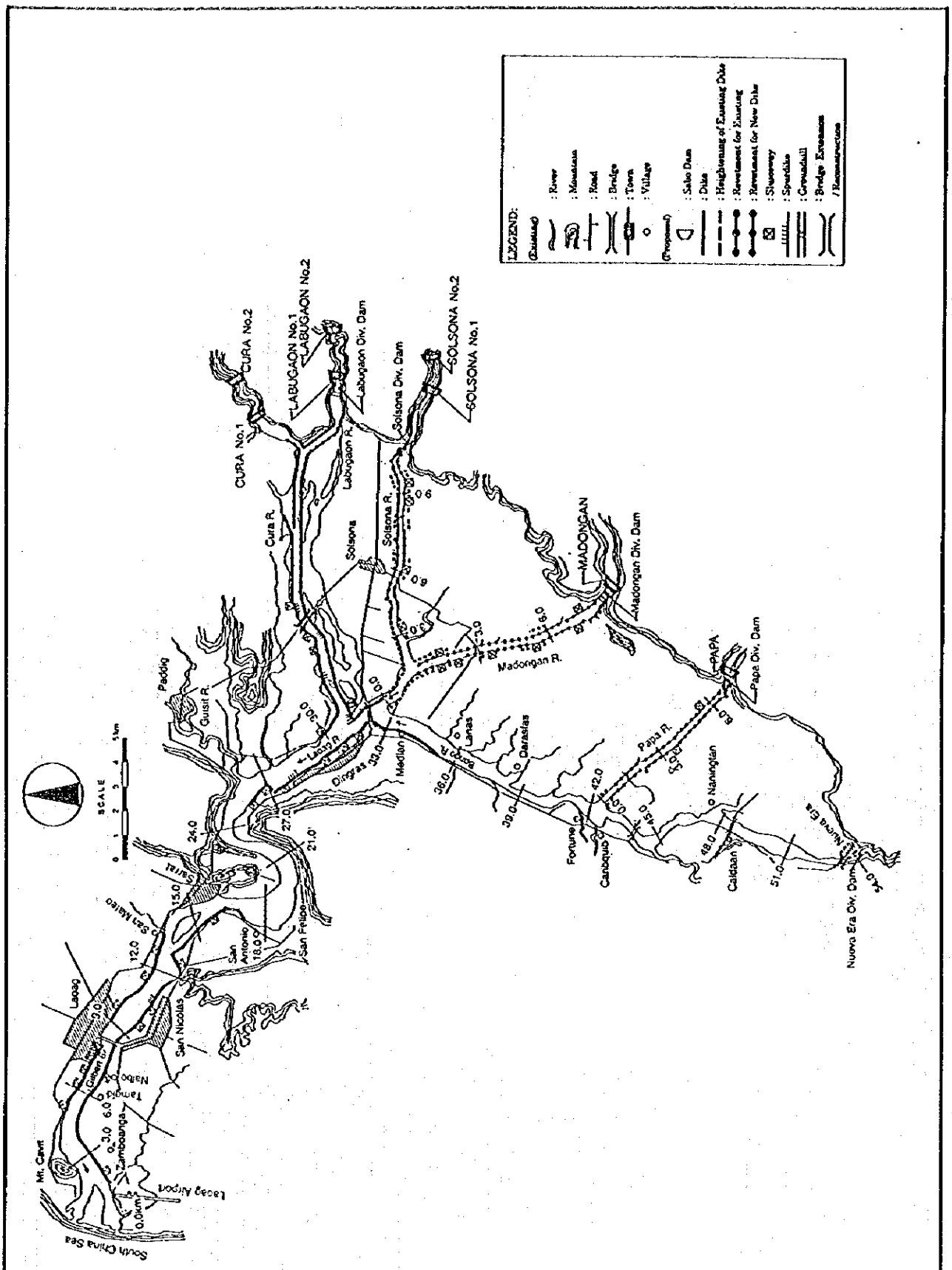


THE STUDY ON SABO AND FLOOD CONTROL IN THE LAOAG RIVER BASIN

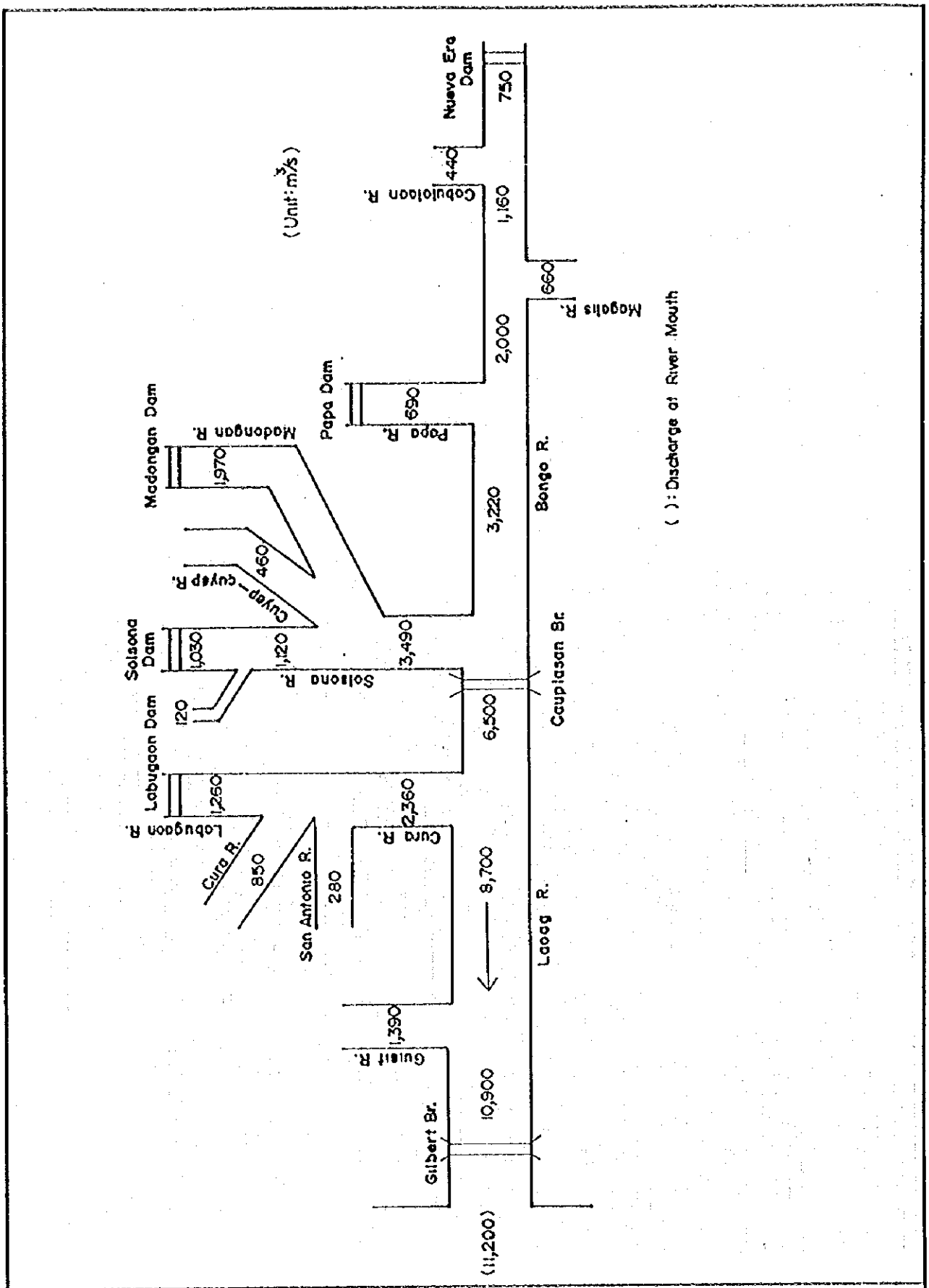
JAPAN INTERNATIONAL COOPERATION AGENCY

Fig. II.1

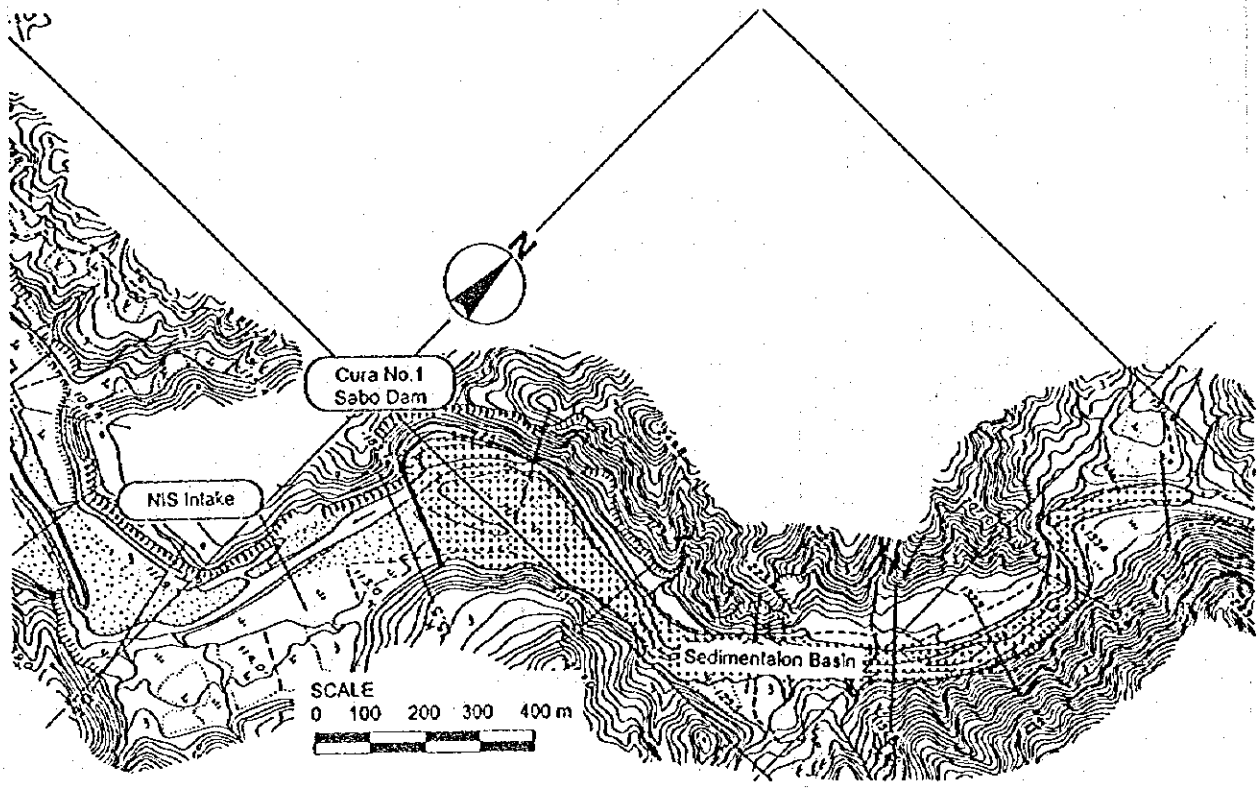
Target Flood Protection Districts

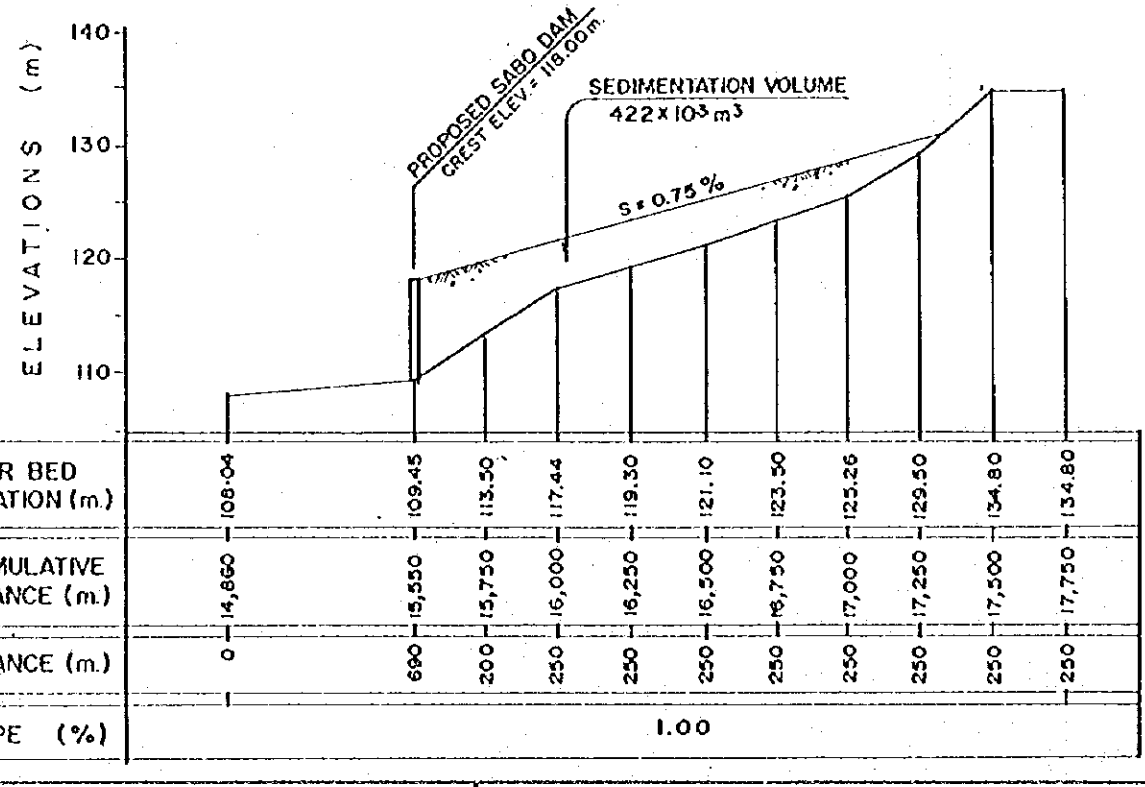


THE STUDY ON SABO AND FLOOD CONTROL IN THE LAOAG RIVER BASIN	Fig. II.2 Sabo and River Improvement Works of Master Plan
JAPAN INTERNATIONAL COOPERATION AGENCY	



THE STUDY ON SABO AND FLOOD CONTROL IN THE LAOAG RIVER BASIN JAPAN INTERNATIONAL COOPERATION AGENCY	Fig. II.3 Design Flood Discharge Distribution



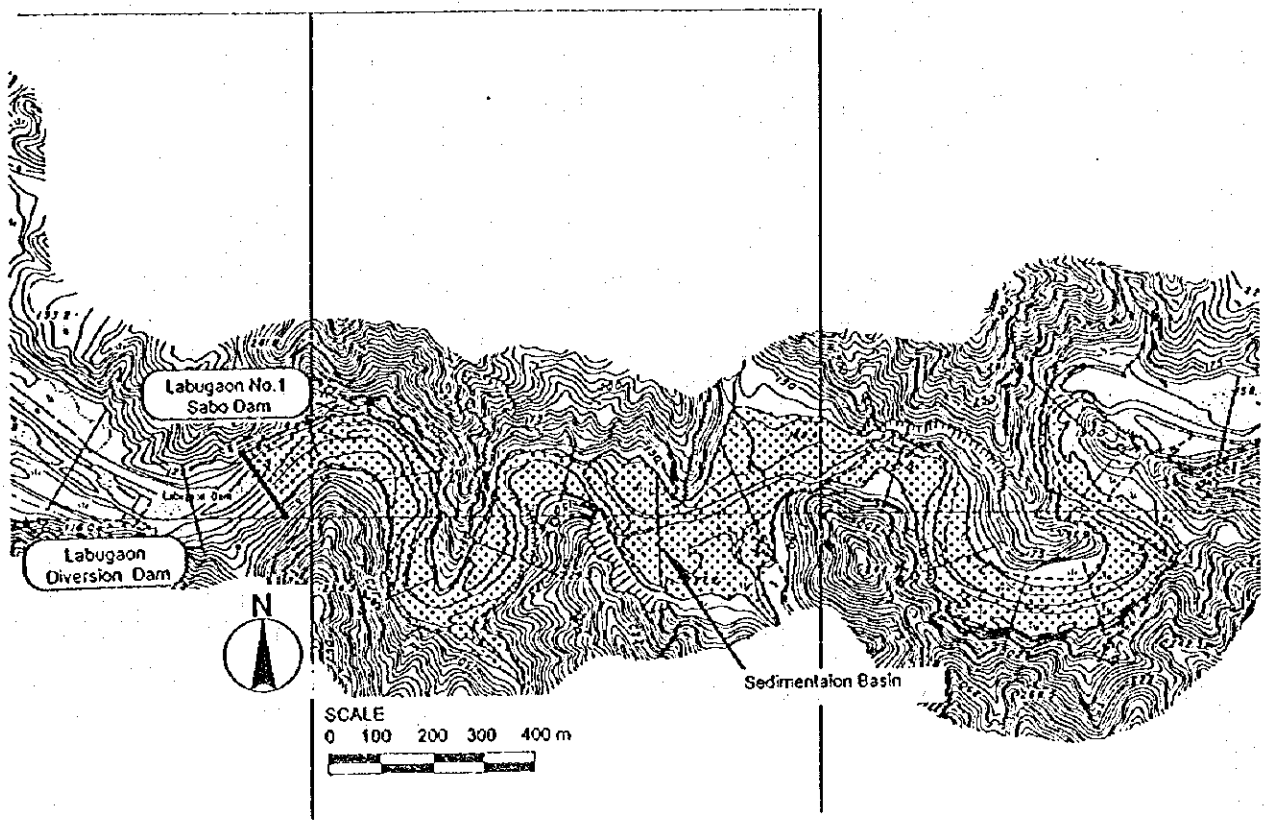


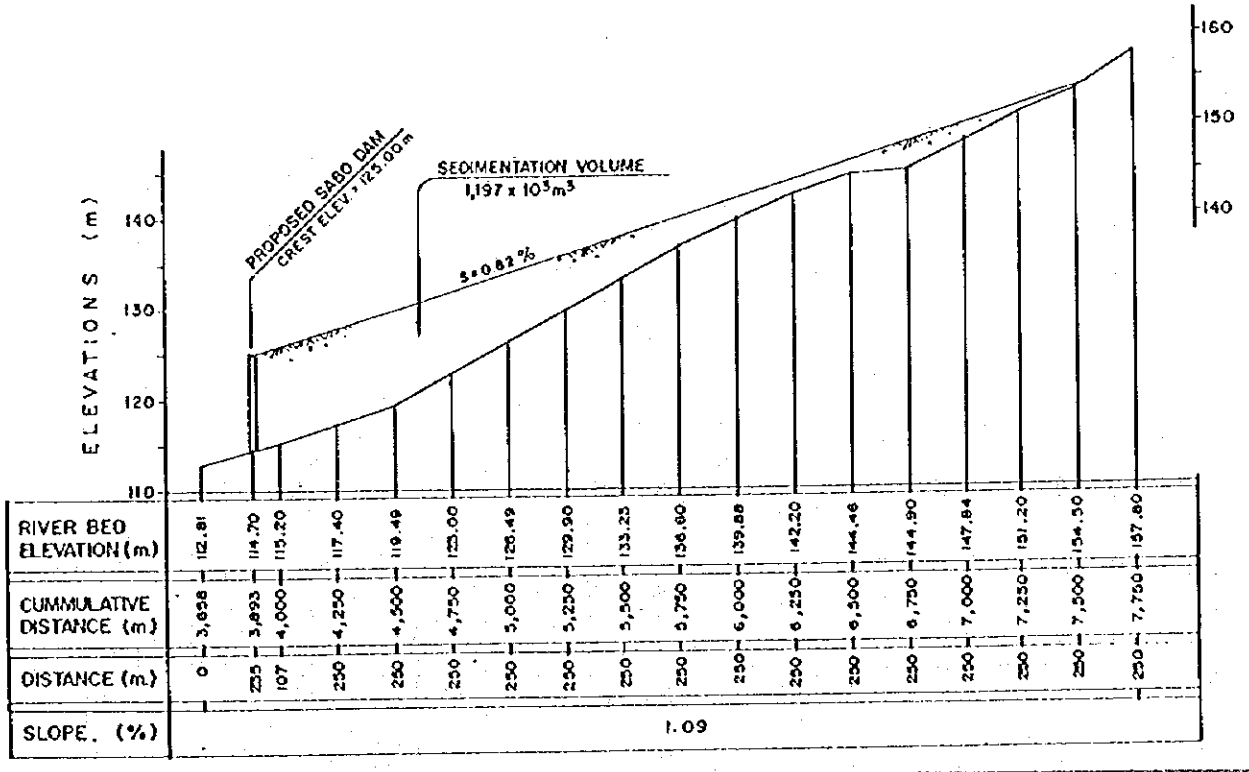
RIVER BED ELEVATION (m.)	108.04	109.45	113.50	117.44	119.30	121.10	123.50	125.26	129.50	134.80	134.80	
CUMMULATIVE DISTANCE (m.)	14,860	15,550	15,750	16,000	16,250	16,500	16,750	17,000	17,250	17,500	17,750	
DISTANCE (m.)	0	690	200	250	250	250	250	250	250	250	250	
SLOPE (%)	1.00											

THE STUDY ON SABO AND FLOOD CONTROL IN THE LAOAG RIVER BASIN

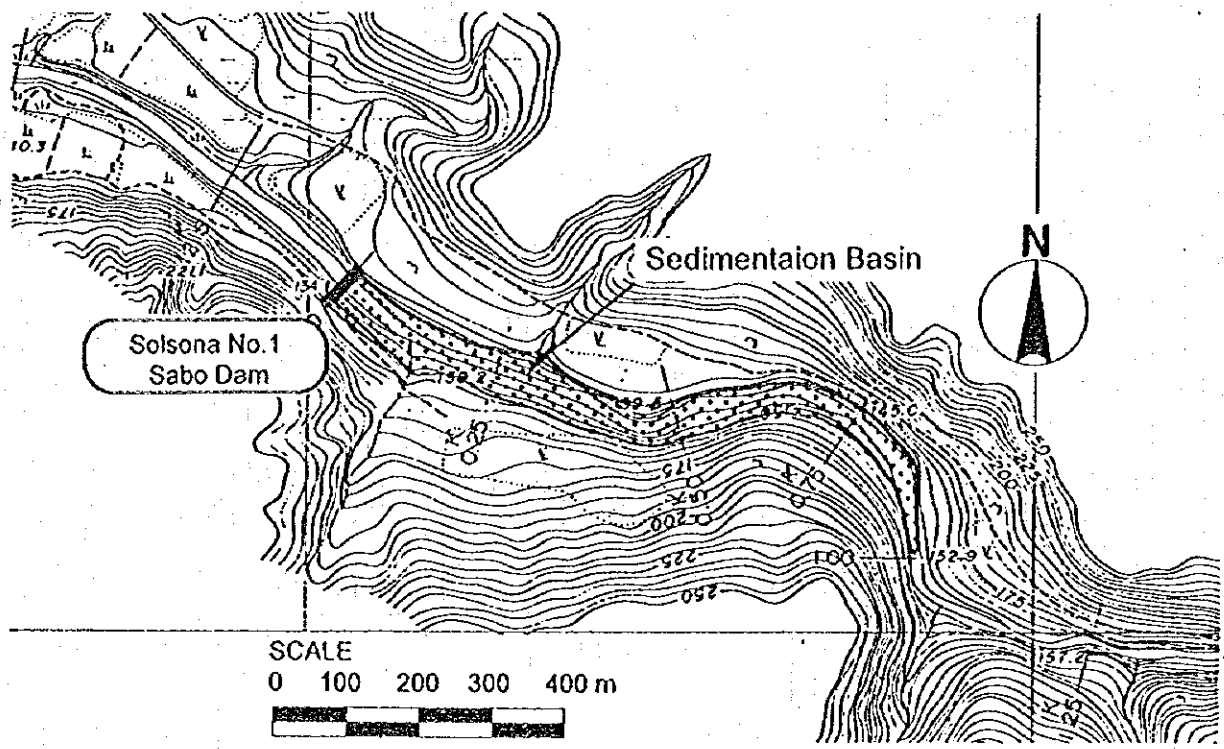
JAPAN INTERNATIONAL COOPERATION AGENCY

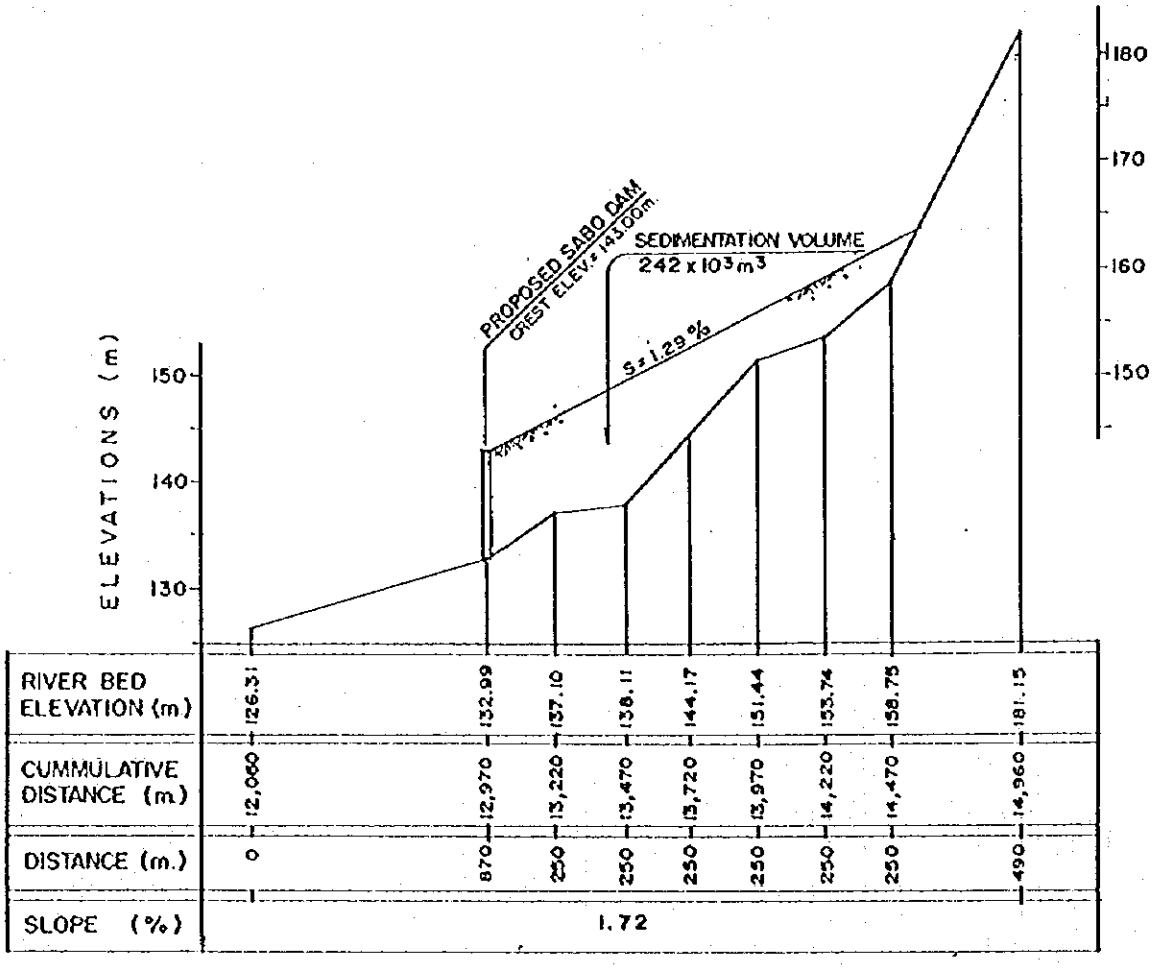
Fig. II.4 (1)
Plan and Longitudinal Profile of Proposed Sabo Dam (Cura No.1)



