

CHAPTER 17 ENVIRONMENTAL IMPACT STUDY

17.1 Objectives of the Study

The important objectives of the environmental impact study for the conceptual planning of the Kok-Ing-Nan Project are to analyse potentiality and limitation of environmental resources within the project area and use these data for selection of the most appropriate alternative for the project's implementation, i.e., the alternative which will affect the least environmental condition. Results of the environmental impact study will be jointly considered with the engineering and economic studies for such purposes.

17.2 Steps and Methods of Study

In selection of the appropriately alternative development, the study team has analysed the preliminary environmental impacts by using the Impact Matrix Table comprising 2-step evaluating score, i.e., the score for environmental resource importance and the score of degree of disturbance in each environmental impact.

The Kok-Ing-Nan Project comprises 2 main structures, i.e., dams in the Kok and the Ing Rivers and canal/tunnel discharging water as described in details in the Engineering Report; these two main components are considered as having different impacts to environment depending on alternatives selected (showing alternative water diversion alignment and Table 17.1 summarizing length/distance of each water discharging alternative).

In the preliminary environmental study, it is therefore important to give an ordering to the impacts derived from these two components; only important environmental resources expected to be affected from the project development are measured.

The ordering of importance of each environmental resource is done by relevant experts by analyzing concerning data of the project, relating environmental resource with the project development and expected impacts. Documents and research reports reviews of similar development projects are also conducted as parts of the study. Results of the importance ordering are shown in Table 17.2. (The level of importance is established based on the environmental parameters of OEPP, Table 17.3).

The preliminary environmental impact evaluation of the Kok-Ing-Nan Project comprises the following steps:

- 1) Analyse data and investigate each environmental condition in the project and adjacent areas

Table 17.1
Distance of Water Diversion Alternative
Kok-Ing-Nan Project, 1996

Unit : km

Interval	Alternative A			Alternative B			Alternative C					
	Canal	Culvert	Tunnel	Total	Canal	Culvert	Tunnel	Total	Canal	Culvert	Tunnel	Total
Kok-Ing	37.30	-	14.60	51.90	37.30	14.70	4.00	56.00	42.90	14.70	4.00	61.60
Ing-Nan (Yod)	2.43	8.66	52.80	63.89	2.43	9.01	52.10	63.54	6.50	-	50.70	57.20
Total	39.73	8.66	67.40	115.79	39.73	23.71	56.10	119.54	49.40	14.70	54.70	118.80

Notes: Culvert lying not lower than 15 m from ground surface.
 Diversion tunnel laying not lower than 500-1,000 m from ground surface.

Table 17.2
Importance Ordering of Environmental Resources in the Study Area
Kok-Ing-Nan Project, 1996

Order	Environmental Resources	Level of Importance*	
		Diversion Structure Area	Canal/Culvert, Tunnel Area
	Physical Resource		
1	Climate / Meteorology	1	1
2	Surface Water Hydrology	3	2
3	Surface Water Quality	3	2
4	Groundwater Hydrology	1	2
5	Groundwater Quality	1	1
6	Soil	2	1
7	Geology / Seismology	2	2
8	Erosion and Sedimentation	2	2
	Biological Resource		
9	Aquatic Biology and Fishery	3	2
10	Forest Resource and Watershed Management	2	3
11	Wildlife	2	3
	Human Use Values		
12	Agriculture	1	1
13	Irrigation and Drainage	1	1
14	Flood Control	2	2
15	Water Use	1	1
16	Land Use	2	2
17	Transportation	2	1
18	Mineral Resource	1	1
	Quality of Life values		
19	Socio-economic / Compensation and Resettlement	3	3
20	Public Health and Nutrition	1	1
21	Tourism / Receration	1	2
22	Archaeology / History	2	2

Note : * Level of importance of environmental resource in this study:
 1 = The Least Important
 2 = Moderately Important
 3 = Very important

Table 17.3: Environmental Parameters for Analysis of Dam and Reservoir Projects (Including Irrigation and Hydroelectric Sub-Projects)

Environmental Resource	Physical Resources										Ecological Resources										Human Use Values										Quality of Life Values					
	Surface Water Hydrology	Surface Water Quality	Ground Water Hydrology	Ground Water Quality	Soils	Geology/Seismology	Erosion/Sedimentation	Climate	Fisheries	Aquatic Biology	Terrestrial Wildlife	Forests	Agriculture/Irrigation (if applicable)	Aquaculture	Water supply	Navigation	Recreation	Power (if applicable)	Flood Control	Dedicated Area Uses	Industry	Agro-Industry	Mineral Development	Highways/Railways	Land Use	Socio-Economic	Resettlement	Cultural/Historical	Aesthetic	Archaeological	Public Health	Nutrition				
Project Component	A	3	2	2	1	-	-	3	1	(3)	(3)	2	(3)	(3)	(3)	(2)	(3)	(3)	(3)	3	-	-	(2)	(2)	3	(3)	3	1	((3))	1	((2))	(3)				
	B	3	-	3	-	2	3	-	1	-	1	-	-	-	-	-	-	-	-	-	-	-	1	1	-	3	-	3	-	-	-	1	-			
Dam and Reservoir	A	1	3	2	-	3	-	2	-	(3)	1	-	(3)	(3)	(3)	-	(1)	-	-	(2)	(2)	-	-	1	3	(3)	-	-	-	-	(2)	(3)				
	B	2	3	3	1	3	3	1	-	3	-	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-	-	-	-	-	-	-			
Irrigation System	A	-	-	-	-	-	-	-	-	-	1	3	1	-	-	-	-	-	3	-	3	2	-	-	3	(3)	-	-	-	-	-	-	-			
	B	1	-	1	1	2	2	1	-	-	1	1	3	-	-	-	-	-	-	1	1	1	1	1	-	-	-	-	-	-	-	-	-			
Hydroelectric Power	A	-	-	-	-	-	-	-	-	-	1	3	1	-	-	-	-	-	-	-	-	-	-	-	3	(3)	-	-	-	-	-	-	-			
	B	1	-	1	1	2	2	1	-	-	1	1	3	-	-	-	-	-	-	1	1	1	1	1	-	-	-	-	-	-	-	-	-			

NOTES:

- (a) (A) means significant impact of project on environmental resources, whereas (B) means impact of the environment on the project.
- (b) Numerical value of 3 means probable major impact, 2 means intermediate, and 1 means significant but relatively minor.
- (c) Numbers in parentheses indicate effects are mostly enhancement of environmental. Numbers in double parentheses represent combination of adverse and beneficial effects. Numbers without parentheses represent either adverse or beneficial effects.

fro alternatives.

- 2) Evaluate the expected impact deriving from the project development both in positive and negative aspects in the primary level including classify the violence level of these impacts.
- 3) Do a comparative analysis of the degree of violence of various impacts in each alternative in order to determining the most appropriate alternative with scores of impact violence according to the following criteria:

• Very positive	=	0.9
• Rather high positive	=	0.8
• Fairly positive	=	0.7
• Low positive	=	0.6
• No impact	=	0.5
• Low negative	=	0.4
• Fairly negative	=	0.3
• Rather high negative	=	0.2
• Very negative	=	0.1

- 4) Score the appropriateness of each environment by multiplying important score with violent score, Important scores derive from each environmental resource relative importance by considering it's expected impact from the development of the project as shown in details in Tables 17.4 and 17.5. This scoring method covers only important environmental resources according to the project's components of the engineering alternatives. The sum score of the environmental impacts then can be compared for selecting the most appropriate alternative of each project's component.
- 5) Summarize the expected major impacts and/or problems of the development of the Kok-Ing-Nan Project and propose the preliminary mitigation measures of the negative environmental impacts.

Table 17.4 (1/2)
Scores of Importance Level of Environmental Resources
for Selection of Diversion Structure
Kok-Ing-Nan Project, 1996

Environmental Resources	Level of Impactance	Score
1. Surface Water Hydrology / Erosion and Sedimentation - Obstruction on the Natural Flow Pattern - Increasing in Suspended Solid during Construciton Period	3	20 10 10
2. Surface Water Quality - Level of Water Quality near the Diversion Structure - Communities Located Upstream - Water Use Upstream/downstream	3	20 6 7 7
3. Geology / Seismology - Stability of Basement and its Comptnent - Seismic Impact	2	10 5 5
4. Aquatic Biology and Fishery - Types and Abundance of Fish Upstream and Downsteram - Types and Abundance of Plankton and Benthos - Abundance of Aquatic Weed - Fishery	3	20 5 5 5 5
5. Terestial Ecology - Ecological Condition at the Diversion Structure - Natural Forest Tree Covering the Construction Area	2	10 5 5
6. Soil / Land Use - Soil Morphology in the Construction Site - Land Use Type - Land Expropriation - Land Expropriation cost	2	10 2 2 3 3

Table 17.4 (2/2)
Scores of Importance Level of Environmental Resources
for Selection of Diversion Structure
Kok-Ing-Nau Project, 1996

Environmental Resources	Level of Impactance	Score
7. Flood Control - Topograhly of the Construcion - Flood Problems around Upstream / Downstream	2	10 5 5
8. Transportation - Access Road to the Construcion Site - Distance from Main Road - Disturbance to the Ragular Traffic Flow - Navigation Traffic Volume - Land Transportation Volume	2	15 3 3 3 3 3
9. Socio-ecnomic / Compensation and Resettlement - Residences Located in the Project Site - Communities adjacent to the Construction Site (± 1,000m)	2	20 15 5
10. Archaeological / Historical Aspect - Wat / Archaeological Sites in the Project Construcion Site - Wats adjacent to the Project Construction Site - Archaeological Sites Adjacent to the Construcion Area	2	15 7 4 4
Total		60

Table 17.5 (1/2)
Score of Importance Level of Environmental Resources for
Selection of Canal/Culvert and Tunnel of Water Diversion Alternatives
Kok-Ing-Nan Project, 1996

