(10) Yao River Training

At the Yao river training area, geological investigations such as drilling accompanying with standard penetration test are required to confirm the geological condition (bearing capacity) of basement at/around main facilities, for example consolidation dam facility (consolidation sill facility) in total 8 locations.

Table11.2.5-1 List of Proposed Additional Geological Investigation (Drilling Investigation) at the Intake and Water Diversion Canal (1)

Item of Facility	Borehole No.	Drilling Depth(m)	In-situ Test SPT	In-situ Test PT	Location	Remarks
Kok intake	KI-1	30	○	○	on the intake axis	Alluvial deposit (bearing capacity)
	KI-2	30	○	○	on the intake axis	- ditto -
	KI-3	30	○	○	on the intake axis	- ditto -
	KI-4	20	○	○	on the apron of intake	- ditto -
total	4 holes	110				
Kok-Ing diversion canal						
Kok basin (L=11.7 km)	KIDC-K1	20	○	○	KM.1+400 (highway bridge)	Alluvial deposit (bearing capacity)
	KIDC-K2	20	○	○	KM.2+000	- ditto -
	KIDC-K3	20	○	○	KM.3+000	- ditto -
	KIDC-K4	20	○	○	KM.4+100	- ditto -
	KIDC-K5	20	○	○	KM.5+000	- ditto -
	KIDC-K6	20	○	○	KM.6+000	- ditto -
	KIDC-K7	20	○	○	KM.6+600 (highway bridge)	- ditto -
	KIDC-K8	20	○	○	KM.7+200	- ditto -
	KIDC-K9	20	○	○	KM.8+200 (highway bridge)	- ditto -
	KIDC-K10	20	○	○	KM.10+000	- ditto -
	KIDC-K11	20	○	○	KM.11+000	- ditto -
sub total	11 holes	220				
Tak basin (L=10.8 km)	KIDC-T1	30	○	○	KM.16+000	Alluvial deposit (bearing capacity)
	KIDC-T2	20	○	○	KM.17+000	- ditto -
	KIDC-T3	20	○	○	KM.18+000	- ditto -
	KIDC-T4	30	○	◎	KM.18+600 (on hill of right side)	Geological condition & permeability of PTR formation
	KIDC-T5	30	○	◎	KM.18+700	- ditto -
	KIDC-T6	20	○	○	KM.19+000	Alluvial deposit (bearing capacity)
	KIDC-T7	20	○	○	KM.20+000	- ditto -
	KIDC-T8	30	○	○	KM.22+000	- ditto -
	KIDC-T9	40	○	○	KM.24+000	Al. dep. & geological condition of P3 formation
	KIDC-T10	40	○	○	KM.25+000	- ditto -
	KIDC-T11	40	○	○	KM.26+000	- ditto -
sub total	11 holes	320				
Ing basin (L=23.6 km)	KIDC-I1	20	○	○	KM.32+000	Alluvial deposit (bearing capacity)
	KIDC-I2	20	○	○	KM.33+000	- ditto -
	KIDC-I3	20	○	○	KM.34+000	- ditto -
	KIDC-I4	20	○	○	KM.35+000	- ditto -
	KIDC-I5	30	○	○	KM.35+800	Geological condition of Bs formation (weathered rock)

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Table11.2.5-1 List of Proposed Additional Geological Investigation (Drilling Investigation) at the Intake and Water Diversion Canal (2)

Item of Facility	Borehole No.	Drilling Depth(m)	In-situ Test SPT	In-situ Test PT	Location	Remarks
Ing basin (L=23.6 km)	KIDC-I6	30	○	○	KM.36+800	- ditto -
	KIDC-I7	20	○	○	KM.37+800	Alluvial deposit (bearing capacity)
	KIDC-I8	20	○	○	KM.39+000	- ditto -
	KIDC-I9	20	○	○	KM.41+000	- ditto -
	KIDC-I10	20	○	○	KM.42+000	- ditto -
	KIDC-I11	20	○	○	KM.43+000	- ditto -
	KIDC-I12	20	○	○	KM.44+000	- ditto -
	KIDC-I13	20	○	○	KM.45+000	- ditto -
	KIDC-I14	20	○	○	KM.46+000	- ditto -
	KIDC-I15	20	○	○	KM.47+000	- ditto -
	KIDC-I16	20	○	○	KM.48+000 (highway bridge)	- ditto -
	KIDC-I17	20	○	○	KM.49+000	- ditto -
	KIDC-I18	20	○	○	KM.50+000	- ditto -
	KIDC-I19	20	○	○	KM.51+000	- ditto -
	KIDC-I20	20	○	○	KM.52+000	- ditto -
	KIDC-I21	20	○	○	KM.53+000	- ditto -
	KIDC-I22	20	○	○	KM.54+000	- ditto -
	KIDC-I23	20	○	○	KM.55+000	- ditto -
sub total	23 holes	480				
total	45 holes	1,020				
Ing diversion weir & intake	IW-1	30	○	○	on the weir axis	Alluvial deposit (bearing capacity)
	IW-2	30	○	○	on the weir axis	- ditto -
	IW-3	30	○	○	on the weir axis	- ditto -
	IW-4	30	○	○	on the intake axis	- ditto -
	IW-5	30	○	○	on the intake axis	- ditto -
	IW-6	30	○	○	on the intake axis	- ditto -
	IW-7	20	○	○	on the apron of intake	- ditto -
total	7 holes	200				
Lao diversion canal (L=13.5 km)	LDC-1	20	○	○	KM.1+000	Alluvial deposit (bearing capacity)
	LDC-2	20	○	○	KM.2+000	- ditto -
	LDC-3	30	○	○	KM.4+800 (Lao siphon, left abutment)	- ditto -
	LDC-4	30	○	○	KM.6+000	- ditto -
	LDC-5	30	○	○	KM.7+000	- ditto -
	LDC-6	30	○	○	KM.8+000	Al. dep. & geological condition of TRpn formation

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Table11.2.5-1 List of Proposed Additional Geological Investigation (Drilling Investigation) at the Intake and Water Diversion Canal (3)

Item of Facility	Borehole No.	Drilling Depth(m)	In-situ Test		Location	Remarks
			SPT	PT		
Lao diversion canal (L=13.5 km)	LDC-7	40	○	○	KM.9+000	- ditto -
	LDC-8	40	○	○	KM.10+000	- ditto -
	LDC-9	40	○	○	KM.11+000	- ditto -
	LDC-10	40	○	○	KM.12+000	- ditto -
	LDC-11	40	○	○	KM.13+000	- ditto -
	LDC-12	40	○	○	KM.13+700	- ditto -
total	12 holes	400				
Grand total	68 holes	1,730				

* SPT : standard penetration test, PT : permeability test
* Standard penetration test should be performed 1.0 m interval in drilling depth.
* Permeability test should be performed at least 3 points per each hole. The target of testing should be applied to the sand layer into the drilling section.
* Permeability test of KIDC-15 and KIDC-16 holes should be performed as lugeon test (it is shown as double circle mark in the above table).