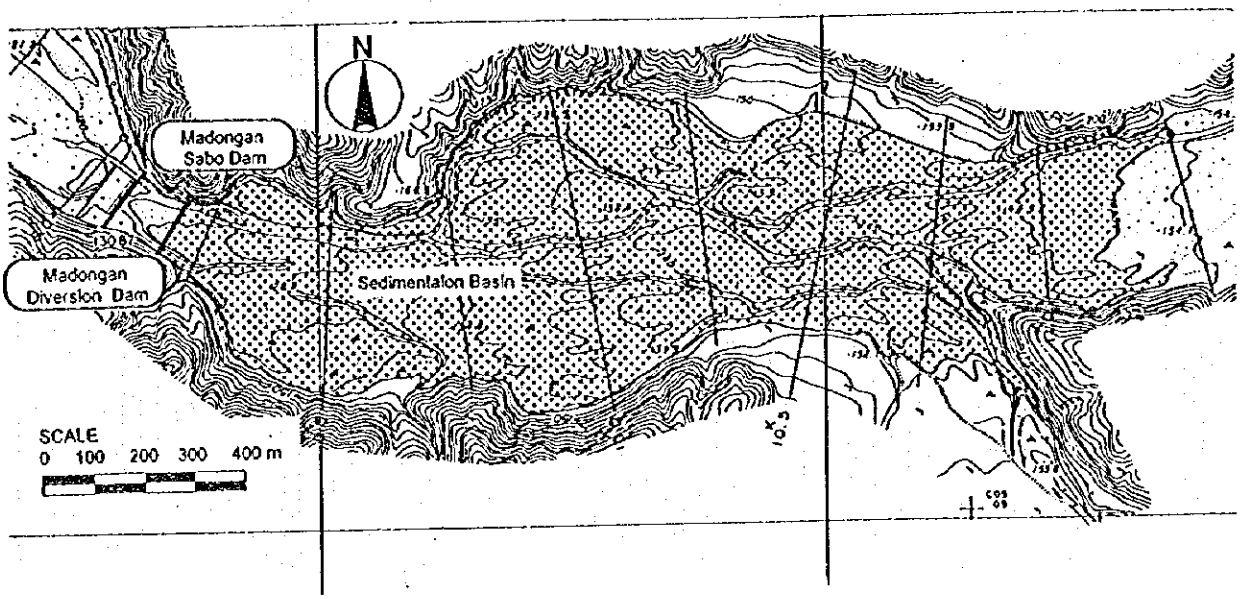


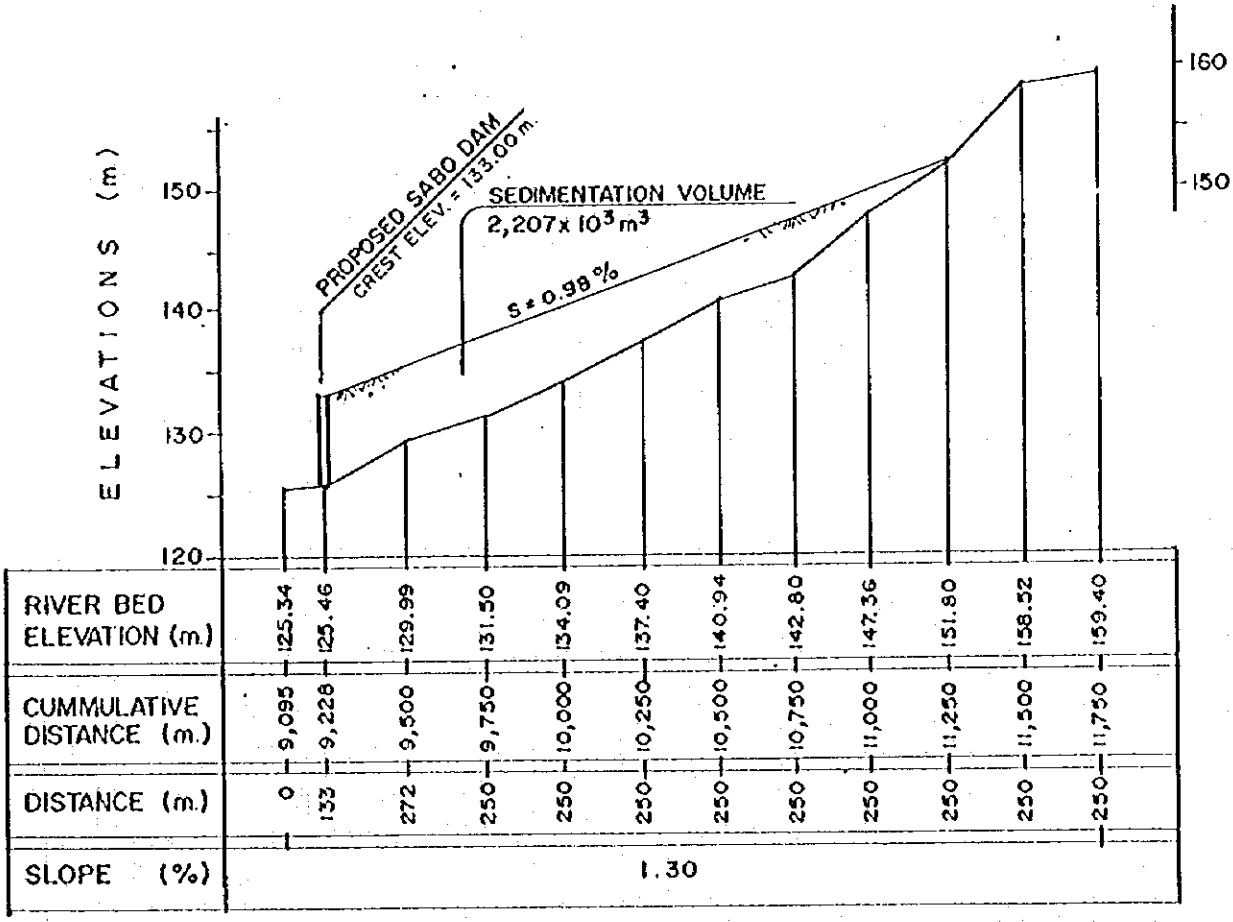
THE STUDY ON SABO AND FLOOD CONTROL IN THE LAOAG RIVER BASIN	Fig. II.4 (2) Plan and Longitudinal Profile of Proposed Sabo Dam (Labugaon No.1)
JAPAN INTERNATIONAL COOPERATION AGENCY	



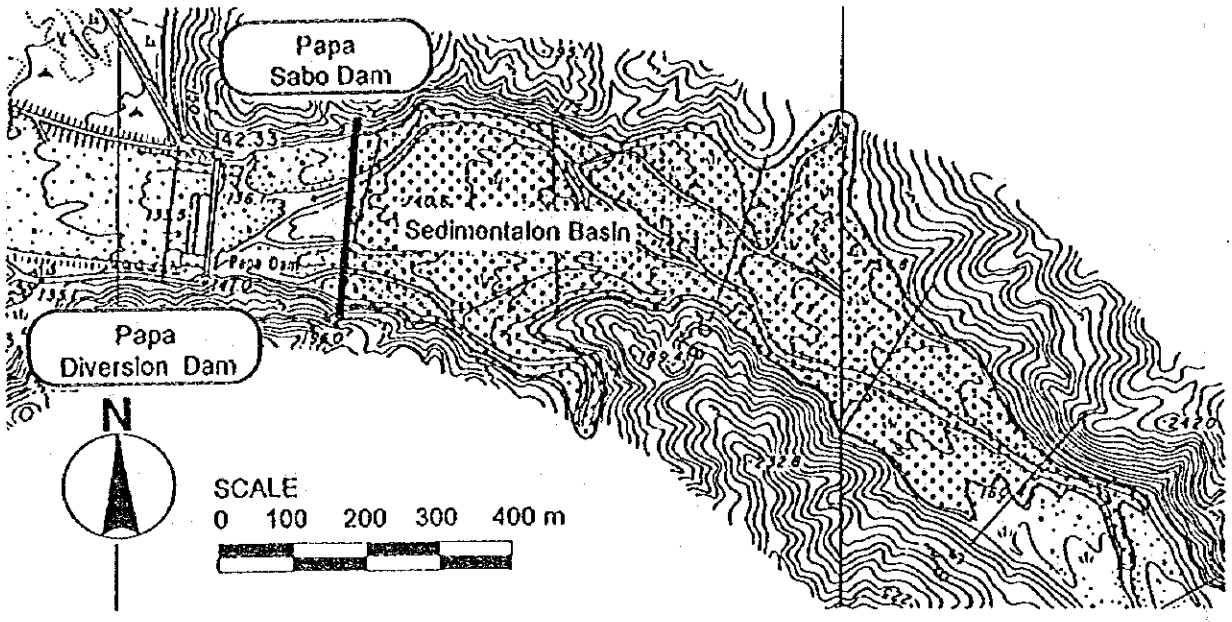


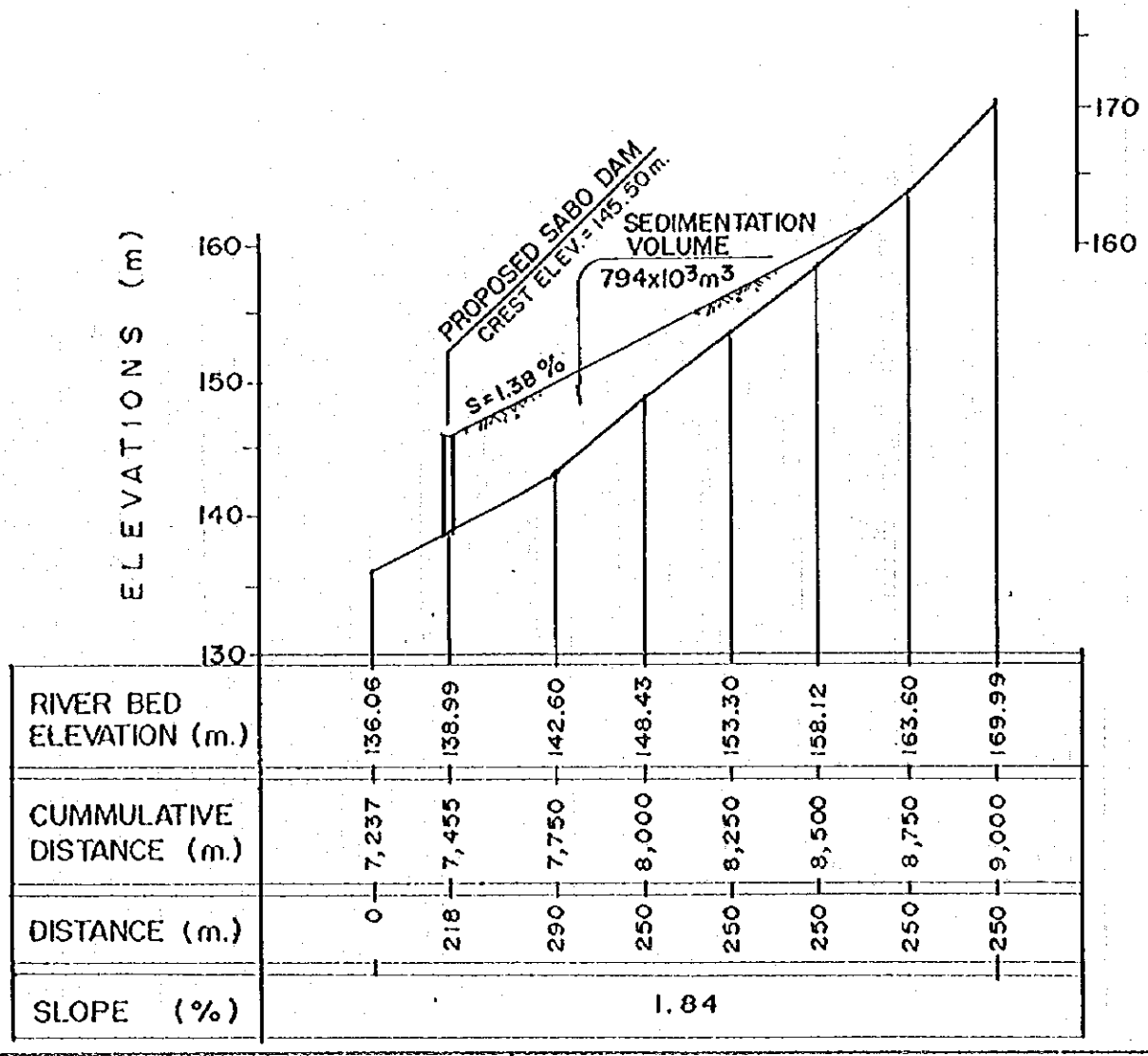
THE STUDY ON SABO AND FLOOD CONTROL IN THE LAOAG RIVER BASIN JAPAN INTERNATIONAL COOPERATION AGENCY	Fig. II.4 (3) Plan and Longitudinal Profile of Proposed Sabo Dam (Solsona No.1)





THE STUDY ON SABO AND FLOOD CONTROL IN THE LAOAG RIVER BASIN	Fig. II.4 (4) Plan and Longitudinal Profile of Proposed Sabo Dam (Madongan)
JAPAN INTERNATIONAL COOPERATION AGENCY	



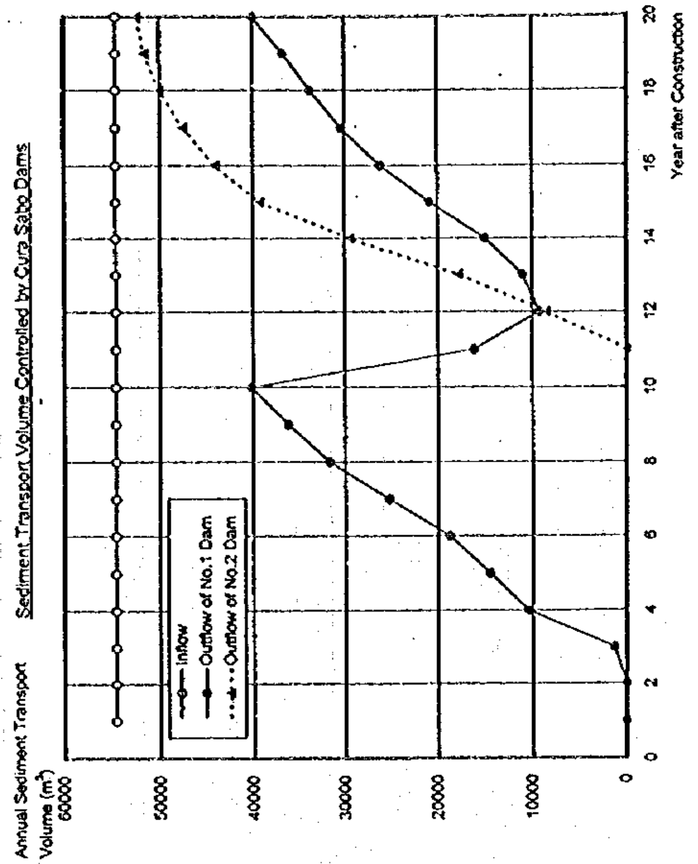


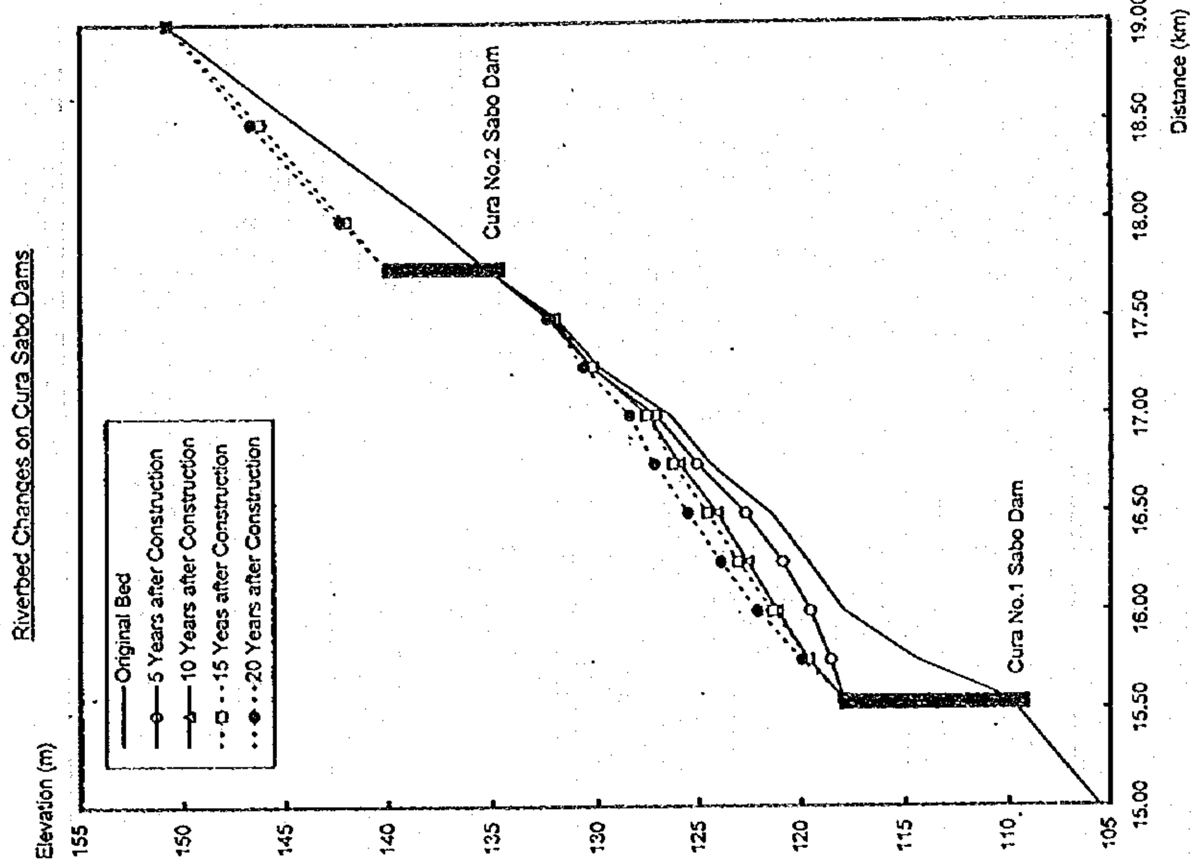
RIVER BED ELEVATION (m.)	136.06	138.99	142.60	148.43	153.30	158.12	163.60	169.99
CUMMULATIVE DISTANCE (m.)	7,237	7,455	7,750	8,000	8,250	8,500	8,750	9,000
DISTANCE (m.)	0	218	290	250	250	250	250	250
SLOPE (%)	1.84							

THE STUDY ON SABO AND FLOOD CONTROL IN THE LAOAG RIVER BASIN

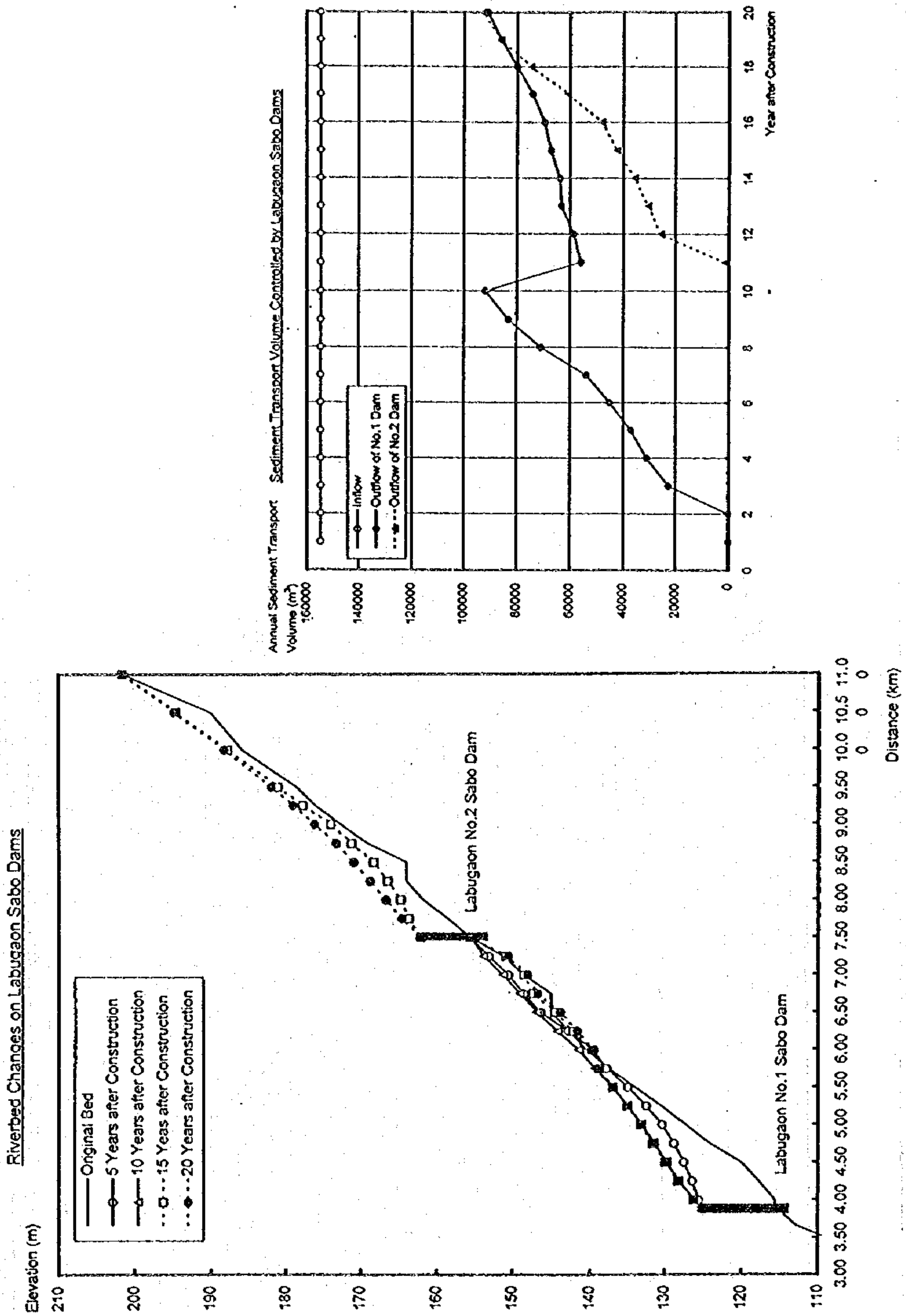
JAPAN INTERNATIONAL COOPERATION AGENCY

Fig. II.4 (5)
Plan and Longitudinal Profile of Proposed Sabo Dam (Papa)

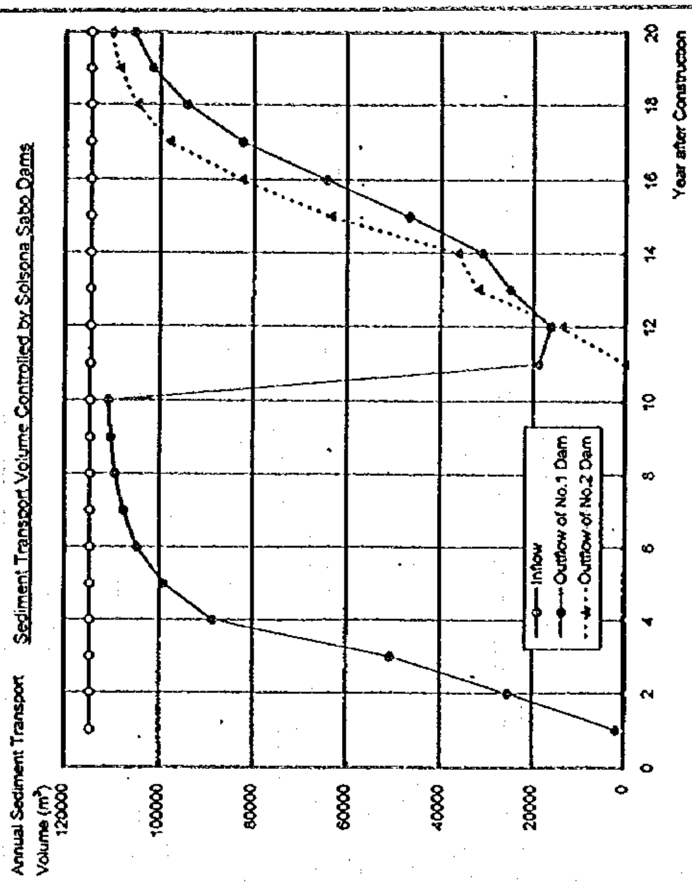


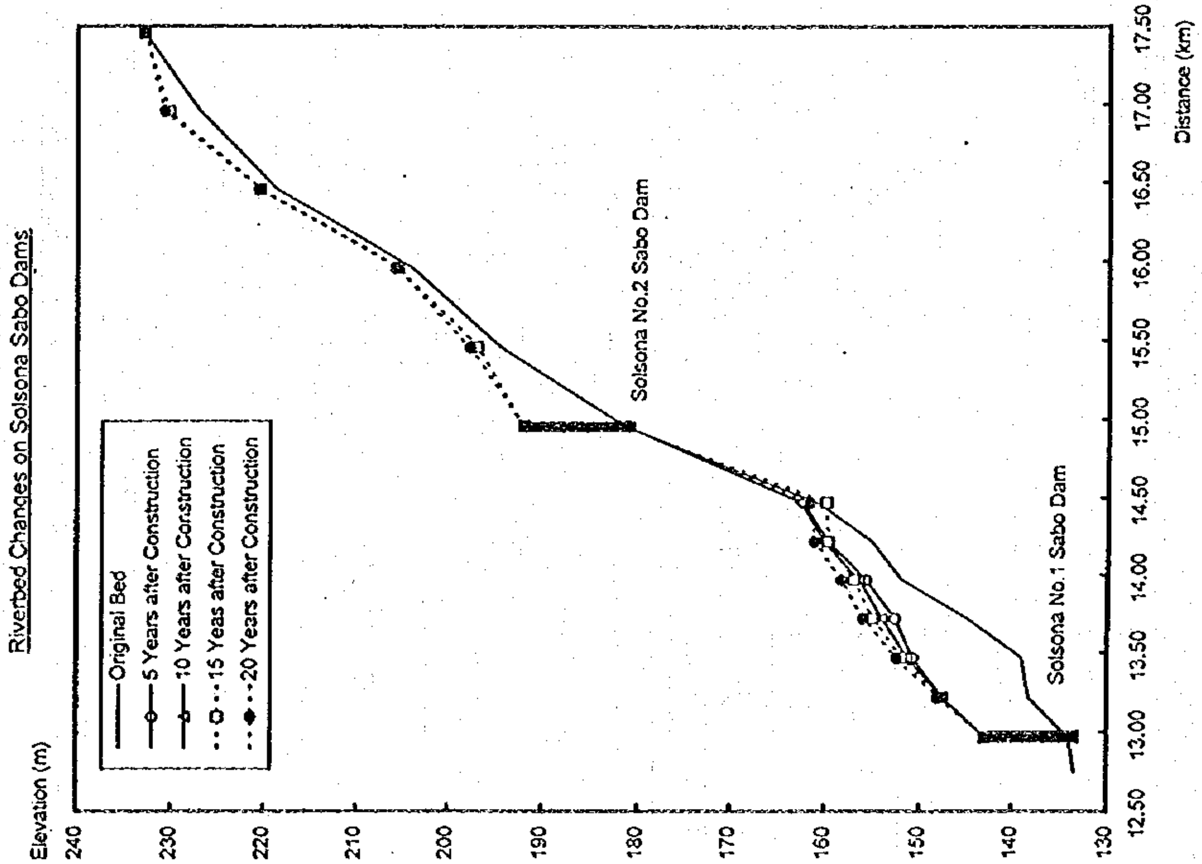


THE STUDY ON SABO AND FLOOD CONTROL IN THE LAOAG RIVER BASIN	Fig. II.5 (1)
JAPAN INTERNATIONAL COOPERATION AGENCY	Riverbed Variation and Sediment Control (Cura Dams)

