APPENDIX 4-6-4

Results of the second site reconnaissance ; JS6

Appendix 4-6-4-(1)

The features of promising potential sites for PSPP

Site Name		JS 6
Location (Name of River)		Upper dam/reservoir： Ninh Thuan Province/ Bac Ai District / Phuoc Hoa Commune (None) Lower dam/reservoir：Ninh Thuan Province/ Bac Ai District / Phuoc Hoa Commune (Cai River)
Project Parameter	Installed Capacity P(MW)	1,000
	Design Discharge Qd(m^3/s)	350
	Effective Head He(m)	360
	Peak Duration Time T(hrs)	7

Field	Point of second field survey	Findings
Topography and Geology	**(Overall geological condition)**	・The geology around this site is generally composed of granite zone with some volcanics and sedimentary rocks. The condition of granite is basically hard and massive with the weathering zone of 5-10m depth on the surface. ・Volcanic rocks are found in the western part of the site, sedimentary rocks are found in the eastern part of this site. ・The southern part of the site, there is a flat area of fan deposits made from the mainly quartz sand origin of the weathered granite. A NW-SE fault and NE-SW fault near the lower dam axis are reported in the published geological map.
	(Upper dam／reservoir) ・Site geology	・ The geology around the dam axis is composed of granite (γ δ J3dq2) and sedimentary rocks (J2 ln). This granite is the oldest of the other granites (γ Kdc1/ γ Kdc3) in this area.
	◎ Checking the Permeability of the Reservoir	◎ The condition of the rock around the Upper reservoir site is generally hard and massive granite as γ δ J3dq2 and has quite low permeability with some weathering in the surface.
	・ Checking the weathering grade on granite and the condition of the geological boundary	・A noticeable geological boundary of sedimentary rocks as J2 ln and granite as γ δ J3dq2 is reported in the published map, but no outcrops and features of the sedimentary rocks were found around the dam site. Some depressed grounds in the reservoir were found in the topographical map and field survey.
	○ Checking the Geology and the strength of the rock around the Dam axis	○ The condition of the granite is massive and hard with the weathered zone of 5-10m depth. Designed dam site is on the boundary of sedimentary rocks and granite in the published map, there are no outcrops of sedimentary rocks in this survey.
	・Checking the weathering grade on granite and the condition of the geological boundary	・The depth of the weathering in granite around the geological boundary is not identified.
	(Intake) ・Checking the Geology and the strength of the rock.	・The geology around the Intake is composed of granite (γ δ J3dq2). Relatively thick weathering as soil/sand of approximately 20-30m depths was predicted in view of the topography.
	(Waterway・Surge Tank) ○Checking the Geology and the strength of the rock around the Tunnel	○The geological condition on the surface of the Waterway and Surge Tank area is hard and massive granite (γ δ J3dq2) with the slope of 30-40 degrees, there is probably no big problems also in the underground. The surface weathering of granite will not affect nega on the construction of the waterway.
	(Underground Power Station) ○Checking the Geology and strength of the rock around the Underground Power House	○Nearly same as waterway.

