APPENDIX 4-4

Calculation method of economic value (B/C)

Sample of calculation of economic value (B/C)

［Calculation of B/C］

Assumption	PSPP	Unit const. cost	75,000	cent/kW
		Installed capacity	1,000	MW
		Expense rate	11.09	%
		Annual peak duration hours	800	hr/year
		Efficiency	70	%
		Pumping energy unit cost	1.33	cent/kWh
	GT	Unit const. cost	63,571	cent/kW
		Expense rate	13.17	%
		Variable cost	2.47	cent/kWh

B/C	Benefit	kW Value	83.7	mil $
		Annual energy generation	800	GWh
		kWh Value	19.8	mil $
		Total	103.5	
	Cost	Generaation cost	83.1	mil $
		Annual energy generation	800	GWh
		Pumping energy cost	11	mil $
		Total	93.8	
	B/C		1.10	

［Annual cost rate］

	Interest rate (%)	Life time (yr)	Remaining Value (%)	Annual Cost (%)	(Capital rate) (%)	(O&M expense) (%)
GT	10.0	20	10%	13.17	11.74	1.42
PSPP	10.0	50	10%	11.09	10.09	1.00

					Ground
GT	Const cost	63,571	cent/kW		
	Fixed O&M	20	cent/kW/mo.		5th M/P
	Variable O&M	830	cent/MWh		5th M/P
	Plant factor	9.1	%		800 hrs
	O&M rate	1.42	%		
PSPP	Salary	0.15	%		TEPCO standard
	Repairs	0.24	%		Ditto
	Other expense	0.35	%		Ditto
	Overhead	0.26	%		Ditto
	O&M expense	1.00	%		

［Variable cost］

Gas	Fuel price	0.794	cent/Mcal	
（Alternative）	Escalation	2.0	%	
	Interest	10	%	
	Life time	50	year	PSPP
	Equalized	0.978	cent/Mcal	
	Heat efficiency	34	%	5th M/P(GT)
	Variable cost	2.473	cent/kWh	

Coal	Fuel price	0.345	cent/Mcal	
(Pumping powe	Escalation	2.0	%	
	Interest	10	%	
	Life time	50	year	PSPP
	Equalized	0.432	cent/Mcal	
	Heat efficiency	40	%	5th M/P
	Variable cost	0.928	cent/kWh	

: Estimate

: Calculation results

	Fuel Price	(unit)	Heat Efficiency	(unit)	Unit Price	(unit)
Gas	2	$/mmBTU	0.252	kcal/BTU	0.794	cent/Mcal
Coal	19	$/ton	5,500	kcal/kg	0.345	cent/Mcal
Ground	5th M/P		5th M/P			

