Appendix 4-6-3 –(2)

P5; Results of the site survey

① Overall geological condition

Geology around P5 site is Silurian-Devonian NS to NNW-SSE system of sedimentary folding zone of mainly limestone, structural line is NW-SE system along the river in the published map. Top of the limestone hill consists of a lot of the irregular topography such as depression grounds and flat area. Limestone as itself is hard and massive, including many eroded holes. Generally underground water level is probably nearly same or a bit higher than Hoa Binh Lake.

② Site Geology

A) Upper dam/reservoir

Upper Dam/Reservoir site is located in the flat area of elevation of 500m above sea level. Some villages are living in this area. The rock around the Upper Reservoir is mainly composed of limestone as Cambrian-Silurian-Devonian sedimentary rocks (O3-Ssv/C2-O1?bk/S2-D1bh). A WNW-ESE system of structural line passes through the upper reservoir. Limestone in this area makes the topography be irregular such as flat, steep valley and small depressed ground not indicated on the topographical map. The condition of limestone is hard and massive but with many open holes. Some streams of ground surface water flow out from the reservoir area to the Hoa Binh Lake, but the underground water level is probably same as Hoa Binh lake or a bit more in basically.

B) Lower Dam/Reservoir

Many open joints are found between the beddings of the limestone and vertical in some places. Dips of the limestone bed are generally 30-40degrees, dips of joints are not only the joints of bedding but nearly vertical. The permeability of rock is probably quite high. The condition of limestone is hard and massive but with many open holes.

Some fractured zones as E-W system are found both side of the Hoa Binh Lake, these fractured zones are probably extended from the P5 Upper Reservoir. Most of the fractured zones are not clear because of being covered by the secondary sediments or weathering surface. There are many streams and valleys along with the geological boundaries in published geological map.

C) Waterway/Underground Power Station

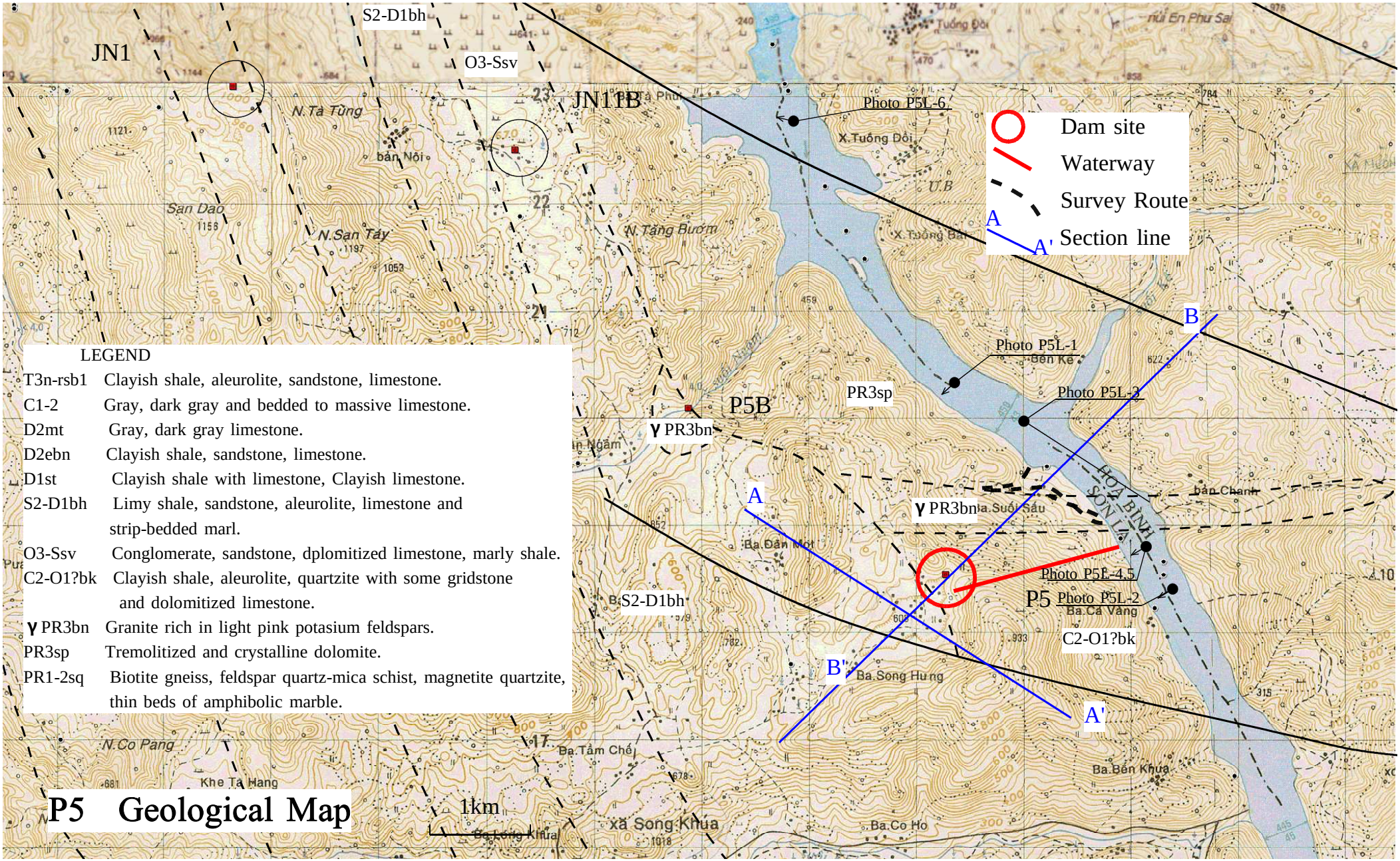
The geology around the waterway to Lower Reservoir is mainly gently bedding as