Environmental Resources	Level of Impactance	Score
1. Surface Water Hydrology	2	20
- Obstruction on the Natural Flow Pattern		10
- Increasing in Suspended Solid during Construcion Period		10
2. Geology and Seimelogy	3	20
- Geological Impact on Boring		10
- Stability and Water Leakage		4
- Amount of Rock to be Excavated and Availability of Dumping Area		3
- Seismic Impact		3
3. Forest	3	30
- Disturbance to the Forest Reserves		6
- Disturbance to Watershed class I Areas		10
- Forest Conditions		7
- Size of Forest Area to be Disturbed		7
4. Wildlife	2	30
- Wildlife Diversification		10
- Disturbance on Food Source of Wildlife		10
- Disturbance on Wildlife Route		10
5. Aquatic Biology and Fishery	2	20
- Distribution of Aquatic Organisms		7
- Impact from Aquatic Weed		3
- Changing of Aquatic Ecosystem		10

Table 17.5 (2/2)
Score of Importance Level of Environmental Resources for
Selection of Canal/Culvert and Tunnel of Water Diversion Alternatives
Kok-Ing-Nan Project, 1996

Environmental Resources	Level of Impactance	Score
6. Soil / Land Use	2	15
- Soil Mophology in the Constucion Site		3
- Land Use Type		4
- Land Expropriation (Size of Land to be Expropriated)		4
- Expropriation Cost		4
7. Transportation	2	20
- Access Road		6
- Disturbance to the Structure of Existing Roads		6
- Disturbance to Communities from Project's Transportation		8
8. Socio-economic / Compensation and Resettlement	3	25
- Residences Located in the Construction Area		15
- Communities Adjacent to the Diversion Alignment (± 1,000m)		5
- Schools Located Adjacent to the Construction Site (± 500m)		5
9. Archaeological / Historical	2	20
- Wat / Archaeological Sites in the Right of Way		8
- Wat / Archaeological Site Adjacent to the Alignments (±500m)		7
- Wat / Archaeological Site Located at 501-1,000 m of Distance		5
Total		200

17.3 Preliminary Environmental Impact

The following tables are presenting the summary of environmental resources of each route sector at alternate route and the environmental appropriate scoring of each alternative route.

The way of scoring is based on the standard of the method in the previous Section 17.2.

TABLE 17.6

SUMMARY OF ENVIRONMENTAL RESOURCES AROUND THE DIVERSION STRUCTURE IN KOK RIVER
ASPECTS AT CONSTRUCTION SITE IN KOK ALTERNATIVE ROUTES

Environmental Resource	Alternative A	Alternative B/C
<p>1. Surface Water Hydrology / Erosion & Sediments</p> <ul style="list-style-type: none"> - Obstruction on the Natural flow Direction - Increasing in Suspended Solid during Construction 	<ul style="list-style-type: none"> - There are the construction for new cut off channel and diversion structure which will affect to flow direction and decrease water quantity downstream in rainy season. The quantity of diverted water are about 1,750 mem/year. There is no diversion in dry season. - Sediment increase in only short construction period due to the small scale project construction. 	<ul style="list-style-type: none"> - No construction for new diversion structures. - Diverted Water quantity is about 1,750 mem/year. - No impact because there are not construction of new structure.
<p>2. Surface Water Quality</p> <ul style="list-style-type: none"> - Water Quality near the Diversion Structure - Communities Located Upstream - Water use of Communities Upstream/ Downstream 	<ul style="list-style-type: none"> - Good water quality (classified as water quality level 2) - There are less communities located upstream than the alternative B. - Water from Kok river is used for water supply, (upstream). 	<ul style="list-style-type: none"> - Good water quality (classified as water quality level 2). - There are more communities located upstream than in the alternative A. - Water from Kok river is used for water supply (upstream).

TABLE 17.6 (Cont'd)

Environmental Resource	Alternative A	Alternative B/C
<p>3. Geology / Seismology</p>	<ul style="list-style-type: none"> - Diversion structure and another structures are minimally impacted by earthquake since project's structure were of minorscale and located on non seismic areas. 	<ul style="list-style-type: none"> - Diversion structure and componet structure are minimally impacted by earthquake since project's structure are of minor scale and located on non seismic areas.
<p>4. Aquatic Biology / Fisheries</p> <ul style="list-style-type: none"> - Type and Abundance of Fish - Abundance of Aquatic Weed - Abundance of Plankton and Benthos - Fisheries 	<ul style="list-style-type: none"> - 4 families and 6 species of small size fish which are generally found in northern area. - Mimosa pigra Lin. was found along both banks of Kok in medium density. - 95,833 cells/m³ of Plankton and 220 individual/m² of benthos were found. - Few fishery activity in water ways. 	<ul style="list-style-type: none"> - Same as alternative 4. - Mimosa pigra Lin. was found along both banks of Kok river in medium density. - 310,933 cells/m³ of plankton and 176 individual/m² of benthos were found. - Few fishery activity in water ways.

TABLE 17.6 (Cont'd)

Environmental Resource	Alternative A	Alternative B/C
<p>5. Terrestrial Ecosystem</p> <ul style="list-style-type: none"> - Ecosystem Condition around the Diversion Structure Site - Natural Forest Tree Covering the Construction Area 	<ul style="list-style-type: none"> - Mainly agricultural areas, especially rice paddy and maize. No forest area. - Area on both sides of Nam Kok at this site is covered with Giant mimosa. No forest tree species. 	<ul style="list-style-type: none"> - Mainly agricultural areas, near to Huai Mae Gorn which flows to Nam Mae Kok. No forest area. - No forest trees in this area, there are only Giant mimosa along both sides of the river.
<p>6. Soil / Land Use</p> <ul style="list-style-type: none"> - Soil Morphology in the Constructions - Land Use Type - Land Expropriation (Size of Land to be Expropriated) - Land Expropriation Cost 	<ul style="list-style-type: none"> - Paddy soils, flat, deep and poorly drained soil. - Paddy, agriculture - About 300 rai of land will be expropriated. - Expropriation cost will be about 150 million baht. 	<ul style="list-style-type: none"> - Mostly Paddy soils, small areas of upland soils, flat, deep soils. - Paddy, upland crops - Not require any areas for diversion structure construction.

TABLE 17.6 (Cont'd)

Environmental Resource	Alternative A	Alternative B/C
<p>7. Flood Control</p> <ul style="list-style-type: none"> - Geological Condition - Flood at Upstream/Downstream Area <p>8. Transportation</p> <ul style="list-style-type: none"> - Access road to the Construction Site - Distance from main road - Disturbance to the Regular Traffic flow. - Navigation Traffic Volume. - Traffic Volume of Land Transportation 	<ul style="list-style-type: none"> - Flood plain - Over flow on both of banks in rainy season. <ul style="list-style-type: none"> - Asphaltic pavement road with 2 lanes in bad condition. - About 10 and 1.5 km. respectively away from highway No. 1232 and 1020. - There may be some obstruction in construction period. - There are very low volume of navigation. Some small fishery boat for setting set fishing net are found. - There is very low volume of traffic. 	<ul style="list-style-type: none"> - Flood plain - Over flow on both of banks in rainy season. <ul style="list-style-type: none"> - Lateritic road with 2 lanes in good condition. - About 1.5 and 6 km. respectively from highway No. 1232 and 1020. - No traffic obstruction since there are no construction for the new diversion structure. - Similar to alternative A. - There is very low volume of traffic.

TABLE 17.6 (Cont'd)

Environmental Resource	Alternative A	Alternative B/C
<p>9. Socio-economic / Resettlement</p> <ul style="list-style-type: none"> - Residences located in the Project Site - Communities adjacent to the Construction Site ($\leq 1,000$ m.) 	<ul style="list-style-type: none"> - There are not any houses located in the construction site, only agricultural area of local people would be expropriated. - The local communities located on the left bank of Kok river, upstream and downstream not far from the dam site, may be slightly disturbed by the construction activities. 	<ul style="list-style-type: none"> - No diversion dam construction. - There wouldn't be any construction activities, the indirect impact wouldn't occur.
<p>10. Archaeological / Historical Aspect</p> <ul style="list-style-type: none"> - Wat / Archaeological Site in the Construction Site - Wat Adjacent to the Diversion Structure Area - Archaeological Site Adjacent to the Construction Area 	<ul style="list-style-type: none"> - No wats and archaeological sites in the construction area. - Wat Ban Dai Kaew is located about 1 km. from the diversion structure in southeast direction. - No archaeological site within 1 km. radius of the project site. 	<ul style="list-style-type: none"> - No wats and archaeological sites in the construction area. - Wat Pa Yang Mon is located about 1.3 km to the southeast of the head regulator. - Prathat Doi Saket is located about 2.5 km. to the southwest of the head regulator.