Table11.2.5-2 List of Proposed Additional Investigation (Drilling Investigation) at the Kok-Ing and Ing-Yot Tunnel (1)

Item of Facility	Borehole No.	Ground Level (EL.m)	Drilling Depth (m)	LT	Logging Test	Rock Test	Inclined Drilling	Location	Remarks
(3) Kok-Ing No.1 Tunnel	KIT1-1	400	40	○	-	-	-	KM.12+700 (inlet)	Around inlet (PTR formation)
	KIT1-2	430	70	○	○	○	-	KM.13+550	Geological condition of JV formation & fault, collation of TEM results
	KIT1-3	420	60	○	-	-	-	KM.14+400	Geological condition of PTR formation, confirmation of fault
sub total	3 holes		170						
(4) Kok-Ing No.2 Tunnel	KIT2-1	400	40	○	-	-	-	KM.26+500 (inlet)	Around inlet (P3 formation)
	KIT2-2	415	90	○	-	-	○	KM.27+050	Geological condition of P2 (limestone) formation, confirmation of fault contact
	KIT2-3	540	180	○	○	○	-	KM.28+500	Geological condition of P3 formation, confirmation of fault
	KIT2-4	470	90	○	-	-	-	KM.30+400 (outlet)	Around inlet (P3 formation)
	KIT2-5	380	30	○	-	-	-	KM.31+200 (outlet)	Around inlet (P3 formation), confirmation of fault zone
sub total	5 holes		430						
(7) Ing-Yot No.1 Tunnel	IYT1-1	390	50	○	-	-	-	KM.2+700 (inlet)	Around inlet (ms3 formation)
	IYT1-2	440	80	○	○	○	-	KM.3+600	Geological condition of ms3 formation, confirmation of fault zone
	IYT1-3	410	70	○	-	-	-	KM.4+400 (outlet)	Around outlet (ms3 formation)
sub total	3 holes		200						
(8) Ing-Yot No.2 Tunnel	IYT2-1	400	60	○	-	-	-	STA.0+450 (inlet)	
	IYT2-2	430	130	○	-	○	○	STA.1+250	Confirmation of contact condition between Porphyry and PTRv formation
	IYT2-3	440	100	○	○	○	-	STA.1+650	Geological condition and rock characteristics of TRhf formation
	IYT2-4	500	160	○	○	○	-	STA.4+100	Geological condition of CPhk formation, confirmation of low resistivity layer by TEM
	IYT2-5	500	170	○	○	○	-	STA.7+400	Geological condition of CPnb formation and confirmation of low resistivity layer by TEM
	IYT2-6	440	110	○	○	○	-	STA.9+510 (the Phu Sang)	Geological condition of CPnb formation, confirmation of influence area of heated groundwater
	IYT2-7	520	190	○	○	○	-	STA.10+250 (the Phu Sang)	- ditto -
	IYT2-8	600	270	○	○	○	-	STA.10+900 (the Phu Sang)	- ditto -
	IYT2-9	490	160	○	○	○	-	the Phu Sang area	- ditto -
	IYT2-10	560	230	○	○	○	-	STA.15+200	Geological condition of CPnb formation, confirmation of fault zone
	IYT2-11	590	260	○	○	○	-	STA.16+900	- ditto -
	IYT2-12	640	310	○	○	○	-	STA.21+000	- ditto -
	IYT2-13	650	320	○	○	○	-	STA.24+900	- ditto -
	IYT2-14	660	330	○	○	○	-	STA.27+400	Geological condition of PTRv formation, confirmation of confined groundwater
	IYT2-15	950	150	○	-	○	○	STA.28+850 (limestone)	Geological condition of TRpl formation and fault zone
	IYT2-16	940	350	○	○	○	-	STA.28+950 (limestone)	Geological condition of TRpl formation and fault zone, collation of TEM results
	IYT2-17	880	150	○	-	○	○	STA.30+150 (limestone)	- ditto -
	IYT2-18	610	290	○	○	○	-	STA.33+200	Geological condition of TRhf formation, confirmation of fault zone
	IYT2-19	590	270	○	○	○	-	STA.35+500	Geological condition of TRhf formation and fault zone, collation of TEM results
	IYT2-20	1,130	350	○	○	○	-	STA.42+600	Geological condition of TRhf and ms5-3 formation, confirmation of fault zone
	IYT2-21	500	180	○	○	○	-	STA.46+300 (limestone)	Geological condition of TRpl formation and fault zone
	IYT2-22	570	250	○	○	○	-	STA.47+300 (limestone)	Geological condition of TRpl and TRhf formation, confirmation of fault zone

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Table11.2.5-2 List of Proposed Additional Investigation (Drilling Investigation) at the Kok-Ing and Ing-Yot Tunnel (2)

Item of Facility	Borehole No.	Ground Level (EL.m)	Drilling Depth (m)	LT	Logging Test	Rock Test	Inclined Drilling	Location	Remarks
(8) Ing-Yot No.2 Tunnel	IYT2-23	460	150	○	○	○	-	STA.49+900 (limestone)	Geological condition of TRpl and TRhf formation, confirmation of fault zone
	IYT2-24	400	110	○	-	○	○	STA.50+500 (limestone)	- ditto -
	IYT2-25	380	70	○	-	-	-	STA.50+600 (outlet)	Around outlet (TRhf formation)
sub total	25 holes		5,120						
total	36 holes		5,920						

* Final decision of borehole location should be performed on the basis of topographical and geological conditions at the site.
* LT : lugeon test, test should be performed at least 3 times per each hole around tunnel horizon.
* Items of logging test are as follows. : caliper logging, full waveform sonic logging P-wave and S-wave), resistivity (short normal and long normal) logging, Spontaneous potential logging, natural gamma logging and water pressure test etc.
* Items of rock test are as follows. : specific gravity, absorption, unconfined compressive strength, tensile strength, ultrasonic velocity, petrographic observation by optical microscope etc.
* IYT2-6, IYT2-7, IYT2-8, IYT-2-9 holes should be used as observation holes for water table after drilling investigation.
* Comments for drilling direction and angle of the inclined borehole are as follows.
  IYT2-2 : upstream dip 45 degree from horizontal, KIT2-2 : downstream dip 45 degree from horizontal
  IYT2-15 : upstream dip 45 degree from horizontal, IYT2-17 : upstream dip 45 degree from horizontal
  IYT2-24 : upstream dip 60 degree from horizontal

