

TABLE G3-1 ENVIRONMENTAL PARAMETERS AND PROPOSED ALTERNATIVE PHYSICAL MEASURES (1/3)

Environmental Parameters	Alternatives Suggested						
	Reinforcement of Ring Dikes	Rehabilitation & Installation of Drainage Gate & Sluices	Rehabilitation & Closure of Existing Outlets	Rehabilitation, Reinforcement, and/or Installation of Pumping Station	Rehabilitation of Installation of Regulation Ponds	Rehabilitation & Installation of Main Drainage Pipes	Dredging & Improvement Channels & Boengs
Natural Environment							
Topography /Location	Due to the difference in altitudes between the areas outside and inside the dike (10 m MSL and 7 m MSL), it is good for flood protection. The dike along Tompun road can also prevent floods due to overflow from Prek Thnot river during rainy season.	The operation sites are located at Kop Sov road (Northwest of Boeng Pongpeay), National road No.5 (Northeast of Boeng Pongpeay), Tompun road (South of Boeng Tompun & Trabek), Monireth road (near Stoeng Mean Chey) and National road No.4 (Near Phum Russei). It can prevent floods due to overflow from the north of Kop Sov road and the south of Tompun road to a certain extent. However, it depends on operating period of the regulator (e.g. during peak flows, floods may be unavoidable and there may be some problem in electrical system and maintenance).	The operation site is located on the west bank of Sap river in front of the Royal Palace. Drainage would be improved and flood retention would be reduced in the limited area (The site is at 11.12 m MSL).	There are 4 pumping stations located at the north of Boeng Pongpeay (1 station), south of Boeng Trabek and Boeng Tompun (1 station of each) and Public Boeng near National road No.4 (1 station). Water could be drained better since the present elevation of the site is ~3 to 8 m MSL.	Boeng Pongpeay and Boeng Kak areas that will be rehabilitated are lowland (~3 m MSL), they can retain additional volume of overflow in rainy season.	Main drainage pipes, there are located along road No 315, No 261, No.245 (Mao Tse Toung), No 217 (Monireth), No.215 (Jawaharlal Nerhu), and No.182. No impact since the operation area is lower flat plain.	The dredging & improvement area, are located at Boeng Salang drainage channel, Boeng Trabek drainage channel, Boeng Tompun drainage channel and drainage channel of Pochentong east area. The project features are already exist. No additional impact is expected.
Flow Regime (Water balance)	Dike construction along Kop Sov road and Tompun road can prevent flood for the area within the dike during rainy season because the dike can block out the overflow form outside. During dry season there might be problems of water shortage in the area within the dike due to flow regulator.	Be able to regulate inflow and outflow volume. During dry season, there would be enough water for agricultural uses. During rainy season, floods can be partly alleviated since the overflow from outside the regulator could cause flood in the area without regulator.	No impact due to most of runoff comes from the north and south part of Phnom Penh. Water equilibrium has not be altered.	Be able to regulate inflow and outflow volume. During dry season, there would be enough water for agricultural activities. During rainy season floods can be partly prevented by pumping main water outside dike.	Positive impact. The operation site could retain water during rainy season which can be use in dry season.	No impact since the operation would not affect water equilibrium.	Positive impact. More water can be retained in Boeng after dredging and drainage system is expected to be improve.
Flooding & Surface Runoff	The dike can reduce the velocity and quantity of runoff from the north and overflow from Prek Thnot river in the south of Phnom Penh. This can reduce the quantity and velocity of runoff flowing into the urban area.	This approach can prevent flood for some areas.	Drainage would be improved and flood retention would be reduced in the limited area (The operation site is at 11.12 m MSL).	During rainy season some area could be alleviated from flood.	Some minor positive, a volume of overflow during rainy season could be retained.	Some positive impact in urban area since the water could be drained more efficiently.	Some minor positive, a volume of overflow during rainy season could be retained.
Eutrophication	Some impact may occur during construction since the construction activities may obstruct water flow and there would be domestic wastewater from communities and construction worker camps causing Eutrophication.	Some impact during construction since the construction activities may obstruct water draining and there would be accumulated of domestic wastewater from communities and construction worker camps causing Eutrophication.	No impact because the water in Sap river is of good quality with good circulation, the eutrophication would not occur.	Some impact during construction since the construction activities might obstruct water flow and there would be more domestic wastewater from communities and construction worker camps causing Eutrophication.	Positive impact, water quality would be improved.	No impact.	Positive impact, water quality would be improved with the removal of poor quality sediment.
Turbid/Polluted Water	There would be some impact during construction phase due to construction activities and wastewater or solid waste from worker communities. Water turbidity would be increased, the water would be polluted causing bad smell and dissolved oxygen reduction.	There would be some minor impact during construction. During operation phase, water circulation would be improved due to the opening and closing of the regulator, this will improve water quality in nearby waterways.	No impact because the water in Sap river is of good quality with good circulation, polluted water with turbidity and bad smell from construction site and worker camp can be diluted.	There would be some minor impact during construction phase but during operation phase better water circulation could improve water quality a little better than dike construction.	Positive impact, the water quality would be improved.	No impact.	Positive impact, the water quality would be improved.
Dissolved Oxygen	There would be some impact during construction phase due to construction activities and wastewater or solid waste from workers community. Water turbidity would be increased, the water would be polluted causing bad smell and dissolved oxygen reduction.	There would be some minor impact during construction. During operation phase, water circulation would be improved due to the opening and closing of the regulator, this will improve water quality in concerned waterway.	No impact because the water in Sap river is of good quality with good circulation, polluted water with turbidity and bad smell from construction site and worker camp can be diluted. Do would increase.	There would be some minor impact during construction phase but during operation phase better water circulation could improve water quality.	Positive impact since the water quality would be improved.	No impact.	Positive impact since the water quality would be improved.