TABLE 17.7
ENVIRONMENTAL APPROPRIATION SCORING FOR SELECTION OF
DIVERSION STRUCTURE SITE IN KOK RIVER

Environmental Resources	Weighting Score	Alternative			
		Alternative A		Alternative B/C ^U	
		Level of ^U Impact	Score	Level of ^U Impact	Score
1. Surface Water Hydrology / Erosion and Sedimentation	20				
- Obstruction on the Natural Flow Pattern	10	0.40	4.00	0.50	5.00
- Increasing in Suspended Solid during Construction Period	10	0.40	4.00	0.50	5.00
2. Surface Water Quality	20				
- Level of Water Quality near the Diversion Structure	7	0.50	3.50	0.50	3.50
- Communities Located Upstream	7	0.40	2.80	0.30	2.10
- Water Use Upstream/Downstream	6	0.40	2.40	0.40	2.40
3. Geology / Seismology	10				
- Stability of Basement and its Component	5	0.50	2.50	0.50	2.50
- Seismic Impact	5	0.50	2.50	0.50	2.50
4. Aquatic Biology and Fishery	20				
- Types and Abundance of Fish Upstream and Downstream	5	0.40	2.00	0.50	2.50
- Types and Abundance of Plankton and Benthos	5	0.40	2.00	0.50	2.50
- Abundance of Aquatic Weed	5	0.40	2.00	0.50	2.50
- Fishery	5	0.50	2.50	0.50	2.50
5. Terrestrial Ecology	10				
- Ecological Condition at the Diversion Structure Site	5	0.50	2.50	0.50	2.50
- Natural Forest Tree Covering the Construction Area	5	0.50	2.50	0.50	2.50
6. Soil / Land Use	10				
- Soil Morphology in the Construction Site	2	0.40	0.80	0.50	1.00
- Land Use Type	2	0.40	0.80	0.50	1.00
- Land Expropriation	3	0.40	1.20	0.50	1.50
- Land Expropriation Cost	3	0.40	1.20	0.50	1.50

TABLE 17.7 (Cont'd)

Environmental Resources	Weighting Score	Alternative ^V			
		A		B/C	
		Level of ^V Impact	Score	Level of ^V Impact	Score
7. Flood Control	10				
- Topography of the Construction	5	0.50	2.50	0.50	2.50
- Flood Problems around Upstream / Downstream	5	0.70	3.50	0.70	3.50
8 Transportation	15				
- Access Road to the Construction Site	3	0.40	1.20	0.50	1.50
- Distance from Main Road	3	0.40	1.20	0.50	1.50
- Disturbance to the Regular Traffic Flow	3	0.40	1.20	0.50	1.50
- Navigation Traffic Volume	3	0.50	1.50	0.50	1.50
- Land Transportation Volume	3	0.40	1.20	0.50	1.50
9. Socio-economic / Compensation and Resettlement	20				
- Residences Located in the Project Site	10	0.50	5.00	0.50	5.00
- Communities Adjacent to the Diversion Alignment	5	0.40	2.00	0.50	2.50
- School Located Adjacent to the Construction Site	5	0.40	2.00	0.50	2.50
10. Archaeological / Historical	15				
- Wat / Archaeological Site in the Project Construction Site	7	0.50	3.50	0.50	3.50
- Wats adjacent to the Project Construction Site	4	0.50	2.00	0.50	2.00
- Archaeological Sites Adjacent to the Construction Area	4	0.50	2.00	0.50	2.00
Total	150		68.0		74.0

Remark : ^V Alternative C and B use the same diversion structure

^V The level of impact

- Very positive = 0.9
- Rather high positive = 0.8
- Fairly positive = 0.7
- Low positive = 0.6
- No impact = 0.5
- Low negative = 0.4
- Fairly negative = 0.3
- Rather high negative = 0.2
- Very negative = 0.1

TABLE 17.8

SUMMARY OF ENVIRONMENTAL RESOURCES AROUND THE DIVERSION STRUCTURE IN ING RIVER

Environmental Resource	Alternative A/B	Alternative C
<p>1. Surface Water Hydrology / Erosion & Sediments</p> <ul style="list-style-type: none"> - Obstruction on the Natural flow Direction - Increasing in Suspended Solid during construction 	<ul style="list-style-type: none"> - There are the construction of small diversion structure at Ing river to divert water from Ing river into Nan river in rainy season for about 2,270 mcm/year (volume of water from Nam Kok is included) - There is sediment increase during construction period. 	<ul style="list-style-type: none"> - There are construction of small diversion structure at Ing river to divert water from Ing river into Nan river in rainy season for about 2,270 mcm/year (volume of water from Nam Kok is included). - There is sediment increase during construction period.
<p>2. Surface Water Quality</p> <ul style="list-style-type: none"> - Water Quality near the Diversion Structure - Communities located Upstream Area - Water use of Communities Upstream/Downstream 	<ul style="list-style-type: none"> - Water is rather soft, DO = 6.0-6.7 mg/l, low BOD and no pesticide, classified as water quality level 2 - Low density - Water usage for agriculture especially water usage from tributaries. 	<ul style="list-style-type: none"> - The water quality were similar to alternative A. - Low density. - Water usage for agriculture in upstream and downstream area.

TABLE 17.8 (Cont'd)

Environmental Resource	Alternative A/B	Alternative C
<p>3. Geology / Seismology</p> <ul style="list-style-type: none"> - Stability of Foundation and Structures - Seismic Impact <p>4. Aquatic Biology / Fisheries</p> <ul style="list-style-type: none"> - Type and Abundance of Fish - Abundance of Aquatic Weed - Abundance of Plankton and Benthos - Fisheries 	<ul style="list-style-type: none"> - No impact due to the suitable geological structures construction. - The construction sites are not in seismic areas. - 5 families and 16 species of fish were found in Ing river, 3 species of which were also found in Kok river. - 296,400 cells/m³ of plankton and 924 individuals/m² of benthos were found in Ing river. - <i>Mimosa pigra</i> Lin. and <i>Monochoris vaginalis</i> were found in Ing river in medium and low density respectively. - Few fishery activities were found in water ways. 	<ul style="list-style-type: none"> - As same as in alternative A/B. - As same as in alternative A/B. - Aquatic biology condition at alternative C does not differ from alternative A/C. - Few fishery activities were found in water ways.

TABLE 17.8 (Cont'd)

Environmental Resource	Alternative A/B	Alternative C
<p>5. Terrestrial Ecosystem</p> <ul style="list-style-type: none"> - Ecosystem Condition around the Diversion Structure Site - Natural Forest Tree Covering the Construction Area <p>6. Soil / Land Use</p> <ul style="list-style-type: none"> - Soil Morphology in the Constructions - Land Use Type - Land Expropriation (Size of Land to be Expropriated) - Land Expropriation Cost 	<ul style="list-style-type: none"> - Mainly agricultural areas, especially rice field and maize, in the vicinity of the site, degraded Mixed Deciduous and Dry Dipterocarp forest were found. - <i>Shorea siamensis</i> (Rung), <i>Shorea obtusa</i> (Teng), <i>Azelia xylocarpa</i> (Makka), <i>Pterocarpus macrocarpus</i> (Pradu), <i>Xylia xylocarpa</i> (Daeng), <i>Spondias pinnata</i> (Makok) are the natural tree species in this area. - Paddy soils, upland, deep to shallow undulating. - Paddy, upland crops, degraded forest. - - 	<ul style="list-style-type: none"> - Mainly agriculture areas i.e., paddy field. - No forest trees in the area adjacent to the proposed dam site. - Paddy and upland soils. - Paddy on lowland and upland crops on upland. - -

TABLE 17.8 (Cont a)

Environmental Resource	Alternative A/B	Alternative C
<p>7. Flood Control</p> <ul style="list-style-type: none"> - Geological Condition - Flood at Upstream/Downstream Area <p>8. Transportation</p> <ul style="list-style-type: none"> - Access Road to the Construction Site - Distance from main road - Disturbance to the regular traffic flow. - Traffic Volume of Navigation - Traffic Volume of Land Transportation <p>9. Socio-economic / Resettlement</p> <ul style="list-style-type: none"> - Residences Located in the Project Site - Communities Adjacent to the Construction Site ($\leq 1,000$ m.) 	<ul style="list-style-type: none"> - Flood plain near foot of mountain. - Over flow on both of banks in rainy season. - Lateritic road with 2 lanes in good condition. - About 2.5 and 3 km. respectively from main local road and highway No. 1020. - No disturbance on regular traffic. - Very low - Low - No houses located in the proposed diversion structure. - The nearest community is about 1 km. to the west of the dam. 	<ul style="list-style-type: none"> - Flood plain - Over flow on both of banks in rainy season. - Lateritic road with 2 lanes in good condition. - About 2.5 and 9.5 km. respectively from main local road and highway No. 1020. - No disturbance on regular traffic. - Very low - Low - No houses located in the proposed diversion structure. - The nearest community is about 3 km to the east of the proposed diversion structure.

TABLE 17.8 (Cont'd)

Environmental Resource	Alternative A/B	Alternative C
<p>10. Archaeological / Historical Aspect</p> <ul style="list-style-type: none"> - Wat / Archaeological Site in the Construction Site - Wat Adjacent to the Diversion Structure Area - Archaeological Site Adjacent to the Construction Area 	<ul style="list-style-type: none"> - No wat / archaeological site in the construction area. - The nearest wat is located about 1.2 km to the northeast of diversion structure. - No archaeological site near the proposed diversion structure. 	<ul style="list-style-type: none"> - No wats and archaeological site in the construction area. - The nearest wat is located about 2 km from the site. - No archaeological site near the proposed diversion structure.