APPENDIX 4-5

Checklists for the second site reconnaissance

Checklist for the Second Field Survey for PSPP

Site name	Points of second site survey				Note
		Geological points	Technical points	Environmental points*	
JN 5	Upper dam/ Resevoir	◎**Checking the Permeability of the Reservoir** ・Checking the weathering grade along the geological boundaries through the Dam Axis ・Checking the Spring point, strike and dip of the bedding of the outcrops ○**Checking the Geology and strength of the rock around the Dam axiss**	. Considering the way of using the ridge of reservoir . Checkinging the thin ridge of the left valley . Estimating the cross section at the proposed dam axis . Surveying the avalability of dam material	. Investivating the number of households, villages that would be submerged in water, as well as compensatory assests	
	Intake	○**Checking the Geology and the strength of the rock around the Intake**	. Checking the topographical conditions at intake post.		
	Waterway/Surge tank	○**Checking the Geology and the permeability around the tunnel** ・Checking the condition around the fault zone			
	Undg. Powerhouse	○**Checking the Geology and the strength of the rock around the Underground Power House**	. Selecting the position for access tunnel		
	Lower dam/Reservoir	◎**Checking the Permeability of the Reservoir** ○**Checking the Geology and the strength of the rock around the Dam axiss** ・Checking the condition around the fault zone through the Lower Reservoir	. Selecting the dam axis, evaluating the topo. Condition . Estimating the cross section at proposed dam axis . Sounding at the proposed dam axis . Selecting the position of diversion, drainage structures . Selecting the position of cofferdam ・Checking the post., elev., and topo of back water . Confirming the sedimetary quantity . Issues related to temporary structure and disposal areas	. Investivating the number of households, villages that would be submerged in water, as well as compensatory assests . Collecting the opinions of those who have once dislocated due to the construction of Hoa Binh power plant . Estimating the effect on the waterway transportation from Hoa Binh reservoir to upstream of the proposed dam site	
	Outlet		. Selecting the candidate positions of outlet		
	Approach		. Selecting the approach route for dam and powerhouse		
	Others	・Checking the condition around the fault zone through the Lower Reservoir	. Confirming the validity of connecting route between upper and lower reservoirs		
P 5	Upper reservoir	◎**Checking the Permeability of the Reservoir** ・Checking the condition of the fracture zone through the Reservoir(in Hoa Binh) ・Checking the weathering grade around the geological boundary			
	Waterway/surge tank	○**Checking the strength of the rock around the tunnel** ・Checking the conditions of the open cracks in the limestone			
	Undg. Power house	○**Checking the Geology and strength of the rock around the tunnel** ・Checking the weathering grade around the boundary of the granite and the other rocks	. Considering the construction method		
	Tailrace		. Considering the construction method		
	Outlet		. Sounding . Considering the construction method		
JN 3	Upper reservoir (Full facing type)	◎**Checking the Permeability of the Reservoir** ・Checking the condition of the fault in southern part of the Reservoir ・Checking the weathering grade around the geological boundary ・Checking the geology and the thickness of the Alluvial in the Reservoi ・Checking the spring points around the Reservoir ○**Checking the Geology and the strength of the rock around the Dam axiss** ・Checking the condition of the fracture zone along the road ・Checking the weathering grade around the geological boundary ・Checking the existence of the Serpentine			
	Intake	○**Checking the Geology and the strength of the rock around the Intake**	. Selecting the candidate positions of intake		
	Waterway/Surge tank	○**Checking the Geology and the permeability around the tunnel** ・Checking the weathering grade around the geological boundary ・Checking the existence of the Serpentine			
	Undg. Power house	○**Checking the Geology and the strength of the rock around the Underground Power House**	. Selecting the position for access tunnel		
	Lower dam/ Reservoir	◎**Checking the the Permeability of the Reservoir** ・Checking the condition around the fault zone through the Lower Reservoir ○**Checking the Geology and the strength of the rock around the Dam axiss** ・Checking the weathering grade around the geological boundary ・Checking the existence of the Serpentine	. Estimating the cross section at the proposed dam axis . Selecting the position of diversion, drainage structures . Selecting the position of cofferdam . Confirming the sedimetary quantity . Issues related to temporary structure and disposal areas		
	Outlet		. Selecting the candidate positions of outlet		
	Approach		. Selecting the approach route for dam and powerhouse		
	Others				

Site name		Points of second site survey			Note
		Geological points	Technical points	Environmental points*	
JS6	Upper reservoir	◎**Checking the Permeability of the Reservoir** ・Checking the weathering grade on granite and the condition of the geological bounary ○**Checking the Geology and the strength of the rock around the Dam axiss** ・Checking the weathering grade on granite and the condition of the geological bounary	. Estimating the cross section at the proposed dam axis ・Selecting the damtype and surveying the materials avalabilit	・Surveying the current situation of using natural forest ・Considering the possiblity of substitute reforestation	
	Waterway/surge tank	○**Checking the Geology and the strength of the rock around the Tunnel**			
	Undg. Power house	○**Checking the Geology and strength of the rock around the Undg. PowerHouse**	. Selecting the position of access tunnel		
	Lower dam/reservoir	◎**Checking the Permeability of the Reservoir** ・Checking the conditions around the fault zone ○**Checking the Geology and the strength of the rock around the Dam axiss** ・Checking the conditions around the fault zone	・Selecting the dam axis（Evaluating the topo cond. and rock) ・Evaluating the cross section at the selected dam axis ・Selecting the structure of diversion (Tunnel or open channel) . Selecting the position of cofferdam and diversion structure . Confirming the validity of sedimentary quantity ・Pointing out issues related to temp. facility and disposal		
	Outlet		・Selecting candidate positions of outlet		
	Approach		・Selecting approach route for the dam and powerhouse		
	Others		・For the survey or construction, finding the way to cross the river is necessary		

* : Reffer to the Checklist Envirmental Considerations for PSPP (Appendix 9-1)

Checklist for Environmental Considerations for PSPP
(modified from ADB, WB and JBIC checklists)