TABLE G3-1 ENVIRONMENTAL PARAMETERS AND PROPOSED ALTERNATIVE PHYSICAL MEASURES (2/3)

Environmental Parameters	Alternatives Suggested						
	Reinforcement of Ring Dikes	Rehabilitation & Installation of Drainage Gate & Sluices	Rehabilitation & Closure of Existing Outlets	Rehabilitation, Reinforcement, and/or Installation of Pumping Station	Rehabilitation of Installation of Regulation Ponds	Rehabilitation & Installation of Main Drainage Pipes	Dredging & Improvement Channels & Boengs
Offensive Odor	There would be some impact during construction phase due to construction activities and wastewater or solid waste from workers community. Water turbidity would be increased, the water would be polluted causing bad smell and dissolved oxygen reduction.	There would be some minor impact during construction. During operation phase, water circulation would be improved due to the opening and closing of the regulator, this will improve water quality.	No impact because the water in Sap river is of good quality with good circulation, polluted water with turbidity and bad smell from construction site and worker camp can be diluted.	There would be some minor impact during construction phase but during operation phase to water quality is expected to be improved.	Positive impact since the water quality would be improved.	No impact.	Positive impact since the water quality would be improved.
Power & Water Supply	There would be some positive impact since dike construction would provide benefit for local people in nearby communities. The project would generate infrastructure development (e.g. public water system, electrical system, drainage system, etc) since the road on top of the dike has been improved.	No impact.	No impact since the operation cause no effect on infrastructure system.	Some electricity is need for pump operation.	Water in Boeng Pongpeay and Boeng Kak can be allevative water supplies for the area.	There would be some temporary impact in terms of relocation of electrical transmission lines suspension towers or relocation of public water pipes.	No impact water retained in Boeng can be alternative water sources.
Sanitary Facilities	There would be some positive impact since dike construction would provide benefit for local people in nearby communities. The project would generate infrastructure development (e.g. public water system, electrical system, drainage system, etc) since the road on top of the dike has been improved.	No impact.	No impact.	No impact	No impact	There would be some impact during construction phase since the operation would cause temporary impact on drainage channels / gutters in community area.	No impact
Drainage Network	There would be some positive impact since dike construction would provide benefit for local people in nearby communities. The project would generate infrastructure development (e.g. public water system, electrical system, drainage system, etc) since the road on top of the dike has been improved.	Positive impact, drainage would be improved with rehabilitation of drainage gate and sluices.	Drainage system is expected to be improved.	Drainage system is expected to be improved.	No impact.	Relatively high positive impact since the community drainage system will be significantly improved.	No impact.
Solid Waste Disposal	There would be some impact during construction phase due to solid waste from construction activity and domestic waste from worker camps in case it is not properly managed, this would cause impact on nearby areas.	There would be some impact during construction phase due to solid waste from construction activity and domestic waste from worker camps in case it is not properly managed, this would cause impact on nearby areas.	There would be some impact during construction phase due to solid waste from construction activity and domestic waste from worker camps in case it is not properly managed, this would cause impact on nearby areas.	There would be some impact during construction phase due to solid waste from construction activity and domestic waste from worker camps in case it is not properly managed, this would cause impact on nearby areas.	There would be some impact during construction phase due to solid waste from construction activity and domestic waste from worker camps in case it is not properly managed, this would cause impact on nearby areas.	There would be some impact during construction phase due to solid waste from construction activity and domestic waste from worker camps.	There would be some impact during construction phase.

TABLE G3-1 ENVIRONMENTAL PARAMETERS AND PROPOSED ALTERNATIVE PHYSICAL MEASURES (3/3)

Environmental Parameters	Alternatives Suggested						
	Reinforcement of Ring Dikes	Rehabilitation & Installation of Drainage Gate & Sluices	Rehabilitation & Closure of Existing Outlets	Rehabilitation, Reinforcement, and/or Installation of Pumping Station	Rehabilitation of Installation of Regulation Ponds	Rehabilitation & Installation of Main Drainage Pipes	Dredging & Improvement Channels & Boengs
Social Environment							
Spontaneous/Planned Settlements	About 150 household would be evacuated from dike construction sites at Kop Srov road and Tompun road. There would be relatively serious impact in case there is no appropriate management in expropriation and compensation since almost all of the evacuee expect that the government would fully support them and they are ready to move out (41.10% of affected households in Kop Srov area and 70.27% of affected households in Tompun area).	The development areas comprise Kop Srov road (2 gates) National road No.3 (2 gates) Tompun road (2 gates) Monireth road (1 gate) National road No.4 (1 gate). There would be some minor impact since there are only a few households to be affected from the project development.	There would be some minor impact since there are only a few households to be evacuated from the west bank of Sap river near the Royal Palace.	The development areas consist of the north of Boeng Pongpeay (1 station) the north of Boeng Trabek (1 station) the south of Boeng Tompun (1 station) the south of Public Boeng near National road No.4 (1 station). There would be some minor impact since there are only a few households to be evacuated.	There would be only some impact on agricultural practices in Boeng Pongpeay and Boeng Kak. The evacuation is not necessary.	There would be no impact since there is no need to expropriate people's land.	It is expected that a number of households would have to be evacuated from 5 development areas as follows:- -125 households from Trabek drainage channel. -240 households from Boeng Trabek -315 households from Mean Chey drainage channel -110 households from Boeng Salang -65 households from Boeng Tompun. The total households to be evacuated are 855. There might be some impacts if the expropriation is not manage appropriately. However most of the households (more than 50%) agreed to move out.
Squatters	150 affected households need to be taking care of properly to prevent additional squatter problem.	There would be minor impact since there are only a few households to be affected and most of the gate/sluices are already existed.	There would be some minor impact since there are only a few households to be affected.	There would be some minor impact since there are only a few households to be affected.	There would be only some impact on agricultural practices in Boeng Pongpeay and Boeng Kak. The evacuation is not necessary.	There would be no impact since there is no need to expropriate people's land.	855 household need to be relocated. Without suitable measures, these group can cause squatter problem elsewhere.
Fishery	There would be some positive impact on fish cultures near Kop Srov road because the dike would prevent overflow in upstream area and prevent flood in downstream area of the dike where there are a lot of fish ponds. For Tompun road area, there would be no impact since there is no fish pond around the area.	There would be positive impact on fish culture especially near Kop Srov road because the proposed structures will facilitate the draining system.	There would be no impact since there is no fish ponds in the area.	Flood protection near Boeng Pongpeay can be expected.	With improvement of water quality, there would be some positive impact on fishery.	There would be no impacts. Since there are no fish ponds in the area.	There would be some positive impact on fishery since people would be able to catch more fishes in Boeng.
Industry	There would be some positive impact since the dike would prevent floods in downstream area especially around Tompun road where there are many industries. Most of which are garment factories. For Kop Srov road which is not flooding area and there are only a few factories, there would be relatively minor impact.	Positive impact, prevent flood in industrial area near Sap river and Stoeng Mean Chey.	Positive impact, prevent flood in industrial area near Sap river.	Positive impact, prevent flood in industrial area near Sap river and Stoeng Mean Chey.	No impact, there is no industrial plant in the operation area.	Some temporary impact during construction, e.g. relocation of supporting towers of electric transmission lines and public water pipes would interrupt bussiness and communication.	No impact, there is no industrial plant in the operation areas.
Tourism	Both of the dike construction sites (Kop Srov and Tompun roads) are not tourist attraction sites, thus there is no impact on tourism.	There is no impact since the project site is not tourist attraction site.	There would be some positive impacts since the rehabilitation and closure of outlets prevent flood from Sap river, The Royal Palace and The National Museum which are important tourist attraction sites would not be affected from flood.	There is no impact since the project site is not tourist attraction.	There is no impact since the project site is not tourist attraction site.	There would be some positive impacts, water from road surface would be drained out more quickly especially around the main tourist attraction sites as Russian Market and National Museum.	There is no impact since the project site is not tourist attraction site.
Land Transportation	Positive impact, people living nearby could use the road on top of the dike as access road for transportation.	Some minor impacts during construction period e.g. closing traffic lane, diverting traffic etc.	Some minor impacts during construction period e.g. closing traffic lane, diverting traffic etc.	Some minor impacts during construction period e.g. closing traffic lane, diverting traffic etc.	No impact since the operation takes place only in Boeng area. Traffic on roads is not obstructed. There would be some minor indirect impact in terms of dredged soil falling from trucks during being transported along roads.	Some minor impacts during construction period e.g. closing traffic lane, diverting traffic etc.	No impact since the operation takes place only in Boeng area. Traffic on roads is not obstructed.

