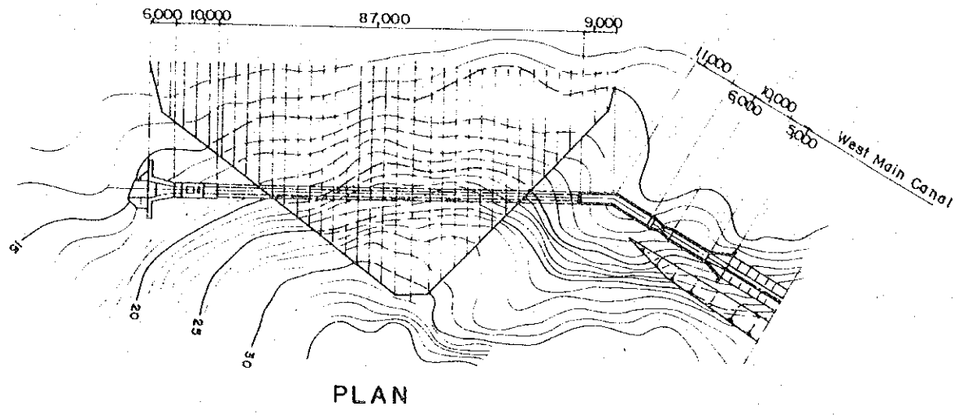
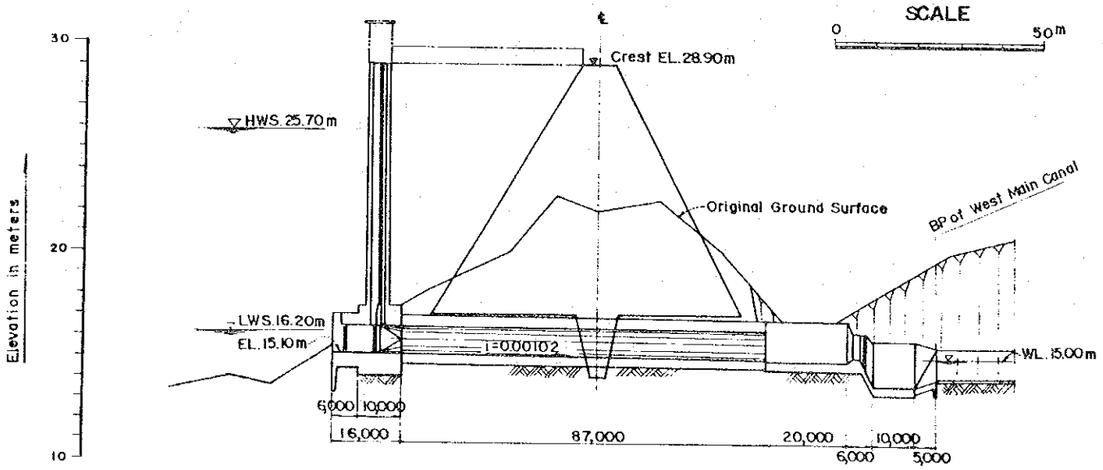
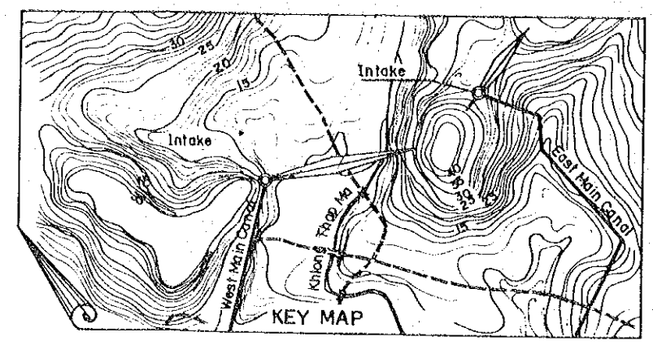
Intake Facilities for West Main Canal