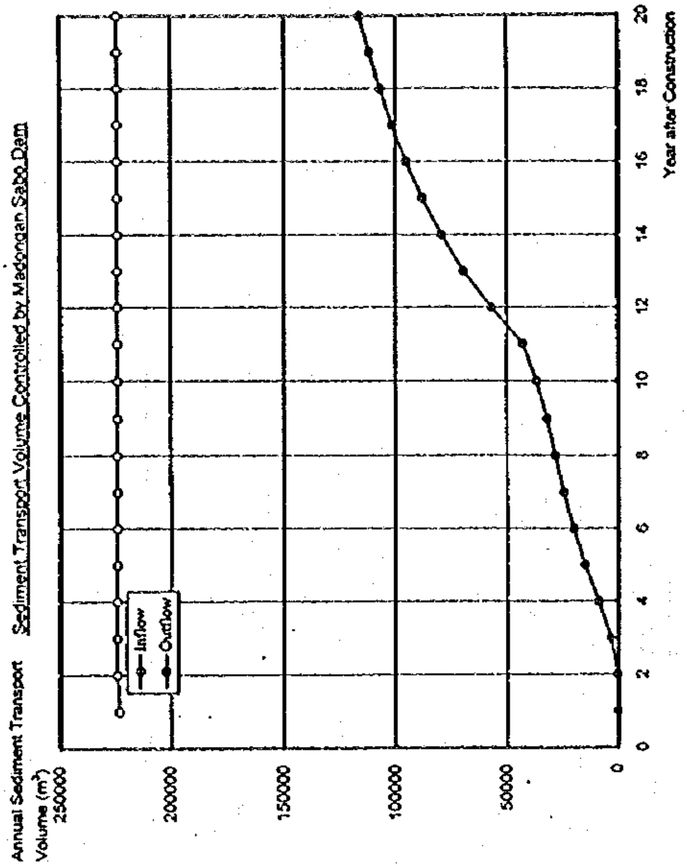


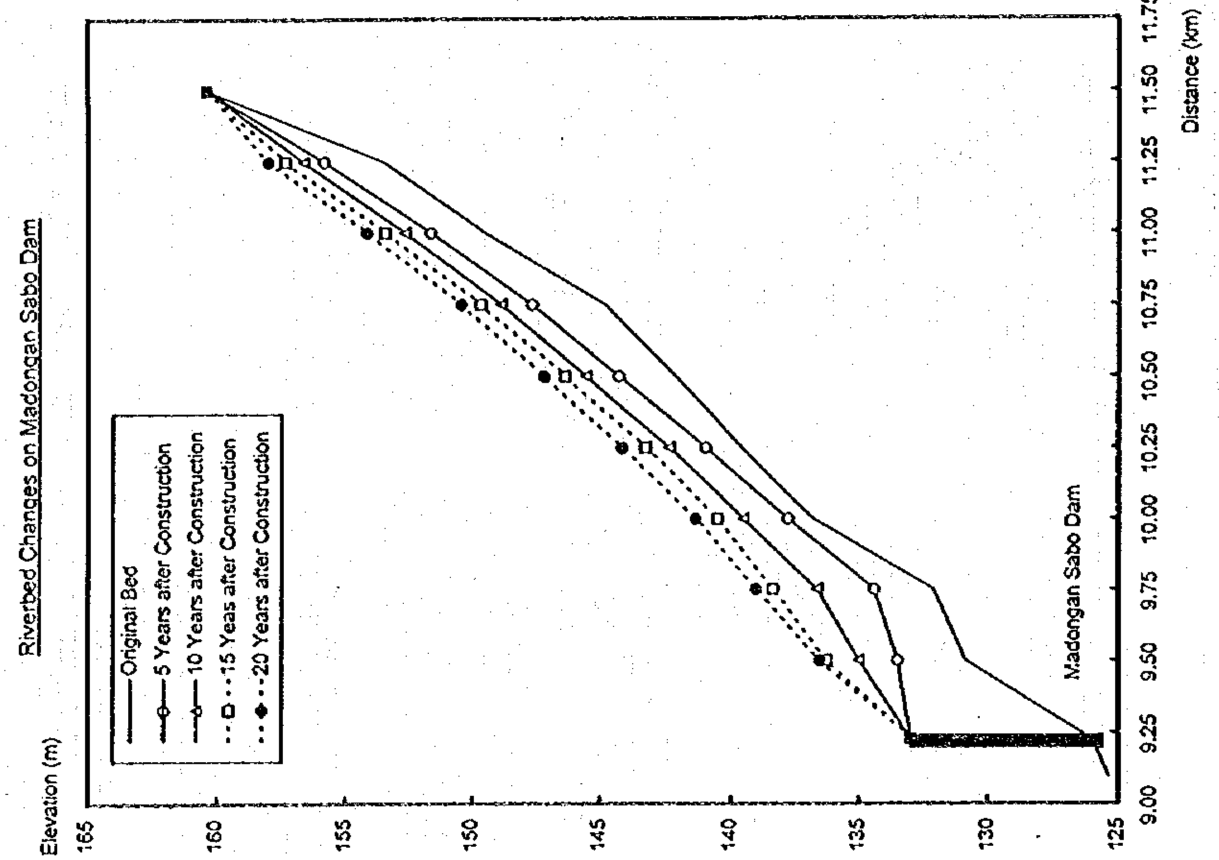
THE STUDY ON SABO AND FLOOD CONTROL IN THE LAOAG RIVER BASIN	Fig. II.5 (2)
JAPAN INTERNATIONAL COOPERATION AGENCY	Riverbed Variation and Sediment Control (Labugaon Dams)



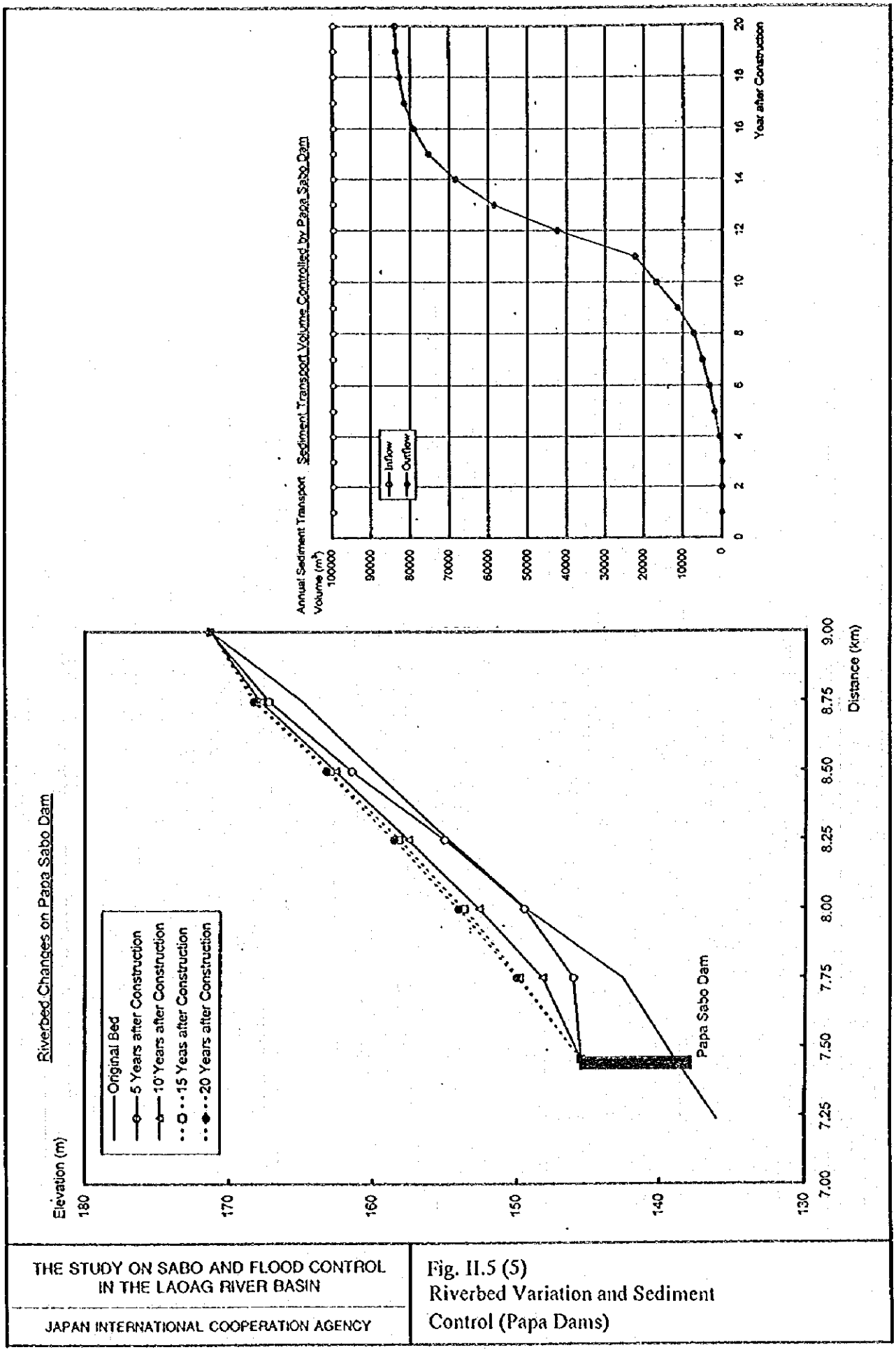


THE STUDY ON SABO AND FLOOD CONTROL IN THE LAOAG RIVER BASIN	Fig. II.5 (3) Riverbed Variation and Sediment Control (Solsona Dams)
JAPAN INTERNATIONAL COOPERATION AGENCY	





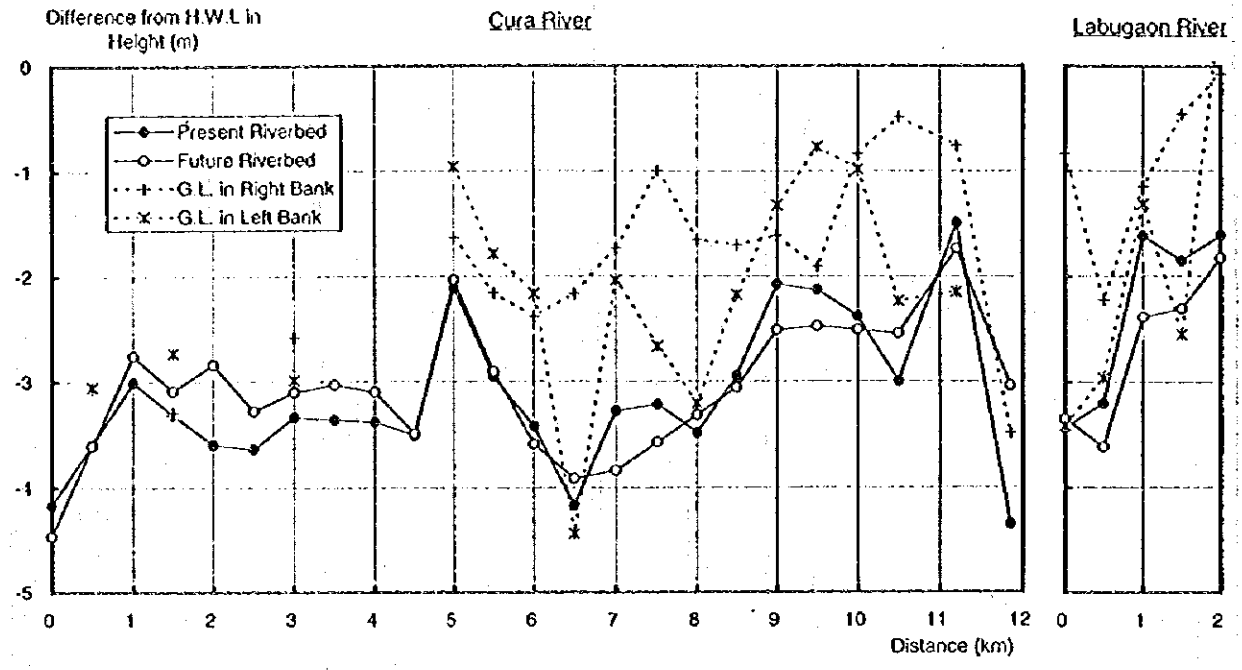
THE STUDY ON SABO AND FLOOD CONTROL IN THE LAOAG RIVER BASIN JAPAN INTERNATIONAL COOPERATION AGENCY	Fig. II.5 (4) Riverbed Variation and Sediment Control (Madongan Dams)

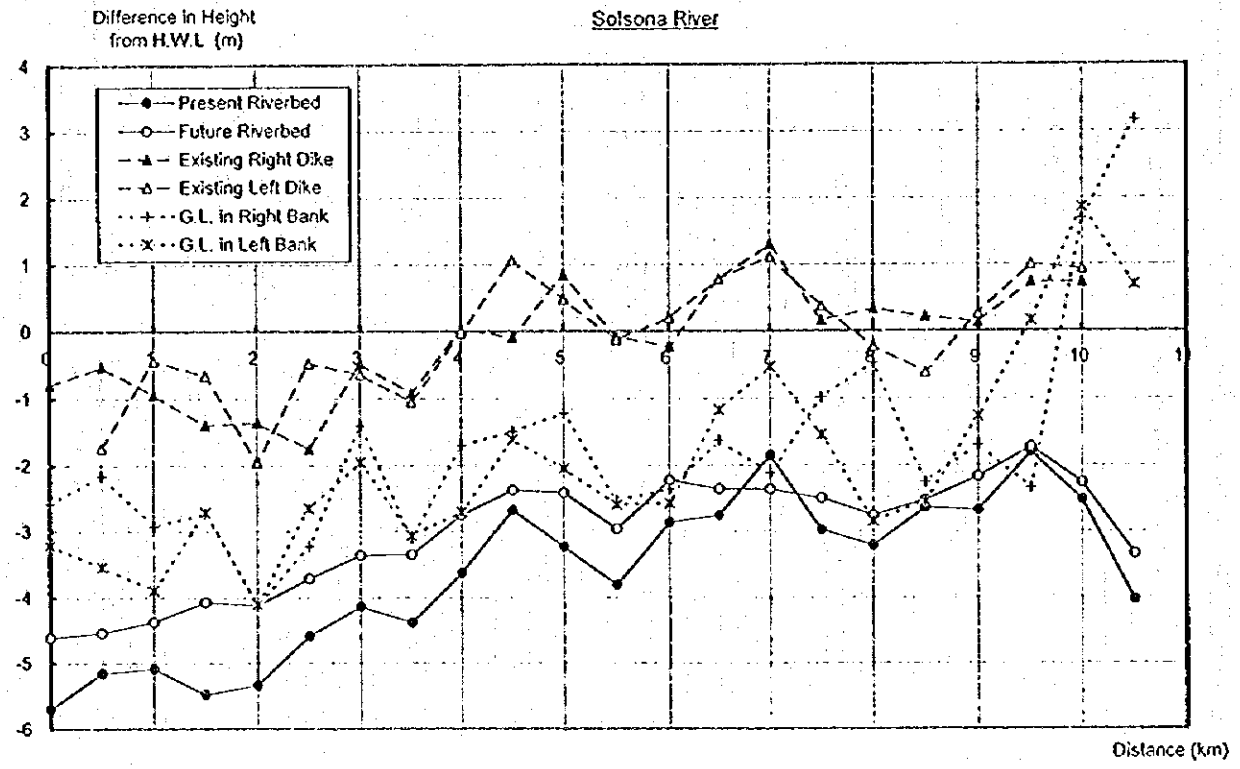


THE STUDY ON SABO AND FLOOD CONTROL IN THE LAOAG RIVER BASIN

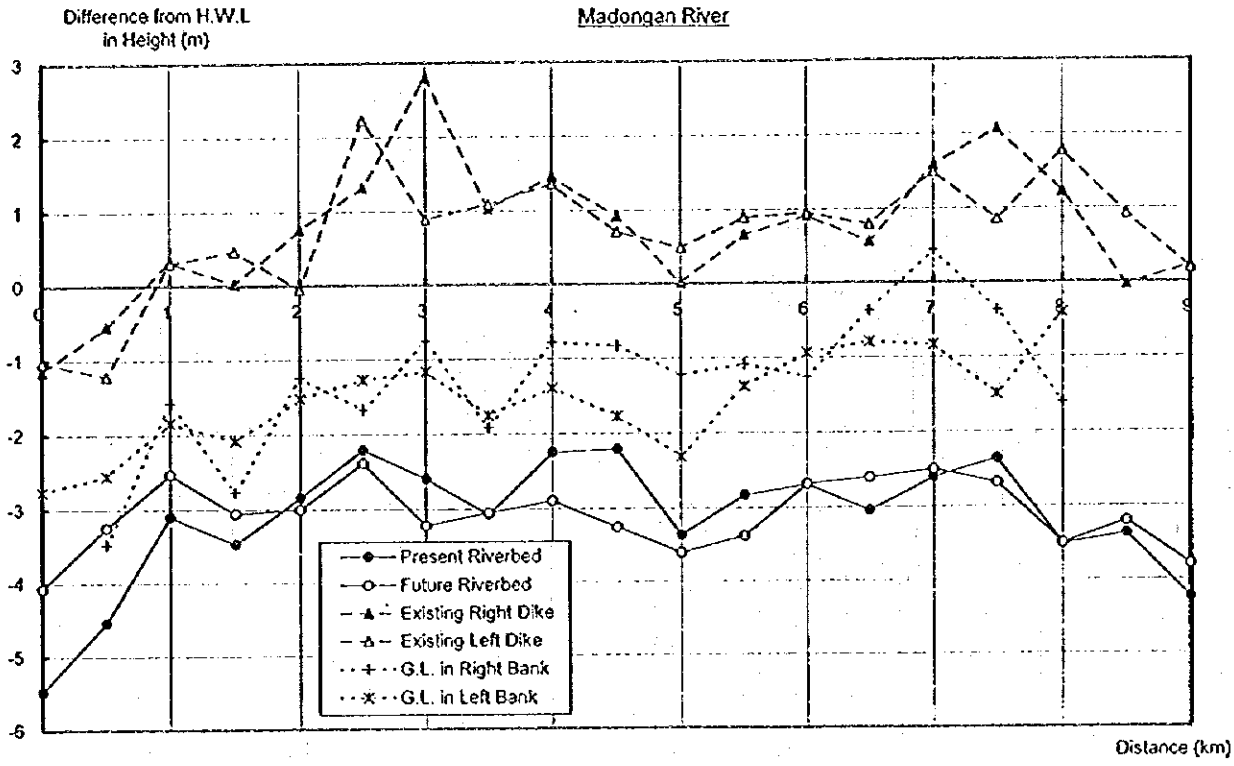
JAPAN INTERNATIONAL COOPERATION AGENCY

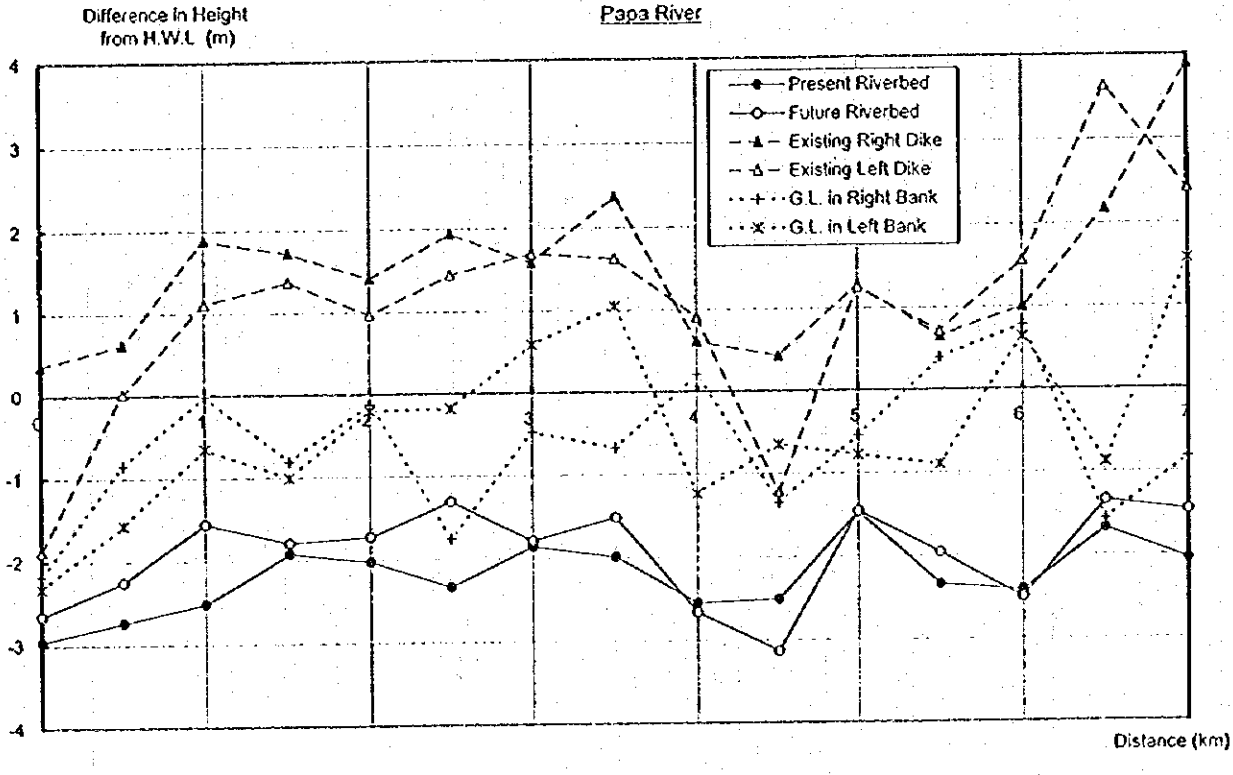
Fig. II.5 (5)
Riverbed Variation and Sediment Control (Papa Dams)



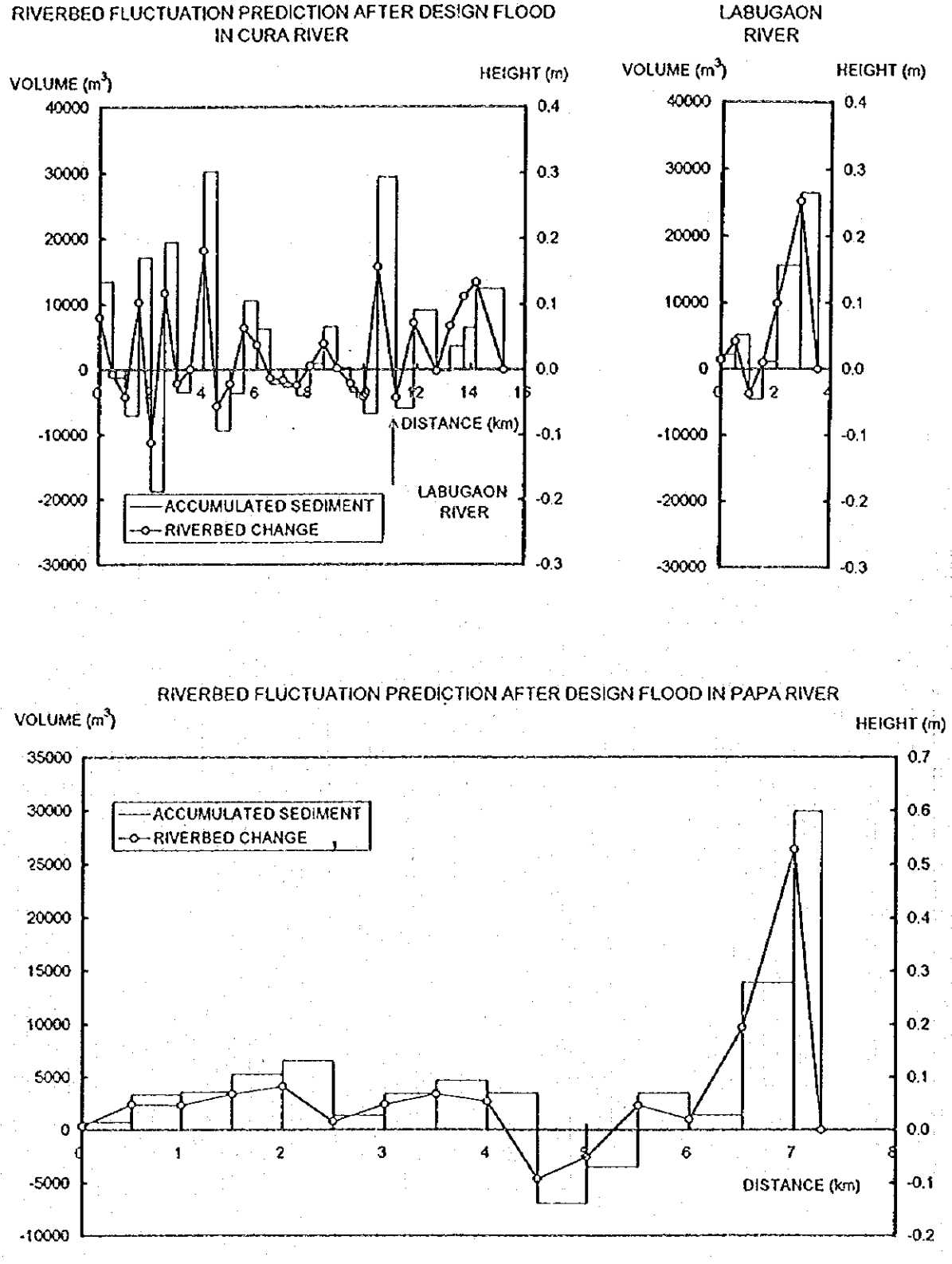


THE STUDY ON SABO AND FLOOD CONTROL IN THE LAOAG RIVER BASIN JAPAN INTERNATIONAL COOPERATION AGENCY	Fig. II.6 (1) Comparison among Riverbed, Landside and Dike Elevation (Cura/Labugaon and Solsona Rivers)