TABLE G3-2 INITIAL ENVIRONMENTAL EXAMINATION MATRIX

Environmental Parameters	Importance	Present Condition	Future Condition without Project	Potential Environmental Impact to be generated *With* the following Project Structural Measures						
				Reinforcement of Ring Dykes	Rehabilitation and installation of drainage gates and sluices	Rehabilitation & closure of existing outlets	Rehabilitation, reinforcement, and/or installation of pumping stations	Rehabilitation of installation of regulation ponds	Rehabilitation and installation of main drainage pipes	Dredging & improvement of channels and Boongs
NATURAL ENVIRONMENT										
Ground Phenomena										
Earthquake	1									
Topography										
Topography & Location	3	2	-3	3	2	1	2	1	0	0
Slope Failure	1									
Erosion										
Stream bed erosion	1									
Geology										
Soil erosion	1									
Soil contamination	1									
Hydrologic phenomena										
Transbasin diversion	1									
Groundwater	1									
Flow regime (water balance)	3	1	-3	2	2	0	2	1	0	1
Flooding & Surface Runoff	3	1	-3	3	2	1	2	1	1	1
Water quality										
Eutrophication	3	1	-2	-1	-1	0	-1	1	0	1
Turbid / polluted water	3	1	-2	-1	1	0	1	1	0	1
Dissolved oxygen	3	1	-2	-1	1	0	1	1	0	1
Salinity	1									
Sediment deposit										
Deposit composition	3	1	-2							
Biosphere										
Terrestrial flora	1									
Terrestrial fauna	1									
Aquatic flora and fauna	2	x	x							
Atmosphere										
Air pollution	1									
Local climate	1									
Offensive odor	2	1	-2	-1	1	0	1	1	0	1
Offensive noise and vibration	1									
Urban infrastructure										
Power and water supply	2	1	0	2	0	0	-2	1	-1	0
Sanitary facilities	3	1	-2	2	0	0	0	0	-1	0
Drainage network	3	1	-3	2	1	1	1	0	2	0
Solid waste/sediment disposal	3	1	-2	-1	-1	-1	-2	-3	-1	-3
SOCIAL ENVIRONMENT										
Human settlements										
Spontaneous settlements	3	1	-3	-2	-1	-1	-1	-1	0	-3
Planned settlements	2	2	-2	-2	-1	-1	-1	-1	0	-3
Squatters	3	1	-3	-2	-1	-1	-1	-1	0	-3
Land tenure and ownership	3	3	0							
Industry										
Agriculture	1									
Fishery	2	3	-1	3	2	0	1	2	0	2
Industry	2	1	-1	3	3	2	3	0	-1	0
Tourism	2	3	-2	0	0	2	0	0	2	0
Communication										
Communication systems	2	3	0							
Transportation										
Land transportation	2	1	-2	3	-1	-1	-1	-1	-1	-1
River transportation	2	2	0							
Water use										
Water & fishing right	1									
Water borne diseases	3	1	-3	-1	-1	-1	-1	-1	-1	-1
Landscape										
Valuable landscape	1									
Social institutions										
Temples, places for prayer	1									
Archaeological monuments	1									

TABLE G3-2 (2/2) INITIAL ENVIRONMENTAL EXAMINATION MATRIX

Scale of Importance

Rating	Criteria
1 (not important)	un-related to or un-affected by flooding
2 (important)	affected to some extent by flooding
3 (very important)	affected significantly by flooding
x (not clear)	may/ may not be affected by flooding; further study necessary

Scale of Present Condition

Rating	Criteria
1	worse quality than twenty years ago
2	almost same as 20 years ago
3	better quality than 20 years ago
x	rating not possible due to lack of data; further study needed

Future Condition without Project and Potential Environmental Impact to be Generated with Project

Rating	"Without" Project/ Potential Impacts to be generated "With" the Project
-3	high significance (negative)
-2	medium significance (negative)
-1	low significance (negative)
0	no impact
x	impact not clear; further study needed
1	low significance (positive or beneficial)
2	medium significance (positive or beneficial)
3	high significance (positive or beneficial)

Table G4-1 Traffic Volumes Records during Field Survey (27/12/98) on Kop Srov Road