	Expected negative impacts			Remarks
	Major	Unknown or can be mitigated	No significant impact	
A. Environmental Problems Due to Project Location				
A-1 Social Environment				
1 Effects on ethnic minorities				
2 Resettlement				
3 Loss of land (agricultural, forest, range and wetlands)				
4 Encroachment into watershed				
5 Encroachment on historical and cultural values				
6 Impairment of navigation				
7 Inundation of mineral resources				
8 Decline of fisheries				
9 Downstream impacts				
A-2 Natural Environment				
1 Encroachment into precious ecosystem (general)				
Encroachment into precious ecosystem (terrestrial)				
Encroachment into precious ecosystem (aquatic)				
2 Encroachment into existing protected area				
3 Migrating fish species				
4 Effects on scenic value				
5 Downstream impacts				
A-3 Physical Environment				
1 Watershed erosion / silt runoff				
2 Effects on groundwater hydrology				
3 Downstream flow variations				
4 Change of sedimentation transportation balance				
B. Environmental Problems Related to Design				
1 Road erosion				
C. Environmental Problems Associated with Construction Stage				
3 Environmental degradation at quarry site				
D. Environmental Problems Related to Project Operations				
D-3 Social Environment				
1 Insect vector / water borne diseases hazards				
2 Estuarine and marine fisheries impacts				
D-4 Natural Environment				
1 Poaching due to new access methods				
2 Illegal logging due to new access methods				
3 Encroachment due to new access methods				
E. Additional Consideration for Hydropower Projects				
Transmission lines				
1 Encroachment on precious ecosystem				
2 Impairment of wildlife movement				
3 Avian hazards from transmission lines and towers				
4 Impairment of environmental aesthetics				
5 Soil erosion from construction and areas left exposed				
6 Inviting new encroachment				
7 Aircraft hazards from transmission lines and towers				
8 Induced effects from electromagnetic fields				

APPENDIX 4-6-1

Results of the second site reconnaissance; JN3

Appendix 4-6-1-(1)

The features of promising potential sites for PSPP

Site Name		JN 3
Location (Name of River)		Upper dam/reservoir : Son La Province/ Phu Yen District/Muong Lang (Dong An) Commune (None) Lower dam/reservoir : Son La Province/ Phu Yen District/Muong Lang Commune (Song Mua River)
Project Parameter	Installed Capacity P(MW) Design Discharge Qd(m^3/s) Effective Head He(m) Peak Duration Time T(hrs)	1,000 230 560 7

Field	Point of second field survey	Findings
Topography and Geology	**(Overall geological condition)**	・ Mainly Devonian WNW-ESE system of sedimentary folding area, the rocks are composed of mainly shale and limestone. The fractured zone reported in the published geological map is along the geological boundaries inside the sedimentary rocks. Some formations include the serpentinite lens in the limestone or shale beds. Around this side, underground water level is nearly the same as the ground surface. An ENE-WSW system of fault through the lower reservoir is reported in the published geological map.
	(Upper dam／reservoir) ・Site geology	・ Rock around the Upper reservoir is clayish shale or limestone (D2mt, D2ebn, D2g-D3bc), the conditions of rocks are hard and massive. Some holes in the limestone were found along the road. The right side of the reservoir has steep slope composed of limestone outcrop, left side of the reservoir has gentle slope composed of the same geology, and small streams are found in this side. There is a nearly NNE-SSW system of small hill in the center of the reservoir area, the geological condition is not clear.
	◎ Checking the Permeability of the Reservoir	◎ Permeability around the upper reservoir seems generally low. The number of open hole and joints in the limestone is lower and fewer than the other limestone area.
	・Checking the condition of the fault in southern part of the Reservoir ・ Checking the weathering grade around the geological boundary	・ No geological features of the fault inside the reservoir except along the road are understood. ・ The weathering condition around the reservoir is slight, some small valleys are existing on the boundaries in the Devonian sedimentary rocks (D2mt-D2ebn).
	・ Checking the geology and the thickness of the Alluvial in the Reservoir ・Checking the spring points around the Reservoir	・ The secondary sediments such as alluvial is not thick, generally less than 5-10m. ・ Several spring points were found in the right side of the reservoir.
	○Checking the Geology and the strength of the rock around the Dam axis	○ Dam site is composed of mainly massive and hard limestone or limy shale, some secondary sediments or weathering in the reservoir less than 5-10m thickness.
	・Checking the condition of the fracture zone along the road ・Checking the weathering grade around the geological boundary ・Checking the existence of the Serpentine	・ No features around the reservoir, several outcrops of the fractured zone are found along the road. ・ There are some fractured zones with no clay. ・ No serpentinite outcrop was found around the reservoir.
	(Intake) ○Checking the Geology and the strength of the rock around the Intake	○ Limestone (D2mt) from the published geological map covered with 5-10m depth of weathered soil, it is basically hard and massive rock.
	(Waterway) ○ Checking the Geology and the permeability around the tunnel	○The rock of waterway area is composed of limestone (D2mt) or clayish shale (D2ebn) according to the published geological map. It is covered with weathered soil. There are no features for the deeper part but in case the position of the waterway is in the limestone (D2mt), the permeability is relatively high, and if in the clayish shale (D2ebn), the permeability is low.