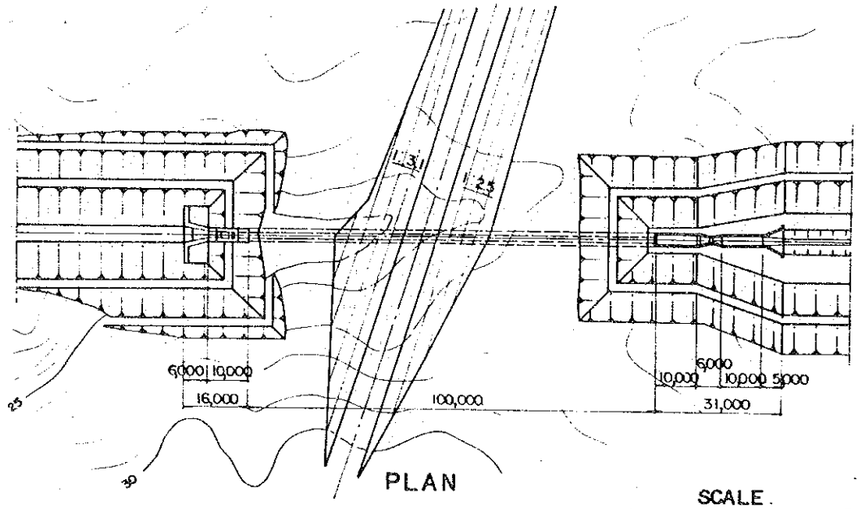
PLAN



PROFILE



Intake Facilities for East Main Canal



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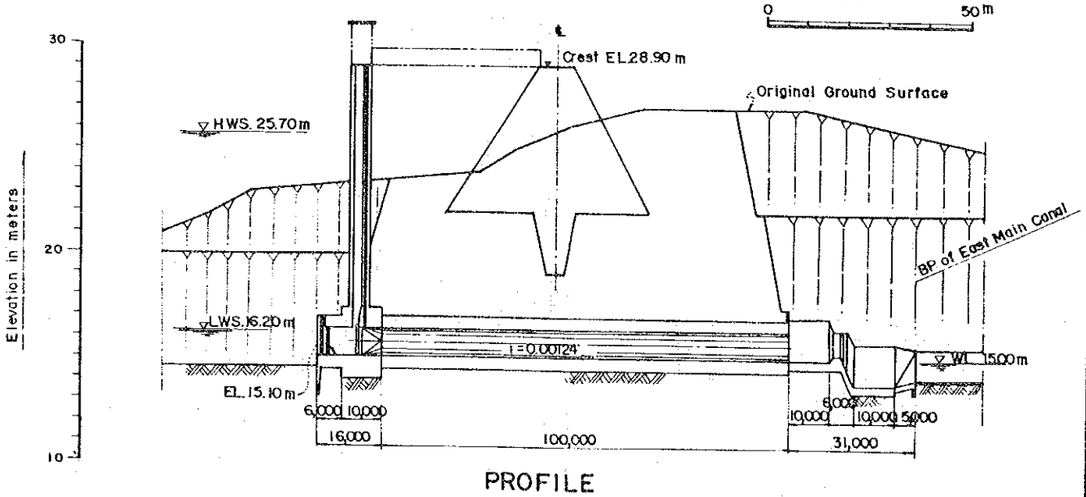