Types/Times	06.00-07.00	07.00-08.00	08.00-09.00	09.00-10.00	10.00-11.00	11.00-12.00	12.00-13.00	13.00-14.00	14.00-15.00	15.00-16.00	16.00-17.00	17.00-18.00	Total
1. Bi & Tricycles	13	53	34	0	0	0	0	0	0	0	0	0	100
2. Motorcycle	257	400	403	333	246	153	194	121	139	195	153	112	2,716
3. Car & Pick-up	2	19	14	0	0	0	0	0	0	0	0	0	35
4. Light Bus (4 wheels)	0	0	0	0	0	0	0	0	0	0	2	0	2
5. Heavy Bus (6 wheels)	0	0	0	0	0	0	0	0	0	0	0	0	0
6. Light Truck (4 wheels)	0	0	0	3	3	1	3	0	4	12	7	7	40
7. Medium Truck (6 wheels)	0	0	0	13	11	7	6	0	18	14	18	13	100
8. Heavy Truck (10 wheels)	0	0	0	2	3	6	2	0	8	7	12	7	47
9. Trailer	0	0	0	1	2	0	0	0	7	3	2	3	18
Sub-total	282	472	451	352	265	167	205	121	176	231	194	142	3,058
other = cart	15	8	5	5	4	2	3	2	2	7	2	2	57
Total	297	480	456	357	269	169	208	123	178	238	196	144	3,115

Remark : unit = vehicle

Table G4-2 Traffic Volumes Records during Field Survey (28/12/98) on Kop Srov Road

Types/Times	06.00-07.00	07.00-08.00	08.00-09.00	09.00-10.00	10.00-11.00	11.00-12.00	12.00-13.00	13.00-14.00	14.00-15.00	15.00-16.00	16.00-17.00	17.00-18.00	Total
1. Bi & Tricycles	19	13	8	20	12	18	13	7	17	19	7	12	165
2. Motorcycle	312	277	162	208	188	160	140	155	240	245	165	133	2,385
3. Car & Pick-up	3	8	10	5	6	11	6	2	11	8	11	5	86
4. Light Bus (4 wheels)	1	1	1	0	0	3	0	0	2	0	0	0	8
5. Heavy Bus (6 wheels)	0	0	0	0	0	0	0	0	0	0	0	0	0
6. Light Truck (4 wheels)	8	6	6	3	1	5	7	1	1	6	6	2	52
7. Medium Truck (6 wheels)	6	8	9	15	14	14	18	13	7	7	14	2	127
8. Heavy Truck (10 wheels)	0	4	4	3	8	11	2	0	1	2	3	2	40
9. Trailer	0	1	0	1	0	2	1	3	2	2	4	0	16
Sub-total	349	318	200	255	229	224	187	181	281	289	210	156	2,879
other = cart	11	6	3	5	4	2	8	2	2	5	2	2	52
Total	360	324	203	260	233	226	195	183	283	294	212	158	2,931

Remark : unit = vehicle

Table G4-3 Traffic Volumes Records during Field Survey (27-28/12/98) on Tompun Road (Station 6)

27/12/98

Types/Times	06.00-07.00	07.00-08.00	08.00-09.00	09.00-10.00	10.00-11.00	11.00-12.00	12.00-13.00	13.00-14.00	14.00-15.00	15.00-16.00	16.00-17.00	17.00-18.00	Total
1. Bi & Tricycles	55	50	45	20	32	26	19	30	40	31	42	43	433
2. Motorcycle	347	373	331	284	254	281	303	218	246	275	460	398	3,770
3. Car & Pick-up	3	15	16	8	12	10	6	11	10	15	16	37	159
4. Light Bus (4 wheels)	3	3	4	5	6	10	4	3	4	1	5	7	55
5. Heavy Bus (6 wheels)	0	0	0	0	0	0	0	0	0	0	0	0	0
6. Light Truck (4 wheels)	0	2	0	0	3	0	0	0	0	0	0	0	5
7. Medium Truck (6 wheels)	6	6	7	0	1	10	12	9	6	8	13	2	80
8. Heavy Truck (10 wheels)	0	2	4	9	2	1	1	3	0	1	0	6	29
9. Trailer	0	0	0	3	0	0	0	0	0	1	0	0	4
Total	414	451	407	329	310	338	345	274	306	332	536	493	4,535

28/12/98

Types/Times	06.00-07.00	07.00-08.00	08.00-09.00	09.00-10.00	10.00-11.00	11.00-12.00	12.00-13.00	13.00-14.00	14.00-15.00	15.00-16.00	16.00-17.00	17.00-18.00	Total
1. Bi & Tricycles	105	77	34	51	23	74	58	16	17	15	33	83	586
2. Motorcycle	368	403	255	228	199	324	265	179	174	177	129	327	3,028
3. Car & Pick-up	4	16	19	19	15	19	9	13	22	21	16	26	199
4. Light Bus (4 wheels)	3	2	3	6	4	9	3	0	8	2	2	4	46
5. Heavy Bus (6 wheels)	0	0	0	0	0	0	0	0	0	0	0	0	0
6. Light Truck (4 wheels)	0	0	1	1	1	0	3	0	0	0	0	0	6
7. Medium Truck (6 wheels)	4	10	14	15	9	5	6	12	18	4	13	7	117
8. Heavy Truck (10 wheels)	0	2	0	1	0	3	1	1	2	0	2	0	12
9. Trailer	0	0	0	0	0	0	0	0	0	0	0	0	0
Total	484	510	326	321	251	434	345	221	241	219	195	447	3,994