20-30degrees of limestone as C2-O1?bk, granite vain as γ PR3bn outcrops with 100-200m width near the waterway line. The condition of limestone is hard and massive with many open holes. The granite outcrops in the left side of the river looks rather granodiorite from the mineral composition. The condition of this granite in the right side of the river was not found clearly due to strong weathering. As for gently sloped limestone, many of small caves and eroded open holes along the Hoa Binh Lake are found.

The conditions and the rock mass permeability around the Underground Power Station are gently inclined bedding as 20-30degrees of limestone with many eroded holes as relatively high permeability. The condition around the boundary of granite and limestone is not clear by the strongly weathered surface and secondary sediments. There were no fresh outcrops of granite in right side of the river. There are some red colored soil originated by the weathered granite in the slope, the other small intrusion of granite probably exists under the ground potentially. This red colored soil is quite easy to be eroded.

D) Others and problems

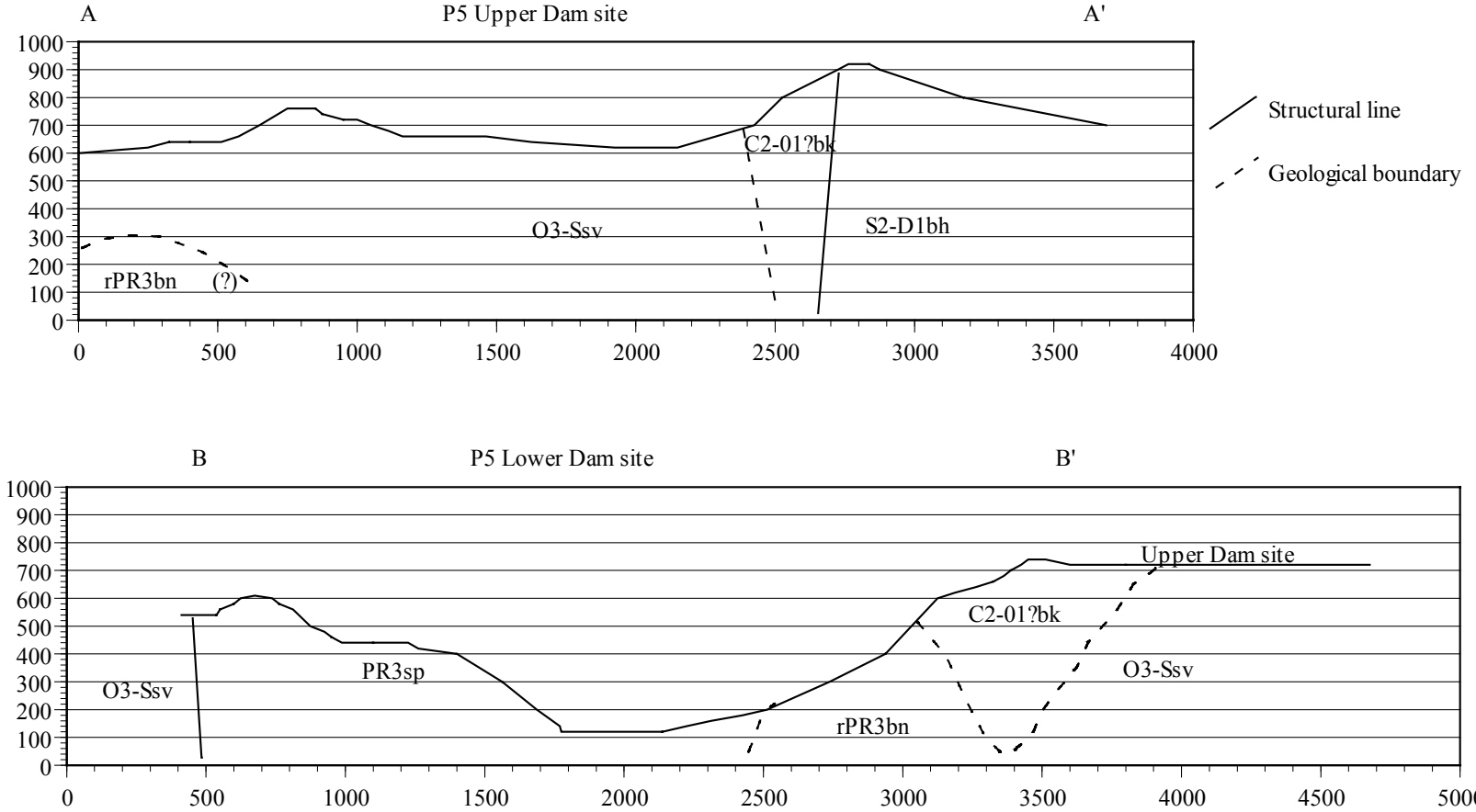
- The number of open hole in the limestone around this area is much more than the other limestone area.
- Outcrops of the limestone in the right side of the Hoa Binh Lake are not clear by the secondary sediments.