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

	(Lower dam／reservoir) ・ Site geology	・Granite as γ δ J3dq2 and andesite K2dd are alternatively outcropped in right side of the river, no noticeable weak zone or open joints were found. Granite near the boundary of andesite is fine grained and changes to the granodiorite by the intrusion of andesite. NW-SE system of the fault along the river is reported in the published geological map.
	◎ Checking the Permeability of the Reservoir ・Checking the conditions around the fault zone	◎ The permeability in this area is probably quite low. ・ The NW-SE system of the structural line along the river is reported in the published geological map, no big fractured zone or fault zone was found in this survey.
	○Checking the Geology and the strength of the rock around the Dam axis ・Checking the conditions around the fault zone	○ The condition of the rock around the Dam axis is Massive and hard granite but slightly weathered outcrops in the right side of the dam site. ・No features of fractured zone along the river were found.
	(Outlet) ・Checking the geological conditions	・There may be secondary sediment and weathered granite around the outlet area.
	(Approach) ・Checking the geological conditions	・There is no difficulty for the construction of the access road.
Design	**(Overall)**	・For further investigations, a new bridge about 150 m is required for crossing the river in order to access to the upper dam site, the underground powerhouse and the tailrace. ・Topography of the left bank of the planned lower dam site is not reliable. Therefore, it is necessary to move the dam axis to 300m downstream. ・The concrete gravity type dam is suitable for the lower dam, which H.W.L. will be 210 m.
	(Upper dam／reservoir) ・ Estimating the cross section at the proposed dam axis ・Selecting the dam type and surveying the materials availability	・The upper dam site could not be accessed because of rise of the river.
	(Intake)	・In connection with shifting the underground cavern and waterways to downstream, it is necessary to relocate.
	(Waterway・Power Station) ・Selecting the position of access tunnel	・As a result of the survey, some problems were found as follows; - The deep valley, which is about 1 km wide, exists on the route of the planned tailrace tunnel. -The ridge of the left bank of the planned dam site is quite thin. ・Therefore, it is necessary to move the tailrace and entrance of the underground powerhouse to the downstream.
	(Lower dam／reservoir) ・Selecting the dam axis （Evaluating the topographic and rock condition)	・The ridge of the left bank of the planned dam site is quite thin. Also, there is a deep valley in the downstream of the dam axis. Therefore, it is necessary to move the dam axis to about 300 m downstream. ・There are fresh outcrops in the riverbed around the dam site. ・The concrete gravity type dam is suitable for the lower dam, which H.W.L. will be 210 m taking into account the sediment volume.
	・Selecting the structure of diversion	・Since there is much water flow in the dam site, it is better to adopt construction method that divides the river into half by coffer dam.
	・Pointing out issues related to temporally facility and disposal area	・Temporary structure area will be planned near the Dam, where are now unused or field. ・Disposal area will be selected inside of the lower reservoir in order to minimize the environmental impact
	(Outlet) ・Selecting candidate positions of outlet	・In connection with shifting the underground cavern and waterways to downstream, it is necessary to relocate the outlet besides the shifted dam site. ・Considering the water flow from the outlet, it is necessary to cut away the edge of the ridge.
	(Approach) ・Selecting approach route for the dam and powerhouse ・For the survey or construction, finding the way to cross the river is necessary	・The access tunnel to the underground powerhouse and the tailrace will be planned from left bank of the Cai river. Therefore a new bridge about 150 m is required for crossing the river.

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

	(Others)	・There is a planned irrigation dam (H.W.L. 175.44 m, L.W.L. 161 m) in the downstream of lower Dam of JS6. When using the irrigation dam for L.W.L, length of waterway is more than double, it is difficult to utilize the irrigation as the lower dam.
Natural and Social Environments	**(Ecosystem)**	・The **terrestrial ecosystem** will be directly impacted by the project because the area of upper dam / reservoir is well-conserved forests. ・The **aquatic ecosystem** of Cai river is not fully understood. At the moment the project is the first one to build a dam for this river, and the aquatic ecosystem will receive the severe impacts by the project. Since the upper dam / reservoir site is a forested area, impact on the aquatic ecosystem is not expected.
	(Resettlement / Loss of assets)	**RESETTLEMENT** **Upper dam / reservoir** ・There is no village or house at the site. **Lower dam /reservoir** ・Although precise number of the resettling families is not identified yet, resettlement is expected to occur. Some families of Ta Lot village need to be resettled. **LOSS OF ASSESTS** **Upper dam / reservoir** ・No asset will be lost. **Lower dam / reservoir** ・Rice field and cropland upstream of the dam site will be lost. They belong to Ta Lot village.
	(Others)	・Sedimentation balance to the downstream will be changed, which may cause impacts to the natural and social environments of the downstream.

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

Photo 1

The deep valley, which is about 1km wide, exists on the route of the planned tailrace tunnel.