Remark : unit = vehicle

Table G4-4 Flood Condition in Year 1995 and 1996

Item	Year 1995	Year 1996
Flood Characteristics		
(1) Peak Water Level at Chaktomuk	EL. 9.12 m (Sep. 18 & 19)	EL. 9.92 m (Oct. 02)
(2) Duration over EL. 8.5 m	47 days (Sep. 07 to Oct. 23)	44 days (Sep. 21 to Nov. 03)
(3) Type of Hydrograph	Flat	Flat
Damage and Flood Defense Activity in the Year 1996 Flood		
(1) General	<p>This flood is the second biggest in the last 38 years in terms of the water level. Severe damage was inflicted on the municipality of Phnom Penh at many locations. However, the great effort for the flood defense activity by official / private organizations concerned could barely avoid the serious impact.</p>	
(2) Kop Srov Dike	<ul style="list-style-type: none"> - In the eastern direction approx. 6 km section of Kop Srov dike starting from NR-5, the flood nearly reached the dike crest whose elevations are 10.1 to 10.7 m (however, no spill-over occurred). - The head of 3 to 4 m (at the highest water stage) between the water levels inside and outside the dike generated more than 20 places of piping holes, most of which penetrated the dike body or its foundation entirely from the outside to the land side, water leaking through them. - Moreover, the dike slopes were damaged by local rainfall and wave action, jeopardizing the dike's stability. - To protect the dike from breaching due to the above phenomena, 92 trucks of soil were brought in the site to fill up the piping holes, and to cover the damaged dike slopes by using sand bags. 	
(3) Tompun Dike	<ul style="list-style-type: none"> - Likewise, Tompun dike, whose crest elevations are 10.0 to 10.4 m, suffered from serious danger during the flood. A lot of piping holes and slope erosion were found in places along the whole stretch, where the water balance between both sides reached nearly 5 m. - 119 trucks of soil were carried therein to repair such piping holes and dike slopes. 	
(4) Tonle Sap and Bassac Riverfront	<ul style="list-style-type: none"> - In the lowest two portions of the roads running by Tonle Sap and Bassac rivers, with surface elevations of 10.2 to 10.5 m and 9.6 to 10.0 m in the upstream and downstream portions, respectively, the floodwater level had nearly exceeded their crests, whereas the construction of temporary embankments on the roads, with 30 trucks of soil, prevented overflowing at each location. - A pipe culvert was broken in the event of the flood at the upstream portion. To prevent floodwater from entering through the culvert into the land side, sand bags were cast therein. 	

Table G4-5 Inundation Condition in Year 1995 and 1996

Item	Year 1995	Year 1996
Rainfall Characteristics		
(1) Annual Rainfall	1,413mm	1,639mm
(2) Daily Rainfall		
(a) Over 50 mm	5 times Apr. 30 : 54mm May 08 : 111mm Sep. 02 : 55mm Sep. 28 : 53mm Oct. 06 : 51mm	6 times Jun. 16 : 52mm Aug. 08 : 62mm Sep. 09 : 57mm Nov. 03 : 58mm Nov. 13 : 137mm Nov. 23 : 58mm
(b) Over 30 mm	16 times	15 times
Inundation Problems in the Year 1996		
(1) General	The description hereunder is with reference to the inundation problems in the year 1996. However, as almost every year very similar inundation problems take place in the Study Area, all the description may be valid for other years.	
(2) Natural Levee Area	This area runs along Tonle Sap and Bassac rivers, about 1 km wide, with elevations above 10 m, so that inundation in the area is slight in magnitude. It lasts only several hours with less than 25 cm of water depths. However, it has repeated some ten times a year, interrupting traffic and in turn stagnating the economy, deteriorating the sanitation, then causing social issues, particularly in City Core.	
(3) Backswamp Area	This area lies behind the Natural Levee area above with widths of 2 to 3 km, whose elevations range from 6 to 8 m, which can be divided into the following two parts:	
(a) Northern Part	This is actually a swampy area, storing runoff from the northern half of the Study Area without problematic inundation.	
(b) Southern Part	The discharge of runoff from this part depends solely on mechanical drainage because of its low elevations. Inundation lasts for a longer time and comes to the peak at the end of the heavy rain period with a maximum water depth of more than 1 m at Trabek.	
(4) West Area Fringe	The area fringes the West Area, Item (5) below, with slightly high elevations, around 10 m, mostly formed by recent artificial fills. No serious inundation is hence observed therein.	
(5) West Area	Paddy fields spread over the area which declines at mild gradients from the west (EL. 13 m) to the east (EL. 9 m). Rainfalls are reserved in the paddy fields for planting / growing rice, of course, without causing damage.	
(6) South Area	This area (EL. 8 to 10 m) is considered a part of the floodplains of Prek Thnot River, the hydraulics directly affected by the river through openings provided along Prey Sar road. The inundation depth reaches more than 1 m at maximum.	

Table G4-6 Summary of Results of Asset and Flood Damage Survey

Item	Unit	Type of Interviewees									
		Household	Shop	Office	Factory	Warehouse	School	Hospital	Farm	Livestock	Fishpond
Number of samples surveyed		416	121	11	16	10	17	9	102	30	20
Number of household members/employees/students/patients		6.5	6.2	22	5	3	2,624	132	6.6	6.9	4.4
Annual income in 1997	\$	1,091	1,268	6,000	23,832	39,673	-	n.a.	873	1,929	6,823
Size of land	m ²	177	64	1,336	511	317	6,962	6,696	13,802	1,360	4,724
Floor area	m ²	105	32	424	239	205	2,154	n.a.	-	-	-
Frequency of flood											
No flood	%	0.2	0.0	27.3	18.8	21.6	0.0	62.5	46.1	93.3	80.0
Once a year	%	59.6	59.5	18.2	50.0	32.4	11.8	0.0	37.3	3.3	20.0
Two to five times a year	%	19.0	27.3	0.0	6.3	5.4	11.8	0.0	1.0	3.3	0.0
More	%	21.2	13.2	54.6	25.0	40.5	76.5	37.5	15.7	0.0	0.0
Height of floor level	m	0.54	0.29	0.39	0.18	0.12	0.72	n.a.	-	-	-
Water depth at inundation											
1995	m	0.62	0.39	0.41	0.52	0.36	0.57	0.57*	1.1	0.55	1.12
1996	m	0.60	0.35	0.39	0.57	0.34	0.53	0.57*	1.2	0.55	0.00
Duration of inundation											
1995	days	22	18	3	14	10	13	6*	80	23	38
1996	days	21	14	3	8	7	10	6*	80	23	0
Suffer from flood											
No answer	%	9.6	0.0	9.1	0.0	0.0	0.0	0.0*	46.1	0.0	80.0
Severely	%	23.3	37.2	63.6	56.3	40.0	94.1	100.0*	10.8	6.7	10.0
Lightly	%	41.8	43.0	9.1	37.5	60.0	5.9	0.0*	24.5	0.0	5.0
No	%	25.2	19.8	18.2	6.3	0.0	0.0	0.0*	18.6	93.3	5.0
Damage in utility / infrastructure in 1996											
Power	%	1.2	0.0	0.0	6.3	0.0	0.0	0.0	-	-	-
Telephone	%	0.0	0.0	0.0	6.3	0.0	0.0	0.0	-	-	-
Water	%	32.5	21.5	0.0	18.8	10.0	0.0	12.5	-	-	-
Transportation	%	31.3	17.4	45.5	12.5	10.0	82.4	25.0	-	-	-
Flood damage in monetary value											
1995	\$	341	235	1,077	2,153	914	3,067	n.a.	230	n.a.	9,245
1996	\$	143	107	10,050	517	1,054	6,571	n.a.	104	n.a.	0
Expectation for flood mitigation											
Strongly support	%	51.7	48.8	100.0	68.8	40.0	94.1	28.6*	24.5	16.7	10.0
Support	%	44.5	47.1	0.0	25.0	60.0	5.9	0.0*	75.5	83.3	0.0
No need	%	3.9	4.1	0.0	6.3	0.0	0.0	71.4*	0.0	0.0	90.0
Other											
Shop closed / stop operation in 1996	days	-	6	0	16	0	n.a.	0	-	-	-
Total number in Phnom Penh	No.	-	4,371	534	613	164	128	29	-	-	-

Notes:

- (1) The values above are all average values except for percentages.
- (2) The values with * are the averages of the samples with effective information only.