Legend : ◎ high priority, ○ important issue ・ general point

	・Checking the weathering grade around the geological boundary ・Checking the existence of the Serpentine	・ There is a valley along the geological boundary (D2mt and D2ebn) according to the published geological map. ・ No serpentinite outcrop was found around the reservoir.
	(Underground Power Station) ○Checking the Geology and the strength of the rock around the Underground Power House	○Geology around the Underground powerhouse is composed of hard and massive clayish shale (D2ebn). The surface is covered with 5-10m thickness of secondary sediments or weathering.
	(Lower dam／reservoir) ・ Site geology ◎ Checking the Permeability of the Reservoir ・Checking the condition around the fault zone through the Lower Reservoir ○Checking the Geology and the strength of the rock around the Dam site ・Checking the weathering grade around the geological boundary ・Checking the existence of the Serpentine	・Gently sloped clayish shale and limy shale in partial (D1st) in the whole area of Lower Reservoir/Dam site. An ENE-WSW system of structural line crosses the reservoir in the published geological map. ◎ Geology around the lower reservoir is mainly composed of clayish shale (D1st), limy shale in partial, generally hard and massive, low permeability. ・ No features of fractured zone are found around the reservoir but in the road. The hard and massive shale with nearly E-W bedding vertical and dips nearly horizontal as 10-20 degrees to the north (D1st) outcrops in the riverbed downstream of the Dam axis. ○ Mainly hard and massive clayish shale around the Dam site, and limestone in partial in the riverbed downstream were found. ・No features of weak zone or strongly weathered zone around the reservoir and dam axis was found. ・No serpentines outcrop was found around the reservoir.
	(Outlet) ・Checking the geological conditions	・ Geology around the outlet is massive and hard clayish shale (D1st) or limestone, but the weathered zone of the slope is covered by 10-20m thickness in the surface.
	(Approach) ・Checking the geological conditions	・Nearly same conditions as the other clayish shale (D1st/D2ebn) zone.
Design	**(Overall)**	・This site is located 20km east from Phu Yen, capital of district, and has a existing road to access to the dam sites. ・However it is a drought season, river flow at the lower dam is as little as about 0.3m^3/s. Therefore some countermeasures such as pumping up from the main river are required.
	(Upper dam／reservoir)	・The topography around the upper reservoir is different from the topographic map. ・Facing type poundage is suitable for this upper reservoir, which H.W.L. is 880 m based on the topographical condition. ・There is a mountain composed of limestone in the west side of the plain, which has a very steep slant, it is necessary to build a bank keeping some distance from the skirts of the mountain to avoid the influences of collapse of the mountain. ・A small hill around EL.870m lies from north to south on the center of plain, which is not appeared in topographic map. Location of the reservoir will be shifted to west to use the hill as a bank of the reservoir. ・A spring is there at EL. 860 m of the north part of the reservoir, which makes a paddy field.
	(Intake)	・Since the planned intake is situated at the east bank of the reservoir, it is necessary to shift its position to the west of the bank.
	(Waterway・Power Station) ・Selecting the position for approach tunnel	・The approach tunnel to the underground powerhouse is situated in the ridge, which has a sufficient width and a gentle slope.