Photo 2

The ridge of the left bank of the planned dam site is quite thin.

Photo 3

It is necessary to move the dam axis to 300 m downstream, which has a sufficient width and a steep slope.

JS6 – Lower Reservoir

Photo 4

The concrete gravity type dam is suitable for the lower dam. There are outcrops in the riverbed of the dam site.

Photo 5

The right bank of the dam site is composed of granite. The surface depth is about 5 m.

Photo 6

There are outcrops composed of andesite around the upstream of the planned reservoir.

Photo 7

The elevation of 210 m has a junction of the tributary.

Photo 8

H. W. L. will be 210 m in order to minimize the environmental impact.

JS6 – Lower Reservoir

Appendix 4-6-4-(2)

JS6; Results of the site survey

① Overall geological condition

The geology around this site is generally composed of granite zone with some volcanics and sedimentary rocks. The condition of granite is basically hard and massive with the weathering zone of 5-10m depths on the surface.

Volcanic rocks are found in the western part of the site, and sedimentary rocks are found in the eastern part of this site. The andesite is the representative of the volcanics in this area, the origin of this volcanics is probably nui Che Linh mountain in the north upstream of the Lower Reservoir. The geological boundary of andesite and granite passes through the river, alternatively outcrops of andesite and granite are found in the right side slope of the river. Granite near the boundary is changed to be fine grained. According to the published geological map, the suoi Chai river as to be designed of Lower Reservoir flows along with the NW-SE system of structural line. Another NW-SE system of structural line is cut around the Lower Dam site by this line.

The area 5-6km downstream of this site is composed by fan deposits of quartz sand from the weathered granite.

② Site geology

A) Upper Dam/Reservoir

＜Reservoir＞

The condition of the rock around the Upper Reservoir site is generally hard and massive granite as γδJ3dq2 and has quite low permeability with some weathering in the surface. A noticeable geological boundary of sedimentary rock and granite around the reservoir is reported in the published geological map, but no outcrops and features of the sedimentary rocks were found around the dam site. Some depressed grounds in the reservoir were found in the topographical map and field survey. This depression probably has some relationship of the limestone in the sedimentary rock.

＜Dam site＞

The geology around the dam axis is composed of granite as γδJ3dq2 and sedimentary rock as J2 ln. This granite is the oldest one of the other granites (γKdc1/γKdc3) in this area. The condition of the reservoir is hard and massive granite with 5-10m of surface weathering. Designed dam site is on the boundary of sedimentary rocks and granite in the published geological map, there were no outcrops of sedimentary rocks around the dam site in this survey.

B) Lower Dam/Reservoir

Granite as γ δ J3dq2 and andesite as K2dd are alternatively outcropped in the right side of the river, no noticeable weak zone nor open joints were found. Granite near the boundary of andesite is changed to be fine-grained and granodioritic composition by the intrusion of andesite into the granite. NW-SE system of the fault along the river is reported in the published geological map. Permeability in this area is probably quite low.

NW-SE system of the structural line along the river is reported, no big fractured zone was found in this survey. Detailed investigation will be needed.

The condition of the rock around the Dam axis is massive and hard granite but slightly weathered outcrops in the right side of the dam site. No features of the fractured zone along the river were found.

C) Waterway/Underground Power Station

The geological condition on the surface of the Waterway and Surge Tank area is hard and massive granite (γ δ J3dq2) with the slope of 30-40degrees, there is probably no big problems also underground. The surface weathering on the granite around the geological boundary is not identified. The conditions of Underground Power Station are nearly same as the condition around the waterway.

D) Others and problems

- The weathering grade on the granite around the geological boundary is not clear in this survey.
- Relatively deeper such as 20-30m of weathering around the Outlet site is predicted.
- NW-SE system of structural line along with suoi Cai river is reported in the published geological map, no noticeable features of fracture zone was found in this survey. Detailed investigation will be needed.
- Weathering grade of the granite around the Outlet is relatively deeper than another granite area. Detailed investigation will be needed.