TABLE 17.9

**ENVIRONMENTAL APPROPRIATION SCORING FOR SELECTION OF
DIVERSION STRUCTURE SITE IN ING RIVER**

Environmental Resources	Weighting Score	Alternative A/B ^U		Alternative C	
		Level of ^V Impact	Score	Level of ^V Impact	Score
1. Surface Water Hydrology / Erosion and Sedimentation	20				
- Obstruction on the Natural Flow Pattern	10	0.40	4.00	0.40	4.00
- Increasing in Suspended Solid during Construction Period	10	0.40	4.00	0.40	4.00
2. Surface Water Quality	20				
- Level of Water Quality near the Diversion Structure	7	0.50	3.50	0.50	3.50
- Communities Located Upstream	7	0.50	3.50	0.50	3.50
- Water Use Upstream/Downstream	6	0.50	3.00	0.50	3.00
3. Geology / Seismology	10				
- Stability of Basement and its Component	5	0.50	2.50	0.50	2.50
- Seismic Impact	5	0.50	2.50	0.50	2.50
4. Aquatic Biology and Fishery	20				
- Types and Abundance of Fish Upstream and Downstream	5	0.40	2.00	0.40	2.00
- Types and Abundance of Plankton and Benthos	5	0.40	2.00	0.40	2.00
- Abundance of Aquatic Weed	5	0.40	2.00	0.40	2.00
- Fishery	5	0.50	2.50	0.50	2.50
5. Terrestrial Ecology	10				
- Ecological Condition at the Diversion Structure Site	5	0.50	2.50	0.50	2.50
- Natural Forest Tree Covering the Construction Area	5	0.50	2.50	0.50	2.50
6. Soil / Land Use	10				
- Soil Morphology in the Construction Site	2	0.50	1.00	0.50	1.00
- Land Use Type	2	0.50	1.00	0.50	1.00
- Land Expropriation	3	0.50	1.50	0.50	1.50
- Land Expropriation Cost	3	0.50	1.50	0.50	1.50

TABLE 17.9 (Cont'd)

Environmental Resources	Weighting Score	Alternative A/B ^{1/}		Alternative C	
		Level of ^{2/} Impact	Score	Level of ^{2/} Impact	Score
7. Flood Control	10				
- Topography of the Construction	5	0.50	2.50	0.50	2.50
- Flood Problems Upstream / Downstream	5	0.70	3.50	0.70	3.50
8 Transportation	15				
- Access Road to the Construction Site	3	0.50	1.50	0.50	1.50
- Distance from Main Road	3	0.50	1.50	0.50	1.50
- Disturbance to the Regular Traffic Flow	3	0.50	1.50	0.50	1.50
- Navigation Traffic Volume	3	0.50	1.50	0.50	1.50
- Land Transportation Volume	3	0.50	1.50	0.50	1.50
9. Socio-economic / Compensation and Resettlement	20				
- Residences Located in the Project Site	10	0.50	5.00	0.50	5.00
- Communities Adjacent to the Diversion Alignment	5	0.50	2.50	0.50	2.50
- School Located Adjacent to the Construction Site	5	0.50	2.50	0.50	2.50
10. Archaeological / Historical	15				
- Wat / Archaeological Site in the Project Construction Site	7	0.50	3.50	0.50	3.50
- Wats adjacent to the Project Construction Site	4	0.50	2.00	0.50	2.00
- Archaeological Sites Adjacent to the Construction Area	4	0.50	2.00	0.50	2.00
Total	150		72.5		72.5

Remark : ^{1/} Alternative A and B use the same diversion structure

^{2/} The level of impact

- Very positive = 0.9
- Rather high positive = 0.8
- Fairly positive = 0.7
- Low positive = 0.6
- No impact = 0.5
- Low negative = 0.4
- Fairly negative = 0.3
- Rather high negative = 0.2
- Very negative = 0.1

TABLE 17.10
SUMMARY OF ENVIRONMENTAL RESOURCES ALONG THE DIVERSION CANALS/CULVERTS AND TUNNELS
FROM NAM KOK TO NAM ING

Environmental Aspects	Alternative A	Alternative B	Alternative C
<p>1. Surface Water Hydrology / Water Quality</p> <ul style="list-style-type: none"> - Obstruction on the Natural flow Direction - Sediments Increase during Construction Period 	<ul style="list-style-type: none"> - No obstruction from the construction of the project. Surface water can flow in natural condition. - Sediment increase due to the soil dredging. 	<ul style="list-style-type: none"> - It is similar to alternative A. - There is more sediment increase than in alternative A due to the soil dredging especially dredging activities in rainy season. 	<ul style="list-style-type: none"> - It is similar to alternative A and B. - There is more sediment increase than in alternative A and B due to the soil dredging for longer canals.
<p>2. Geology and Seismology</p>	<ul style="list-style-type: none"> - The diversion canals will pass the area which consist of silt, gravel, sand and clay in quaternary up to present. Tunnel alignment will pass the area of sedimentary rocks, volcanic rocks and plutonic rocks. Minor faults and splits were found in granit and volcanic rocks. 	<ul style="list-style-type: none"> - The geological condition is similar to alternative A. 	<ul style="list-style-type: none"> - The geological condition is similar to alternative A and B.
<p>3. Forest</p> <ul style="list-style-type: none"> - Disturbance to the Forest Reserves 	<ul style="list-style-type: none"> - The diversion canal and tunnel from Mae Kok to Mae Ing will pass 5 national forest reserves in zone C about 12 km, and zone E for 4 km, most of these sections pass underneath the mountain. 	<ul style="list-style-type: none"> - The diversion canal and tunnel from Mae Kok to Mae Ing will pass 5 national forest reserves in zone C for 4 km and zone A for 2.5 km. National forest would be slightly disturbed because the diversion structure at those sections mostly pass underground, not lower than 500-1,000 m. from ground surface. 	<ul style="list-style-type: none"> - Not differ from alternative B.

TABLE 17.10 (Cont'd)

Environmental Aspects	Alternative A	Alternative B	Alternative C
<p>3. Forest (Cont'd)</p> <ul style="list-style-type: none"> - Disturbance to Watershed Class I areas - Forest Conditions - Size forest of areas to be disturbed 	<ul style="list-style-type: none"> - Tunnel will pass underneath watershed class I areas, with distance about 2 km. - The canal mainly passes through the rice field and upland crops areas. Mixed Deciduous and Dry Dipterocarps Forests were scattering and Bamboos were found near the tunnel inlet. - About 100-200 rai of degraded forest will be disturbed. 	<ul style="list-style-type: none"> - Both canal and tunnel will not pass through watershed class I area. - Mostly areas which will be destroy are agriculture. The area at the tunnel inlet and outlet was slope hillside or slope hillfoot covered mostly with upland crop. Remaining forest areas are in a few. - Forest area ~ 100 rai will be disturbed. 	<ul style="list-style-type: none"> - Both canal and tunnel will not pass through watershed class I area. - Almost affected areas area are the same areas as alternative B. - About 100 rai of degraded forest will be disturbed.
<p>4. Wildlife</p> <ul style="list-style-type: none"> - Wildlife Diversification 	<ul style="list-style-type: none"> - Wildlifes found were of small size and able to adapt themselves to disturbed area. Most of them was bird group. Siamese hare and Common civet were the biggest mammals found. 	<ul style="list-style-type: none"> - Almost of wildlife species found were similar to those found at alternative A, bird is the majority group which were found. 	<ul style="list-style-type: none"> - Wildlife in the area of alternative C was similar to those found in Alternative B.
<ul style="list-style-type: none"> - Disturbance on Food source and Wildlife Route <p>5. Aquatic Ecology / Fisheries</p> <ul style="list-style-type: none"> - The Distribution of Aquatic Organisms - The Change of Aquatic Ecological Condition 	<ul style="list-style-type: none"> - Dominant ecological conditions of all 3 alternatives were agricultural area which has been continuously disturbed. Wildlife that could be living in this area would be able to adapt themselves or be used to the ecological changes. It was expected that wildlife could use the nearby area instead of the disturbed area. - 4 families and 6 species were found in Kok River. 4 families and 16 species were found in Ing River. The 3 species found in both rivers were Rak Kluai, Kod Luang and Chon. - Medium impact on light, temperature and oxygen consumption in diversion tunnel. 	<ul style="list-style-type: none"> - Lower impact on aquatic ecological change compared with alternative A. 	<ul style="list-style-type: none"> - As same as alternative B.

TABLE 17.10 (Cont'd)

Environmental Aspects	Alternative A	Alternative B	Alternative C
<p>6. Soil / Land Use</p> <ul style="list-style-type: none"> - Soil Morphology in the Constructions - Land Use Type - Land Expropriation (Size of Land to be Expropriated) - Land Expropriation Cost 	<ul style="list-style-type: none"> - Most are paddy soils, flat, deep and poorly drain soils, some area which alternative A will pass through are upland and hilly soils. - Agriculture, paddy and upland crop, degraded forest on hillfoot. - About 6,800 rai of land will be expropriated. - The expropriation cost will be about 730 million baht. 	<ul style="list-style-type: none"> - Most are paddy soil as found in alternative A, upland and hilly soils were found at the inlet and outlet. - Most are paddy, upland crop and degraded forest were found near the tunnel inlet/outlet. - About 8,700 rai of land will be expropriated. - The expropriation cost will be about 1,230 million baht. 	<ul style="list-style-type: none"> - Most of this alternative was similar to alternative B. - Most area are agriculture paddy and upland crop. - About 9,500 rai of land will be expropriated. - The expropriation cost will be about 1,250 million baht.
<p>7. Transportation</p> <ul style="list-style-type: none"> - Impact on local Transportation. - Impact on the structure of Existing road. - Disturbance to the nearby Communities/ transportation. 	<ul style="list-style-type: none"> - Bridges will be provided for crossing the Diversion canal and there are low traffic volumes in local road, the impact will be minimal. - There may be impacted on pavement condition due to the transportation for construction materials and equipments/machines. - Local people may be disturbed from loud noise, black smoke and dust from project's trucks including the damage of pavement. 	<ul style="list-style-type: none"> - It's similar to alternative A - It's similar to alternative A - It's similar to alternative A 	<ul style="list-style-type: none"> - It's similar to alternative A - It's similar to alternative A - It's similar to alternative A

TABLE 17.10 (Cont'd)

Environmental Aspects	Alternative A	Alternative B	Alternative C
<p>8. Socio-economic / Compensation and Resettlement</p> <ul style="list-style-type: none"> - Residents Located in the Construction Area - Communities Adjacent to the Diversion Alignment ($\leq 1,000$ m.) - Schools Located Adjacent to the Construction Site (≤ 500 m.) <p>9. Archaeological / Historical</p> <ul style="list-style-type: none"> - Diversion Canal / Culvert - Wat / Archaeological Sites in the Right of Way - Wat / Archaeological Sites Adjacent to the Alignments (< 500 m.) - Wat / Archaeological Sites Located at 501 - 1,000 m Distance - Tunnel Inlet and Outlet - Wat / Archaeological Site Adjacent to the Inlet/Outlet (within 1,000 m.) 	<ul style="list-style-type: none"> - About 20 households will be directly affected. - About 49 villages are located in 1,000 m distance. - There are 2 schools within 500 m. from the alternative. - No Wat / Archaeological site in construction area. - 5 Wats / Archaeological sites were found. - 7 Wats / Archaeological sites were found. - No Wat / Archaeological site. 	<ul style="list-style-type: none"> - No households will be directly affected. - About 39 villages are located in 1,000 m distance. - There are 3 schools located in the distance of about 500 m. - same as alternative A. - 9 Wats / Archaeological sites were found. - 10 Wats / Archaeological sites were found. - 1 Wat was found. 	<ul style="list-style-type: none"> - No directly affected households. - About 35 villages are located in 1,000 m distance. - 3 schools are far from the alternative C not over 500 m. - same as alternative A. - 10 Wats / Archaeological sites were found. - 12 Wats / Archaeological sites were found. - 1 Wat was found.