Source:

Asset and Flood Damage Survey conducted by TEAM Consulting Engineers Co., Ltd.

Table G4-7 Sample Distribution of Socio-economic Survey

Type of Respondents House	Number of Household	Number of Sample	Percentage of Sample
Kop Srov Dike			
1. Concrete House (1A)	10	3	30.00
2. Tile Roof House (2A)	34	8	23.53
3. Pantile Roof House (3A)	7	2	28.57
4. Metal Roof (4A)	232	52	22.41
5. Thatch Roof (5A)	160	27	16.88
Sub-total	443	92	20.77
Tompun Dike			
1. Concrete House (1A)	43	9	20.93
2. Tile Roof House (2A)	107	24	22.43
3. Pantile Roof House (3A)	70	18	25.71
4. Metal Roof (4A)	458	88	19.21
5. Thatch Roof (5A)	40	11	27.50
Sub-total	718	150	20.89
Grand Total	1,161	242	20.84

Source: Compensation Survey results

Table G4-8 General Information of Household and Family Structure in Kop Srov and Tompun Dikes Improvement Area

Item	Kop Srov Dike		Tompun Dike		Total	
	Number	%	Number	%	Number	%
Number of Respondents	92	38.02	150	61.98	242	100.00
1. Information of Respondent						
1.1 Sex						
- Male	53	57.61	110	73.33	163	67.36
- Female	39	42.39	40	26.67	79	32.64
1.2 Age						
- Less than 30 years	12	13.04	15	10.00	27	11.16
- 30 - 40 years	32	34.78	40	26.67	72	29.75
- 41 - 50 years	26	28.26	43	28.67	69	28.51
- 51 - 60 years	7	7.61	37	24.67	44	18.18
- More than 60 years	15	16.30	15	10.00	30	12.40
Average age (years)	43.48		45.49		44.73	
1.3 Education Level of Respondents						
- Never Attend School	16	17.39	17	11.33	33	13.64
- Primary School	30	32.61	53	35.33	83	34.30
- Secondary School	29	31.52	70	46.67	99	40.91
- High School	12	13.04	8	5.33	20	8.26
- Certificate	3	3.26	1	0.67	4	1.65
- Higher than Bachelor Degree	2	2.17	0	0.00	2	0.83
- Studied from Temple	1	1.09	1	0.67	1	0.41
1.4 Status in Family						
- Head	70	76.09	130	86.67	200	82.64
- Wife	8	8.70	8	5.33	16	6.61
- Child	2	2.17	5	3.33	7	2.89
- Father / Mother	12	13.04	7	4.67	19	7.85
1.5 Religious						
- Buddhism	91	98.91	150	100.00	241	99.59
- Christian	1	1.09	0	0.00	1	0.41
2. Information of Family Structure						
2.1 Number of Household Members (person/HH)						
1) Size of Family						
- Lower than 5	30	32.61	35	23.33	65	26.86
- 5 - 7	41	44.57	75	50.00	116	47.93
- 8 - 10	16	17.39	30	20.00	46	19.01
- More than 10	5	5.43	10	6.67	15	6.20
Total Average Persons	5.93		6.31		6.17	
2) Sex						
- Male	3.00	50.59	2.99	47.39	2.99	48.56
- Female	2.93	49.41	3.32	52.61	3.17	51.44
2.2 Age of Family Member (person/ HH)						
- Lower than 6 years old	0.79	13.32	0.72	11.41	0.75	12.11
- 6 - 13	1.61	27.15	1.54	24.41	1.57	25.41
- 14 - 20	1.01	17.03	1.19	18.86	1.12	18.19
- 21 - 60	2.26	38.11	2.53	40.10	2.43	39.37
- Higher than 60	0.26	4.38	0.33	5.23	0.30	4.92
2.3 Education Level of Member						
- Never Attend School	0.42	7.08	0.46	7.29	0.44	7.21
- Primary School	1.47	24.79	1.58	25.04	1.54	24.95
- Secondary School	0.61	10.29	1.20	19.02	0.98	15.83
- High School	0.34	5.73	0.22	3.49	0.27	4.31
- Certificate	0.04	0.67	0.04	0.63	0.04	0.65
- Bachelor Degree	0.04	0.67	0.02	0.32	0.03	0.45
- Higher than Bachelor Degree	0.04	0.67	0.00	0.00	0.02	0.25
- Pre-school	1.03	17.37	0.84	13.31	0.91	14.80
- In-school	1.94	32.72	1.95	30.90	1.95	31.57
2.4 Employment / Unemployment of Family Member (person per Household)						
- Employment	1.68	28.33	1.82	28.84	1.77	28.66
- Unemployment	4.24	71.50	4.49	71.16	4.39	71.28
- Dependency Ratio	2.52		2.47		2.49	