PROFILE

FEATURES OF INTAKE FACILITIES

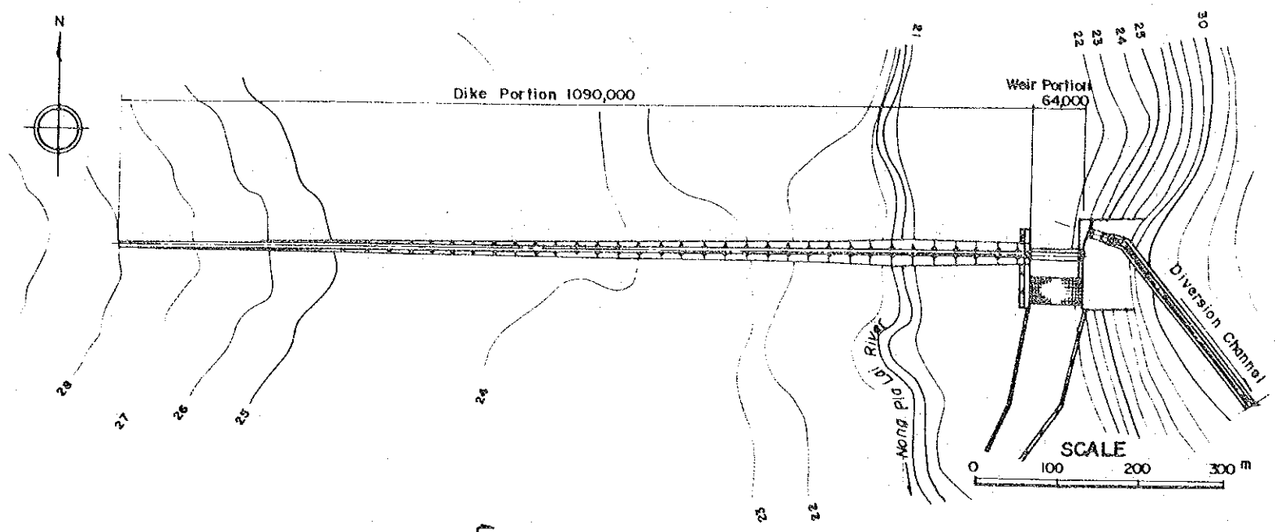
1. West Main Canal
   1) Intake Tower — 2.0 x 1.3 x 13.9 m
      Pressure Gate — 1.3 x 1.3 m
      Bed EL. — EL. 15.1 m
      Design Intake Discharge — 1.63 m^3/sec
   2) Conduit
      Type — Open Channel Type
      Length — 87.0 m
      Diameter — ϕ 1.3 m
      Gradient — i = 0.00102
   3) Outlet
      Length — 41.0 m
      Parshall Flume — W = 4 ft Type
      Head WL of Main Canal — WL. 15.0 m

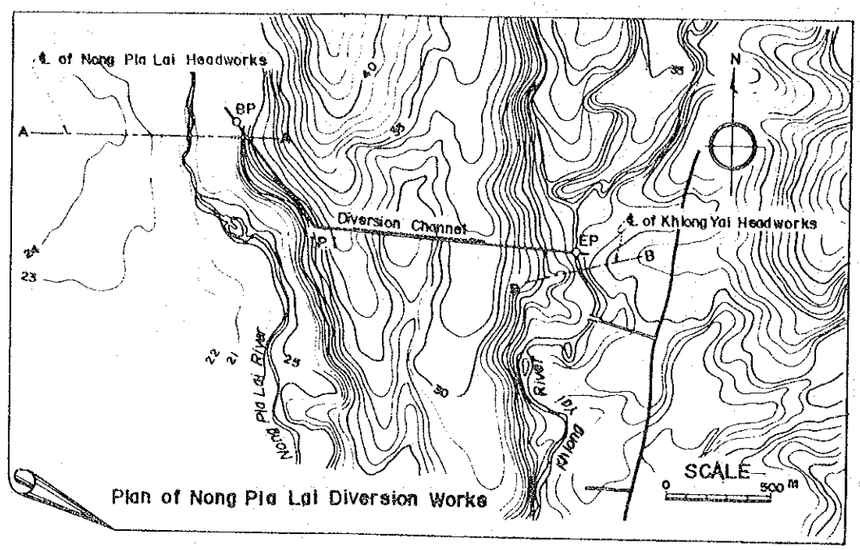
2. East Main Canal
   1) Inlet
      Inlet Channel — 2.70 m
      Intake Tower — 2.0 x 1.3 x 13.9
      Pressure Gate — 1.3 x 1.3 m
      Bed EL. — EL. 15.1 m
      Design Intake Discharge — 1.80 m^3/sec
   2) Conduit
      Type — Open Channel Type
      Length — 100 m
      Diameter — ϕ 1.3 m
      Gradient — i = 0.00124
   3) Outlet
      Length — 31.0 m
      Prshall Flume — W = 4 ft Type
      Head WL of Main Canal — WL. 15.0 m

Fig. 9 Configurations of the Intake Structures for the Khlong Thap Ma Irrigation Scheme