Table11.2.5-3 List of Proposed Additional Geological Investigation (Drilling Investigation) at the Yao Flood Control Dam and Yao River Training Area

Item of Facility	Borehole No.	Drilling Depth (m)	SPT	Lugeon Test	LLT	Rock Test	Location	Remarks
Yao flood control dam								
Along the dam axis	YD-1	60	○	○	○	○	left abutment	Geological and permeable condition of foundation, thick weathered layer
	YD-2	80	○	○	○	○	- ditto -	- ditto -
	YD-3	80	○	○	-	○	left abutment (around riverbed)	Geological and permeable condition of foundation
	YD-4	60	○	○	-	○	right abutment	- ditto -
	YD-5	60	○	○	-	○	- ditto -	- ditto -
subtotal	5 holes	340						
At the dam base	YD-6	30	○	○	○	-	upstream, left abutment	Geological and permeable condition of foundation, thick weathered layer
	YD-7	30	○	○	-	-	upstream, riverbed	Geological and permeable condition of foundation
	YD-8	30	○	○	-	-	upstream, right abutment	- ditto -
	YD-9	30	○	○	○	-	downstream, left abutment	Geological and permeable condition of foundation, thick weathered layer
	YD-10	30	○	○	-	-	downstream, riverbed	Geological and permeable condition of foundation
	YD-11	30	○	○	-	-	downstream, right abutment	- ditto -
subtotal	6 holes	180						
Along the spillway axis	YD-12	60	-	○	-	○	crest base (overflow base)	Geological and permeable condition of foundation (bearing capacity)
	YD-13	60	○	○	-	-	gentle chute base	- ditto -
	YD-14	40	○	-	-	-	steep chute base	Geological condition of foundation (bearing capacity)
	YD-15	30	-	-	-	-	energy dissipator base	- ditto -
subtotal	4 holes	190						
Along the diversion tunnel axis	YD-16	60	-	-	○	○	intake gate base	Geological condition of foundation
	YD-17	80	-	○	○	○	middle of diversion tunnel	Geological and permeable condition of foundation
	YD-18	30	-	-	-	-	outlet of diversion tunnel	Geological condition of foundation
subtotal	4 holes	170						
grand total	18 holes	880						
Yao river training								
	YRT-1	20	○	-	-	-	consolidation sill	Geological condition of foundation (bearing capacity)
	YRT-2	20	○	-	-	-	- ditto -	- ditto -
	YRT-3	20	○	-	-	-	- ditto -	- ditto -
	YRT-4	20	○	-	-	-	- ditto -	- ditto -
	YRT-5	20	○	-	-	-	- ditto -	- ditto -
	YRT-6	20	○	-	-	-	- ditto -	- ditto -
	YRT-7	20	○	-	-	-	- ditto -	- ditto -
	YRT-8	20	○	-	-	-	- ditto -	- ditto -
total	8 holes	160						

* SPT : standard penetration test, LLT : lateral loading test

Table11.2.5-4 List of Proposed Additional Investigation (Electromagnetic prospecting Survey, TEM and TDEM) at the Kok-Ing and Ing Yot Tunnel