Legend : ◎ high priority, ○ important issue ・ general point

	(Lower dam／reservoir) ・Estimating the cross section at the proposed dam axis ・Selecting the position of cofferdam ・Selecting the position of diversion, drainage structures ・Confirming the sedimentary quantity ・Issues related to temporary structure and disposal areas	・The elevation of the riverbed at the dam site is 210 m, which is the identical value of the topographical map. ・Since topography of the site is a steep slope and a narrow width of the river, concrete gravity type dam is suitable. ・The location of the cofferdam will be selected between the junction of three tributaries and the dam site. ・The position of the diversion will be planned in the left bank of the stream based on the topographical condition. ・Since the river flow in the lower dam site is as little as 0.3-0.4 m3/s and the catchment area is small, sediment volume is assumed to be little. ・Temporary yard for construction is available in the reservoir area. ・Disposal area will be selected in the lower reservoir.
	(Outlet) ・Selecting the candidate positions of outlet	・The location of the outlet will be planned under the largest ridge in the surrounding area, which has a sufficient width and a gentle slope.
	(Approach) ・Selecting the approach route for dam and powerhouse	**Upper dam/reservoir** ・There is an existing road about 500m away from the planned reservoir. Therefore new approach road of about 1.5km long will be planned. **Lower dam/reservoir/powerhouse** ・While there is a road from the national road to Manh village, some section of them are quite steep and narrow. Therefore drastic improvement or building new road is required. ・Since the new roads are constructing along Mua River from Manh village, it is possible to utilize them for the access road to the lower dam site. ・There is a narrow road to the approach tunnel to the underground powerhouse. Improvement of road and building bridges are required.
Natural and Social Environments	**(Ecosystem)**	・The **terrestrial ecosystem** at upper and lower dams / reservoirs has already been degraded due to human activities. ・Some secondary forests are left, and they need to be conserved as much as possible. ・Although the **aquatic ecosystem** of both areas is not fully understood, the impacts can be limited and small because of small size of the aquatic ecosystem.
	(Resettlement / Loss of assets)	**RESETTLEMENT** **Upper dam / reservoir** ・There is no house within the site. ・An approach road from the closest national road is planned. The road is long and goes through several villages, which may lead resettlement. **Lower dam /reservoir** ・The entire households of Thung Lang village (c. 37 households) may have to move out from the site. ・An approach road from the closest national road is planned. The road is long and goes through several villages, which may lead resettlement. **LOSS OF ASSESTS** **Upper dam / reservoir** ・Rice field and grazing land will be lost. An approach road from the closest national road is planned, which may lead lost of agricultural lands. **Lower dam / reservoir** ・The rice field of Thang Lang village will be lost. An approach road from the closest national road is planned, which may lead lost of agricultural lands.

Legend : ◎ high priority, ○ important issue ・ general point

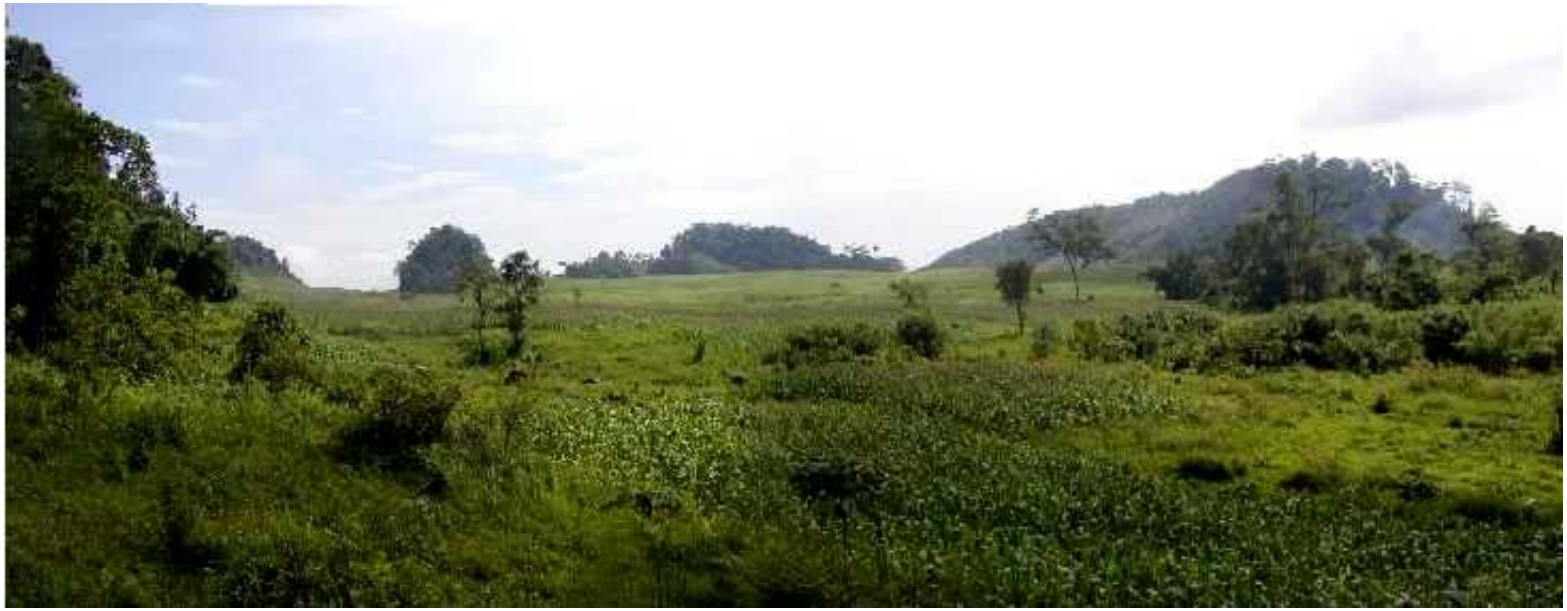

Photo 1

Facing type poundage is suitable for the upper reservoir, which H.W.L. is 880 m based on the topographical condition.