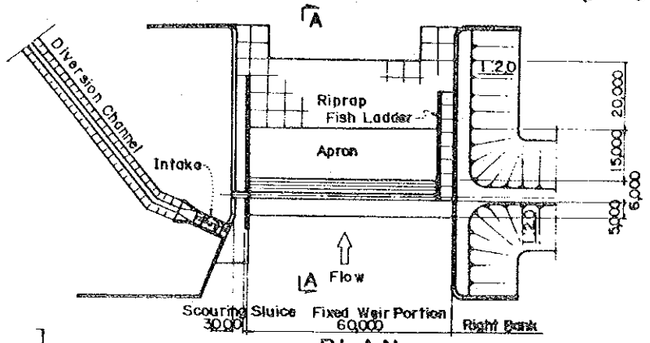
KINGDOM OF THAILAND
THE EAST COAST WATER RESOURCES DEVELOPMENT PROJECT PHASE II
JAPAN INTERNATIONAL COOPERATION AGENCY

NONG PLA LAI HEADWORKS





Plan of Nong Pla Lai Diversion Works



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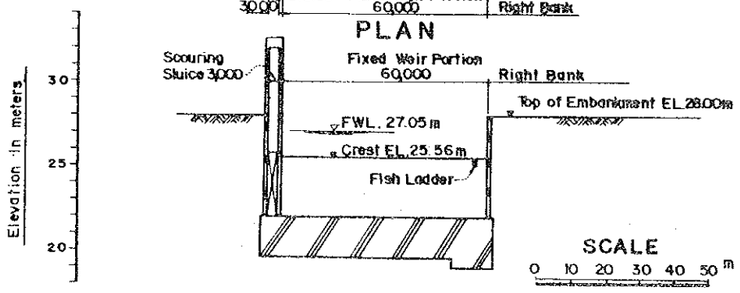
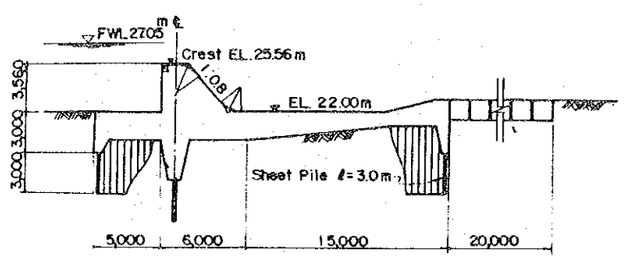


ELAVATION



SECTION A-A

FEATURES OF DIVERSION WORKS

1) Headworks

1.1 Fixed Weir Portion

Length	60.0 m
Height	3.56 m
Crest EL.	25.56 m
Design Flood Discharge	200 m^3/sec
Design Flood Water Level	F.W.L. 27.05 m

1.2 Movable Weir Portion

Gate (B x H)	3,000 x 4,000
Nos.	1
Bed EL.	EL. 22.0 m

1.3 Dike Portion

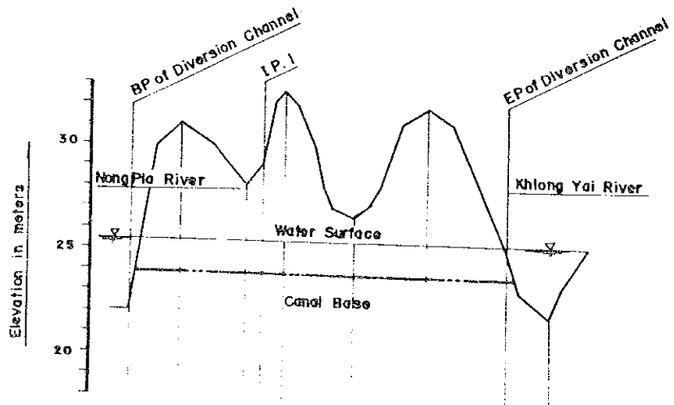
Length	1,090.0 m
Height	7.5 m
Slop	1 : 2.0
Crest EL.	EL. 28.0 m
Width	5.0 m

1.4 Intake

Gate	2,500 x 2,000 x 2 Nos.
Design Intake Discharge	4.90 m^3/sec
Design Intake Water Level	I.W.L. 25.46 m
Bed EL.	23.96 m

2) Diversion Channel

Canal Type	Concrete Lining
Gradient	1/5,000
Base Width	2.0 m
Height	2.1 m
Length	1,800.0 m
Design Discharge	4.90 m^3/sec