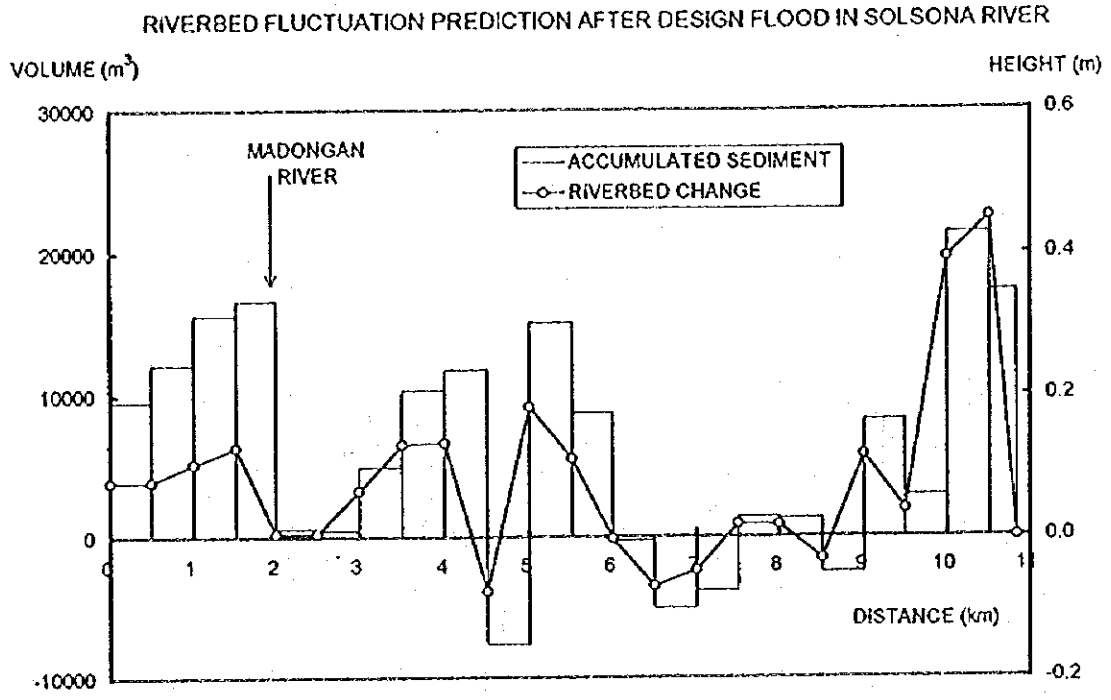


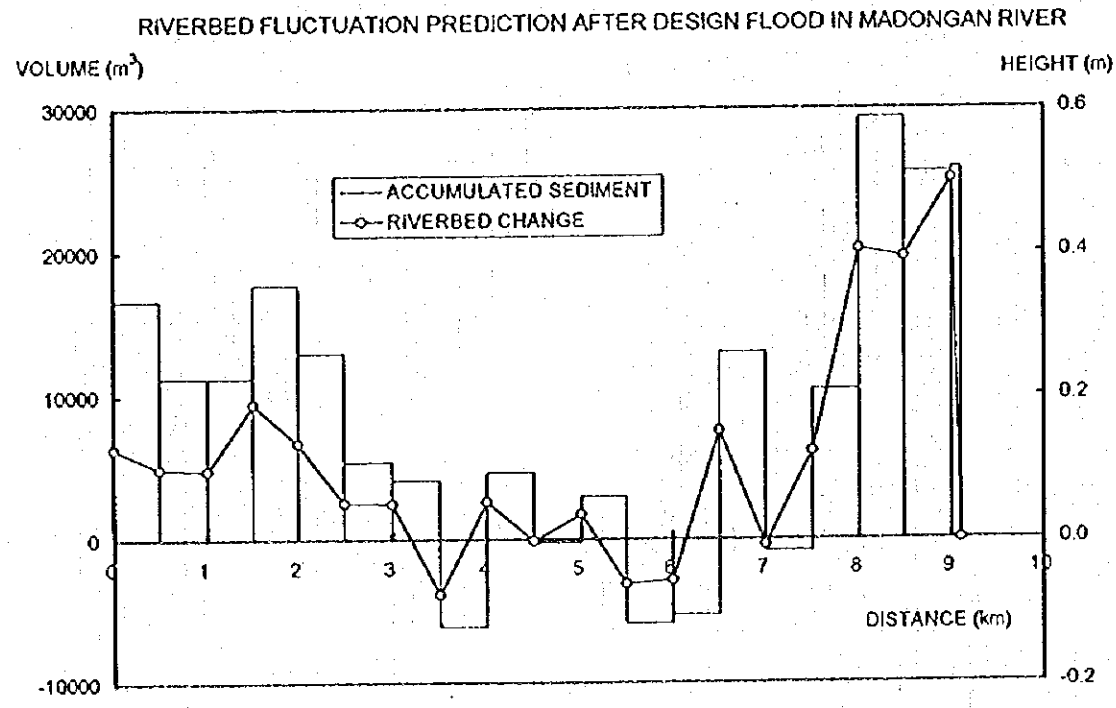


THE STUDY ON SABO AND FLOOD CONTROL IN THE LAOAG RIVER BASIN JAPAN INTERNATIONAL COOPERATION AGENCY	Fig. II.6 (2) Comparison among Riverbed, Landside and Dike Elevation (Madongan and Papa Rivers)

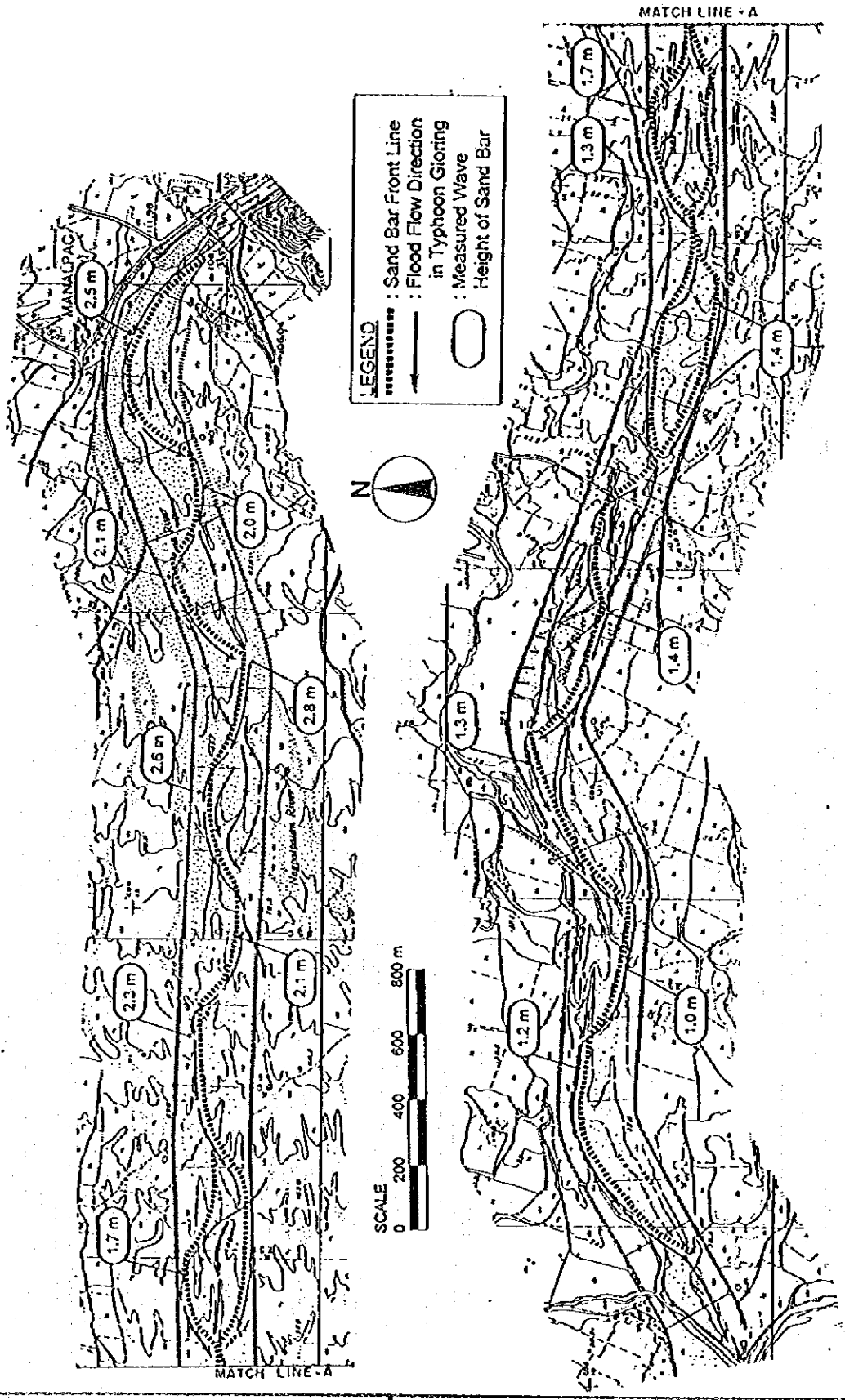


THE STUDY ON SABO AND FLOOD CONTROL IN THE LAOAG RIVER BASIN	Fig. II.7 (1) Riverbed Variation at Design Flood (Cura/Labugaon, Papa)
JAPAN INTERNATIONAL COOPERATION AGENCY	





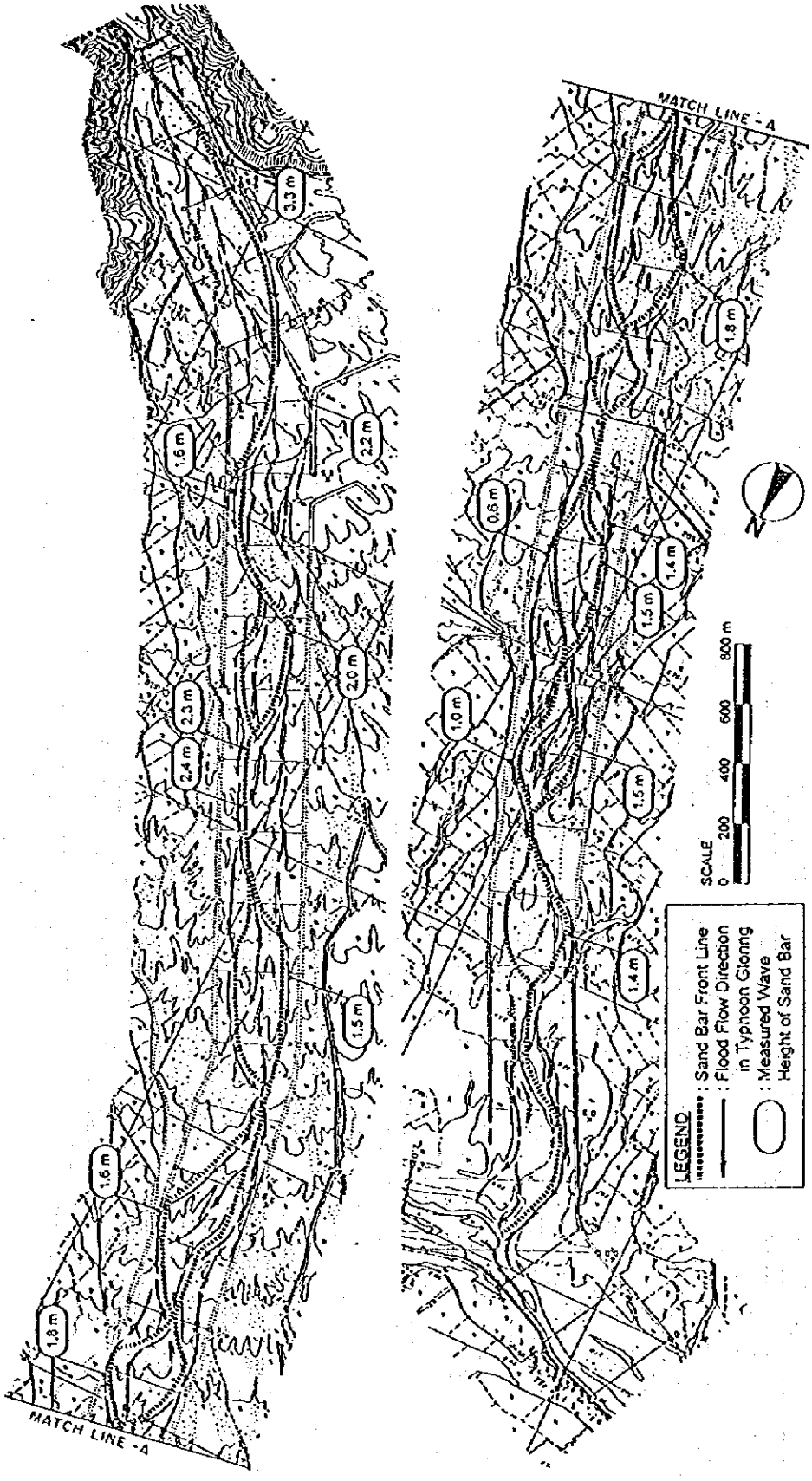
THE STUDY ON SABO AND FLOOD CONTROL IN THE LAOAG RIVER BASIN JAPAN INTERNATIONAL COOPERATION AGENCY	Fig. II.7 (2) Riverbed Variation at Design Flood (Solsona, Madongan)



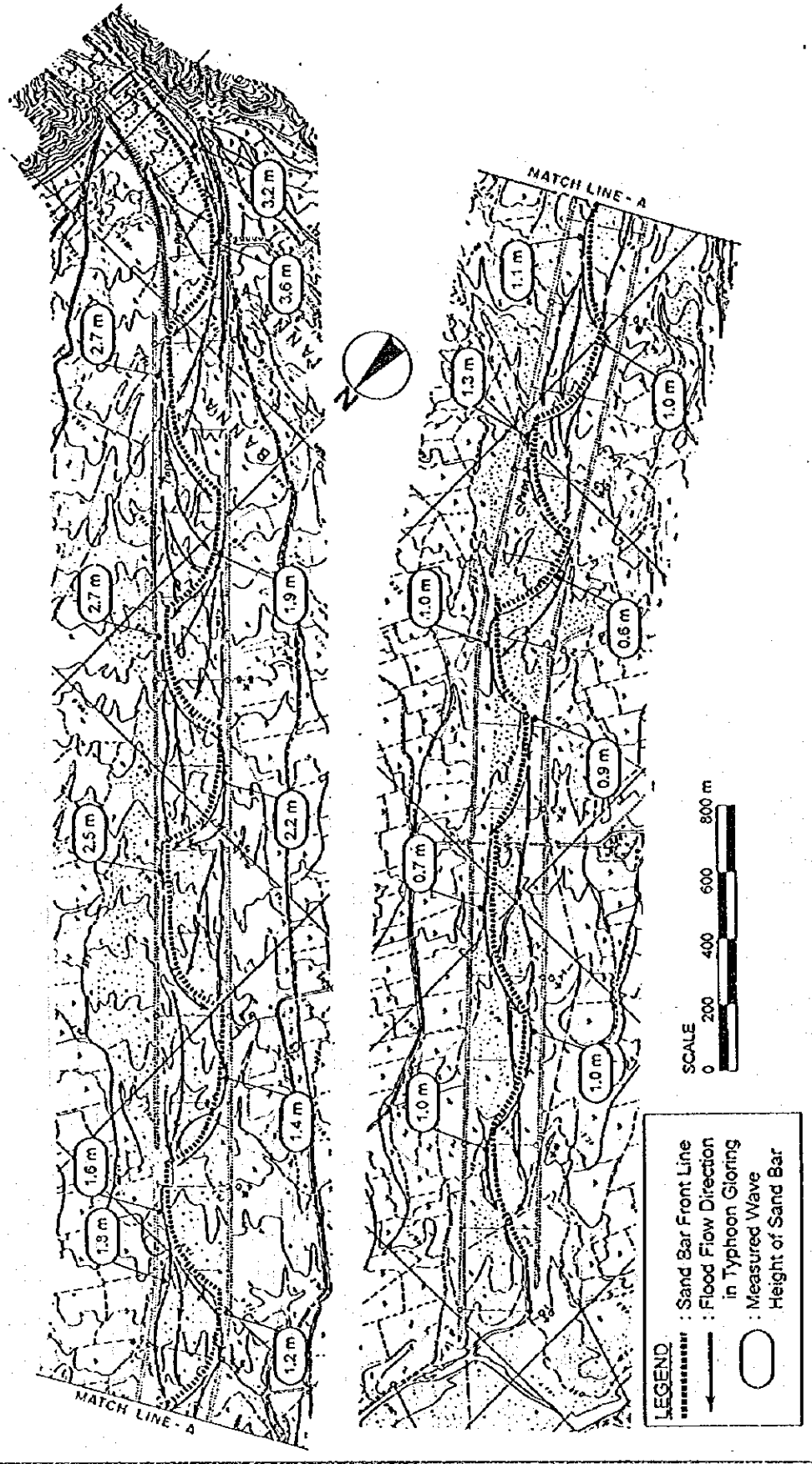
THE STUDY ON SABO AND FLOOD CONTROL IN THE LAOAG RIVER BASIN

JAPAN INTERNATIONAL COOPERATION AGENCY

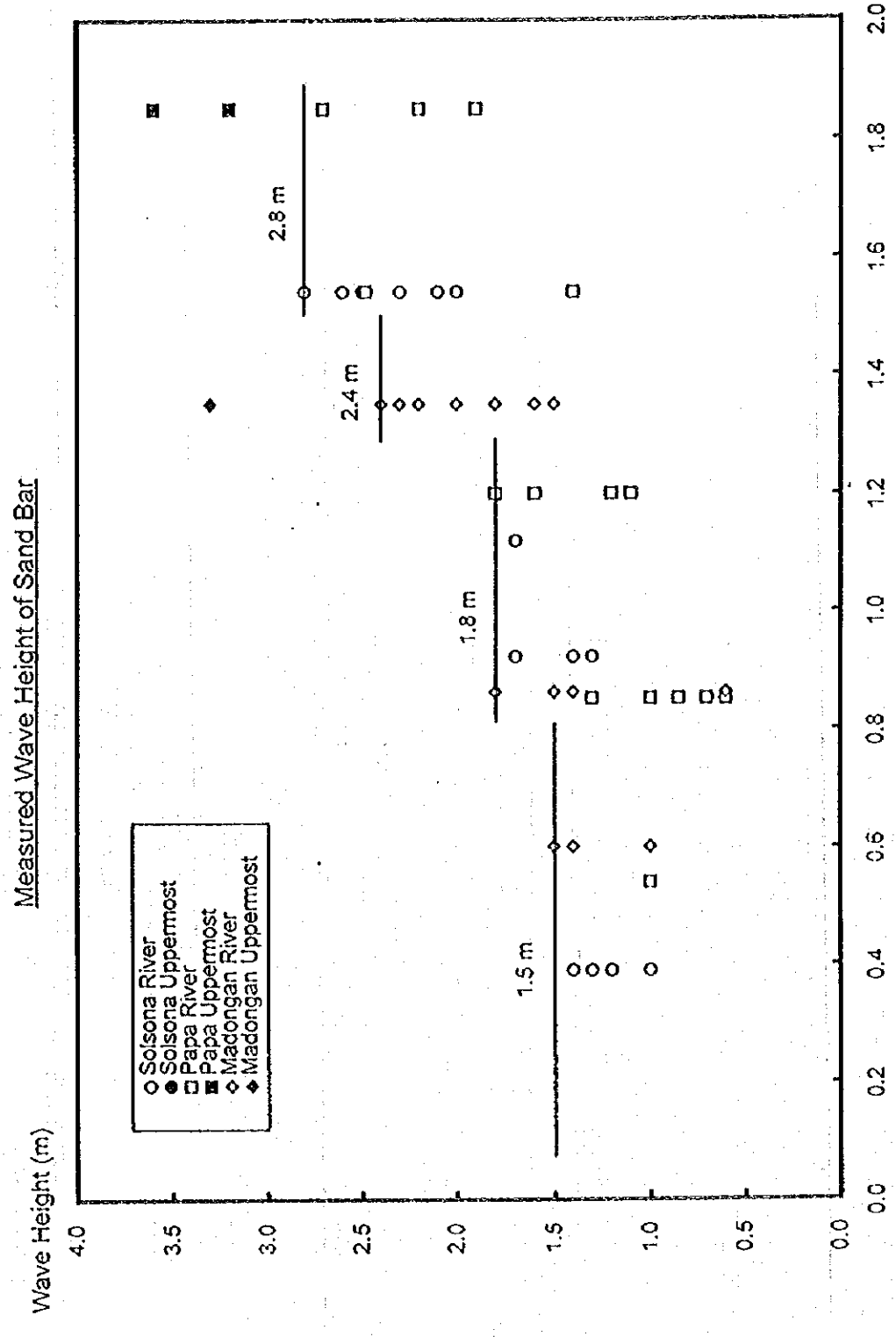
Fig. II.8 (1)
River Morphological Condition
(Solsona River)



THE STUDY ON SABO AND FLOOD CONTROL IN THE LAOAG RIVER BASIN	Fig. II.8 (2) River Morphological Condition (Madongan River)
JAPAN INTERNATIONAL COOPERATION AGENCY	



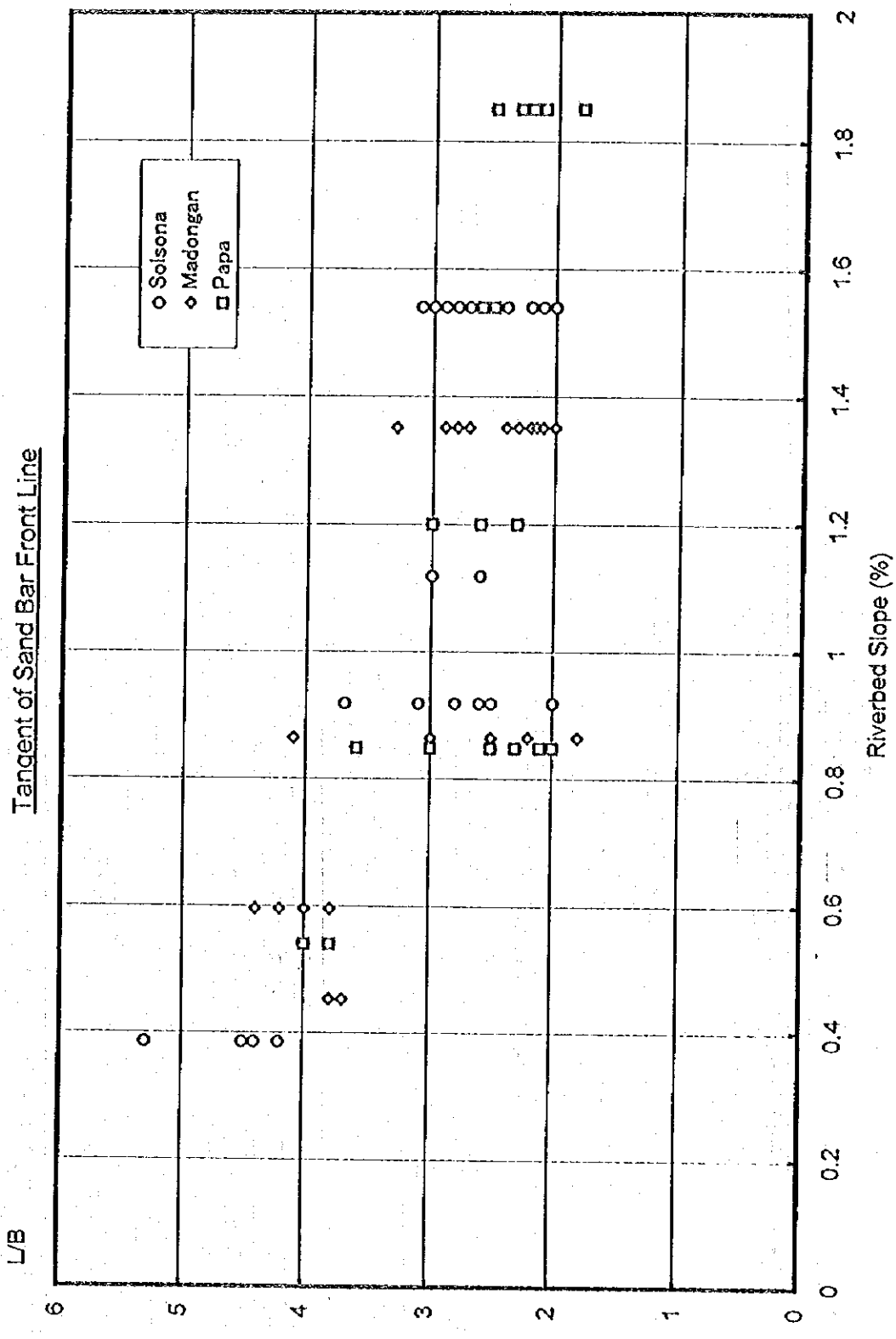
THE STUDY ON SABO AND FLOOD CONTROL IN THE LAOAG RIVER BASIN	Fig. II.8 (3) River Morphological Condition (Papa River)
JAPAN INTERNATIONAL COOPERATION AGENCY	