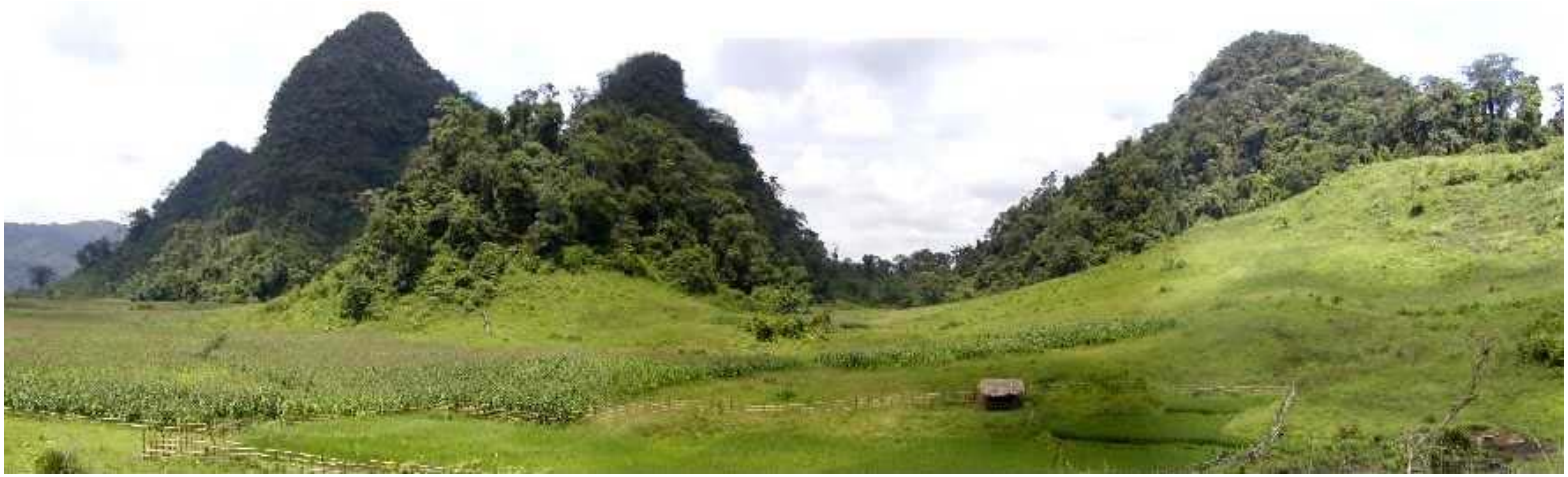

Photo 2

There are mountains composed of limestone in the west side of the plain.
A spring is there at EL.860 m of the north part of the reservoir, which makes a paddy field.