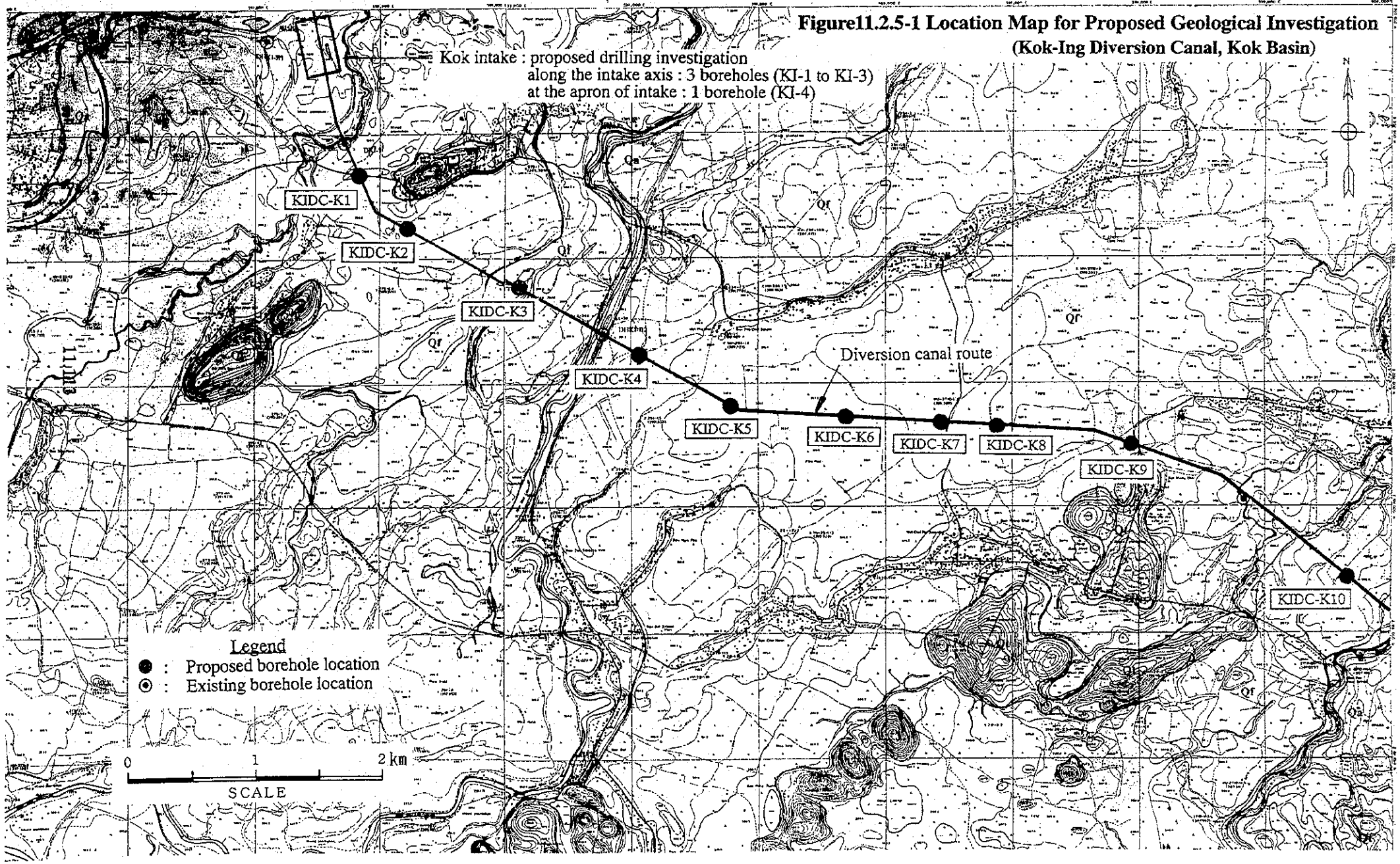
Item of Facility	Line Name	Line Length (m)	Location	Remarks
(3) Kok-Ing No.1 Tunnel	KI1-TEM	3,000	KM.12+300-15+300	Geological condition of Jv and PTR formation & fault condition
(4) Kok-Ing No.2 Tunnel	KI2-TEM	5,300	KM.26+200-31+500	Geological condition of ms3 formation and confirmation of fault zone
(7) Ing-Yot No.1 Tunnel	IY1-TEM	2,000	KM.2+600-4+600	Geological condition of Bs, P3, PTR formation and confirmation of fault
(8) Ing-Yot No.2 Tunnel	IY2-TEM1	1,500	STA.9+500-11+000 (the Phu Sang)	Geological condition around the Phu Sang area. Confirmation of influence area of heated groundwater
	IY2-TEM2	1,800	Along the tunnel adit No.2 (the Phu Sang)	- ditto -
	IY2-TEM3	1,200	The Phu Sang area	- ditto -
	IY2-TEM4	1,400	- ditto -	- ditto -
	IY2-TEM5	1,000	STA.15+100-16+100	Geological condition of CPnb formation, confirmation of fault zone
	IY2-TEM6	1,000	STA.16+500-17+500	- ditto -
	IY2-TEM7	1,000	STA.20+100-21+100	- ditto -
	IY2-TEM8	1,000	STA.33+200	- ditto -
	IY2-TEM9	1,000	STA.49+000-50+000	Geological condition of TRhf and TRpl (limestone) formation, confirmation of fault zone
	IY2-TDEM1	1,200	STA.27+650	Geological condition of CPnb formation, confirmation of fault zone and confined aquifer.
	IY2-TDEM2	1,000	STA.28+800 (TDEM)	Geological condition of TRpl (limestone) formation, confirmation of fault zone and cave
20 points	IY2-TDEM3		Point sounding by TDEM	- ditto -
	IY2-TDEM4	1,200	Along the tunnel adit No.5 (TDEM)	Geological condition of TRhf formation, confirmation of fault zone
	IY2-TDEM5	1,600	STA.41+700-43+300 (TDEM)	Geological condition of TRhf and ms5-3 formation, confirmation of fault zone
sub total	14 lines	15,900	(and 20 points)	
(9) Yao flood Control Dam	YD-TEM	800	Left abutment along the dam axis	Confirmation of distribution of thick weathered rock zone and the existence of fault zone
total	18 lines	27,000	(and 20 points)	

* TEM or TDEM : the transient, or time-domain, electromagnetic method
* IY2-TDEM2 line : Observation points are set as point sounding around the tunnel alignment because of difficult line setting by the rugged topographical condition.

Table11.2.5-5 List of Proposed Additional Investigation of Seismic Refraction Survey

Item of Facility	Line Name	Line Length	Location	Remarks
(8) Ing-Yot No.2 Tunnel	IY1-1	500	tunnel inlet	Around inlet (P3 formation)
	IYI-2	500	tunnel outlet	Around outlet (P3 formation)
total	2 lines	1,000		

Figure11.2.5-1 Location Map for Proposed Geological Investigation
(Kok-Ing Diversion Canal, Kok Basin)