LEGEND

T3n-rsb1	Clayish shale, aleurolite, sandstone, limestone.
C1-2	Gray, dark gray and bedded to massive limestone.
D2mt	Gray, dark gray limestone.
D2ebn	Clayish shale, sandstone, limestone.
D1st	Clayish shale with limestone, Clayish limestone.
S2-D1bh	Limy shale, sandstone, aleurolite, limestone and strip-bedded marl.
O3-Ssv	Conglomerate, sandstone, dplomitized limestone, marly shale.
C2-O1?bk	Clayish shale, aleurolite, quartzite with some gridstone and dolomitized limestone.
γ PR3bn	Granite rich in light pink potasium feldspars.
PR3sp	Tremolitized and crystalline dolomite.
PR1-2sq	Biotite gneiss, feldspar quartz-mica schist, magnetite quartzite, thin beds of amphibolic marble.

P5 Geological Map



P5 Geological Section

Photo 1

Outcrop of limestone
Right side of the Hoa Binh Lake

Photo 2

Outcrop of limestone
Upstream of the Lower Dam axis of P5

Photo 3

Outcrop of granite
Left side of the Hoa Binh Lake,
Near and upstream of the outlet of P5.

P5－Geological issues (Outlet & Lower reservoir)

Photo 4

Site around the outlet
Left side of the Hoa Binh Lake.

Photo 5

Site around the outlet

Photo 6

Condition of the Upper Reservoir of P11B
7-8km upstream of P5B outlet
Falls from the Upper Reservoir of P11B.

Photo 7

Right side of the Hoa Binh Lake,
Near the geological boundary of granite (γ PR3bn) and limestone (PR3sp);
Highly weathered limestone.

Photo 8

Right side of the Hoa Binh Lake
Around the granite outcropped area,
Thick secondary sediments or highly weathered surface covers the outcrop

Photo 9

Nearly vertical open joint on the right side of the Hoa Binh Lake. (Limestone)

Checklist of Environmental Parameters: P5

NOTE: The remarks are made based on the current plan. The assessments are based on the information obtained during the survey and should be reviewed and corrected, if necessary, at the next stage.

	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	×			**Upper dam / reservoir** The site is occupied by Song Hung village which comprises Viet, Muong and Thai minorities. The villagers moved to the current site by the Hoa Binh dam project. **Lower dam / reservoir** The site of the outlet is occupied Suoi Sau.
2. Resettlement	×			**Upper dam / reservoir** Although all the area of the village is not submerged, the agricultural lands are lost and many of the villagers may need to be resettled. **Lower dam /reservoir** All residents of Suoi Sau may need to be resettled. An approach road to the site is planned. The road goes through Ben Khua, Ca Vang and other villages, which may lead resettlement.
3. Loss of land (e.g. agricultural land)		×		**Upper dam / reservoir** Rice field and cropland will be lost. **Lower dam / reservoir** The situation is not studied by this survey.
4. Encroachment into watershed			×	**Upper dam / reservoir** The approach road may affect the secondary forest around the reservoir. **Lower dam / reservoir**