TABLE 17.11
ENVIRONMENTAL APPROPRIATION SCORING FOR SELECTION OF
WATER DIVERSION CANAL/TUNNEL FROM KOK TO ING

Environmental Resources	Weighting Score	Alternative A		Alternative B		Alternative C	
		Level of ^y Impact	Score	Level of ^y Impact	Score	Level of ^y Impact	Score
1. Surface Water Hydrology / Water Quality	20						
- Obstruction on the Natural Flow Pattern	10	0.40	4.00	0.40	4.00	0.40	4.00
- Increasing in Suspended Solid during Construction Period	10	0.40	4.00	0.30	3.00	0.30	3.00
Geology and Seismology	20						
- Geological Impact on Boring	10	0.30	3.00	0.40	4.00	0.40	4.00
- Stability and Water Leakage	4	0.30	1.20	0.30	1.20	0.30	1.20
- Amount of Rock to be Excavated and Availability of Dumping Area	3	0.30	0.90	0.40	1.20	0.40	1.20
- Seismic Impact	3	0.50	1.50	0.50	1.50	0.50	1.50
3. Forest	30						
- Disturbance to the Forest Reserves	6	0.40	2.40	0.50	3.00	0.50	3.00
- Disturbance to Watershed Class 1 Area	10	0.50	5.00	0.60	6.00	0.60	6.00
- Forest Condition	7	0.50	3.50	0.50	3.50	0.50	3.50
- Size of Forest Area to be Disturbed	7	0.40	2.80	0.50	3.50	0.50	3.50
4. Wildlife	30						
- Wildlife Diversification	10	0.40	4.00	0.40	4.00	0.40	4.00
- Disturbance on Food Source of Wildlife	10	0.40	4.00	0.40	4.00	0.40	4.00
- Disturbance on Wildlife Route	10	0.40	4.00	0.40	4.00	0.40	4.00
5. Aquatic Biology and Fishery	20						
- Distribution of Aquatic Organisms	10	0.40	4.00	0.40	4.00	0.40	4.00
- Changing of Aquatic Ecosystem							
o Tunnel length	4	0.30	1.20	0.40	1.60	0.40	1.60
o Water current	2	0.20	0.40	0.20	0.40	0.20	0.40
o Temperature	2	0.30	0.60	0.40	0.80	0.40	0.80
o Oxygen	2	0.30	0.60	0.40	0.80	0.40	0.80
6. Soil / Land Use	15						
- Soil Morphology in the Construction Site	3	0.30	0.90	0.40	1.20	0.40	1.20
- Land Use Type	4	0.40	1.60	0.40	1.60	0.40	1.60
- Land Expropriation (Size of Land to be Expropriated)	4	0.50	2.00	0.40	1.60	0.30	1.20
- Expropriation Cost	4	0.50	2.00	0.40	1.60	0.30	1.20

TABLE 17.11 (Cont'd)

Environmental Resources	Weighting Score	Alternative A		Alternative B		Alternative C	
		Level of ^u Impact	Score	Level of ^u Impact	Score	Level of ^u Impact	Score
7. Transportation	20						
- Access Road	6	0.40	2.40	0.40	2.40	0.40	2.40
- Disturbance to the Structure of Existing Roads	6	0.30	1.80	0.30	1.80	0.30	1.80
- Disturbance to Communities from Project's Transportation	8	0.30	2.40	0.30	2.40	0.30	2.40
8. Socio-economic / Compensation and Resettlement	25						
- Residences Located in the Construction Area	15	0.40	6.00	0.50	7.50	0.50	7.50
- Communities Adjacent to the Diversion Alignment (≤ 1,000 m.)	5	0.30	1.50	0.40	2.00	0.40	2.00
- School Located Adjacent to the Construction Site (≤ 500 m.)	5	0.40	2.00	0.40	2.00	0.40	2.00
9. Archaeological / Historical	20						
- Wat / Archaeological Sites in the Right of Way	8	0.50	4.00	0.50	4.00	0.50	4.00
- Wat / Archaeological Site Adjacent to the Alignments (≤ 500 m.)	7	0.40	2.80	0.30	2.10	0.30	2.10
- Wat / Archaeological Site Located at 501 - 1,000 m Distance	5	0.40	2.00	0.30	1.50	0.30	1.50
Total	200		78.5		82.2		81.4

Remark : ^u the Level of Impact

- Very positive = 0.9
- Rather high positive = 0.8
- Fairly positive = 0.7
- Low positive = 0.6
- No impact = 0.5
- Low negative = 0.4
- Fairly negative = 0.3
- Rather high negative = 0.2
- Very negative = 0.1

TABLE 17.12

SUMMARY OF ENVIRONMENTAL RESOURCES ALONG THE DIVERSION CANALS/CULVERTS AND TUNNELS FROM NAM ING TO NAM NAN (YOD)

Environmental Aspects	Alternative A	Alternative B	Alternative C
<p>1. Surface Water Hydrology / Water Quality</p> <ul style="list-style-type: none"> - Obstruction on the Natural flow Direction - Sediments Increase during Construction Period 	<ul style="list-style-type: none"> - Most areas that the diversion tunnels will pass beneath are mountains. For the plain areas the project will provide diversion canals and culverts which will not obstruct the natural flow. - Sediments increase due to the construction activities and it will disappear when construction activities already finish 	<ul style="list-style-type: none"> - It is similar to alternative A. - It is similar to alternative A. 	<ul style="list-style-type: none"> - It is similar to alternative A. - There are less impact than those of alternative A and B due to the shorter diversion canals or culverts.
<p>2. Geology and Seismology</p> <ul style="list-style-type: none"> - Geological Condition - Seismic 	<ul style="list-style-type: none"> - The geological condition of alignment A and B are mostly similar. Faults are found along tunnels alignment. Most of rocks lie on NE-SW direction. - The 3 alignments are not in seismic areas. 	<ul style="list-style-type: none"> - Volcanic rocks are found. There are more faults than in alternative A and B. 	<ul style="list-style-type: none"> - Volcanic rocks are found. There are more faults than in alternative A and B.
<p>3. Forest</p> <ul style="list-style-type: none"> - Disturbance to the Forest Reserves 	<ul style="list-style-type: none"> - Most of alternative A are tunnel which will pass beneath 3 national forest reserves in the forest conservation zone (C) about 56.61 km and the economic forest zone (E) about 0.54 km. 	<ul style="list-style-type: none"> - The diversion tunnel of alternative B will pass beneath 3 national forest reserves in the forest conservation zone (C) about 56.61 km and the economic forest zone (E) about 0.54 km. 	<ul style="list-style-type: none"> - The tunnel will pass beneath 9 national forest reserves in the forest conservation zone (C) about 34.46 km, the economic forest zone (E) about 3.39 km and the forest land suitable for agriculture about 3.57 km

TABLE 17.12 (Cont'd)

Environmental Aspects	Alternative A	Alternative B	Alternative C
<p>3. Forest (Cont'd)</p> <ul style="list-style-type: none"> - Disturbance to Watershed Class 1 areas - Forest Conditions - Size of forest areas to be disturbed 	<ul style="list-style-type: none"> - The diversion tunnel of alternative A will pass underneath WC1 about 29.70 km and shaft No.1 and 4 will be in the boundary of WC 1. - The alternative A will pass through agricultural land and degraded forest. - About 700-800 rai of degraded forest will be disturbed. 	<ul style="list-style-type: none"> - The diversion tunnel of alternative B will pass underneath WC 1 about 27.0 km and shaft No.3 will be in the boundary of WC1. - The alternative B will pass through agricultural land and degraded forest. - About 400-500 rai of degraded forest will be disturbed. 	<ul style="list-style-type: none"> - The diversion tunnel of alternative C will pass underneath WC 1 about 16.30 km. - As same as Alternative A and B. - About 300-400 rai of degraded forest will be disturbed.
<p>4. Wildlife</p> <ul style="list-style-type: none"> - Wildlife Diversification - Disturbance on Food source and Wildlife Route 	<ul style="list-style-type: none"> - 4 groups of wildlife were found, the majority of them are birds of small size which are able to adapt themselves to the disturbed area. 	<ul style="list-style-type: none"> - Wildlife species found in alternative B were small size and able to adapt themselves to the disturbed area likely found in alternative A. 	<ul style="list-style-type: none"> - Most of them were similar to those found in alternative B.
<p>5. Aquatic Ecology / Fisheries</p> <ul style="list-style-type: none"> - The Distribution of Aquatic Organisms - The Change of Aquatic Ecological Condition 	<ul style="list-style-type: none"> - Alternative A, B and C will pass mostly through agricultural area which has been continuously disturbed, wildlifes that could be living in this area would be able to adapt themselves and could use the nearby area for living if the project is implemented. - 5 families and 16 species were found in Ing River; 7 families and 20 species were found in Lao-Ing River, 6 family and 14 species are were found in Huai Yod, and 8 families with 12 species were found in Nam Yao. - Plankton and benthos were found in all rivers with not different on quality and density. - Lower impact on fish migration but rather high impact on Oxygen consumption and light during tunnel diversion operation, and few impact on increasing of turbidity during construction period. 		