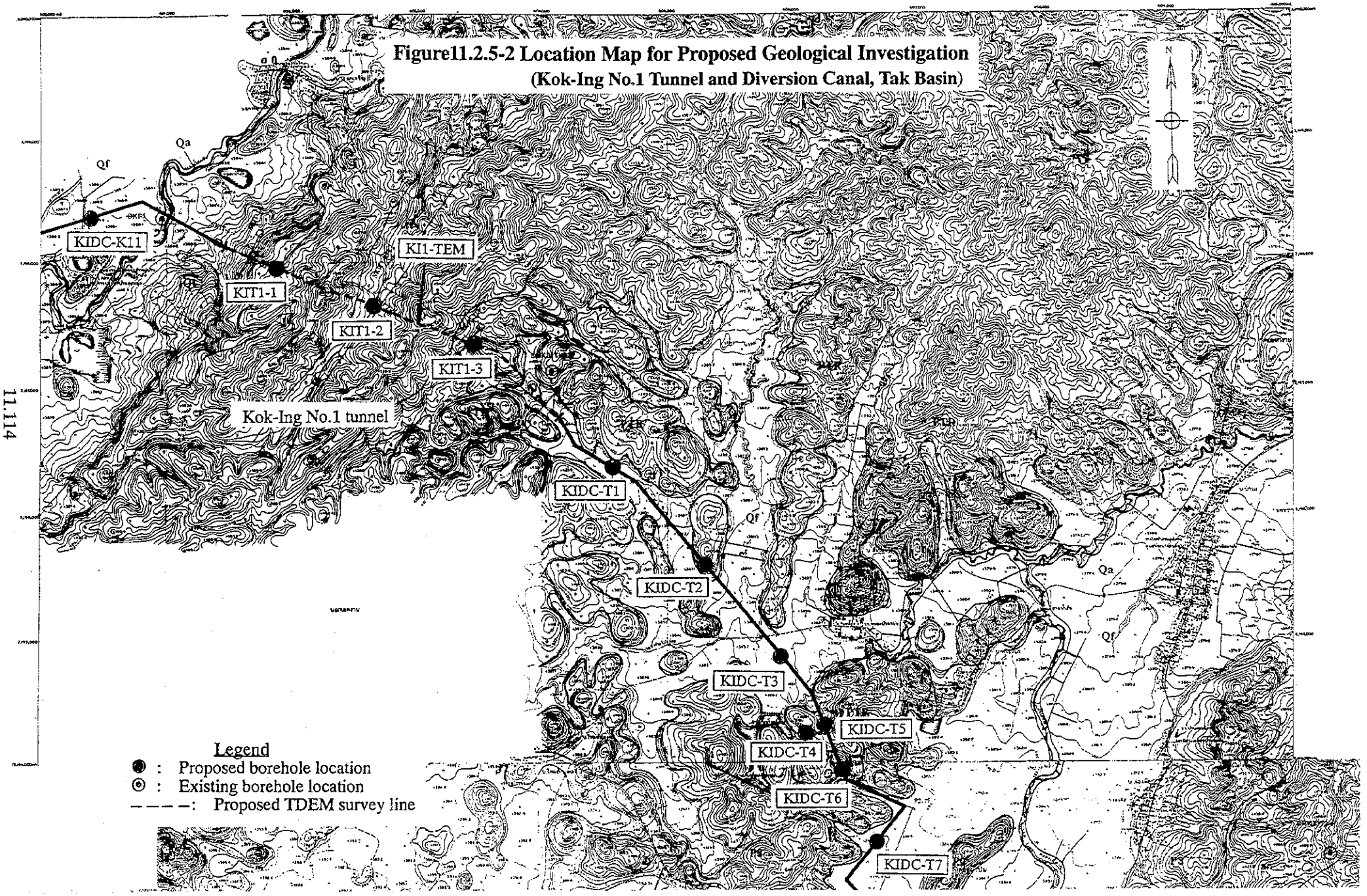


Figure11.2.5-2 Location Map for Proposed Geological Investigation
(Kok-Ing No.1 Tunnel and Diversion Canal, Tak Basin)
KIDC-K11
KI1-TEM
KIT1-1
KIT1-2
KIT1-3
Kok-Ing No.1 tunnel
KIDC-T1
KIDC-T2
KIDC-T3
KIDC-T4
KIDC-T5
KIDC-T6
KIDC-T7
Qa
Qf
PkR
PtR
Legend
● : Proposed borehole location
⊙ : Existing borehole location
– – – –: Proposed TDEM survey line

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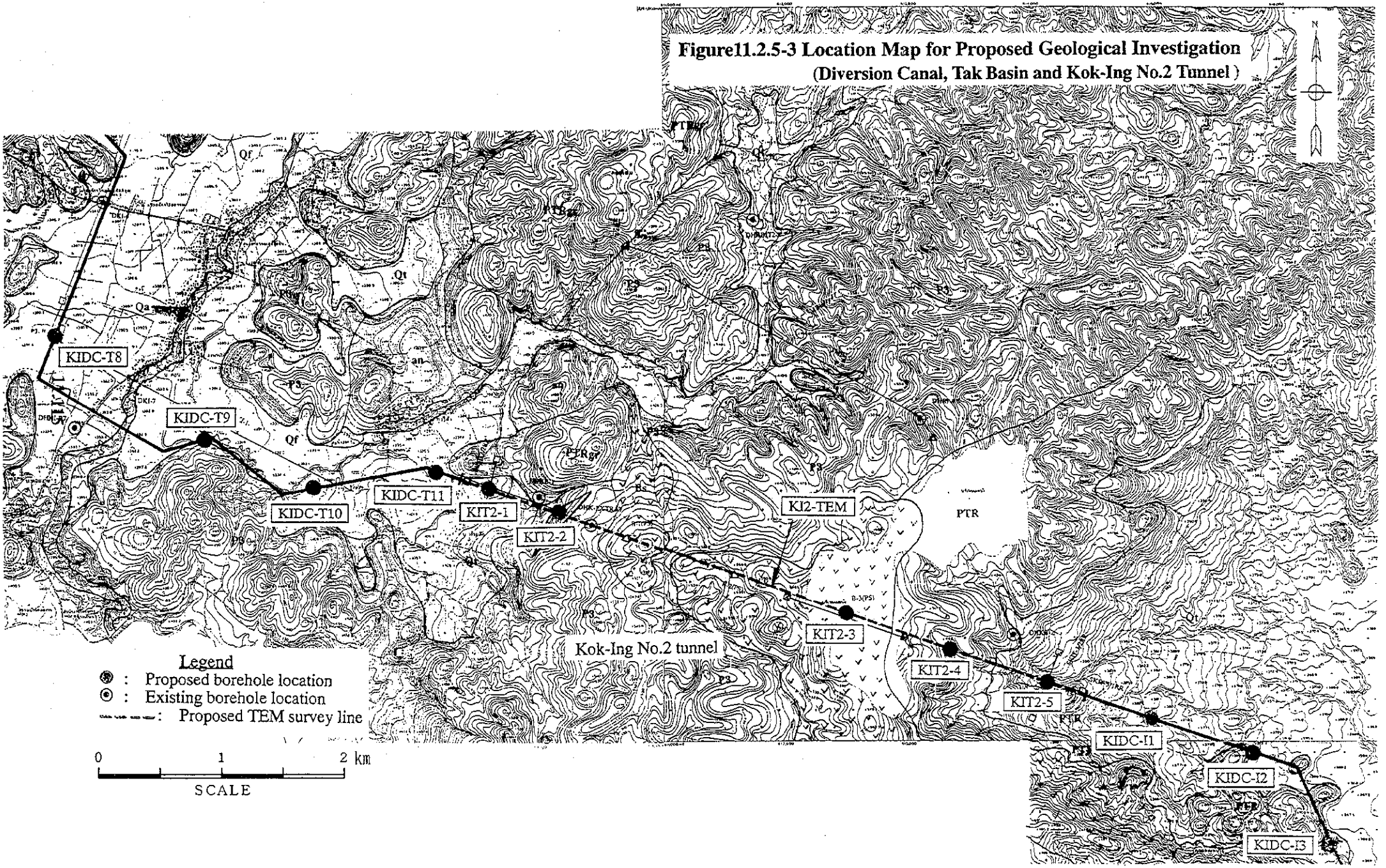
Figure11.2.5-3 Location Map for Proposed Geological Investigation
(Diversion Canal, Tak Basin and Kok-Ing No.2 Tunnel)