				Small impact is expected.
5. Encroachment on historical and cultural values			×	There is no historical and cultural site in both areas.
6. Impairment of navigation			×	**Upper dam / reservoir** There is no shipping traffic. **Lower dam / reservoir** Impacts are not expected.
7. Inundation of mineral resources			×	There is no mineral resource in both areas.
8. Decline of fisheries			×	**Upper dam / reservoir** Small-scale fishery may be practised and at the moment impacts cannot be assessed due to lack of information. **Lower dam / reservoir** Small-scale fishery for people's own consumption is practised in Hoa Binh lake, which is not affected by the project.
9. Downstream impacts			×	**Upper dam / reservoir** There are small streams from the sites. The social environment of the downstream is expected to be small and limited. **Lower dam / reservoir** The lower dam is Hoa Binh lake and no significant impact is expected.
A-2. Natural Environment				
1. Encroachment into precious 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.
2. Encroachment into existing protected areas			×	Both areas are not in the national protected areas.
3. Migrating fish species			×	**Upper dam / reservoir** There are small streams from the site and the system is limited and small. Although precise impact is not known, the impact is expected to be limited. **Lower dam / reservoir** The project will not give impacts to fish species of Hoa Binh lake.

4. Effects on scenic value			×	Impact on scenic value is limited.
5. Downstream impacts			×	Impacts on the **terrestrial ecosystems of both sites** are limited and are expected small. Impact on the **aquatic ecosystems of both sties** is not fully understood. However, the scale of the impacts on the ecosystem of the upper dam / reservoir is expected to be limited due to its size.
A-3. Physical Environment				
1. Watershed erosion / silt runoff		×		**Upper dam / reservoir** The site is not prone to severe erosion. **Lower dam / reservoir** Some parts of the slope of the valley have experienced weathering and these parts may be prone to severe erosion.
2. Effects on groundwater hydrology			×	**Upper dam / reservoir** It is unlikely that there is severe impact to groundwater hydrology. **Lower dam / reservoir** It is unlikely that there is severe impact to groundwater hydrology.
3. Downstream water flow variations			×	No significant impact is expected.
4. Change of sedimentation transportation balance			×	No significant impact is expected.
B. Environmental Problems Associated with Construction Stage		×		All the items in this section should be carefully considered and technical specifications must be given to contractors to conduct all necessary mitigation measures. Route of the approach road should be carefully planned in order to avoid villages and agricultural areas as much as possible and to prevent soil erosion and landslides as much as possible. Workers' camp is expected to be big and its social impacts are to be carefully assessed and fully mitigated. Careful consideration should be paid to select disposal area to prevent secondary impacts. It is ideal to site the disposal area within the reservoir areas. Poaching and introduction of alien species must be well controlled to prevent disturbance to the local ecosystem and biodiversity (even if they are already degraded). Especially at the upper dam / reservoir

				site, the biodiversity of the surrounding forests should be protected.
B-1. Construction Monitoring				
1. Construction monitoring				
B-2. Construction				
1. Soil erosion / silt runoff				
2. Toxic wastes from equipment and cement factory				
3. Environmental degradation at quarry site				
B-3. Workers				
1. Safety of workers				
2. Sanitation at workers' camp				
3. Dust/ odors / fumes / noise / vibrations				
4. Quarrying hazards				
B-4. Social Environment				
1. Negative perception of local people				
2. Traffic accidents				
3. Traffic congestion and damage to road and bridge				
4. Environmental aesthetics				
B-5. Natural Environment				
1. Poaching by workers				
2. Firewood collection				
3. Introduction of alien species				
C. Environmental Problems Related to Project Operations		×		All the items in this section should be carefully considered and necessary mitigation measures must be undertaken by operation organisation to reduce impacts as much as possible. Insect vector / waterborne diseases are at the moment not prevailing in the areas. The water levels of reservoirs of PSPP change everyday, which may not make insects (e.g. mosquito) actively breed. It is therefore likely that the diseases will not prevail. However, necessary caution should be given to the local people. Impacts on the natural environment should be carefully assessed and necessary countermeasures should be undertaken.

C-1. Operation Monitoring				
1. Operation monitoring				
C-2. Operation				
1. Warning system				
2. Downstream erosion				
3. Eutrophication of the reservoir				
4. Downstream water quality				
5. Reservoir bank stability				
C-3. Social Environment				
1. Insect vector / waterborne diseases hazards				
2. Estuarine and marine fisheries impacts				
C-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				
D. Additional Consideration for Hydropower Projects		×		All the items in this section should be carefully considered and necessary mitigation measures must be undertaken. At the moment, it is unlikely that avian hazards from transmission lines and towers occur. This is because large birds such as *Ciconia* spp. do not migrate in the region. At the moment, it is unlikely that aircraft hazards from transmission lines and towers occur. This is because there is not an airfield in the region.
D-1. 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				