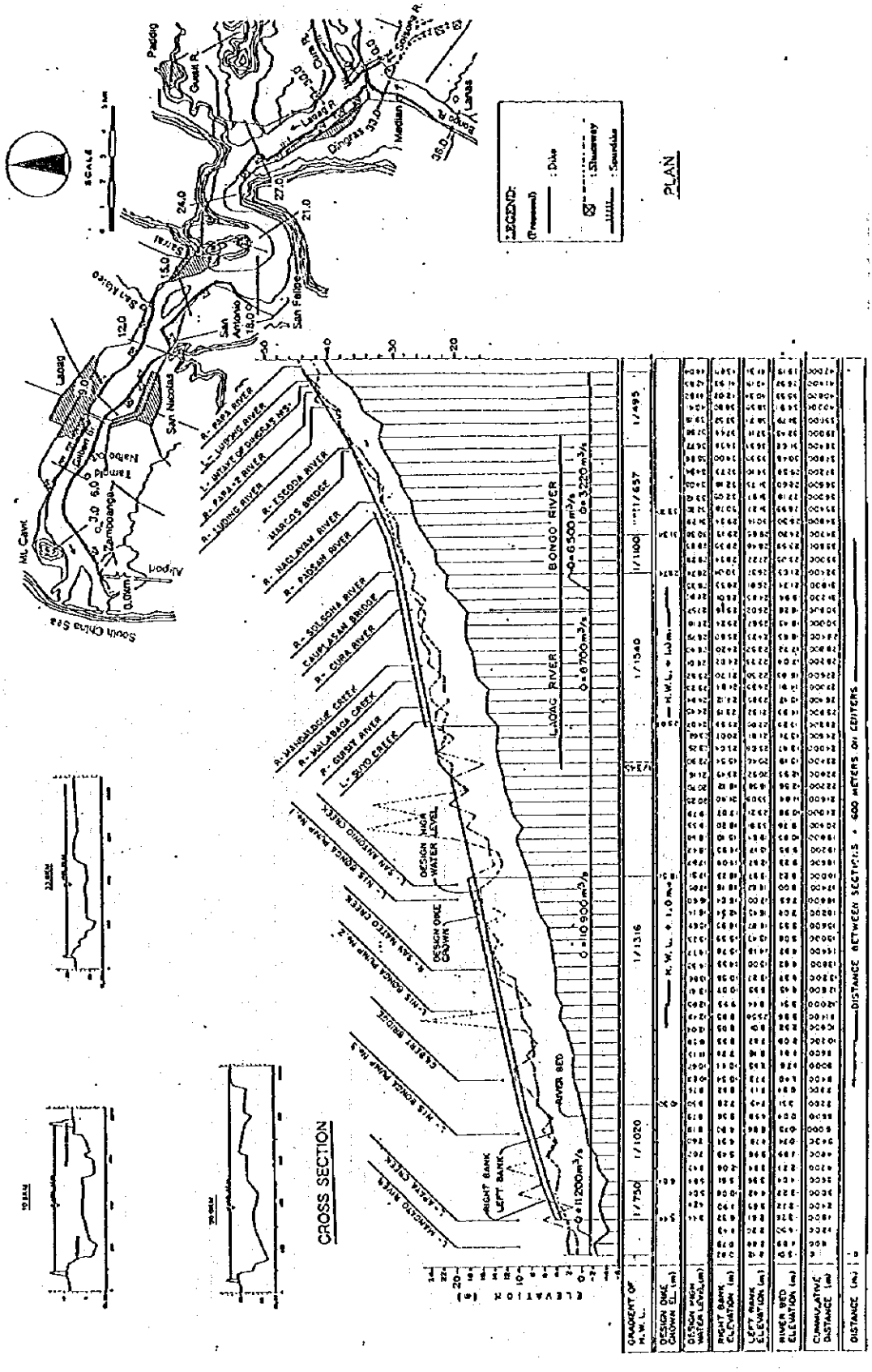
THE STUDY ON SABO AND FLOOD CONTROL IN THE LAOAG RIVER BASIN

JAPAN INTERNATIONAL COOPERATION AGENCY

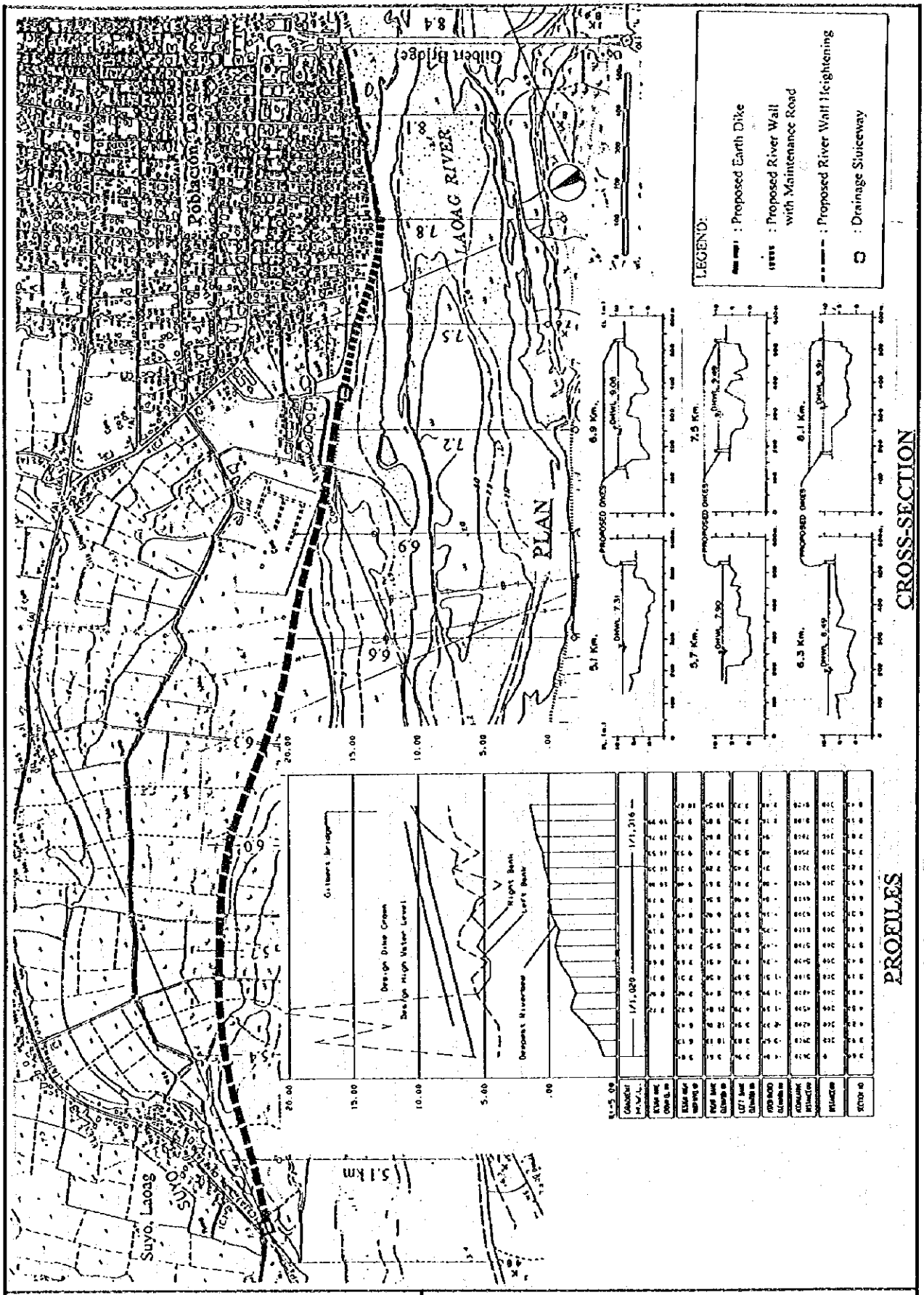
Fig. II.9
Relation between Wave Height and Riverbed Slope



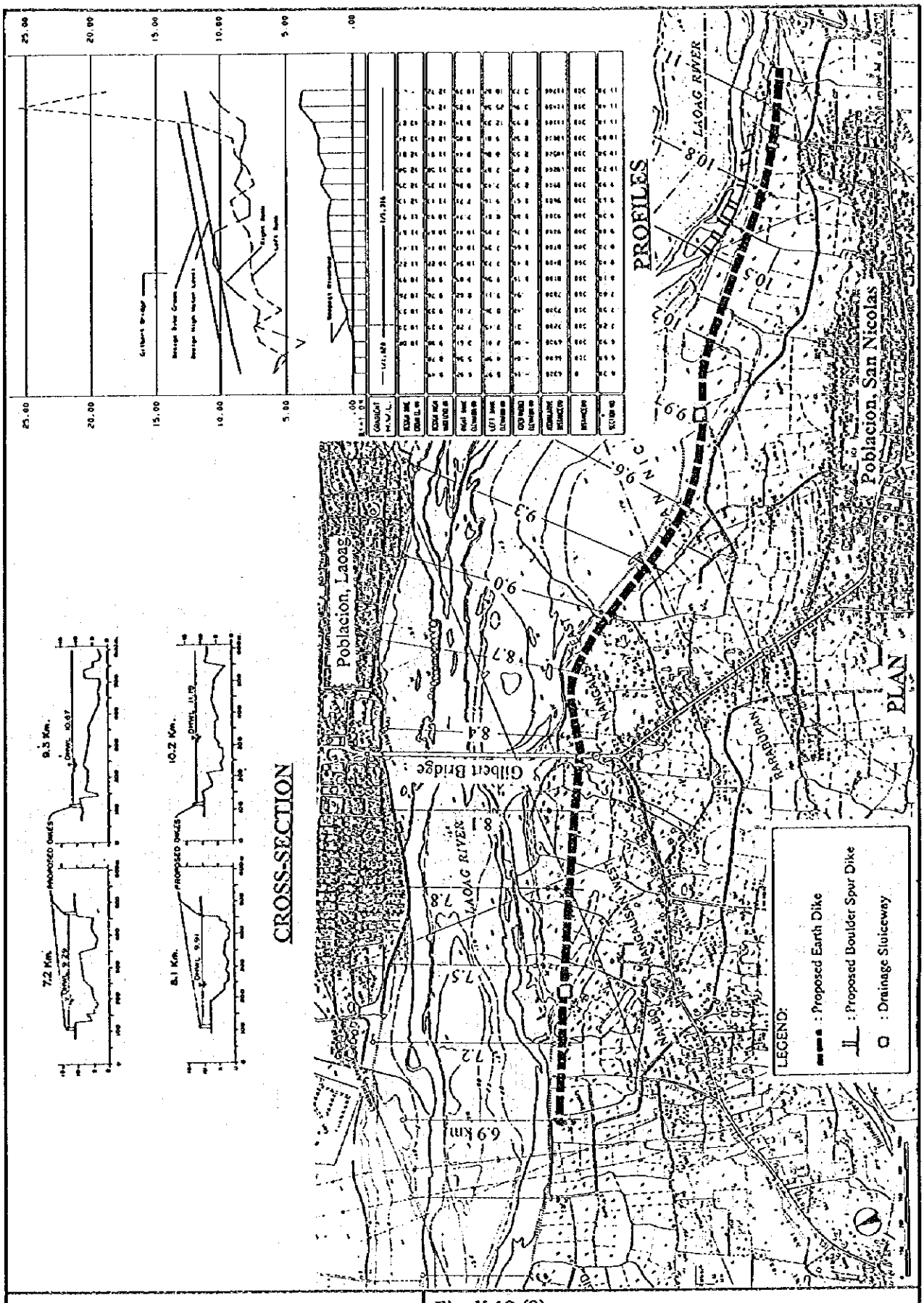
THE STUDY ON SABO AND FLOOD CONTROL IN THE LAOAG RIVER BASIN JAPAN INTERNATIONAL COOPERATION AGENCY	Fig. II.10 Relation between Tangent of Sand Bar Front Line and Riverbed Slope



THE STUDY ON SABO AND FLOOD CONTROL IN THE LAOAG RIVER BASIN	Fig. II.11 Master River Improvement Plan (Laoag-Bongo River)
JAPAN INTERNATIONAL COOPERATION AGENCY	



THE STUDY ON SABO AND FLOOD CONTROL IN THE LAOAG RIVER BASIN	Fig. II.12 (1)
JAPAN INTERNATIONAL COOPERATION AGENCY	Alignment, Profile and Cross-Section of Proposed Laoag-Bongo River Improvement (Poblacion Laoag)

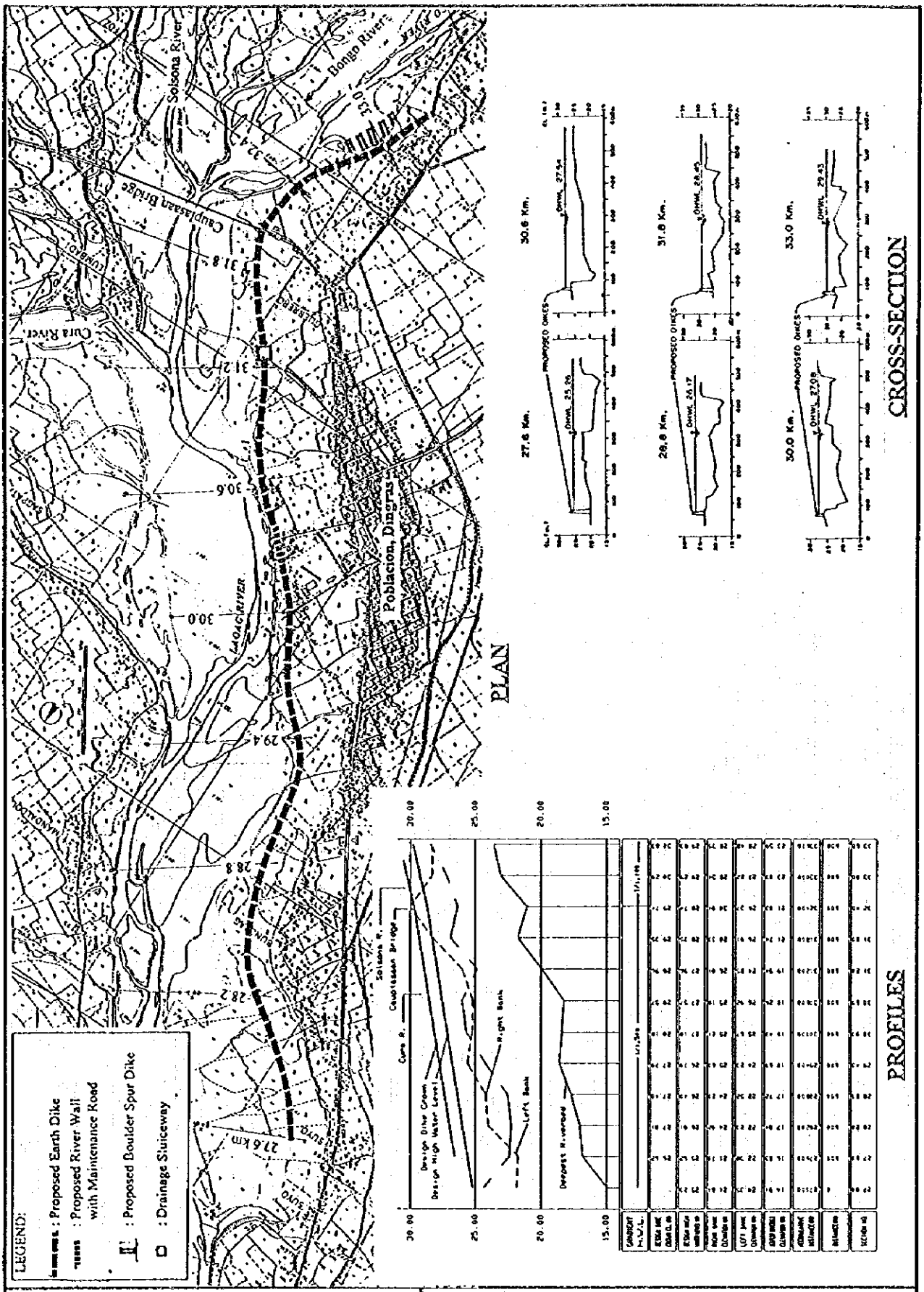


THE STUDY ON SABO AND FLOOD CONTROL IN THE LAOAG RIVER BASIN

JAPAN INTERNATIONAL COOPERATION AGENCY

Fig. II.12 (2)

Alignment, Profile and Cross Section of Proposed Laoag-Bongo River Improvement (Poblacion San Nicolas)

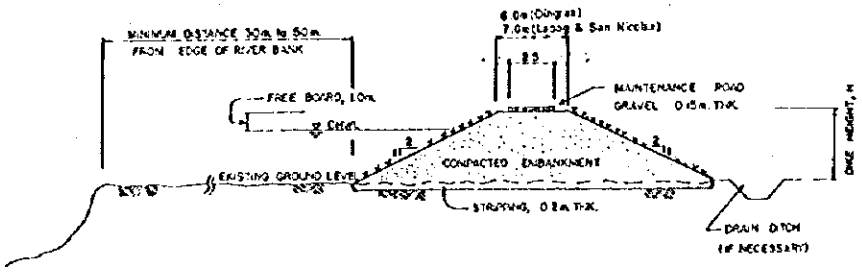


THE STUDY ON SABO AND FLOOD CONTROL IN THE LAOAG RIVER BASIN

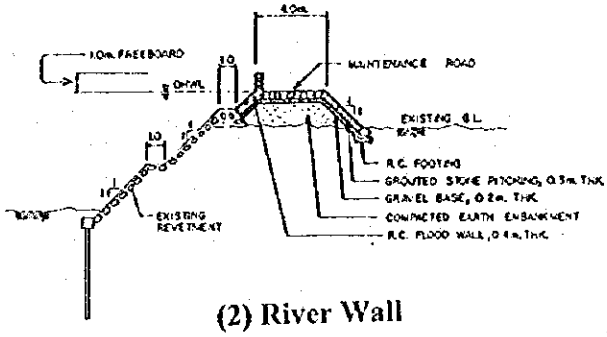
JAPAN INTERNATIONAL COOPERATION AGENCY

Fig. II.12 (3)

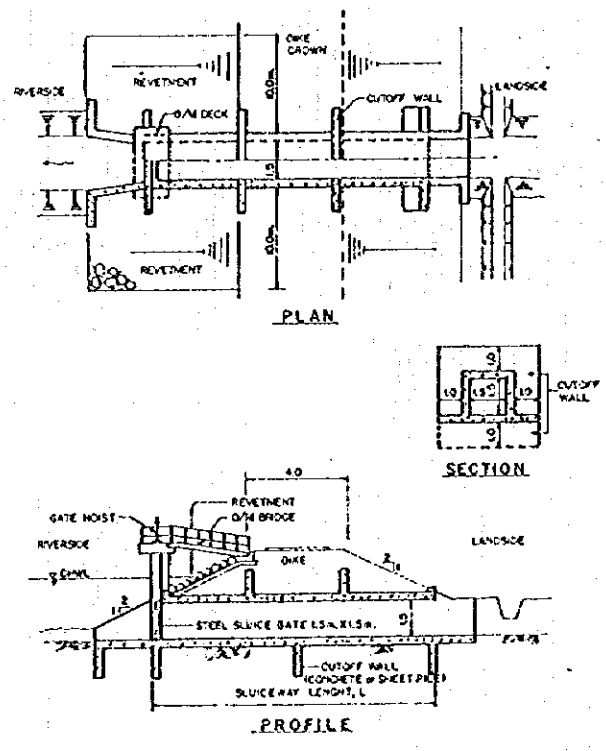
Alignment, Profile and Cross Section of Proposed Laoag-Bongo River Improvement (Poblacion Dingras)