Table G4-9 Compensation Cost Estimates for Affected Properties

Type			Compensation Cost (US\$) / sq.m	Area (sq.m.)	No. of House	Total (US\$)	Remark
Well Established House	I	A	65.00	40	1	2,600	
		B	40.00	-	-	-	
		C	40.00	350	2	14,000	
		D	59.00	30	1	1,770	
	II	A	18.00	341	6	6,138	
		B	32.00	150	1	4,800	
		C	39.00	120	1	4,680	
		D	26.00	0	0	0	
Good Quality	III	A	23.00	22	1	506	
		B	33.00	-	-	-	
		C	50.00	-	-	-	
		D	9.00	-	-	-	
	IV	A	20.00	848	21	16,960	
		B	29.00	-	-	-	
		C	41.00	12	1	492	
		D	20.00	-	-	-	
Poor Quality	V	A	25.00	28	1	700	
		B	25.00	-	-	-	
		C	32.00	200	6	6,400	
		D	27.00	22	2	594	
		E	9.00	312	7	2,808	
Sub Total				2,475	51	62,448	
Fence (m)	1	4.00	230	-	920	(Wooden)	
	2	8.00	60	-	480	(Barbed Wire)	
	3	20.00	520	-	10,400	(Concrete)	
	4	14.00	-	-	-	(Concrete / Iron Bar)	
Sub Total				810		11,800	
Total						74,248	

Table G4-10 Breakdown of Compensation Cost Estimates for Each Model of Structure

Type		Area of Sampled House (sq.m)	Compensation Cost (US\$/sq.m)	Compensation Cost (US\$)					Unit Cost (US\$/sq.m)	
				(1) Material Cost (US\$)	(2) Labor Cost (US\$)	(3) Dismantling (US\$)	(4) Transportation Cost (US\$)	(5) Total (US\$)		
Well Established House	I	A	72	4,212.47	3,177.96	972.09	486.05	50.00	4,686.10	65
		B	144	6,008.55	3,592.20	1,385.18	692.59	50.00	5,719.97	40
		C	36	1,432.67	894.70	330.61	165.31	50.00	1,440.62	40
		D	9	580.45	312.08	113.70	56.85	50.00	532.63	59
	II	A	81	2,083.47	614.72	480.81	240.41	100.00	1,435.94	18
		B	28	1,049.16	473.43	242.13	121.06	50.00	886.62	32
		C	54	2,699.18	1,127.31	622.90	311.45	50.00	2,111.66	39
		D	8	215.99	67.05	49.83	24.92	50.00	191.80	26
Good Quality	III	A	64	2,232.56	574.30	515.22	257.61	100.00	1,447.13	23
		B	24	985.19	410.78	227.35	113.67	50.00	801.80	33
		C	54	2,995.29	1,569.48	724.31	362.16	50.00	2,705.95	50
		D	48	603.41	152.77	139.25	69.63	50.00	411.65	9
	IV	A	60	1,822.99	489.45	420.69	210.35	100.00	1,220.49	20
		B	36	1,152.84	586.50	266.04	133.02	50.00	1,035.56	29
		C	54	2,630.19	1,233.12	606.97	303.49	50.00	2,193.58	41
		D	18	466.40	155.95	107.63	53.82	50.00	367.40	20
Poor Quality	V	A	12	429.68	98.06	99.17	49.59	50.00	296.82	25
		B	9	294.09	71.37	67.87	33.94	50.00	223.18	25
		C	9	358.72	112.13	82.78	41.39	50.00	286.30	32
		D	9	308.64	88.55	71.24	35.62	50.00	245.41	27
		E	12	92.73	28.53	21.55	10.78	50.00	110.86	9
Fence (m)	1	6	21.03	16.18	4.86	2.43	-	23.47	4	
	2	6	42.90	33.00	9.90	9.95	-	52.85	8	
	3	6	108.81	83.70	25.11	12.60	-	121.41	20	
	4	6	75.34	57.95	17.39	8.70	-	84.04	14	

Notes;

(2) Labor Cost: 23% of Material Cost

(3) Dismantling: 50% of Labor Cost

Fence type 1: Wooden

Fence type 2: Barbed Wire

Fence type 3: Concrete

Fence type 4: Concrete/Iron Bar

Table G5-1 Land Use Type along the Proposed Meanchey Drainage Channel Improvement within 20m width from Center Line

No.	Land Use Type	Approximate Area(m ²)	Percentage(%)
1.	Resident (U/R)	9,126	1.22
2.	Factory / Industry (U/F)	3,627	0.49
3.	Entertainment / Restaurant / Hotel (U/E)	179,240	24.06
4.	Orchards (A/O)	7,506	1.01
5.	Vegetable (A/V)	14,663	1.97
6.	Idle land (M/I)	36,655	4.92
7.	Water bodies (W)	494,178	66.33
Total		744,998	100.00

Source : Field survey in December, 1998.

Table G5-2 Land Use Type at the Proposed Tompun Regulation Pond Improvement

No.	Land Use Type	Approximate Area(m ²)	Percentage(%)
1.	Resident (U/R)	1,282	0.23
2.	Aquatic plants (A/A)	174,797	30.92
3.	Vegetable (A/V)	14,663	2.59
4.	Idle land (M/I)	15,182	2.69
5.	Water bodies (W)	359,287	63.57
Total		565,213	100.00

Source : Field survey in December, 1998.

Table G5-3 Land Use Type along the Proposed Boeng Salang and Drainage Channel Improvement within 20m width from Center Line

No.	Land Use Type	Approximate Area(m ²)	Percentage(%)
1.	Resident (U/R)	12,543	7.17
2.	Factory / Industry (U/F)	640	0.37
3.	Idle land (M/I)	27,575	15.77
4.	Water bodies (W)	134,132	76.69
Total		174,890	100.00

Source : Field survey in December, 1998.