TABLE 17.12 (Cont'd)

Environmental Aspects	Alternative A	Alternative B	Alternative C
<p>6. Soil / Land Use</p> <ul style="list-style-type: none"> - Soil Morphology in the Constructions - Land Use Type - Land Expropriation (Size of Land to be Expropriated) - Land Expropriation Cost <p>7. Transportation</p> <ul style="list-style-type: none"> - Impact on local Transportation - Impact on road Structure - Disturbance to the nearby communication. 	<ul style="list-style-type: none"> - Diversion tunnel will pass mostly through hilly, shallow soils. Paddy and upland soil were found along the canal and culvert sections. - Paddy on lowlands and upland crops on upland soil. - The directly affected areas will be about 1,500 rai. - The land expropriation cost will be about 788 million baht. - No impact because bridges will be installed for local travelling and there are low traffic volumes in existing condition. - There may be impacted on pavement condition due to the transportation for construction materials and equipments/machines. - Local people may be disturbed from loud noise, black smoke and dust from project's trucks including the damage on pavement of roads. 	<ul style="list-style-type: none"> - Paddy on lowlands and upland crops on upland soil. - The directly affected areas will be about 1,580 rai. - The land expropriation cost will be about 69 million baht. - It's similar to alternative A. - It's similar to alternative A. - It's similar to alternative A. 	<ul style="list-style-type: none"> - Not differ from alternative A and B - The direct affected area will be about 1,200 rai. - The land expropriation cost will be about 29 million baht. - It's similar to alternative A. - It's similar to alternative A. - It's similar to alternative A.

TABLE 17.12 (Cont'd)

Environmental Aspects	Alternative A	Alternative B	Alternative C
<p>8. Socio-economic / Compensation and Resettlement</p> <ul style="list-style-type: none"> - Residences Located in the Construction Area - Communities Adjacent to the Diversion Alignment ($\leq 1,000$ m.) - Schools Located Adjacent to the Construction Site (≤ 500 m.) <p>9. Archaeological / Historical Diversion Canal / Culvert</p> <ul style="list-style-type: none"> - Wat / Archaeological Sites in the Right of Way - Wat / Archaeological Sites located adjacent to the Alignments (< 500 m.) - Wat / Archaeological Sites located at 501 - 1,000 m. of Distance Tunnel Inlet and Outlet - Wat / Archaeological Site located adjacent to the Inlet/Outlet (within 1,000 m.). 	<ul style="list-style-type: none"> - No residential buildings in the ROW. - 11 local communities are adjacent to the proposed line. - None <ul style="list-style-type: none"> - Wat / Archaeological site are not found in construction area. - 4 Wats / Archaeological sites were found - 5 Wats / Archaeological sites were found - 1 Wat was found 	<ul style="list-style-type: none"> - No residential building in the construction site. - 25 local communities are adjacent to the alternative B. - None <ul style="list-style-type: none"> - None - 3 Wats / Archaeological sites were found - 1 Wat / Archaeological site were found - 1 Wat was found 	<ul style="list-style-type: none"> - No residential building in the construction site. - 6 local communities are adjacent to the alternative C. - None <ul style="list-style-type: none"> - None - None - 2 Wats / Archaeological sites were found - 1 Wat was found

TABLE 17.13

**ENVIRONMENTAL APPROPRIATION SCORING FOR SELECTION OF
WATER DIVERSION CANAL/TUNNEL FROM ING TO NAN**

Environmental Resources	Weighting Score	Alternative A		Alternative B		Alternative C	
		Level of ^v Impact	Score	Level of ^v Impact	Score	Level of ^v Impact	Score
1. Surface Water Hydrology	20						
- Obstruction on the Natural Flow Pattern	10	0.40	4.00	0.40	4.00	0.40	4.00
- Increasing Suspended Solid during Construction Period	10	0.40	4.00	0.40	4.00	0.40	4.00
2. Geology and Seimelogy	20						
- Geological Impact on Boring	10	0.30	3.00	0.30	3.00	0.20	2.00
- Stability and Water Leakage	4	0.30	1.20	0.30	1.20	0.20	0.80
- Amount of Rock to be Excavated and Availability of Dumping Area	3	0.10	0.30	0.10	0.30	0.10	0.30
- Seismic Impact	3	0.50	1.50	0.50	1.50	0.50	1.50
3. Forest	30						
- Disturbance to the Forest Reserves	6	0.20	1.20	0.20	1.20	0.30	1.80
- Disturbance to Watershed Class I Area	10	0.40	4.00	0.40	4.00	0.40	4.00
- Forest Conditions	7	0.50	3.50	0.50	3.50	0.50	3.50
- Size of Forest Area to be Disturbed	7	0.40	2.80	0.40	2.80	0.40	2.80
4. Wildlife	30						
- Wildlife Diversification	10	0.30	3.00	0.30	3.00	0.40	4.00
- Disturbance on Food Source of Wildlife	10	0.40	4.00	0.40	4.00	0.40	4.00
- Disturbance on Wildlife Route	10	0.40	4.00	0.40	4.00	0.40	4.00
5. Aquatic Biology and Fishery	20						
- Distribution of Aquatic Organisms	10	0.40	4.00	0.40	4.00	0.40	4.00

TABLE 17.13 (Cont'd)

Environmental Resources	Weighting Score	Alternative A		Alternative B		Alternative C	
		Level of ^v Impact	Score	Level of ^v Impact	Score	Level of ^v Impact	Score
		5. Aquatic Biology and Fishery (Cont'd)					
- Changing of Aquatic Ecosystem							
• Tunnel length	4	0.10	0.40	0.10	0.40	0.10	0.40
• Water current	2	0.10	0.20	0.10	0.20	0.10	0.20
• Temperature	2	0.10	0.20	0.10	0.20	0.10	0.20
• Oxygen	2	0.10	0.20	0.10	0.20	0.10	0.20
6. Soil / Land Use							
	15						
- Soil Morphology in the Construction Site	3	0.40	1.20	0.40	1.20	0.40	1.20
- Land Use Type	4	0.40	1.60	0.40	1.60	0.40	1.60
- Land Expropriation (Size of Land to be Expropriated)	4	0.40	1.60	0.40	1.60	0.40	1.60
- Expropriation Cost	4	0.20	0.80	0.40	1.60	0.40	1.60
7. Transportation							
	20						
- Access Road	6	0.40	2.40	0.40	2.40	0.40	2.40
- Disturbance to the Structure of Existing Roads	6	0.30	1.80	0.30	1.80	0.30	1.80
- Disturbance to Communities from Project's Transportation	8	0.30	2.40	0.30	2.40	0.30	2.40
8. Socio-economic / Compensation and Resettlement							
	25						
- Residences Located in the Construction Area	15	0.50	7.50	0.50	7.50	0.50	7.50
- Communities Adjacent to the Diversion Alignment (≤ 1,000 m)	5	0.50	2.50	0.40	2.00	0.50	2.50
- School Located Adjacent to the Construction Site (≤ 500 m)	5	0.40	2.00	0.40	2.00	0.40	2.00

TABLE 17.13 (Cont'd)

Environmental Resources	Weighting Score	Alternative A		Alternative B		Alternative C	
		Level of ^{1/} Impact	Score	Level of ^{1/} Impact	Score	Level of ^{1/} Impact	Score
9. Archaeological / Historical Sites	20						
- Wat / Archaeological Sites in the Right of Way	8	0.50	4.00	0.50	4.00	0.50	4.00
- Wat / Archaeological Site Adjacent to the Alignments (≤ 500 m.)	7	0.30	2.10	0.40	2.80	0.50	3.50
- Wat / Archaeological Site Located at 501 - 1,000 m Distance	5	0.40	2.00	0.40	2.00	0.40	2.00
Total	200		73.4		74.4		75.8

Remark : 1/ The Level of Impact

- Very positive	=	0.9
- Rather high positive	=	0.8
- Fairly positive	=	0.7
- Low positive	=	0.6
- No impact	=	0.5
- Low negative	=	0.4
- Fairly negative	=	0.3
- Rather high negative	=	0.2
- Very negative	=	0.1