JN3－Upper Reservoir

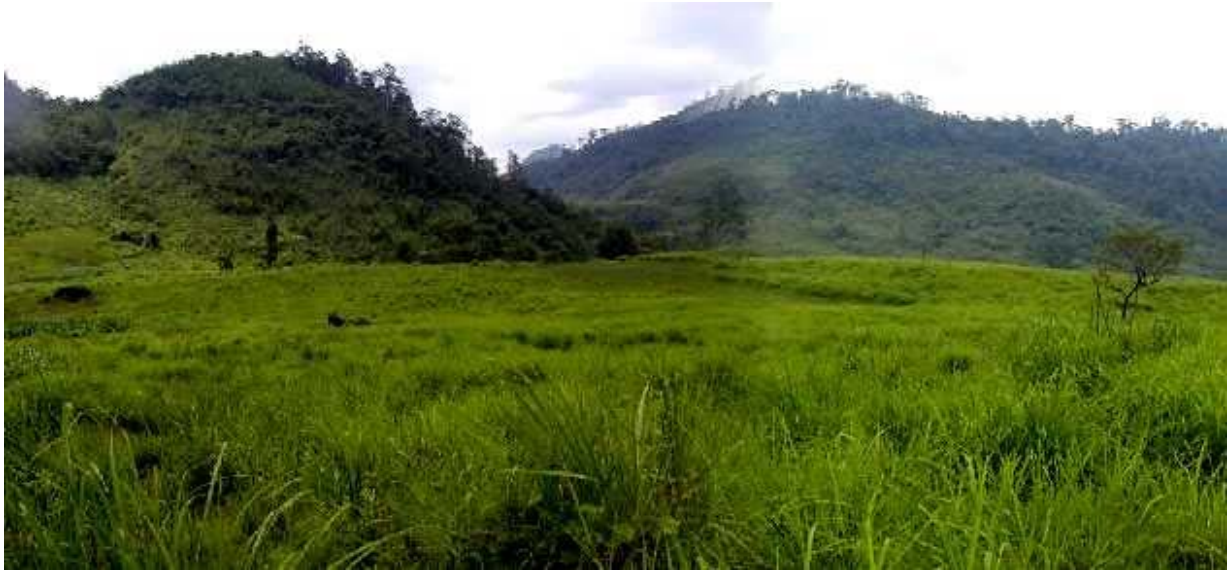

Photo 3

A small hill around EL. 870 m lies from north to south on the center of plain. Location of the reservoir will be shifted to the west part to use the hill as a bank of the reservoir.

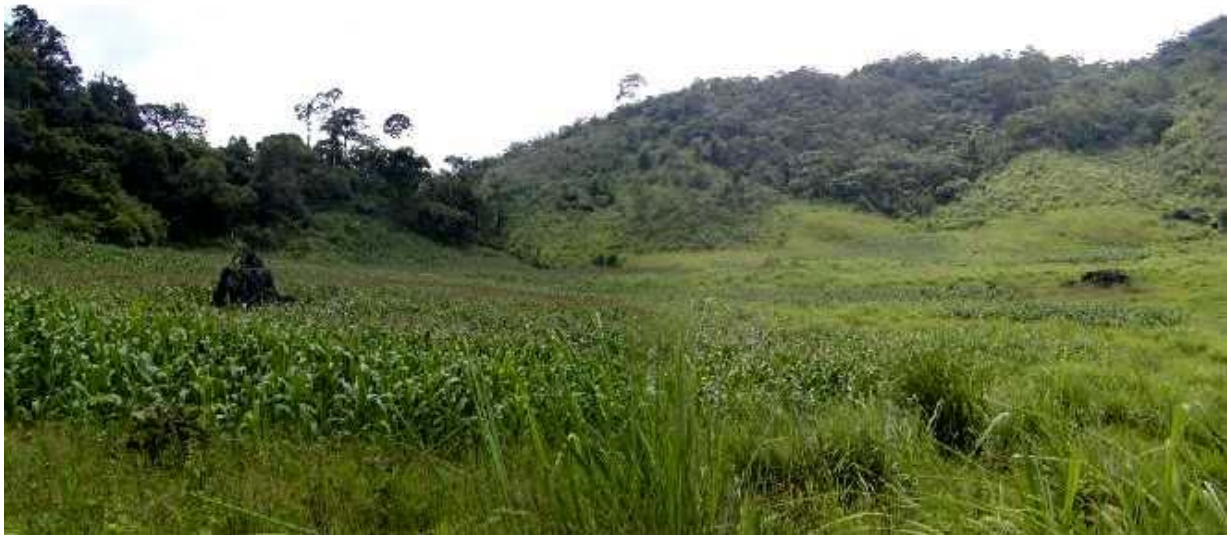

Photo 4

Since the planned intake is situated at the east bank of the reservoir, it is necessary to shift its position to the west of the bank.

JN3 – Upper Reservoir

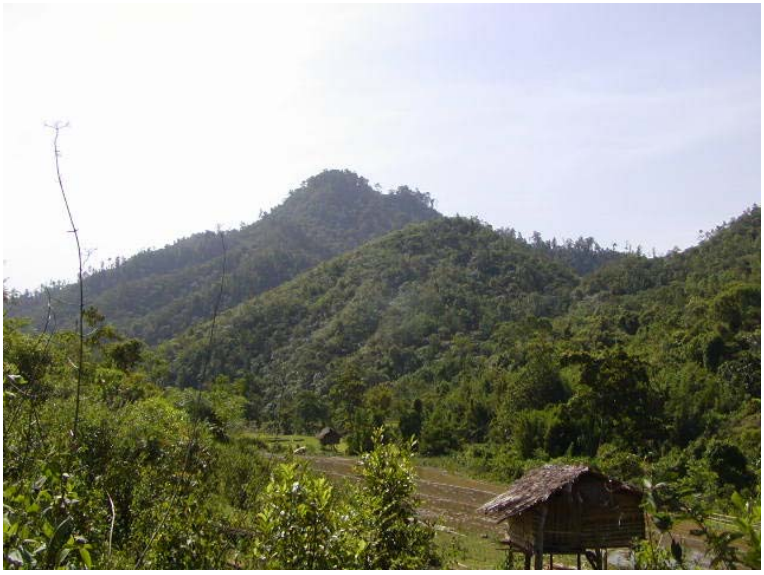

Photo 5

The mountain is at the dam site, looking from the upstream of the main river.