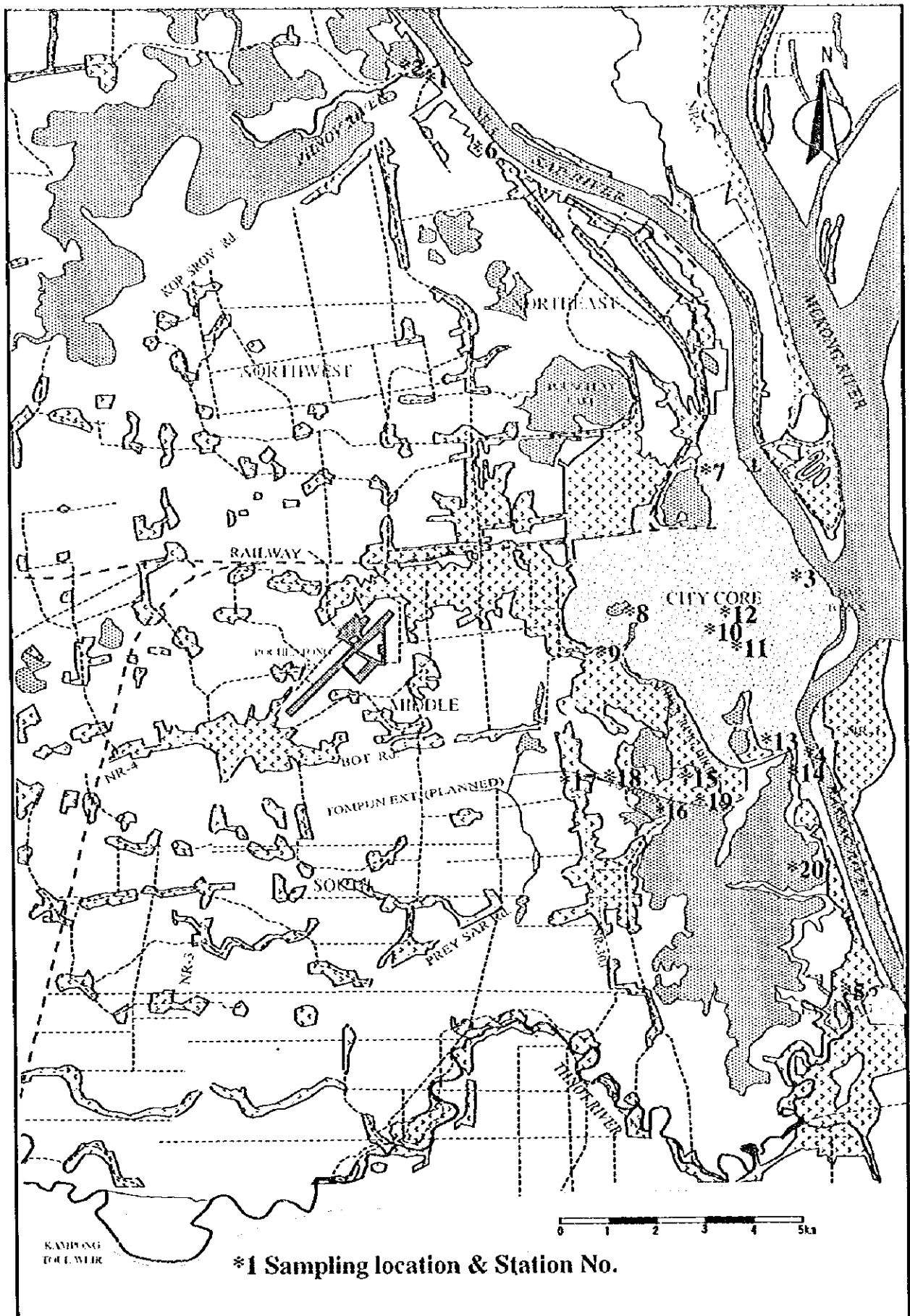
Table G5-4 Sample Distribution of Socio-economic Survey

Type of Respondents House	Number of Household	Number of Sample	Percentage of Sample
1. Concrete House (1A)	11	1	9.09
2. House with Tile Roof (2A)	3	2	66.67
3. House with Tile Roof (3A)	15	5	33.33
4. House with Metal Roof (4A)	309	64	20.71
5. House with Thatch Roof (5A)	197	40	20.30
Total	535	112	20.93

Table G5-5 Summary of Environmental Impacts

Environmental Resources	Environmental Impacts
1. Physical Resources	
1.1 Hydrology	<p>Construction Period</p> <ul style="list-style-type: none"> - Flow disturbance during construction period. <p>Operation Period</p> <ul style="list-style-type: none"> - No adverse impact.
1.2 Water Quality	<p>Construction Period</p> <ul style="list-style-type: none"> - Addition of suspend solid from construction area. - Wastewater discharge from construction camp, site office and workshop. - Contamination of oil, lubricants from equipment. <p>Operation Period</p> <ul style="list-style-type: none"> - No adverse impact.
1.3 Soil/ Sediment	<p>Construction Period</p> <ul style="list-style-type: none"> - Excavation of soil totally 62 ha. - Fill up soil in resettlement site 7.56 ha - Dredge Soil Disposal <p>Operation Period</p> <ul style="list-style-type: none"> - Monitoring of dredge spoil disposal site location
2. Human Use Values	
2.1 Land Use	<p>Construction Period</p> <ul style="list-style-type: none"> - 14,214 m², 152,157 m², 10,465 m² and 10,454 m² of residential area, water body, agriculture land and idle land respectively need to be acquired for construction and installation of project facilities. <p>Operation Period</p> <ul style="list-style-type: none"> - No adverse impact.
2.2 Transportation	<p>Construction Period</p> <ul style="list-style-type: none"> - Traffic congestion and high risk of accident. - Deterioration of road surface. - Increase of dust dispersion. - Inconvenience in local transportation. <p>Operation Period</p> <ul style="list-style-type: none"> - No adverse impact. - Tompun road's condition will be improved.
2.3 Flood Control	<p>Construction Period</p> <ul style="list-style-type: none"> - Drainage of rain water will be blocked. <p>Operation Period</p> <ul style="list-style-type: none"> - The effectiveness of the flood control structure will be significantly improved.
3. Quality of Life Values	
3.1 Socio-economic	<p>Construction Period</p> <ol style="list-style-type: none"> 1. 345 families who need to relocate will take longer distance to work place, or school; <ul style="list-style-type: none"> - 6.11% of families have to take longer distance to school. - all affected families have to pay higher cost of transportation. - 5 families will lose cropping land. 3. Lost of income livelihood opportunity of affected people. 4. Disturbance of communities by dust, noise, and transportation inconvenience. <p>Operation Period</p> <ul style="list-style-type: none"> - Quality of life in communities near Tompun pumping station, Boung Salang and Meanchey will be improved.
3.2 Compensation / Resettlement	<p>Pre-Construction Period</p> <ul style="list-style-type: none"> - 357 households need to be relocated. - Compensation cost is 5,466,710 USD. <p>Operation Period</p> <ul style="list-style-type: none"> - No adverse impact.
3.3 Archaeology and Tourism	<p>Construction Period</p> <ul style="list-style-type: none"> - No impact <p>Operation Period</p> <ul style="list-style-type: none"> - No adverse impact.





KAMPONG
CHHMEU

*1 Sampling location & Station No.

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Figure G2-1
Location of Water Quality and Benthic Material Quality
Sampling

G-7-35









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