APPENDIX

**AQUATIC ECOLOGY DATA FROM
THE 1ST FIELD SURVEY (27 - 28 MAY, 1996)**

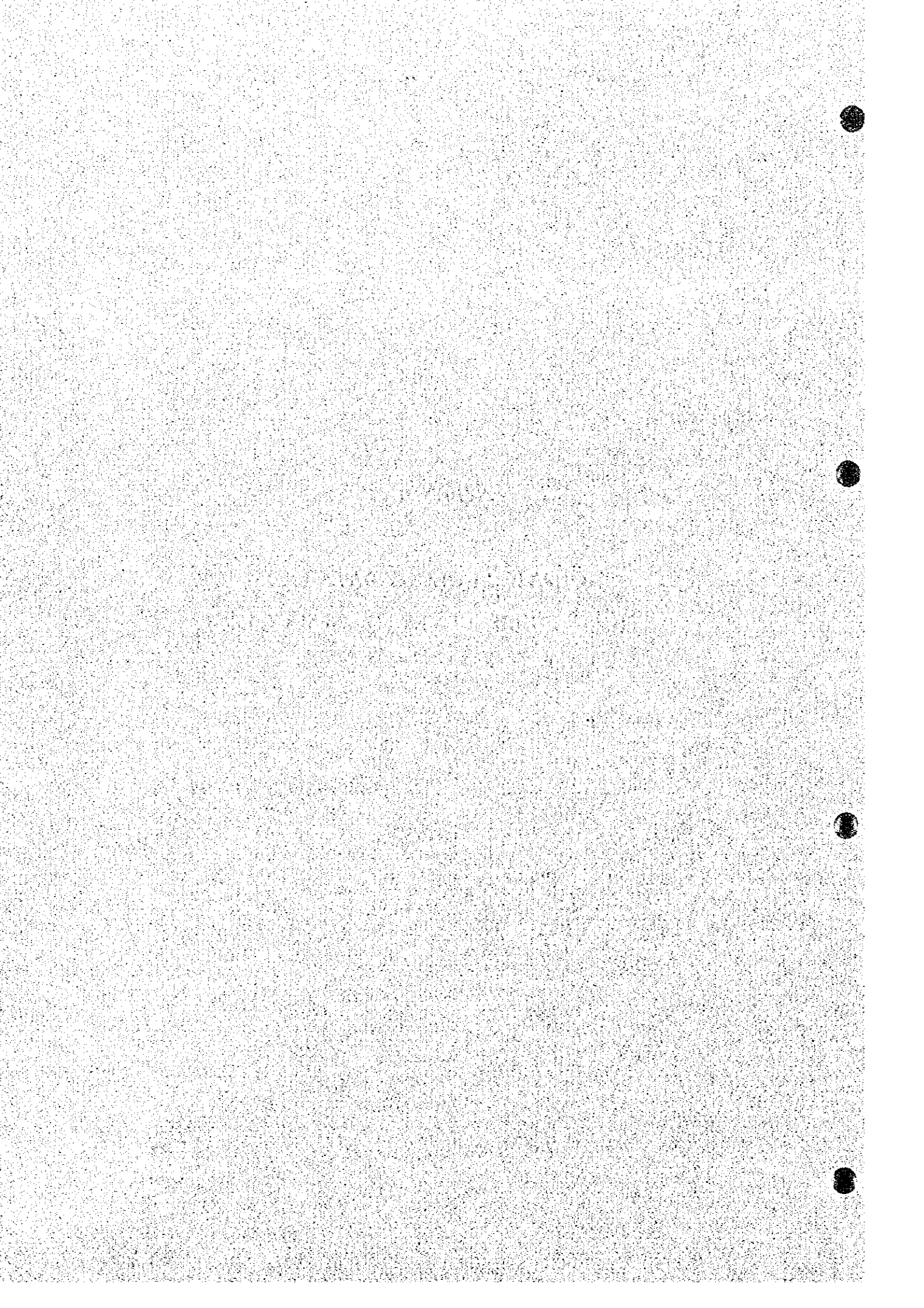


TABLE 1

TYPE, NUMBER, SIZE AND WEIGHT OF FISH IN KOK-ING-NAN PROJECT AREA
FIRST SURVEY (MAY 27-28, 1996)

Family / Scientific Name	Number (tails)	Size (cms.)	Weight (gm.)	Form of mouth/teeth
Station 2				
Family Cyprinidae				
Barilius guttatus	18	3.5-10.0	28.3	supraterminal/no
Epalzeorhynchos coatesi	1	10.5	11.4	subterminal/no
Mystacoleucus marginatus	250	1.5-6.0	124.3	terminal/no
Family Cobitidae				
Acanthopsis shoirorhynchos	3	2.6-2.7	0.2	inferior/no
Family Bagridae				
Mystus nemurus	3	5.0-17.5	91.2	subterminal/no
Leiocassis siamensis	3	6.5-11.0	28.2	subterminal/no
Family Channidae				
Channa striata	3	8.2-10.0	18.5	terminal/canine
Total 4 Family	7 species	281	1.5-17.5	302.1
Station 6				
Family Cyprinidae				
Barilius nanensis	2	2.9-3.0	0.4	supraterminal/no
Cirrhinus jullieni	1	8.3	8.6	subterminal/no
Cyclocheilichthys siamensis	3	5.2-5.8	4.6	subterminal/no
Epalzeorhynchos siamensis	3	5.0-5.5	3.8	subterminal/no
Esomus metallicus	1	5.5	1.2	supraterminal/no
Labeo erythrurus	1	7.3	3.3	subterminal/no
Labiobarbus lineatus	7	6.7-8.0	27.9	subterminal/no
Mystacoleucus marginatus	15	1.7-4.0	3.9	terminal/no
Osteochilus vittatus	1	10.4	14.6	subterminal/no
Puntius ticto	1	3.2	0.3	terminal/no
Rasbora palustris	11	3.5-4.5	7.0	supraterminal/no
Family Cobitidae				
Acanthopsis choirorhynchos	98	3.5-9.5	94.7	inferior/no
Botia eos	7	5.0-10.0	31.9	inferior/no
Cobitoplus anguillaris	1	7.5	1	inferior/no
Family Bagridae				
Mystus cavasius	5	7.0-8.5	17.1	subterminal/no
Leiocassis siamensis	2	5.8-7.6	8.6	subterminal/no

TABLE 1

Family / Scientific Name	Number (tails)	Size (cms.)	Weight (gm.)	Form of mouth/teeth
Family Centropomidae				
<i>Chanda siamensis</i>	1	3.3	0.4	supraterminal/villiform
Family Pristolepidae				
<i>Pristolepis fasciatus</i>	2	6.3-6.5	11.1	terminal/villiform
Family Anabantidae				
<i>Trichopsis vittatus</i>	1	3.8	0.6	terminal/villiform
Family Mastacembelidae				
<i>Macrognahtus siamensis</i>	3	14.5-18.0	46.7	subterminal/no
Total 7 Family 20 species	166	2.9-18.0	287.7	
Station 7				
Family Cyprinidae				
<i>Cirrhinus jullieni</i>	25	4.0-8.0	67.1	subterminal/no
<i>Cyclocheilichthys armatus</i>	9	3.9-5.4	9.1	subterminal/no
<i>Esonus metallicus</i>	2	5.3-5.7	2.9	supraterminal/no
<i>Labeo erythrus</i>	6	5.0-7.5	12.6	subterminal/no
<i>Labiobarbus lineatus</i>	1	7.5	4.2	subterminal/no
<i>Morulus chrysophekadion</i>	1	11.2	15.4	subterminal/no
<i>Mystacoleucus marginatus</i>	30	2.2-3.0	5.3	terminal/no
<i>Osteochilus vittatus</i>	2	6.0-7.7	7.8	subterminal/no
<i>Rasbora palustris</i>	7	3.2-5.0	4.1	supraterminal/no
Family Cobitidae				
<i>Acanthopsis shoirorhynchus</i>	612	2.5-17.0	623.5	inferior/no
<i>Botis hymenophusa</i>	4	5.0-10.3	14.4	inferior/no
<i>Cobitophis anguillar</i>	2	3.9-4.0	0.2	inferior/no
Family Bagridae				
<i>Mystus nemurus</i>	1	8.5	5.3	subterminal/no
<i>Mystus cavasius</i>	17	6.0-8.0	43.9	subterminal/no
Family Centropomidae				
<i>Chanda siamensis</i>	4	3.2-3.5	2.5	supraterminal/villiform
Family Channidae				
<i>Channa striata</i>	1	7	3.6	terminal/canine
Total 5 Family 16 species	724	2.2-17.0	821.9	
Station 8				
Family Cyprinidae				
<i>Carra teaniata</i>	16	4.0-7.8	43.8	inferior/no
<i>Puntius ticto</i>	5	3.7-9.0	6.3	terminal/no
<i>Rasbora borapetensis</i>	23	3.5-5.0	23.2	supraterminal/no

TABLE 1

Family / Scientific Name	Number (tails)	Size (cms.)	Weight (gm.)	Form of mouth/teeth
Family Cobitidae				
Nemacheilus binotatus	2	3.9-4.0	0.8	inferior/no
Nemacheilus menanensis	30	1.7-5.4	22.3	inferior/no
Nemacheilus nicholsi	72	2.2-6.5	51.8	inferior/no
Nemacheilus redei	29	3.0-5.8	34.1	inferior/no
Nemacheilus pallidus	2	5.2-7.4	4.4	inferior/no
Nemacheilus multifasciatus	11	2.3-6.3	12.2	inferior/no
Nemacheilus poculi	53	3.1-5.6	37.4	inferior/no
Family Bagridae				
Xenentodon cancila	1	7	0.7	terminal/villiform
Family Pritolepidae				
Pristolepis fasiatus	3	1.5-2.5	0.8	terminal/villiform
Family Gobiidae				
Pasudogobioptis siamensis	40	2.2-4.0	13.1	supraterminal/villiform
Family Mastacembelidae				
Mastacembelus maculatus	15	3.0-13.0	19	subterminal/no
Total 6 Family	14 species	302	269.9	
Satation 10				
Family Notopteridae				
Notopterus notopterus	1	8.5	4.8	supraterminal/villiform
Family Cyprinidae				
Barilius nanensis	8	4.0-6.5	12.2	supraterminal/no
Hampala macrolepidota	3	3.0-4.2	2.2	supraterminal/no
Mystacoleucus marginatus	88	1.5-7.6	60.2	terminal/no
Puntius ticto	2	2.9-3.0	1.0	terminal/no
Family Cobitidae				
Nemacheilus binotatus	1	4	0.7	inferior/no
Family Centropomidae				
Chanda siamensis	3	3.7-5.7	5.5	supraterminal/villiform
Family Belontiidae				
Xenentodon cancila	7	6.0-15.5	21.5	terminal/villiform
Family Pritolepidae				
Pristolepis fasiatus	23	2.3-12.5	163.1	terminal/villiform
Family Mastacembelidae				
Macroglyptus siamensis	18	8.5-21.0	243.2	subterminal/no
Mastacembelus armatus	3	7.5-8.5	5.5	subterminal/no
Family Tetraodontidae				
Tetraodon leiurus	1	3.5	1.7	terminal/beak like
Total 8 Family	12 species	158	521.6	