Photo 6

This is the junction of the main river and the tributary that has a dam site.

Photo 7

This is around pumping system to store up water from the main river.

Photo 8

There are outcrops composed of shale around the riverbed of the planned dam site.

Photo 9

Left bank of the dam site.
(Around riverbed)

Photo 10

Right bank of the dam site.
(Around riverbed)

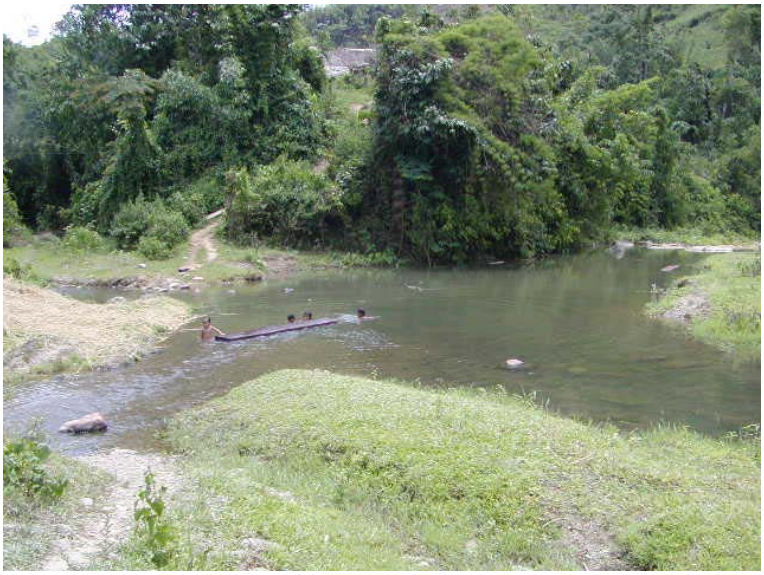

Photo 11

The location of the cofferdam will be selected between the junction of three tributaries and the dam site.

Photo 12

H.W.L. of the planned lower reservoir is 280 m based on the topographical condition.

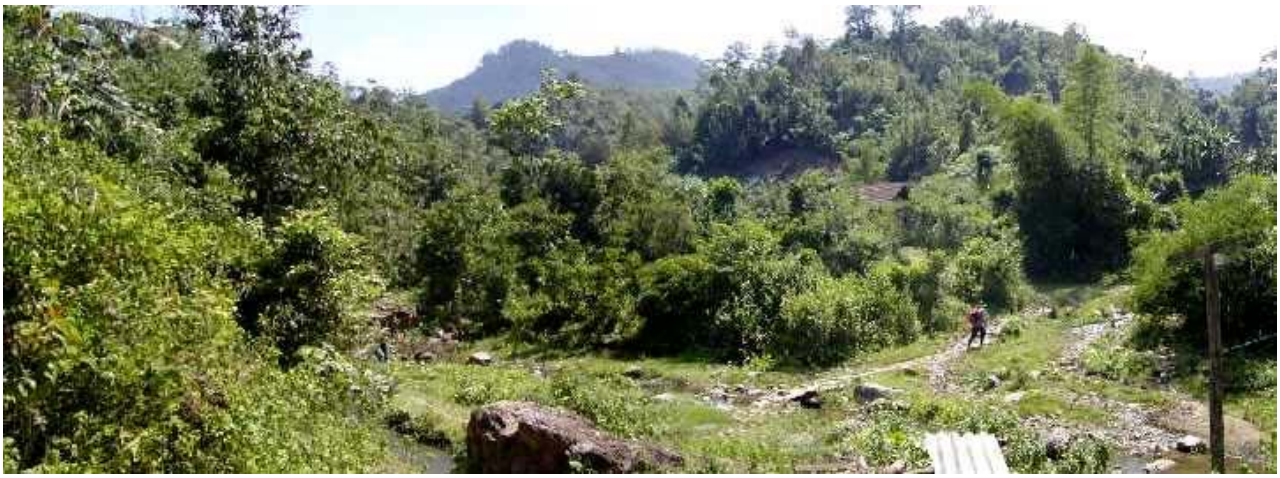

Photo 13 The location of the outlet will be planned under the largest ridge in the surrounding area.