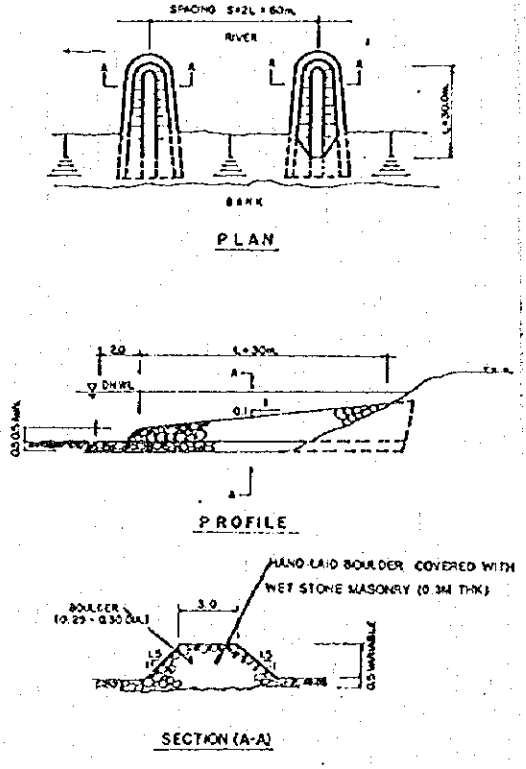
(1) Earth Dike



(2) River Wall

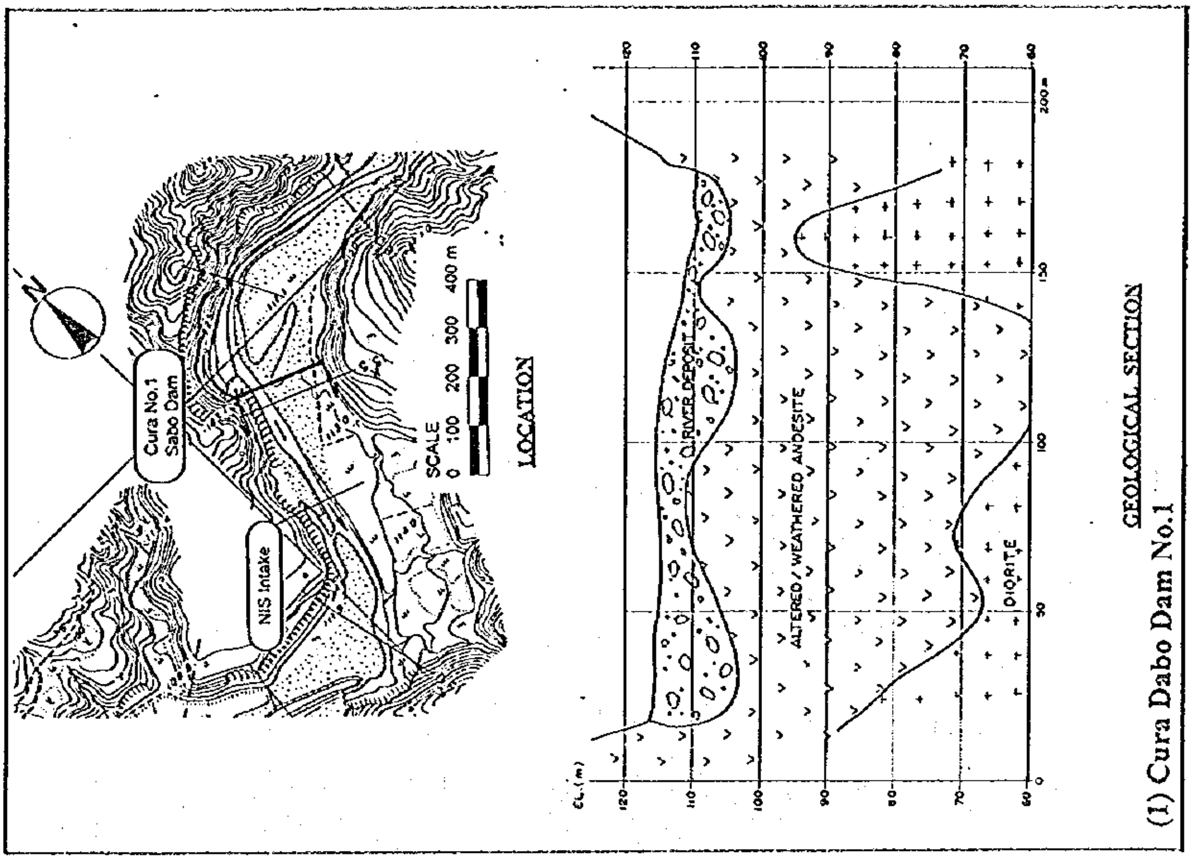


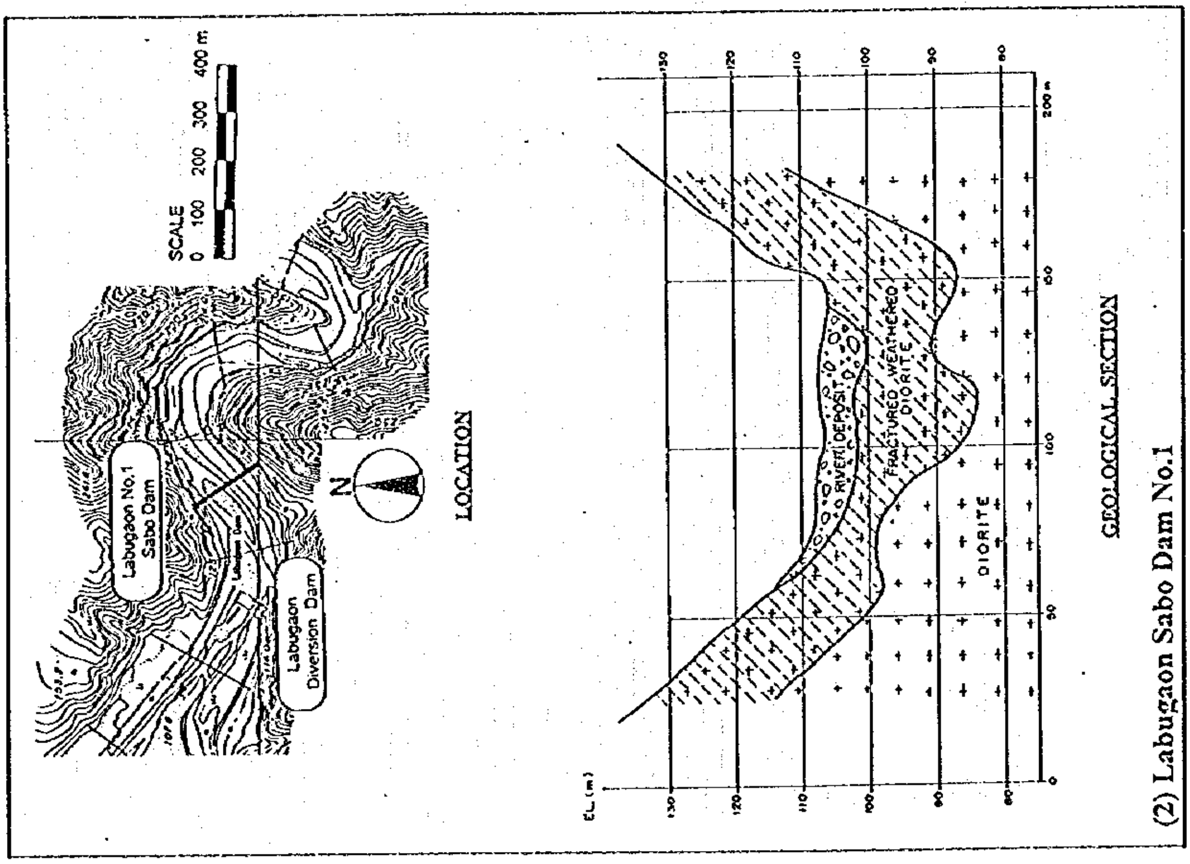
(3) Drainage Sluiceway



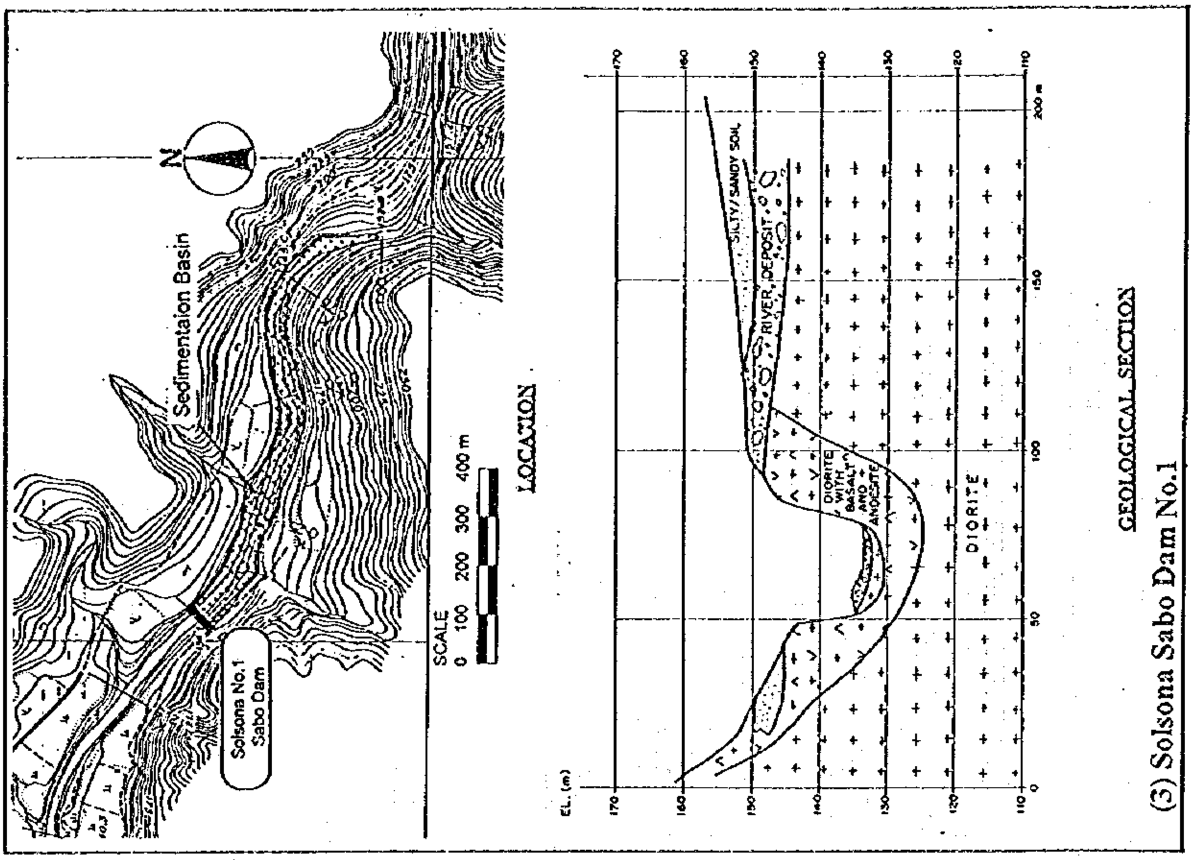
(4) Boulder Spur Dike

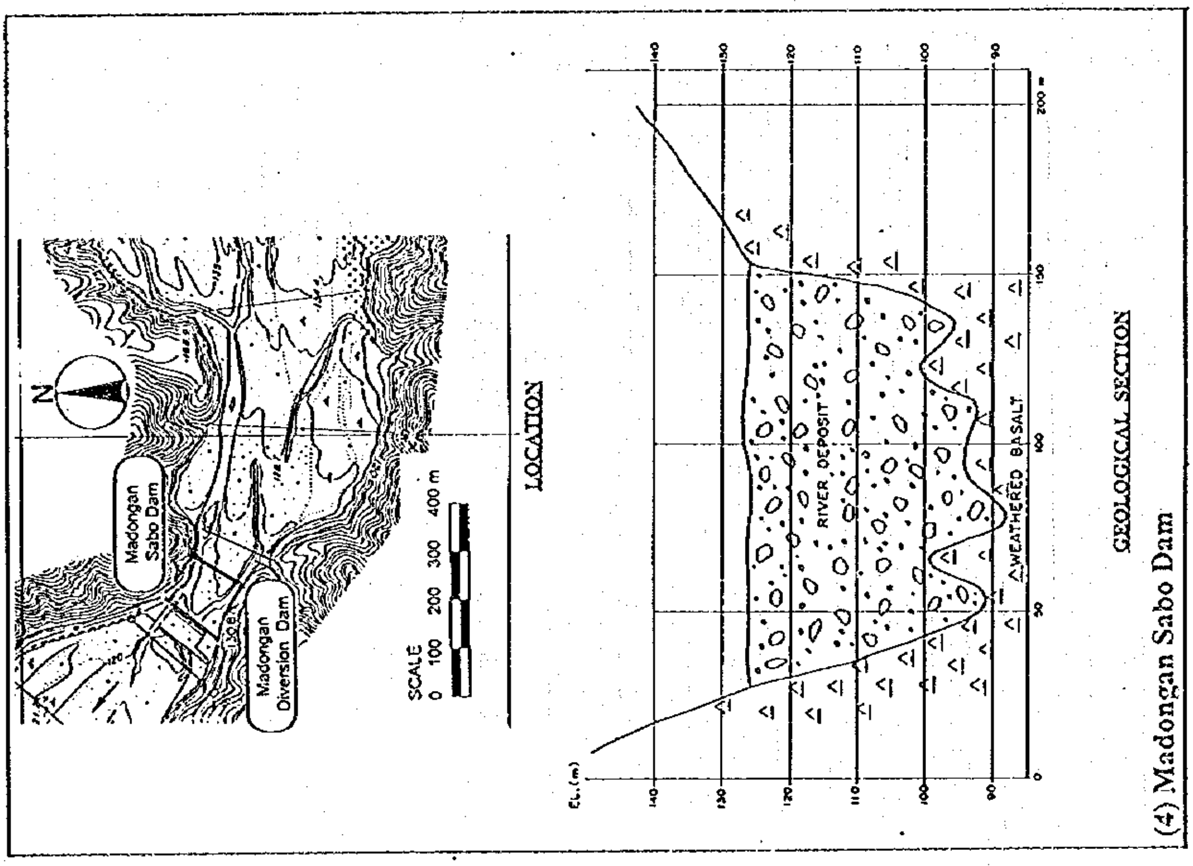
THE STUDY ON SABO AND FLOOD CONTROL IN THE LAOAG RIVER BASIN	Fig. II.13 Typical Structural Design of Proposed Laoag-Bongo River Improvement
JAPAN INTERNATIONAL COOPERATION AGENCY	



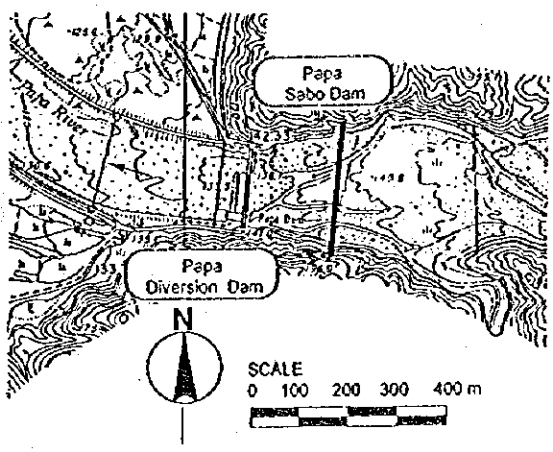


THE STUDY ON SABO AND FLOOD CONTROL IN THE LAOAG RIVER BASIN JAPAN INTERNATIONAL COOPERATION AGENCY	Fig. II.14 (1) Geological Section at Sabo Dam Site (Cura No.1 and Labugaon No.1)

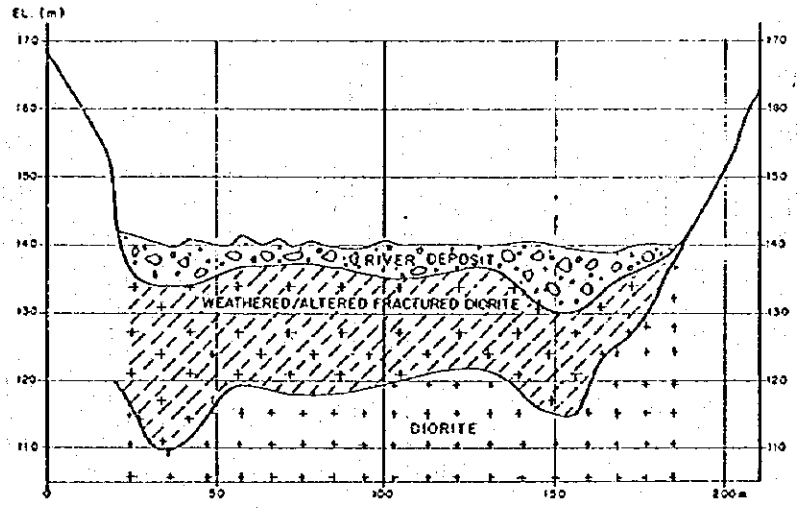




THE STUDY ON SABO AND FLOOD CONTROL IN THE LAOAG RIVER BASIN	Fig. II.14 (2)
JAPAN INTERNATIONAL COOPERATION AGENCY	Geological Section at Sabo Dam Site (Solsona No.1 and Madongan)



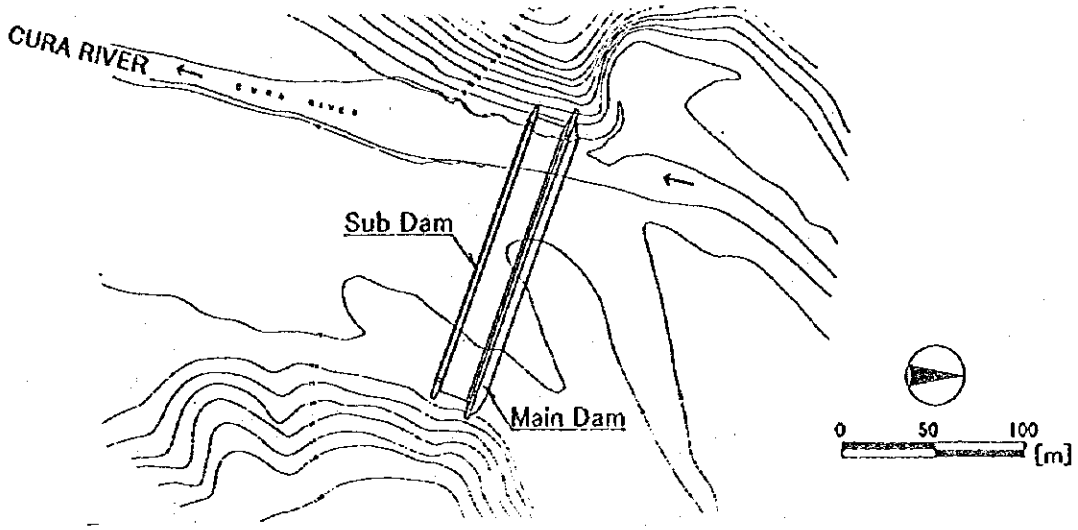
LOCATION



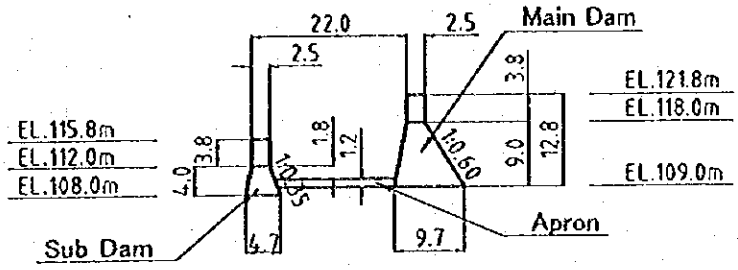
GEOLOGICAL SECTION

(5) Papa Sabo Dam

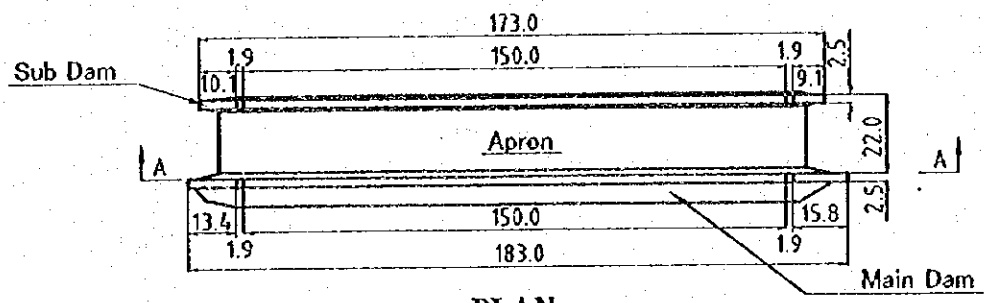
THE STUDY ON SABO AND FLOOD CONTROL IN THE LAOAG RIVER BASIN	Fig. II.14 (3) Geological Section at Sabo Dam Site (Papa)
JAPAN INTERNATIONAL COOPERATION AGENCY	



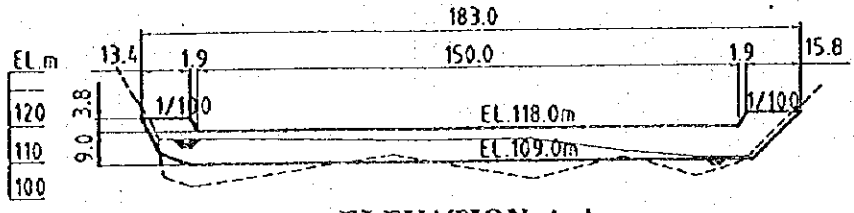
LOCATION



PROFILE



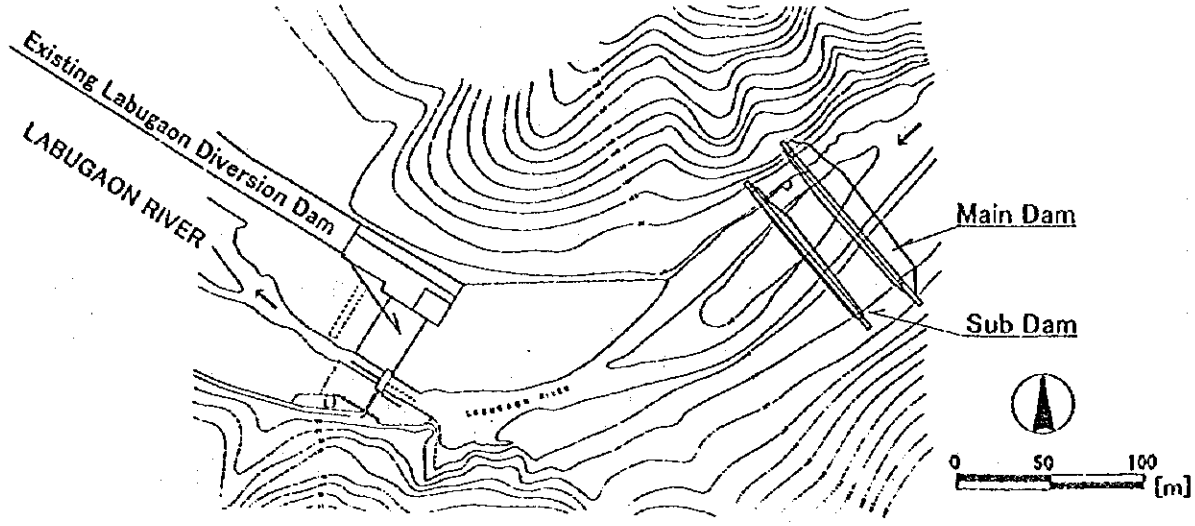
PLAN



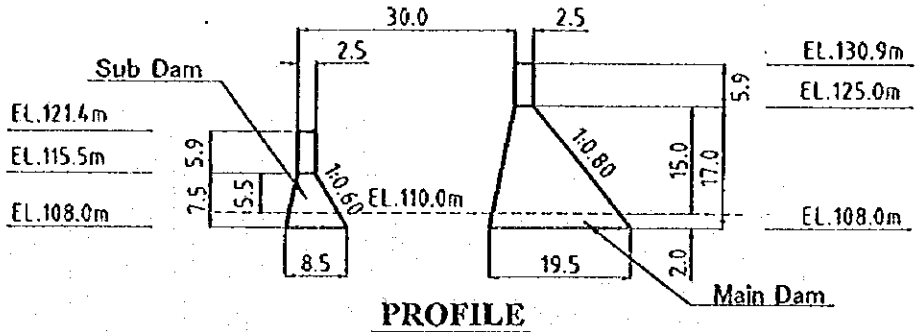
ELEVATION A-A

(Unit : in meter)

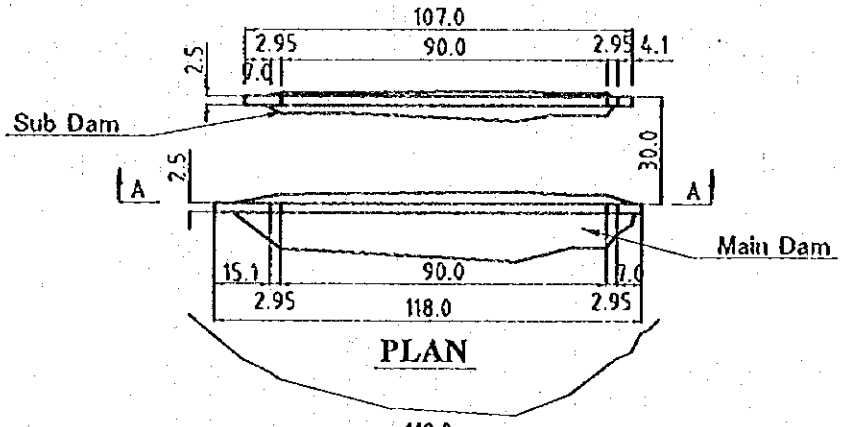
THE STUDY ON SABO AND FLOOD CONTROL IN THE LAOAG RIVER BASIN	Fig. II.15 (1) Structural Design of Proposed Sabo Dam (Cura No.1)
JAPAN INTERNATIONAL COOPERATION AGENCY	



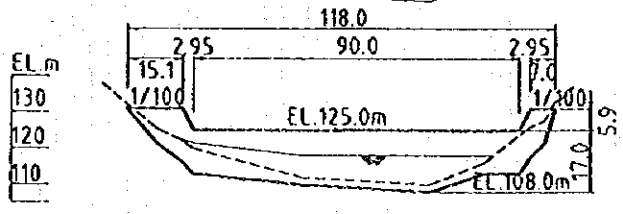
LOCATION



PROFILE



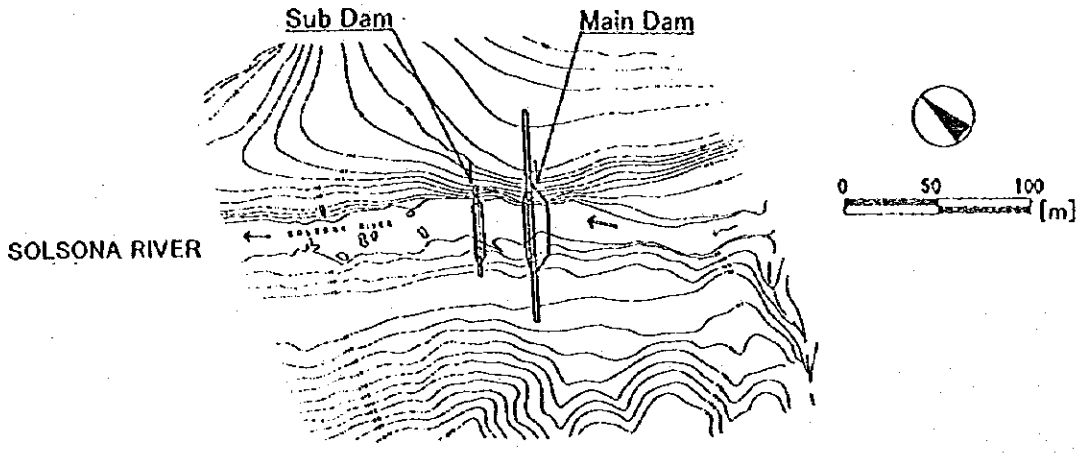
PLAN



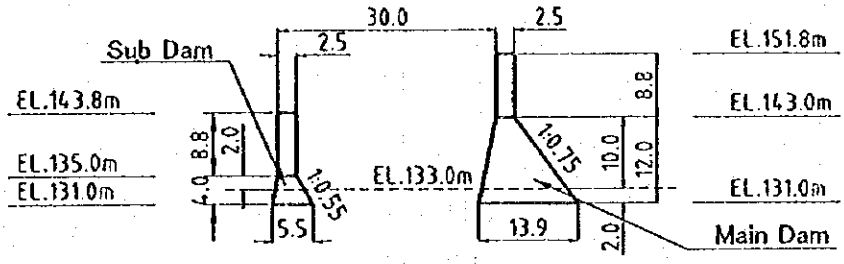
ELEVATION A-A

(Unit : in meter)

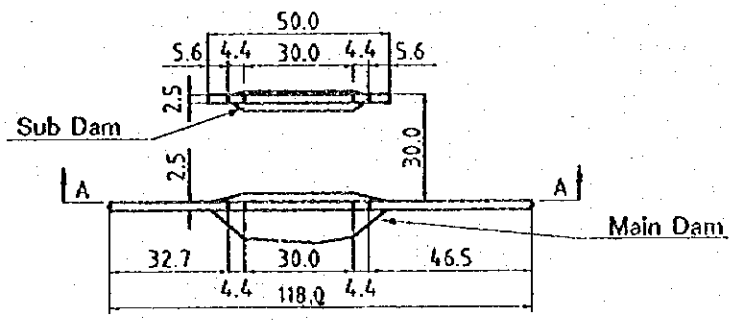
THE STUDY ON SABO AND FLOOD CONTROL IN THE LAOAG RIVER BASIN	Fig. II.15 (2) Structural Design of Proposed Sabo Dam (Labugaon No.1)
JAPAN INTERNATIONAL COOPERATION AGENCY	



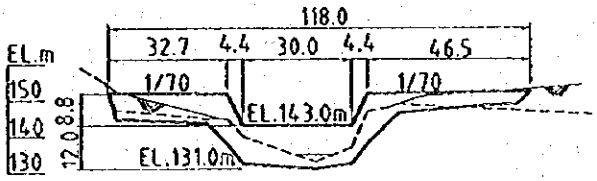
LOCATION



PROFILE



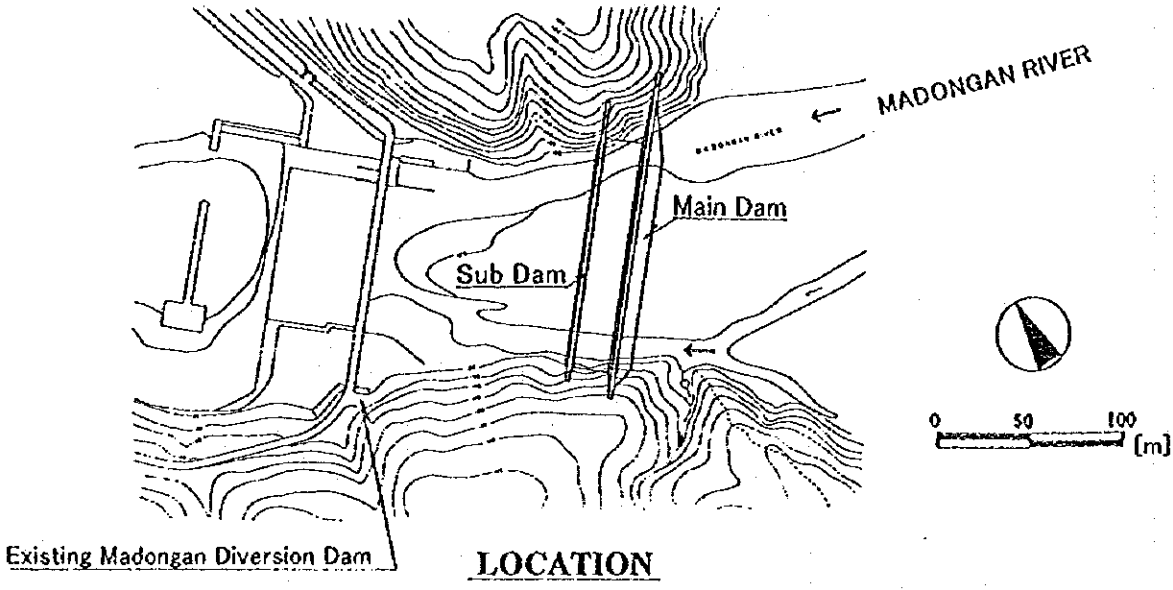
PLAN



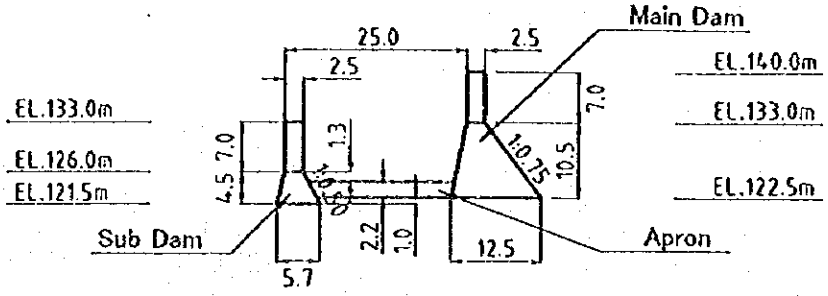
ELEVATION A-A

(Unit : in meter)

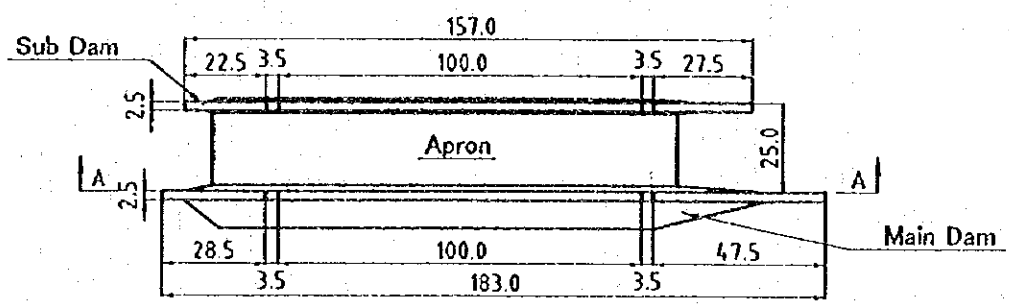
THE STUDY ON SABO AND FLOOD CONTROL IN THE LAOAG RIVER BASIN	Fig. II.15 (3) Structural Design of Proposed Sabo Dam (Solsona No.1)
JAPAN INTERNATIONAL COOPERATION AGENCY	



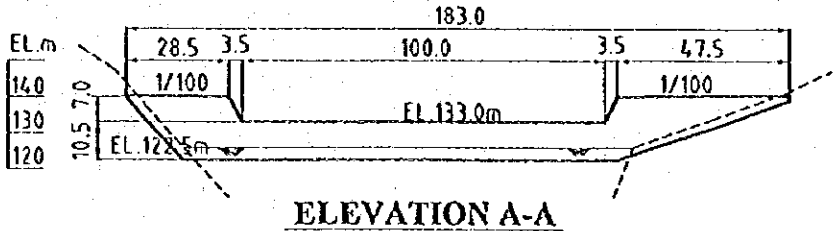
LOCATION



PROFILE



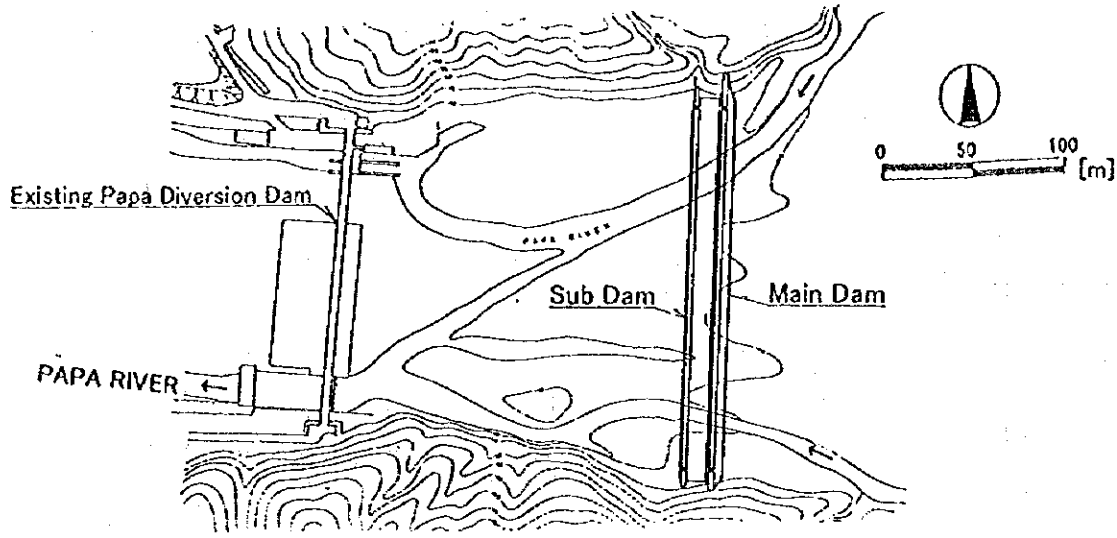
PLAN



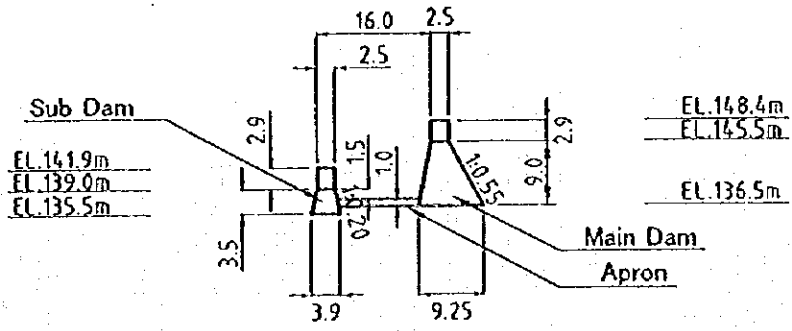
ELEVATION A-A

(Unit : in meter)