TABLE 2
FISH PRODUCTION OF KOK-ING-NAN PROJECT AREA,
MAY 27-28, 1996

Station	Catching Area (km ²)	Total Weight (gm.)	Productivity (gm./rai)
2	300	302.1	1,611.20
6	300	287.7	1,534.40
7	300	823.3	4,390.93
8	300	269.9	1,439.47
10	300	521.6	2,781.87
Mean	300	440.92	2,351.57

TABLE 3

TYPE AND NUMBER OF PLANKTON IN KOK-ING-NAN PROJECT AREA
MAY 27-28, 1996

Phylum/species	Density of plankton (cells/cc.)									
	1	2	3	4	5	6	7	8	9	10
Phytoplankton										
Bacillariophyta (diatom)										
diatoma elongatum	20,833	56,533	3,033			2,900	4,200	236,167	1,034,800	82,200
Neidium affine	16,667	7,067				2,900		10,900	5,200	
Fragilaria construens	8,333	21,200						21,800	10,400	13,700
synedra tabulata		17,667				5,800		43,600	192,400	9,133
S. acus								18,167	36,400	4,567
S. ulna								29,067	78,000	
Surirella rubusta		3,533							5,200	
Pleurosigma sp.		3,533			2,533					4,567
Meridion sp.		3,533								
Pinnularia nobilis			3,033							
Amphora hendeyi								3,633	5,200	
Rhopalodia gibba								3,633		
Amphipleura sp.								3,633		
Chlorophyta (green algae)										
Derbesia sp.	8,333	74,200					4,200	3,633		4,567
Spirogyra ionia	4,167	10,600						3,633	26,000	
Hyalotheca mucosa		7,067							15,600	
Oedogonium sp.		7,067								
Chaetophora sp.		7,067					4,200			
Closterium moniliformis		3,533			2,533					4,567
Volvox sp.			127,400	16,667						

TABLE 3

Phylum/species	Density of plankton (cells/cc.)									
	Station									
	1	2	3	4	5	6	7	8	9	10
Pediastrum simplex					2,533	5,800	4,200			
Mougeotia scalaris						5,800				
Rhizoclonium hookeri							8,400		5,200	
Microspora sp.										
Stigeoclonium sp.										
Cyanophyta (blue green algae)										
Oscillatoria sp.	8,333	35,333	6,067	8,333		11,600	54,600	7,267	5,200	
Schizothrix sp.	4,167	10,600						7,267		
Rivularia sp.	4,167									
Microspora sp.		3,533								
Polycystis sp.					2,533		4,200			
Rhaphidiopsis sp.										
Euglenophyta (euglenoids)										
Trachelomonas sp.	4,167			12,500						
Pyrophyta (dinoflagellate)										
Pendinium sp.		7,067			2,533			3,633		4,567
* unidentified										
Zooplankton										
Rotifera										
Brachionus falcatus	4,167		382,200	8,333			29,400	3,633	5,200	
Br. plicatilis			3,033							
Br. caudatus			3,033							
Testudinella clypeata										
Hexathra sp.	4,167		6,067	12,500	7,600		4,200			
Polyarthra vulgaris			3,033	20,833						

TABLE 3

Phylum/species	Density of plankton (cells/cc.)									
	Station									
	1	2	3	4	5	6	7	8	9	10
<i>Elosa woralli</i>			3,033							
<i>Filinia terminalis</i>				12,500						
<i>Ploesoma truncatum</i>				4,167					5,200	
<i>Mytilina</i> sp.										
Protozoa										
<i>Arcella</i> sp.	4,167									
<i>Astramoeba radiosa</i>	4,167	10,600	3,033							
<i>Centropyxis ecornis</i>		7,067								
<i>tintinnopsis major</i>				4,167	2,533		4,200			
Arthropoda										
*Copepod		3,533	51,567	208,333	111,467			3,633		
*Nauplius			148,633	395,833	129,200		16,800	3,633		
<i>Ceriodaphnia locustis</i>			6,067	91,667	12,667					
<i>C. megalops</i>				8,333						
<i>Bosmina</i> sp.			3,033		2,533					
<i>Diaphanosoma brachyurum</i>			3,033		12,667					
<i>Moira</i> sp.					2,533					
*Class Insecta						2,900				
*Nematodes		10,600								
Total	95,835	310,933	755,298	804,166	296,398	37,700	138,600	406,932	1,430,000	132,435
Phytoplankton	79,167	279,133	139,533	37,500	12,665	34,800	84,000	396,033	1,419,600	132,435
Zooplankton	16,668	31,800	615,765	766,666	283,733	2,900	54,600	10,899	10,400	0

Note * = unidentified

TABLE 4

TYPE AND ABUNDANT OF BENTHOSES IN KOK-ING-NAN PROJECT AREA,
MAY 27-28, 1996

Group/Species	Station									
	1	2	3	4	5	6	7	8	9	10
PHYLUM ANNELIDA										
Class oligochaeta		22	-	-	-	-	-	-	-	-
Family Naididae		-	-	-	-	-	-	-	-	-
Family tubificidae		-	22	-	-	88	-	902	22	264
PHYLUM ARTHROPODA										
Class Insecta										
Order Ephemeroptera										
Family Baetidae	220	-	-	44	-	44	-	1,782	528	352
family Caenidae	-	-	-	-	22	22	22	44	154	22
Family Ephemeridae	-	88	22	22	22	-	-	44	-	-
Order Coleoptera										
Family Elmidae	-	44	-	-	-	-	-	22	-	-
Order Diptera										
Family Chironomidae	-	-	44	44	220	-	-	220	-	44
Family Ceratopogonidae	-	-	22	-	-	-	-	22	-	44
Family Tipulidae	-	-	-	-	-	-	22	-	44	22
Order Odonata										
Family Libellulidae	-	-	22	-	-	-	-	416	-	22
Family Coenagrionida	-	-	-	-	-	-	-	110	-	-
Order Trichoptera										
Family Linnephilidae	-	-	-	-	-	-	-	-	44	-
Family Pyralidae	-	-	-	-	-	-	-	22	-	-

TABLE 4

Group/Species	Station									
	1	2	3	4	5	6	7	8	9	10
Order Hemiptera	-	-	22	-	-	-	-	-	-	-
Family Corixidae	-	-	22	-	-	-	-	-	-	-
Class Crustacea	-	-	-	-	-	-	-	-	-	-
Order Decapoda	-	-	-	-	-	-	-	-	-	-
Family Palaemonidae	-	-	-	-	-	-	-	-	-	-
Macrobrachium sp.	-	-	22	330	22	22	22	-	66	44
PHYLUM MOLLUSCA										
Class Gastropoda										
Order Mesogastropoda										
Family viviparidae										
Filopaludina sp.	-	-	22	22	264	-	66	-	-	-
Family Ampullariidae	-	-	-	-	44	22	-	-	-	-
Pila sp.	-	-	-	-	-	-	-	-	-	-
Family Thiariidae	-	-	-	-	22	-	-	-	-	2,112
Melanoides sp.	-	-	-	-	-	-	-	-	-	44
Brotis sp.	-	-	-	-	-	22	-	-	-	-
Order Brasommatophora										
Family Lymnaeidae										
Lymnaea sp.	-	-	-	-	-	-	-	1,012	-	176
Class Bivalvia										
Order Venerina										
Family Corbiculidae										
Corbicula sp.	-	22	22	-	176	-	22	110	22	110
Order Unionoida										
Family Ambiemidae										
Pilsbryoconcha sp.	-	-	-	-	22	-	-	-	-	-
Pseudodon sp.	-	-	-	-	22	-	-	-	-	-
Ensisidens sp.	-	-	-	-	88	-	-	-	-	-

TABLE 4

Group/Species	Station									
	1	2	3	4	5	6	7	8	9	10
Uniandra sp.	-	-	-	-	-	-	22	-	-	-
Total (Cell/m ³)	220	176	220	462	924	220	176	4,706	880	3,256

Note: Station 1, 2 Kok river
 Station 3,4,5,6,7 Ing river
 Station 8,9,10 Nan river

TABLE 5
TYPE OF AQUATIC WEEDS IN KOK-ING-NAN PROJECT AREA
DURING MAY 20-30, 1996

Family/Scientific Name/Thai Name	Station									
	1	2	3	4	5	6	7	8	9	10
1. CHARACEAE										
<i>Chara zeylanica</i>	-	-	+	-	-	-	-	+	-	-
<i>Nitella</i> sp.	-	-	-	-	-	+	-	-	-	-
2. MARSILEACEAE										
<i>Marsilea crenata</i>	-	-	+	-	-	-	+	-	-	+
3. PARKERICEAE										
<i>Ceratopteris thalictroides</i>	-	-	-	+	-	-	+	-	-	+
4. SALVINIACEAE										
<i>Salvinia cucullata</i>	-	-	-	-	-	-	+	-	-	-
5. ARACEAE										
<i>Colocasia esculenta</i>	-	-	-	+	-	+	-	-	-	-
<i>Pistia stratiotes</i>	-	-	-	-	-	-	+	-	-	-
6. COMMELINACEAE										
<i>Commelina benghalensis</i>	-	-	+	-	-	+	-	-	-	-
<i>C. diffusa</i>	-	-	+	-	-	+	-	-	-	-
7. HYDROCHARITACEAE.										
<i>Hydrilla verticillata</i>	-	-	-	+	-	-	-	+	-	-
8. POACEAE										
<i>Leersia hexandra</i>	-	-	-	+	-	+	-	-	-	-
9. POBTERUACEAE										
<i>Monochoria vaginalis</i>	-	-	-	-	+	-	-	-	-	-
10. LERATOPHYLLIACEAE										
<i>Ceratophyllum demersum</i>	-	-	-	-	-	-	+	+	-	-
11. MIMOSACEAE										
<i>Mimosa pigra</i>	+	+	++	-	++	++	++	-	-	++
12. ONAGRACEAE										
<i>Jussiaea repens</i>	-	-	-	-	-	+	-	-	-	-

+ Less abundant
++ Medium abundant
- Not found