No.		Distance	Reduced Distance	Ground Height	Canal Base	Water Level
BP.	0.0	0.0	0.0	22.0	24.03	25.46
+ 230	230.0	230.0	230.0	31.0	23.98	25.41
No. 1	400.0	170.0	400.0	29.7	23.95	25.38
+150	550.0	150.0	550.0	28.0	23.92	25.35
I.P. 1	630.0	80.0	630.0	29.0	23.90	25.33
+330	730.0	100.0	730.0	32.6	23.88	25.31
No. 2	800.0	70.0	800.0	31.7	23.87	25.30
+ 270	1,070.0	270.0	1,070.0	26.5	23.82	25.25
No. 3	1,200.0	130.0	1,200.0	28.2	23.79	25.22
+ 210	1,410.0	210.0	1,410.0	31.8	23.75	25.18
No. 4	1,600.0	190.0	1,600.0	29.4	23.71	25.14
E.P.	1,800.0	200.0	1,800.0	25.0	23.67	25.10
	2,010.0	210.0	2,010.0	21.6		25.10

Fig. 10 General Feature of Nong Pla Lai Headworks and Diversion Channel

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THE EAST COAST WATER RESOURCES DEVELOPMENT PROJECT PHASE II
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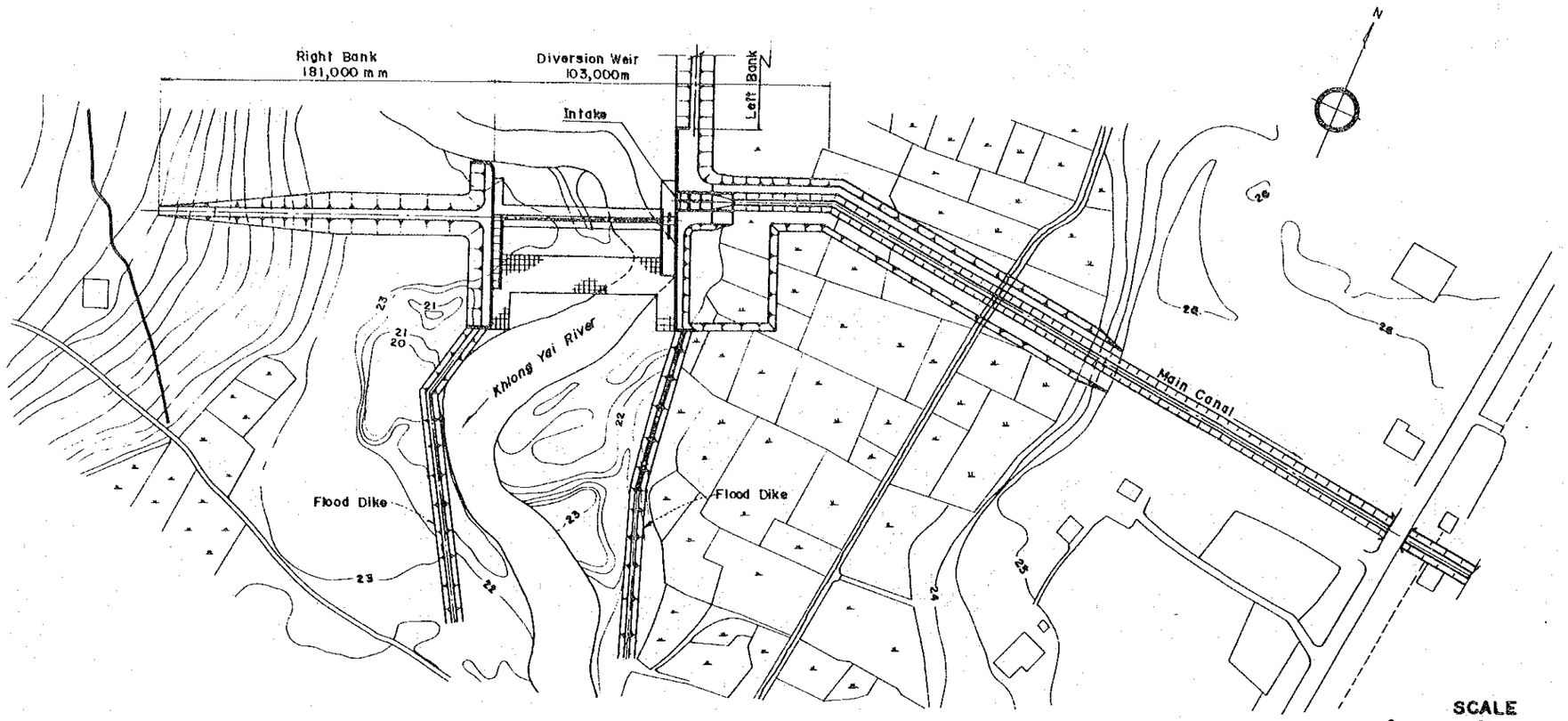