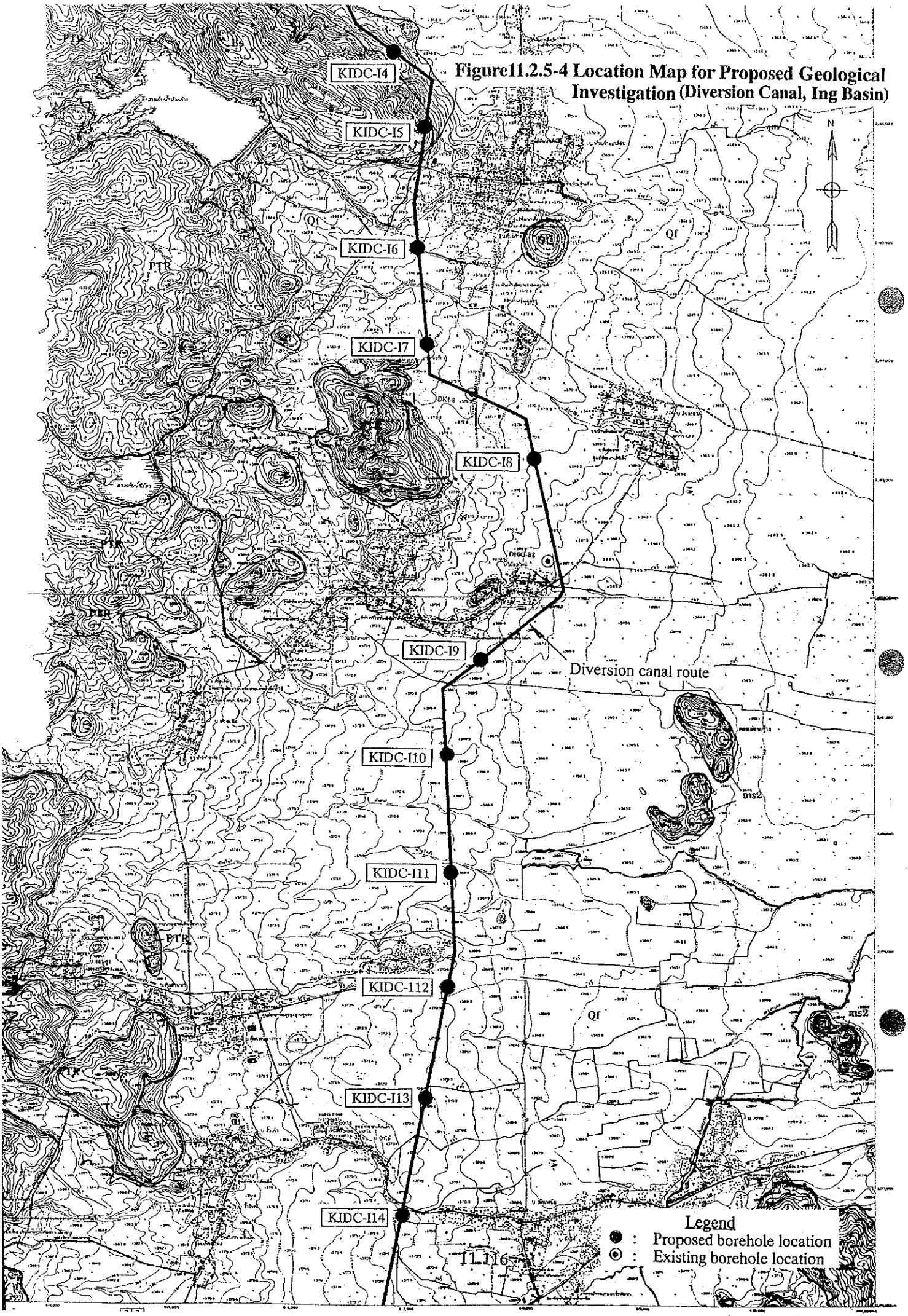


Figure11.2.5-4 Location Map for Proposed Geological Investigation (Diversion Canal, Ing Basin)