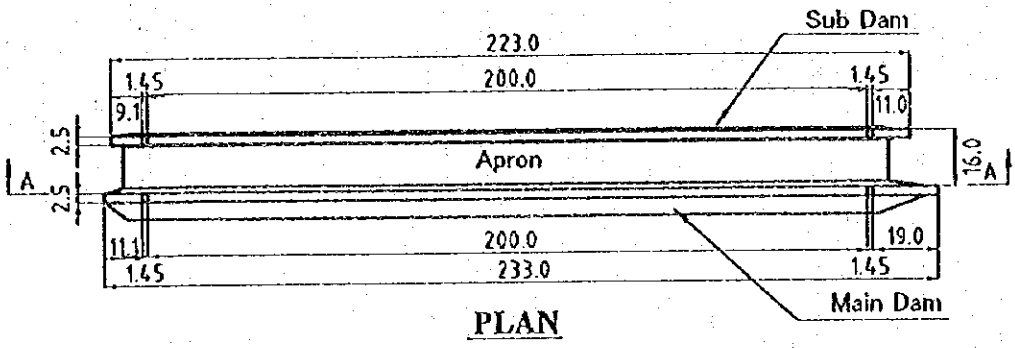
THE STUDY ON SABO AND FLOOD CONTROL IN THE LAOAG RIVER BASIN	Fig. II.15 (4) Structural Design of Proposed Sabo Dam (Madongan)
JAPAN INTERNATIONAL COOPERATION AGENCY	



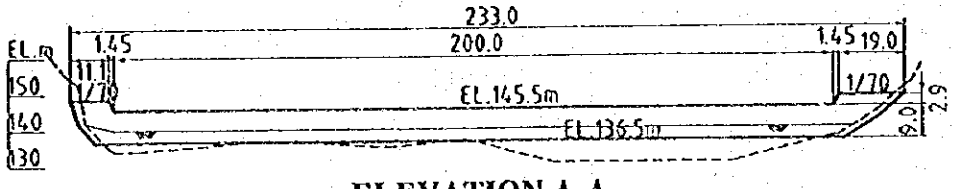
LOCATION



PROFILE



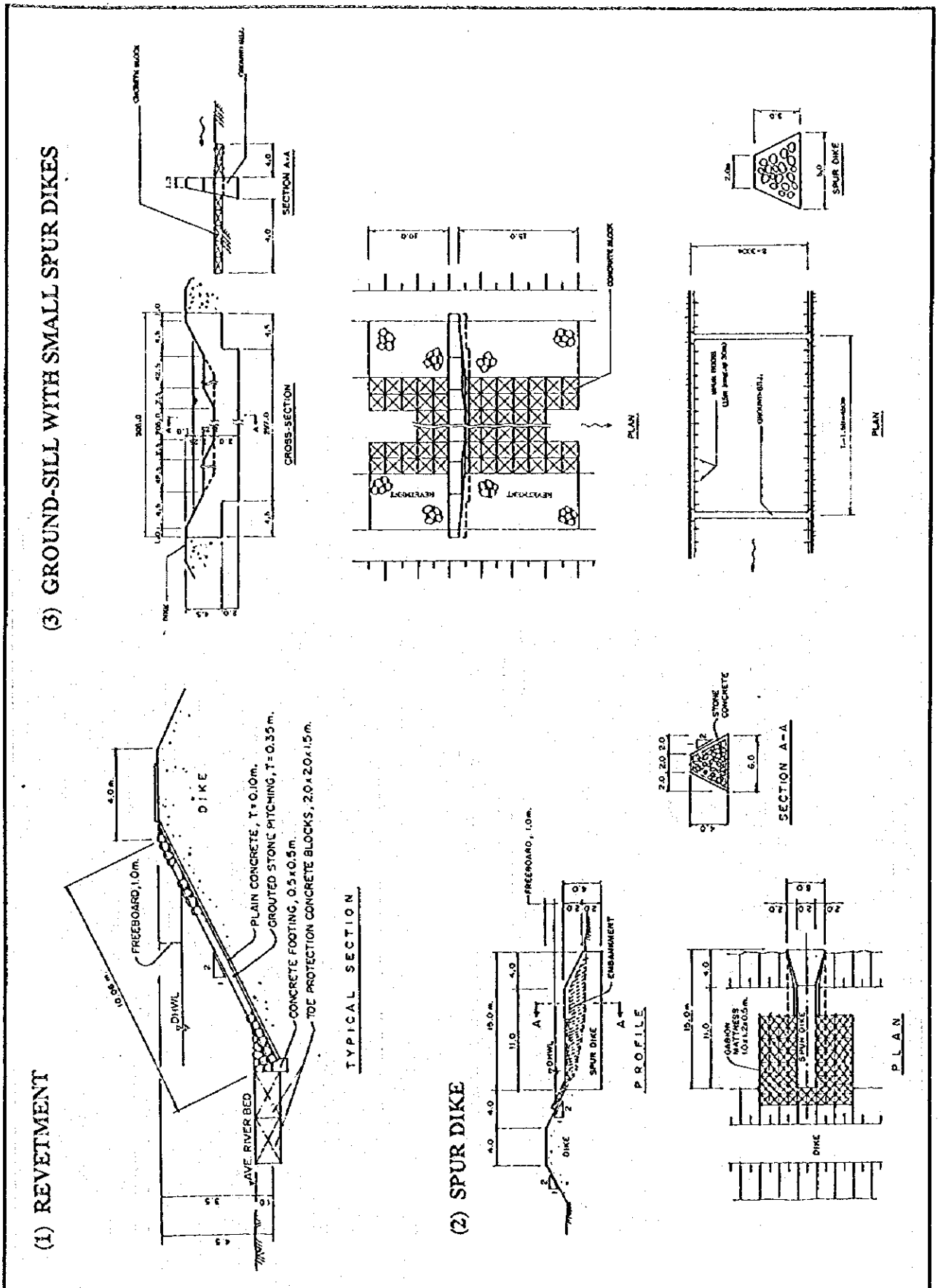
PLAN



ELEVATION A-A

(Unit : in meter)

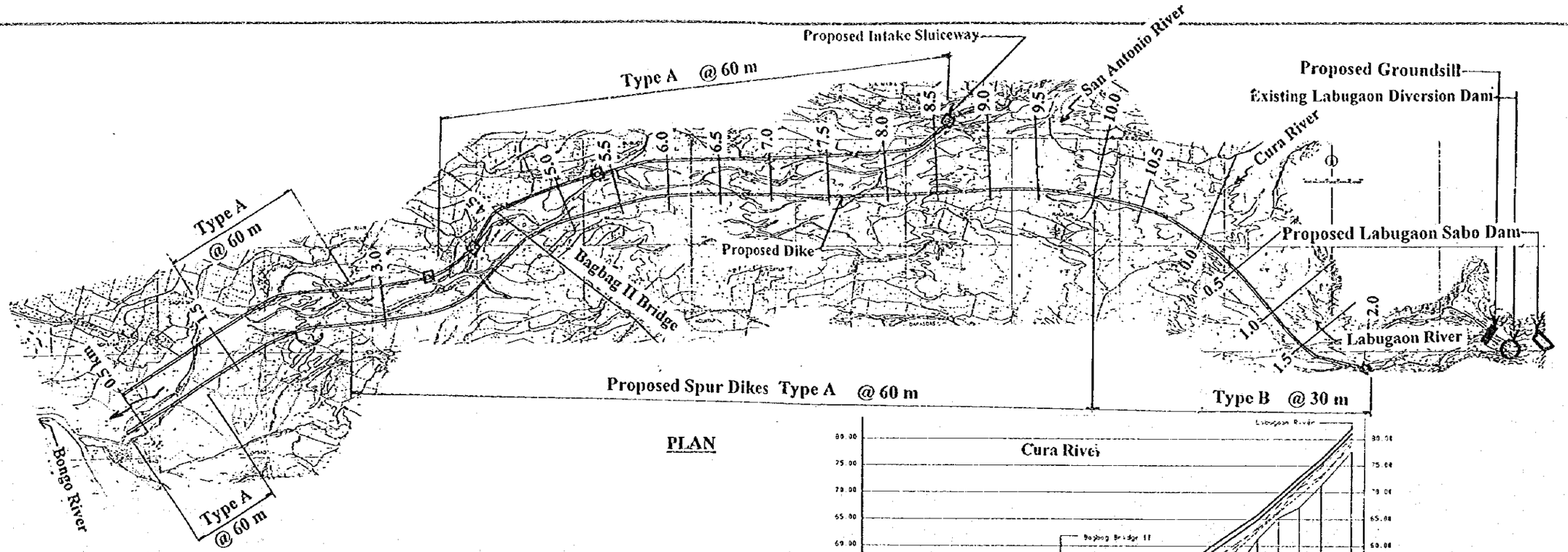
THE STUDY ON SABO AND FLOOD CONTROL IN THE LAOAG RIVER BASIN	Fig. II.15 (5) Structural Design of Proposed Sabo Dam (Papa)
JAPAN INTERNATIONAL COOPERATION AGENCY	



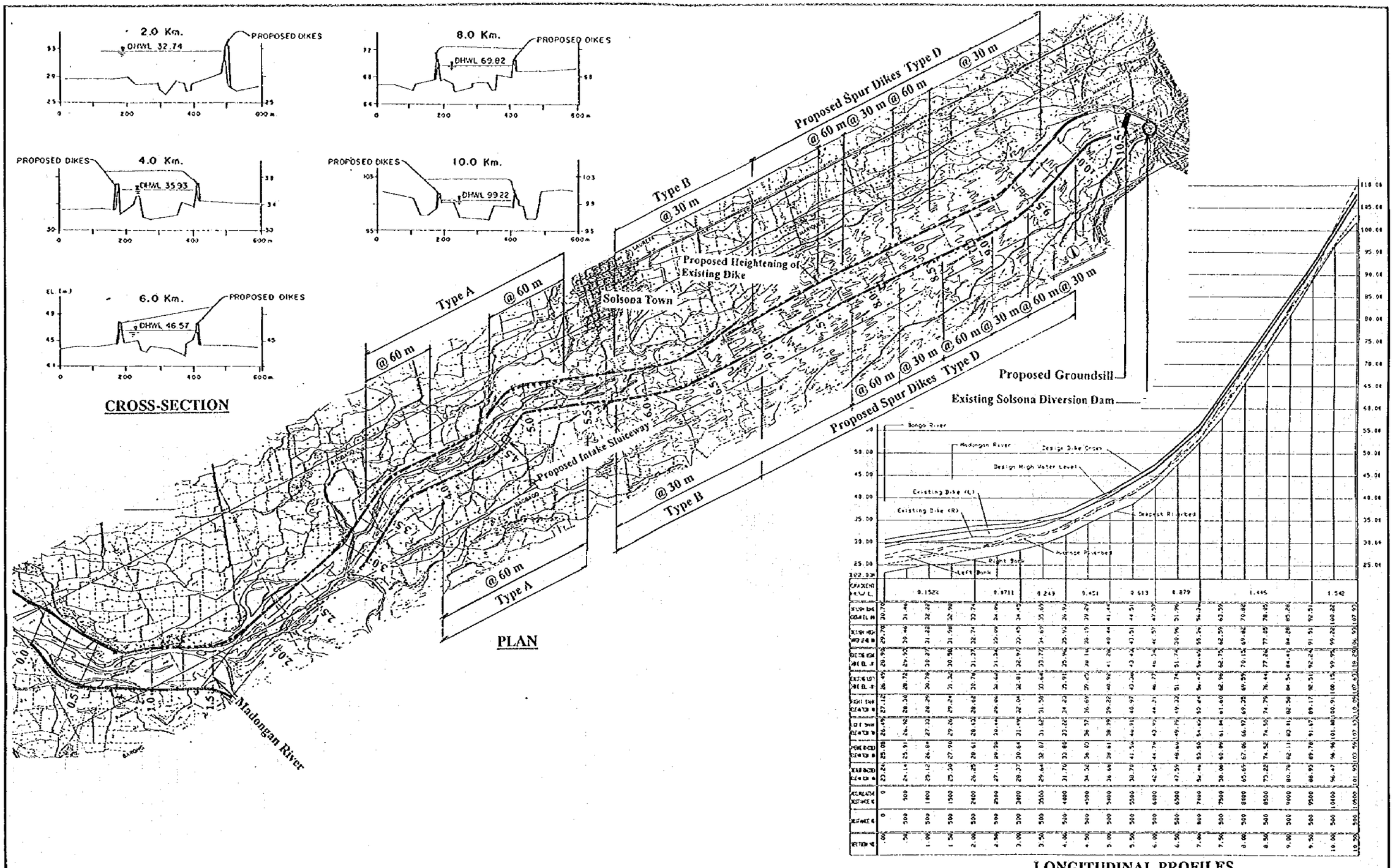
THE STUDY ON SABO AND FLOOD CONTROL IN THE LAOAG RIVER BASIN

JAPAN INTERNATIONAL COOPERATION AGENCY

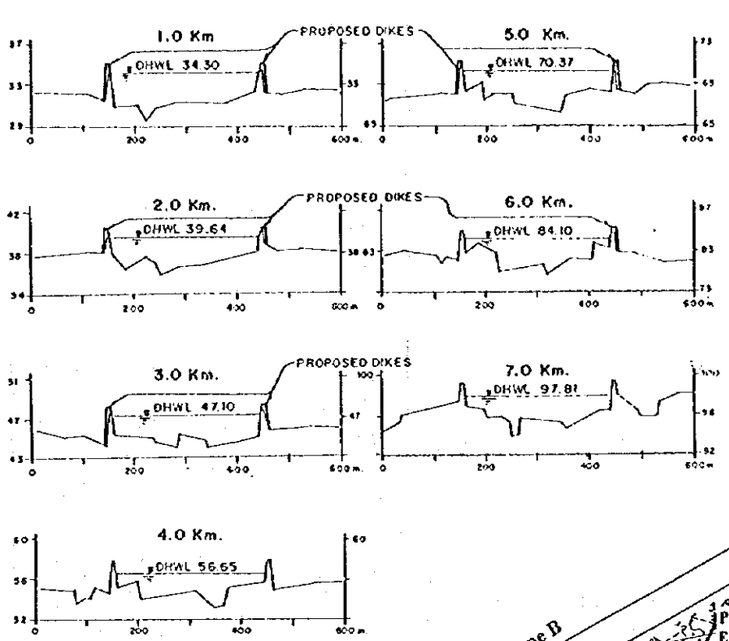
Fig. II.16
Comparison of Bank Protection Works



THE STUDY ON SABO AND FLOOD CONTROL IN THE LAOAG RIVER BASIN JAPAN INTERNATIONAL COOPERATION AGENCY	Fig. II.17 (1) Alignment, Profile and Cross-Section of Proposed Alluvial Fan River Improvement (Cura/Labugaon)



THE STUDY ON SABO AND FLOOD CONTROL IN THE LAOAG RIVER BASIN	Fig. II.17 (2)
JAPAN INTERNATIONAL COOPERATION AGENCY	Alignment, Profile and Cross-Section of Proposed Alluvial Fan River Improvement (Solsona)

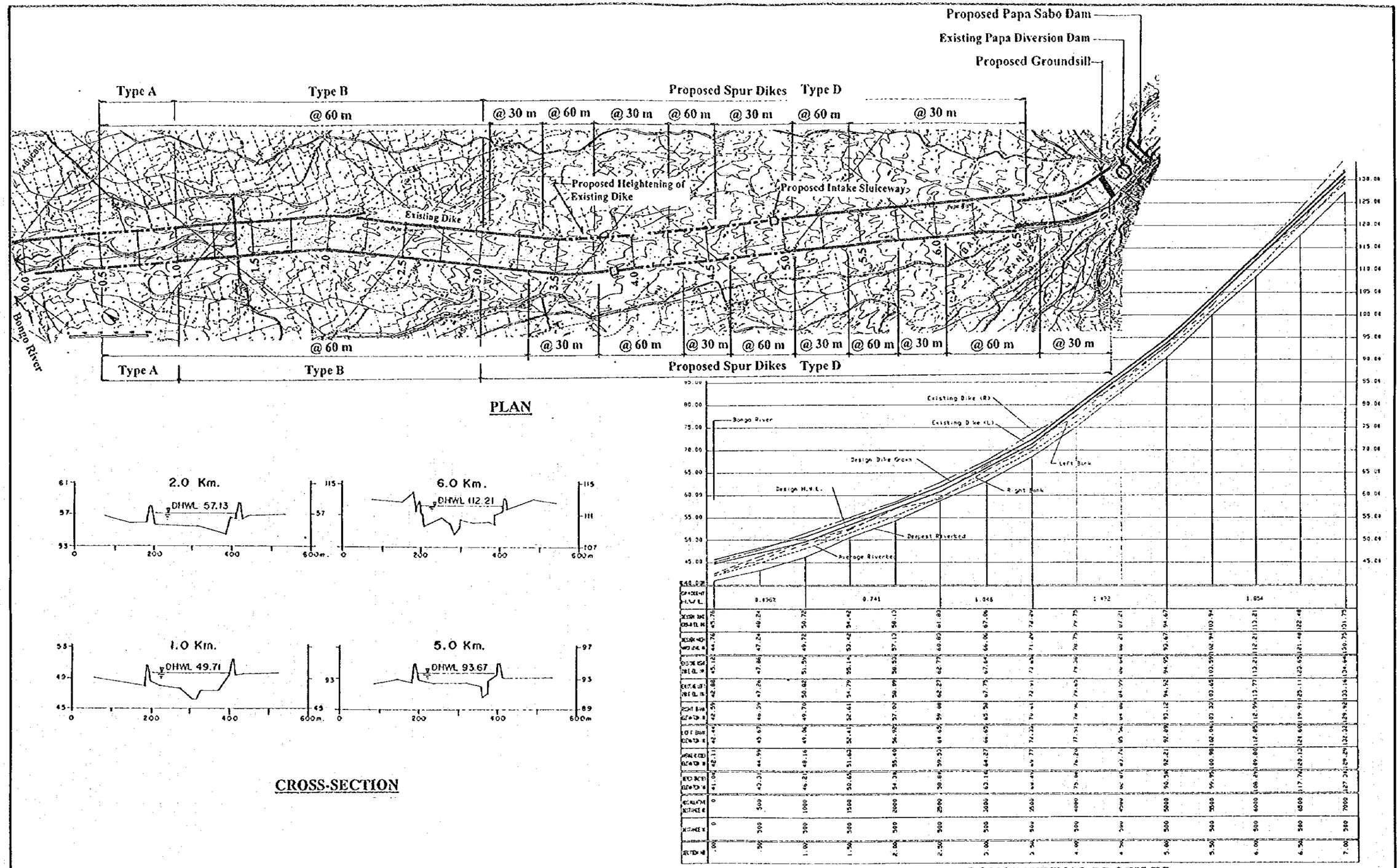


CROSS-SECTION

PLAN

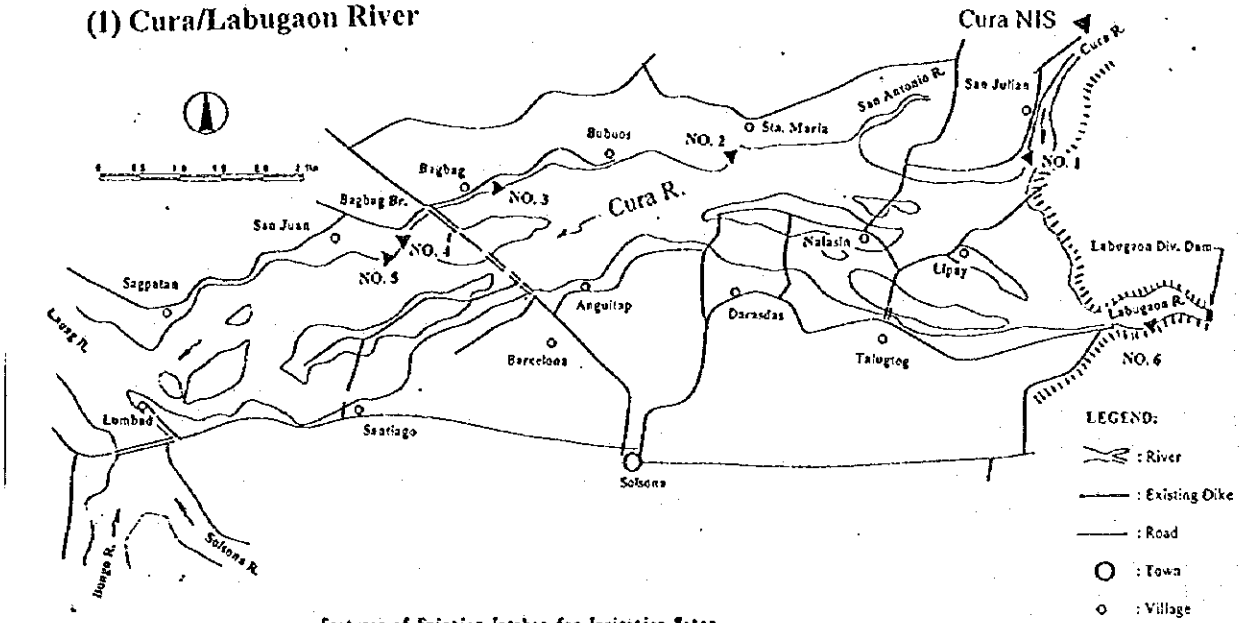
LONGITUDINAL PROFILES

THE STUDY ON SABO AND FLOOD CONTROL IN THE LAOAG RIVER BASIN	Fig. II.17 (3)
JAPAN INTERNATIONAL COOPERATION AGENCY	Alignment, Profile and Cross-Section of Proposed Alluvial Fan River Improvement (Madongan)



THE STUDY ON SABO AND FLOOD CONTROL IN THE LAOAG RIVER BASIN	Fig. II.17 (4) Alignment, Profile and Cross-Section of Proposed Alluvial Fan River Improvement (Papa)
JAPAN INTERNATIONAL COOPERATION AGENCY	

(1) Cura/Labugaon River

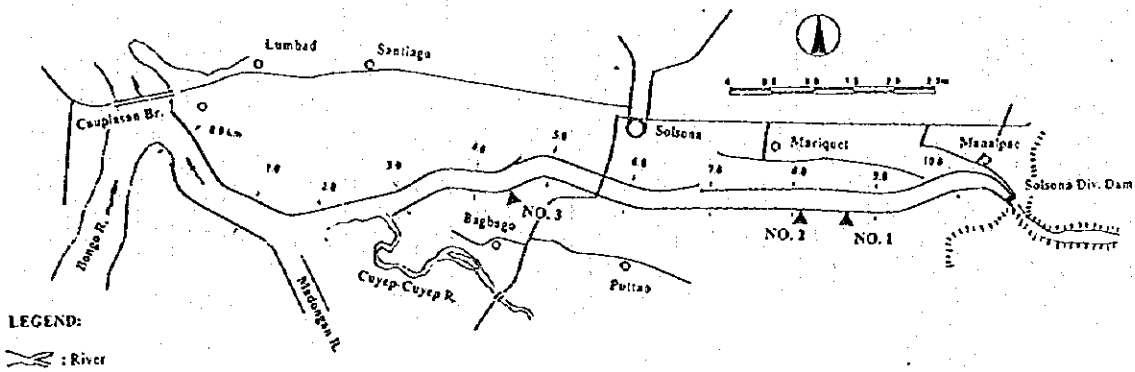


Features of Existing Intakes for Irrigation Water

(Cura/Labugaon River)

No.	Location	Service Area (ha)	Intake Structure
1	San Jurian, Solsona	300	Brush Dam w/ Steelgates (2 - 1.5m x 1.5m)
2	Sta. Maria	-	Bush Dam
3	Bagbag, Solsona	43	Brush Dam w/ Stop-log (2.0m x 1.0m)
4	San Juan, Solsona	85	Brush Dam
5	San Juan, Solsona	45	Brush Dam
6	Left Bank of Labugaon near Labugaon Div. Dam	302	Brush Dam w/ Steelgates

(2) Solsona River



Features of Intakes Constructed under UDP (NIA, 1993)

(Solsona River)

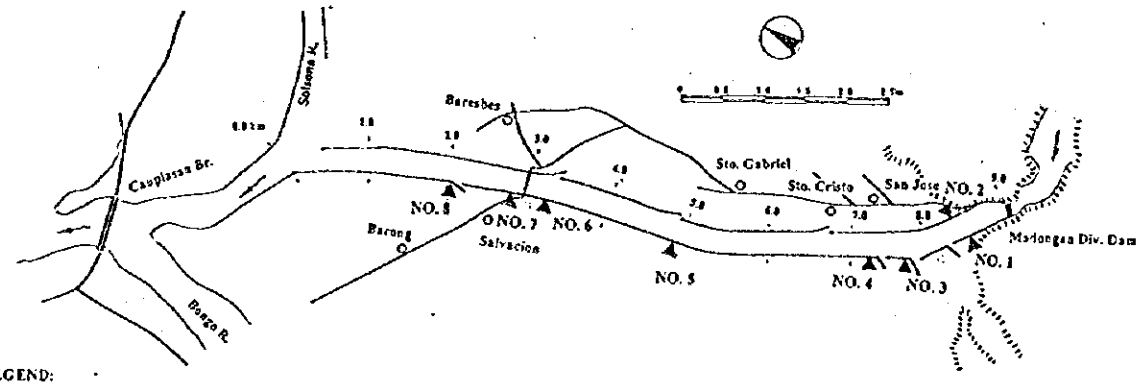
No.	Bank	Station (NIA)	Service Area (ha)	Estimated Discharge (m3/s)	Intake Structure (Sectional Height x Width: m)
1	Left	8+840(7+000)	40	0.266	Concrete Box Culvert (1.0 x 1.6)
2	Left	8+140(7+700)	60	0.241	Concrete Box Culvert (1.0 x 1.6)
3	Left	4+560(6+275)	20	0.239	Concrete Box Culvert (1.0 x 1.6)