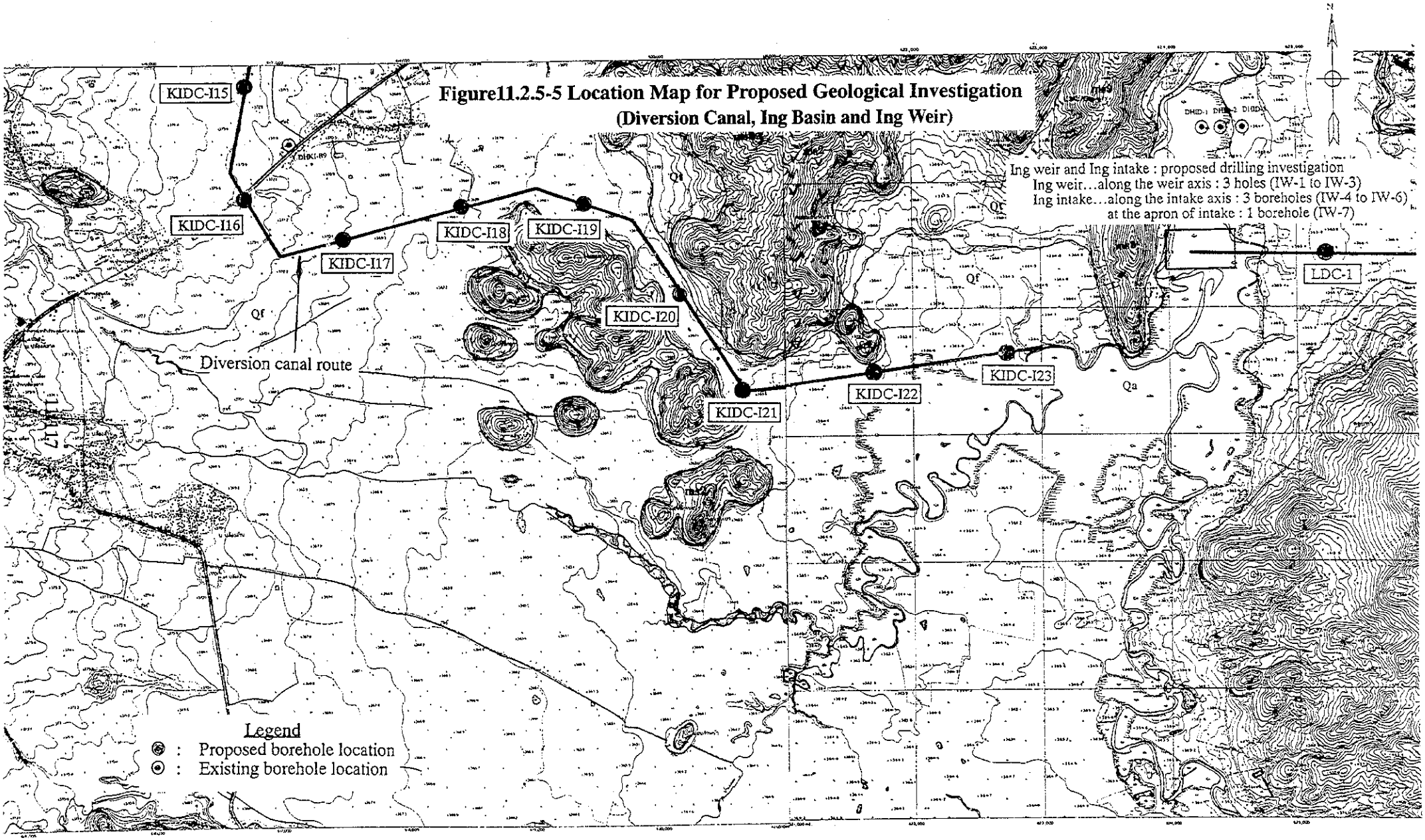
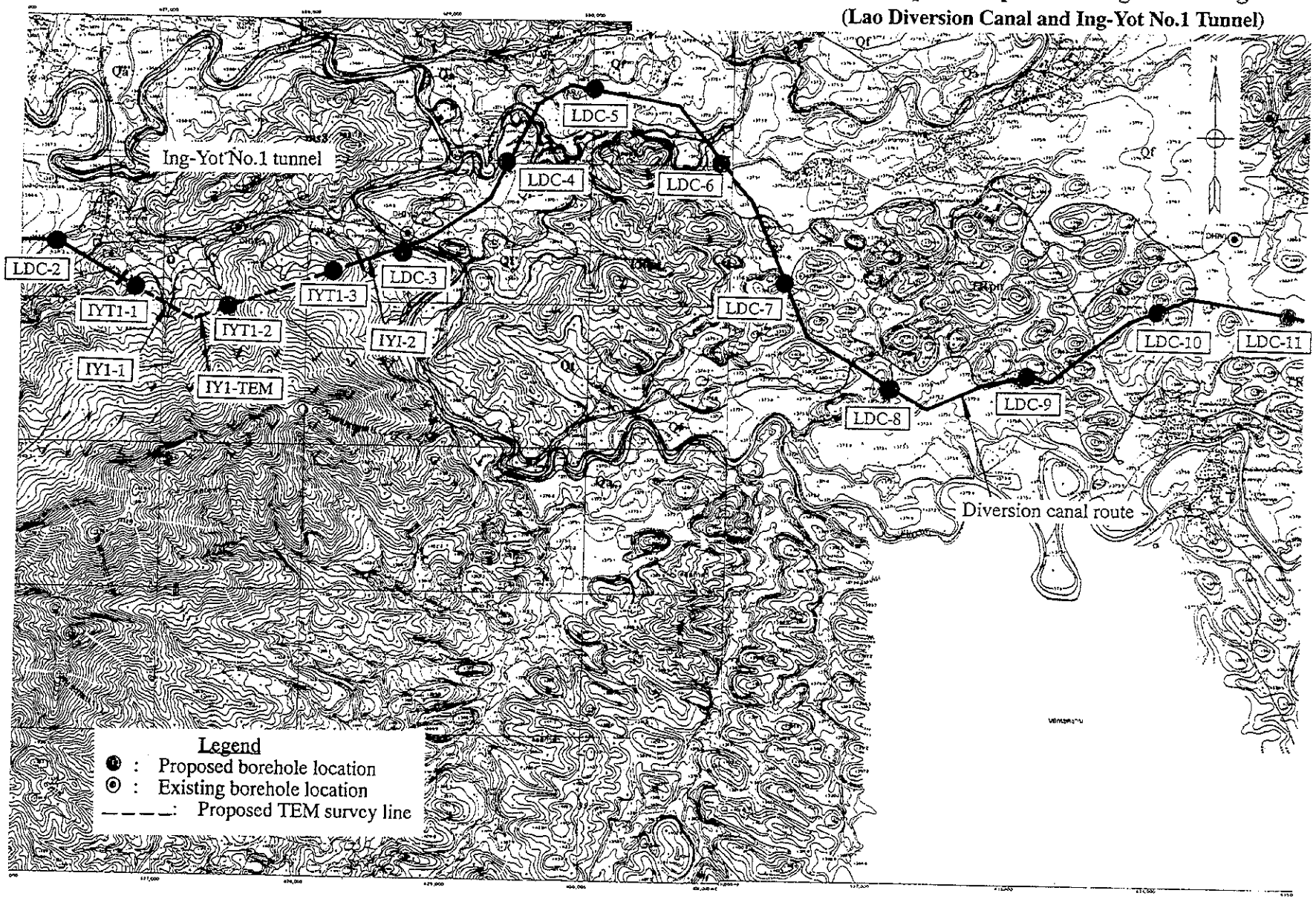


Figure11.2.5-5 Location Map for Proposed Geological Investigation
(Diversion Canal, Ing Basin and Ing Weir)

Figure11.2.5-6 Location Map for Proposed Geological Investigation
(Lao Diversion Canal and Ing-Yot No.1 Tunnel)