THE STUDY ON SABO AND FLOOD CONTROL IN THE LAOAG RIVER BASIN

JAPAN INTERNATIONAL COOPERATION AGENCY

Fig. II.18 (1)
Location of Existing Irrigation Intakes
(Cura/Labugaon and Solsona Rivers)

(3) Madongan River



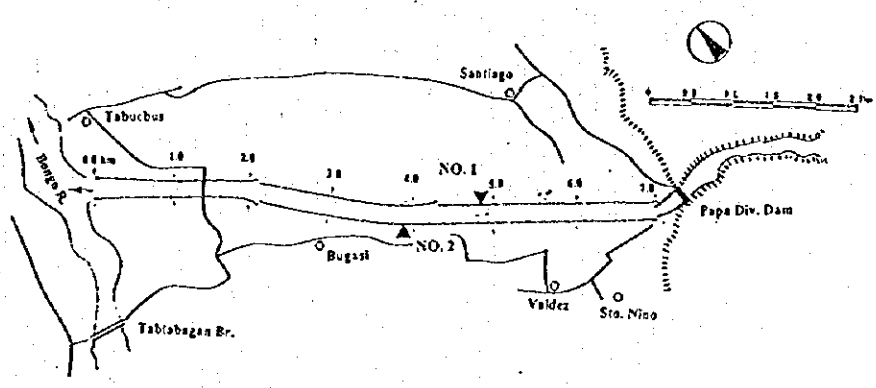
LEGEND:
- : River
- : Existing Dike
- : Road
- : Town
- : Village
- : Bridge
- : Mountain
- : Intake

Features of Intakes Constructed under UDP (NIA, 1993)

(Madongan River)

No.	Bank	Station (NIA)	Service Area (ha)	Estimated Discharge (m3/s)	Intake Structure (Sectional Height x Width: m)
1	Left	8+520(0+575)	400	2.912	Concrete Box Culvert (2 - 1.0 x 1.6)
2	Right	8+350(0+750)	786	5.310	Concrete Box Culvert (2 - 1.0 x 1.6)
3	Left	7+760(1+340)	415	3.021	Concrete Box Culvert (2 - 1.0 x 1.6)
4	Left	7+240(1+858)	715	5.205	Concrete Box Culvert (2 - 1.0 x 1.6)
5	Left	4+850(4+245)	441	3.210	Concrete Box Culvert (2 - 1.0 x 1.6)
6	Left	3+300(5+800)	25	0.182	Concrete Box Culvert (1.0 x 1.6)
7	Left	2+800(6+300)	14	0.102	Concrete Box Culvert (1.0 x 1.6)
8	Left	2+050(7+050)	110	0.762	Concrete Box Culvert (1.0 x 1.6)

(4) Papa River



LEGEND:
- : River
- : Existing Dike
- : Road
- : Town
- : Village
- : Bridge
- : Mountain
- : Intake

Features of Intakes Constructed under UDP (NIA, 1993)

(Papa River)

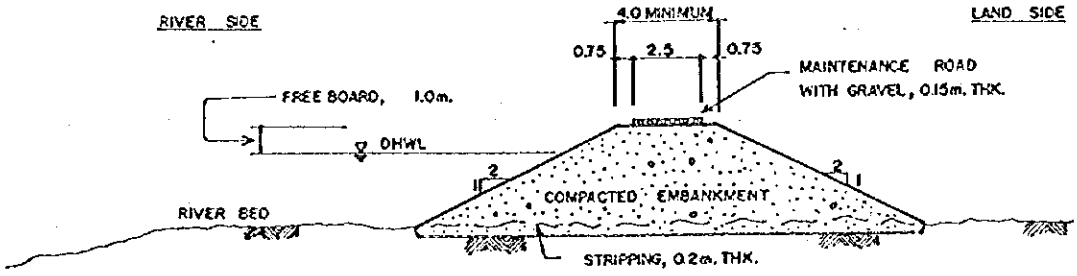
No.	Bank	Station (NIA)	Service Area (ha)	Estimated Discharge (m3/s)	Intake Structure (Sectional Height x Width: m)
1	Right	4+910(2+325)	64	0.471	Concrete Box Culvert (1.0 x 1.4)
2	Left	3+640(3+600)	115	0.779	Concrete Box Culvert (1.0 x 1.6)

THE STUDY ON SABO AND FLOOD CONTROL IN THE LAOAG RIVER BASIN

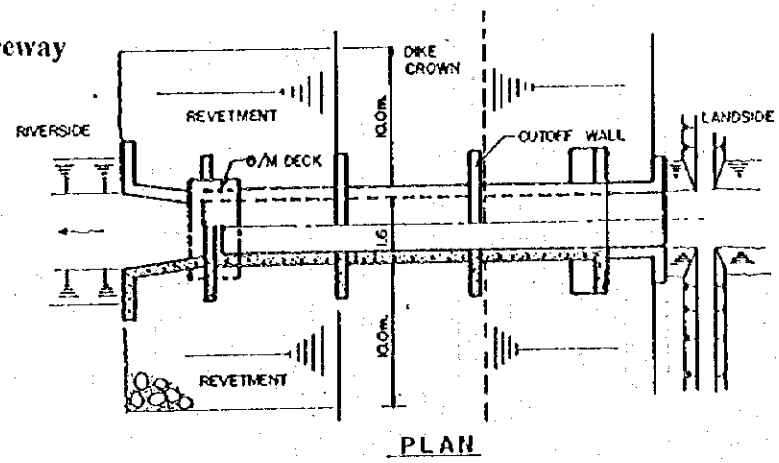
JAPAN INTERNATIONAL COOPERATION AGENCY

Fig. II.18 (2)
Location of Existing Irrigation Intakes
(Madongan and Papa Rivers)

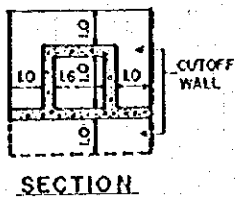
(1) Dike

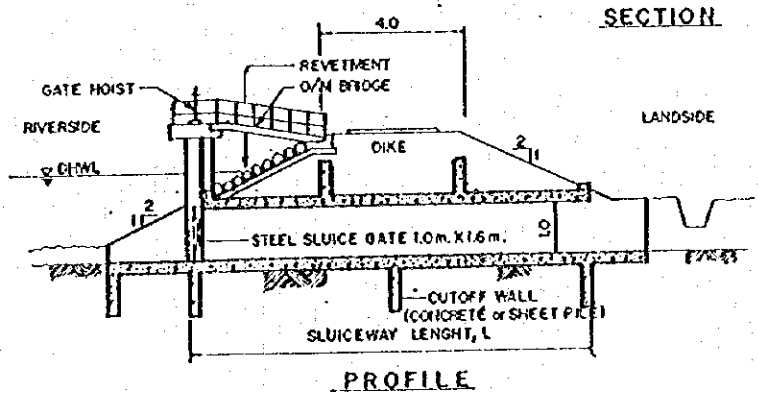


(2) Intake Sluiceway



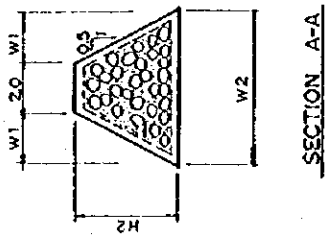
TYPE	NO. OF BOX
A	1
B	2



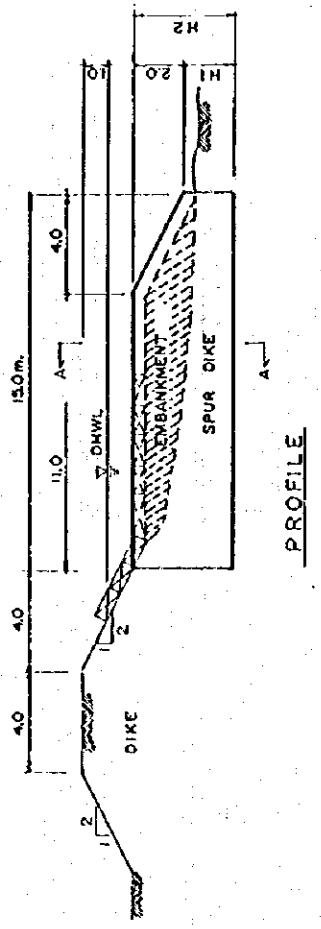


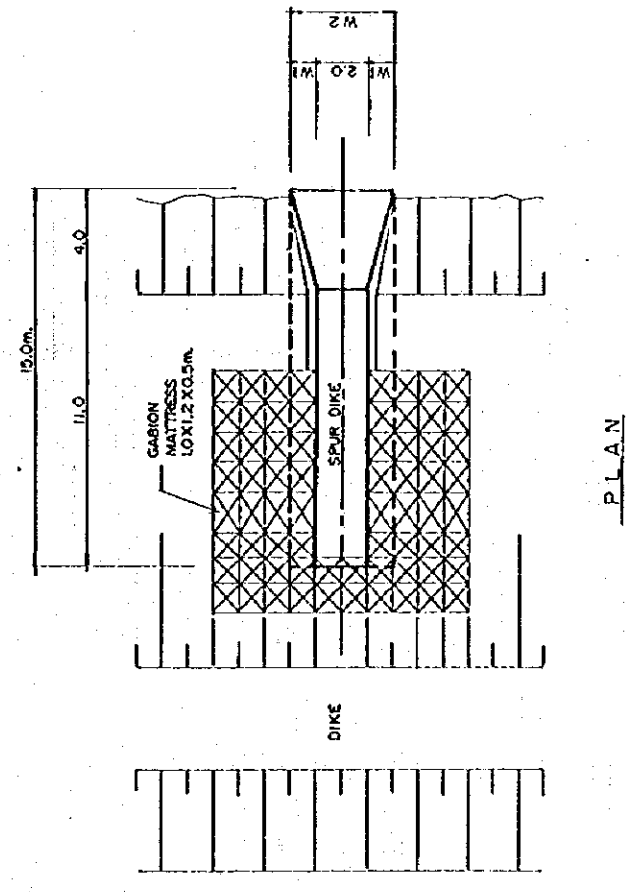
THE STUDY ON SABO AND FLOOD CONTROL IN THE LAOAG RIVER BASIN JAPAN INTERNATIONAL COOPERATION AGENCY	Fig. II.19 (1) Typical Structural Design of Proposed Alluvial Fan River Improvement

(3) Stone Concrete Spur Dike



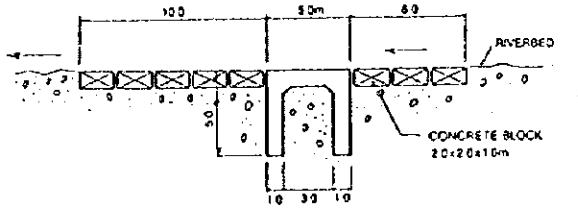
TYPE	H1	H2	W1	W2
A	1.20	3.20	1.60	5.20
B	1.50	3.50	1.75	5.50
C	2.00	4.00	2.00	6.00
D	2.30	4.30	2.15	6.30

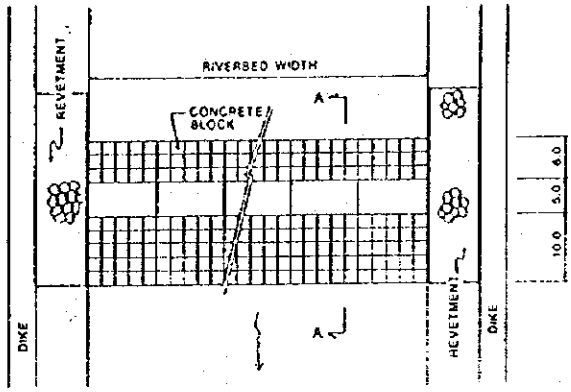




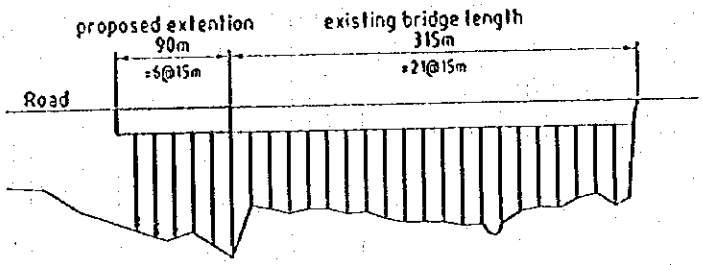
THE STUDY ON SABO AND FLOOD CONTROL IN THE LAOAG RIVER BASIN	Fig. II.19 (2)
JAPAN INTERNATIONAL COOPERATION AGENCY	Typical Structural Design of Proposed Alluvial Fan River Improvement

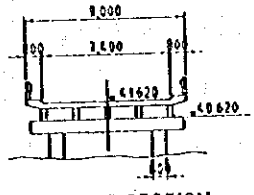
(4) Groundsill

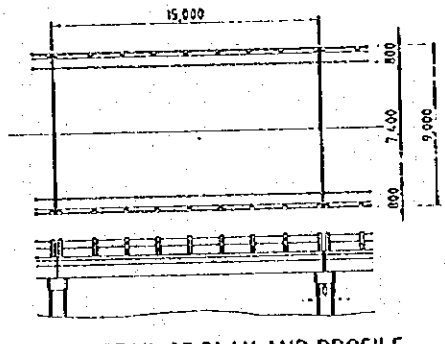




(5) Bagbag Br. Extension







THE STUDY ON SABO AND FLOOD CONTROL IN THE LAOAG RIVER BASIN	Fig. II.19 (3) Typical Structural Design of Proposed Alluvial Fan River Improvement
JAPAN INTERNATIONAL COOPERATION AGENCY	

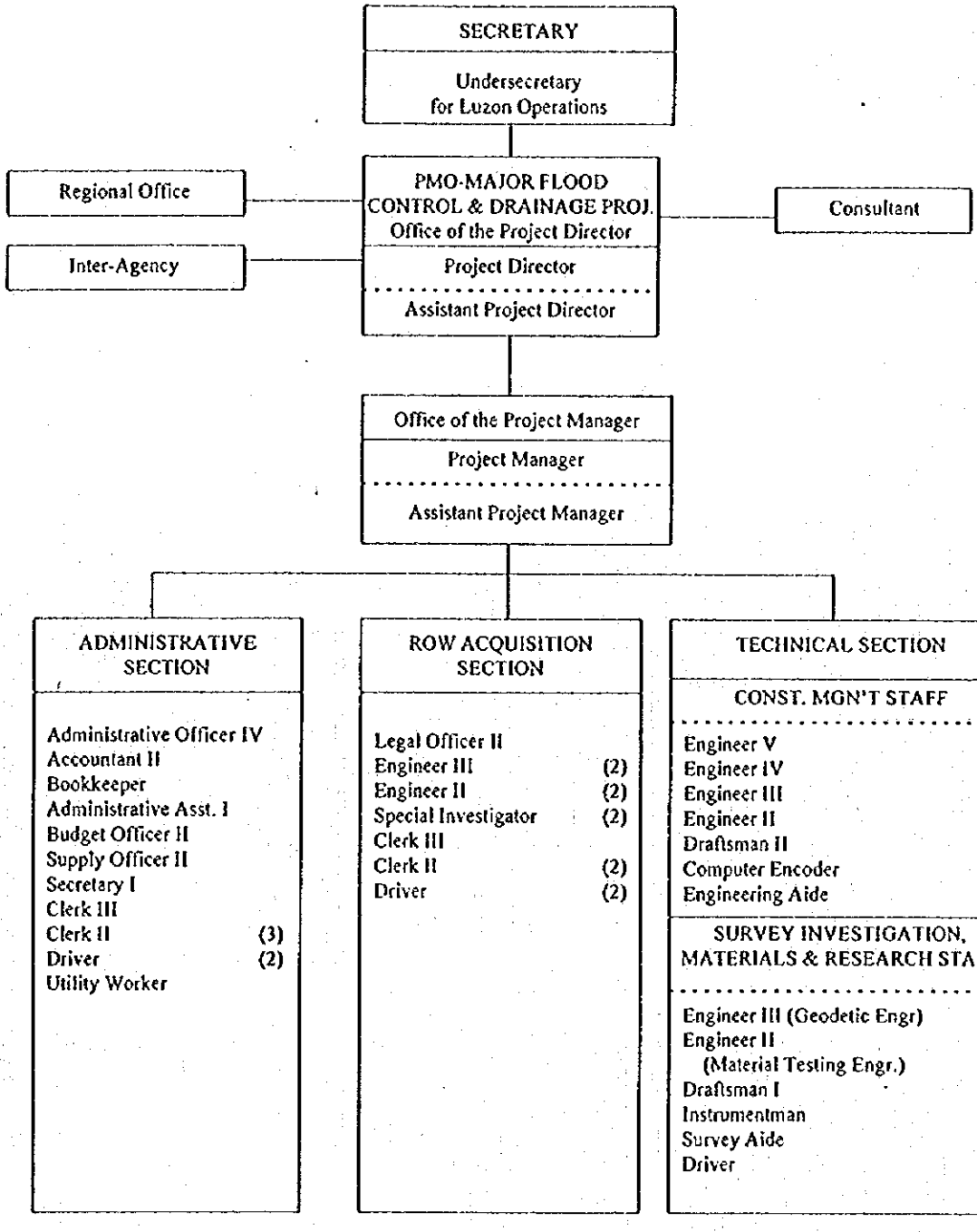
Items	Quantity	1997	1998	1999	2000	2001	2002	2003
1. Feasibility Study								
2. Loan Application & Other Preparations								
3. Detailed Design								
4. Construction								
4.1 Sabo Dams and Alluvial Fan River Improvement								
(1) Cura/Labugaon River								
a) Cura Sabo Dam No.1	15,100 m3							
b) Labugaon Sabo Dam No.1	16,900 m3							
c) River Improvement	12.7 km							
(2) Solsona River								
a) Solsona Sabo Dam No.1	5,200 m3							
b) River Improvement	11.0 km							
(3) Madongan River								
a) Madongan Sabo Dam	20,800 m3							
b) River Improvement	9.0 km							
(4) Papa River								
a) Papa Sabo Dam	16,900 m3							
b) River Improvement	7.0 km							
4.2 Laoag-Bongo River Improvement	13.14 km							
a) Poblacion Laoag River Improvement	3.49 km							
d) Poblacion San Nicolas River Improvement	4.20 km							
c) Poblacion Dingras River Improvement	5.45 km							
5. Land Acquisition	40.5 ha							

THE STUDY ON SABO AND FLOOD CONTROL IN THE LAOAG RIVER BASIN

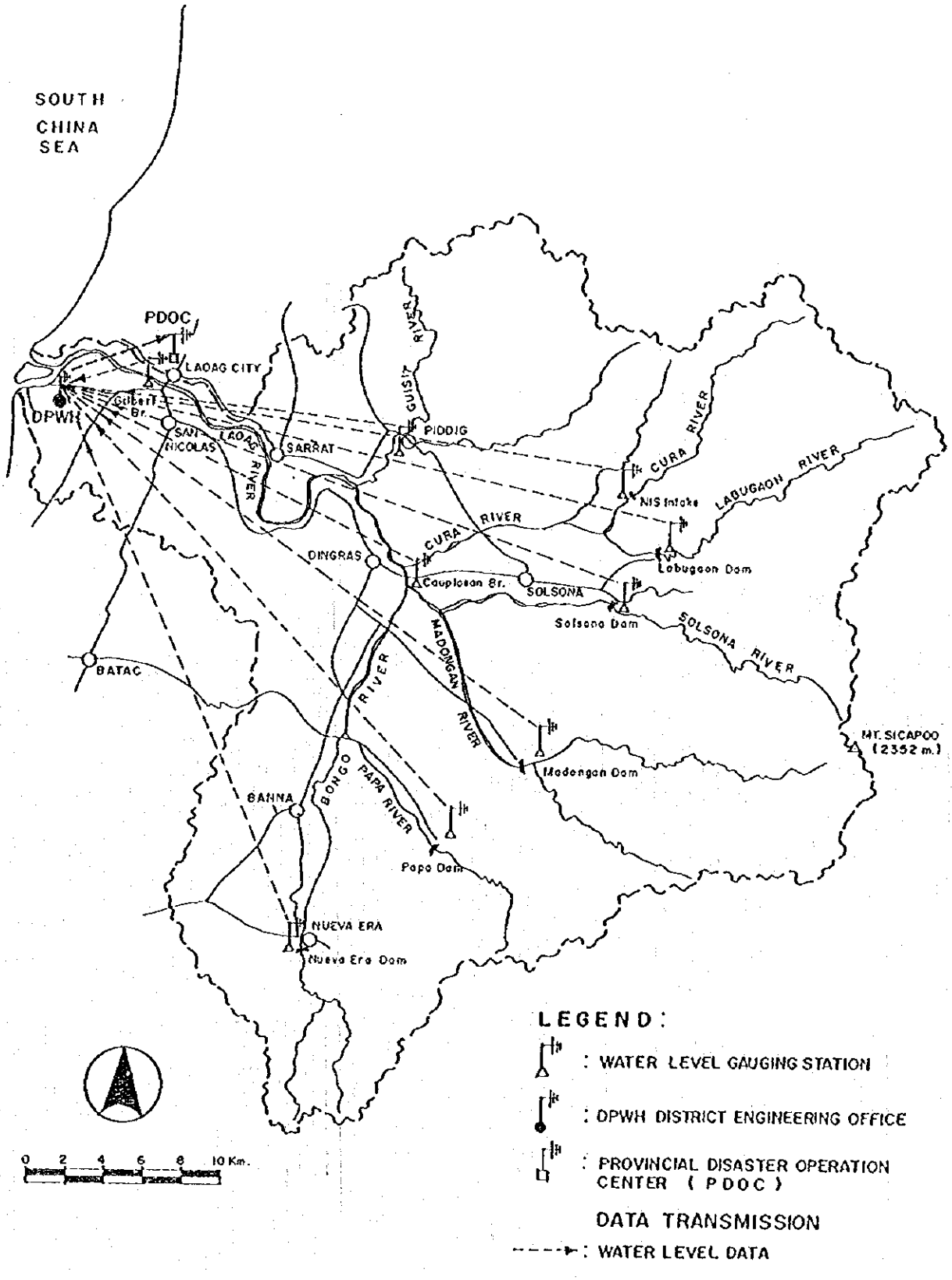
JAPAN INTERNATIONAL COOPERATION AGENCY

Fig. II.20
Implementation Schedule of Priority Project

POSITION CHART
PROJECT MANAGMENT OFFICE
LAOAG RIVER SABO AND FLOOD CONTROL PROJECT



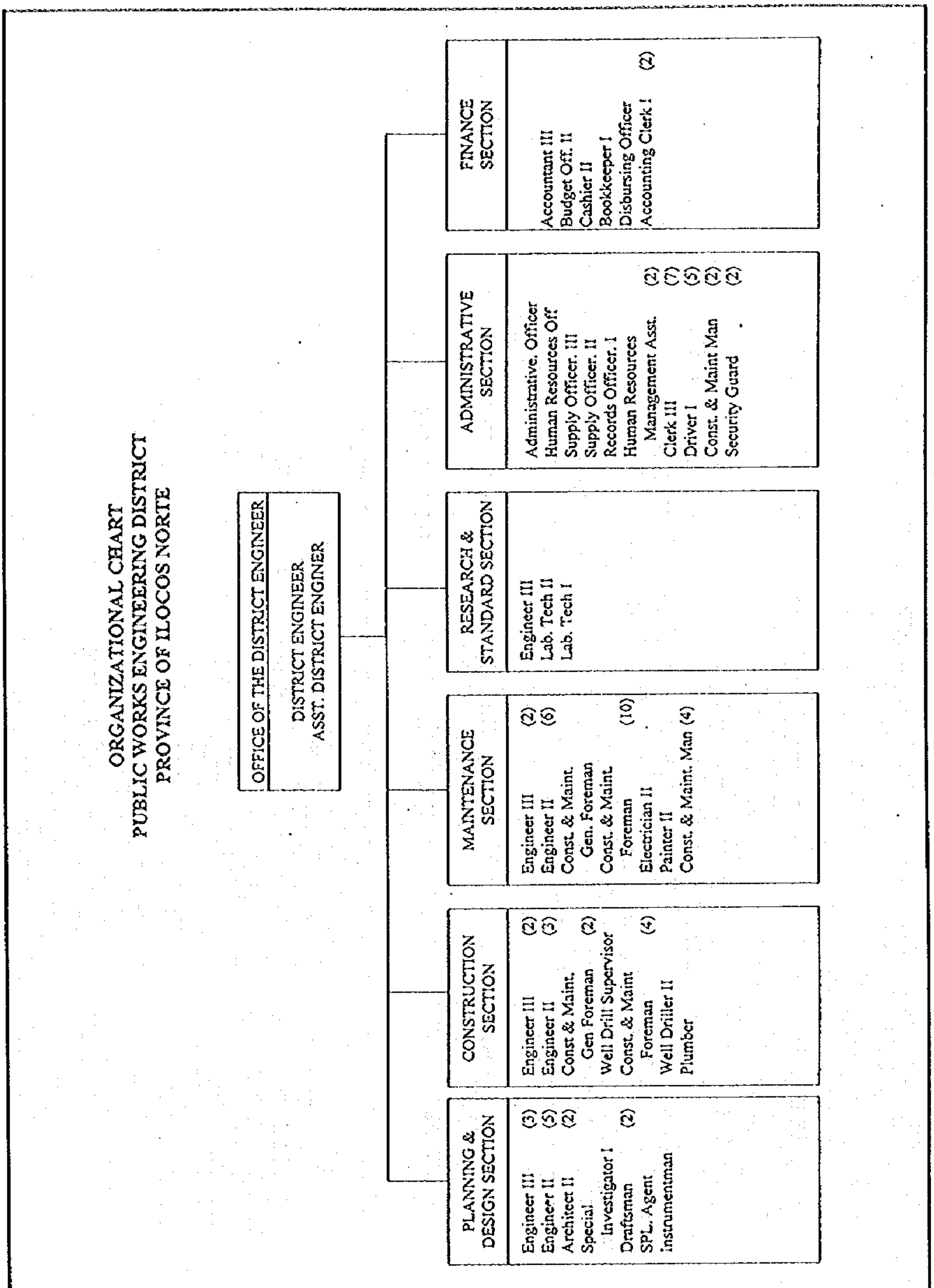
THE STUDY ON SABO AND FLOOD CONTROL IN THE LAOAG RIVER BASIN JAPAN INTERNATIONAL COOPERATION AGENCY	Fig. II.21 Project Implementation Organization



THE STUDY ON SABO AND FLOOD CONTROL IN THE LAOAG RIVER BASIN

JAPAN INTERNATIONAL COOPERATION AGENCY

Fig. II.22
Hydrological Observation Network



THE STUDY ON SABO AND FLOOD CONTROL IN THE LAOAG RIVER BASIN

JAPAN INTERNATIONAL COOPERATION AGENCY

Fig. II.23
Existing Organization of DPWH Engineering District, Ilocos Norte