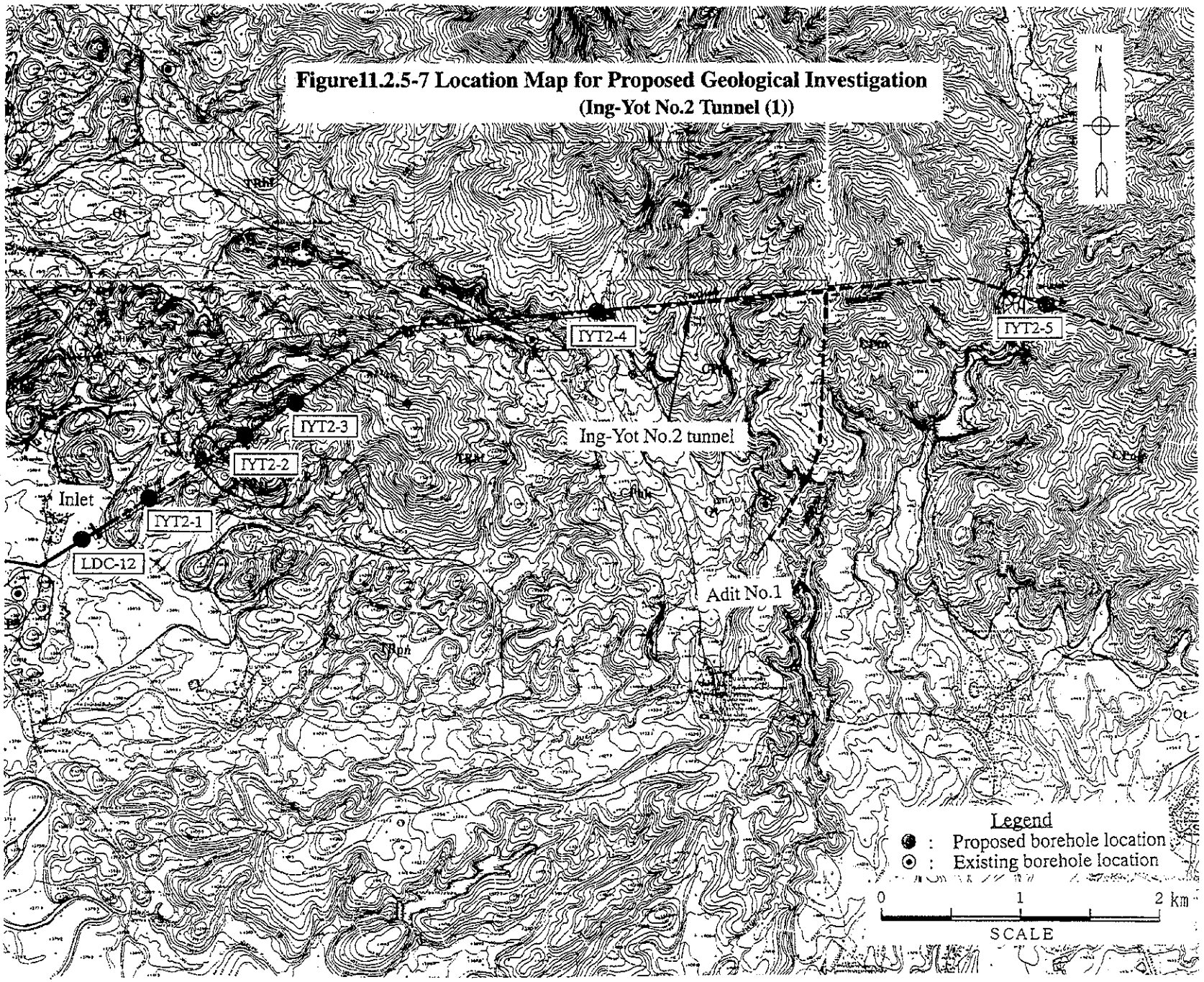


Figure11.2.5-7 Location Map for Proposed Geological Investigation
(Ing-Yot No.2 Tunnel (1))

Figure11.2.5-8 Location Map for Proposed Geological Investigation
(Ing-Yot No.2 Tunnel (2))

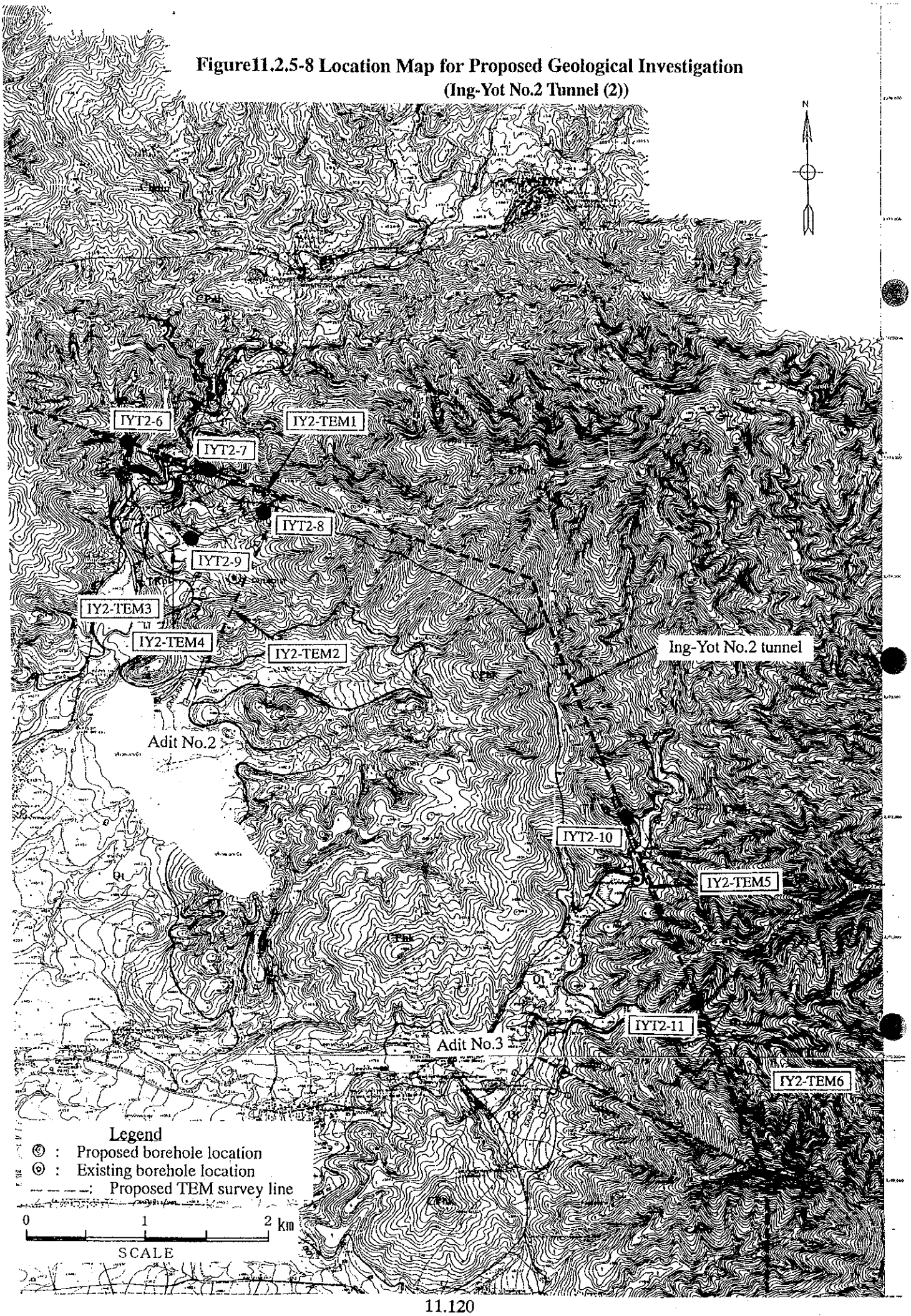


Figure11.2.5-9 Location Map for Proposed Geological Investigation (Ing-Yot No.2 Tunnel (3))