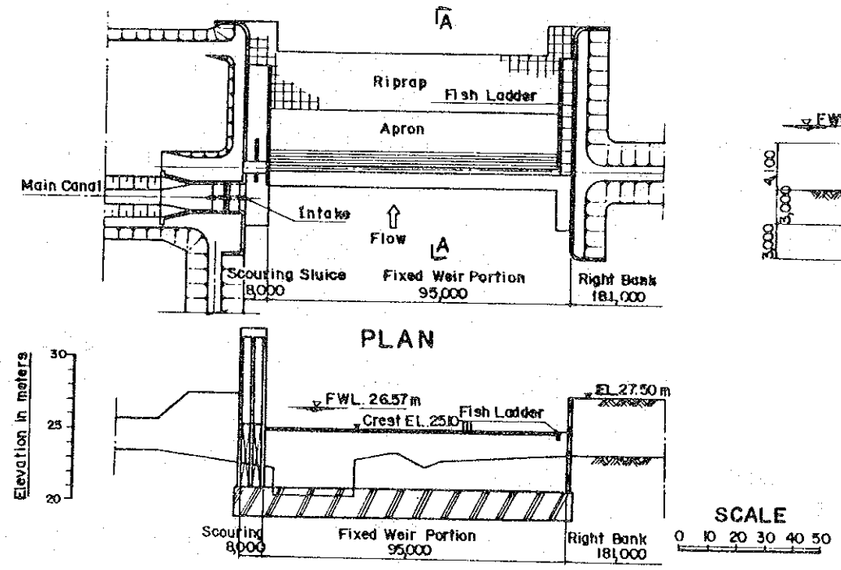

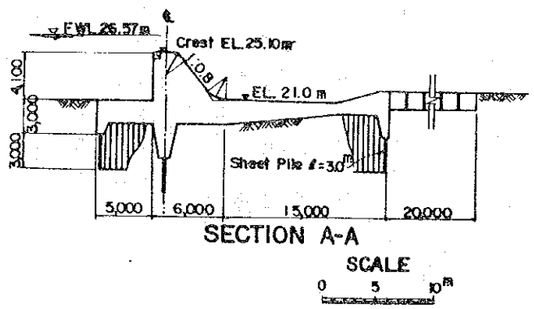

FEATURES OF KHLONG YAI HEADWORKS

1. Fixed Weir (Flood Way Portion)
   - Length — 95.0 m
   - Height — 3.5 m
   - Crest EL. — EL. 24.5 m
   - Design Flood Discharge — 280 m³/sec
   - Design Flood Water Level — FWL. 2598 m
2. Movable Weir Portion
   - Gate (B x H) — 3,000 x 4,400
   - Nos. — 2
   - Bed EL. — EL. 21.0 m
3. Dike Portion
   1) Right Bank
      - Length — 181 m
      - Height — 4.5 m
      - Slope — 1 : 2.0
      - Crest EL. — EL. 27.5 m
      - Width — 5.0 m
   2) Left Bank
      - Length — 700.0 m
      - Height — 4.5 m
      - Slope — 1:2.0
      - Crest EL. — EL. 27.5 m
      - Width — 5.0 m
4. Intake
   - Gate (B x H) — 4,000 x 3,000
   - Nos. — 2
   - Design Intake Discharge — 11.09 m³/sec
   - Design Intake Water Level — IWL 25.00 m
   - Bed EL. — EL. 23.00m

Fig. 11 General Feature of Khlong Yai Headworks

KINGDOM OF THAILAND
THE EAST COAST WATER RESOURCES DEVELOPMENT PROJECT PHASE II
JAPAN INTERNATIONAL COOPERATION AGENCY

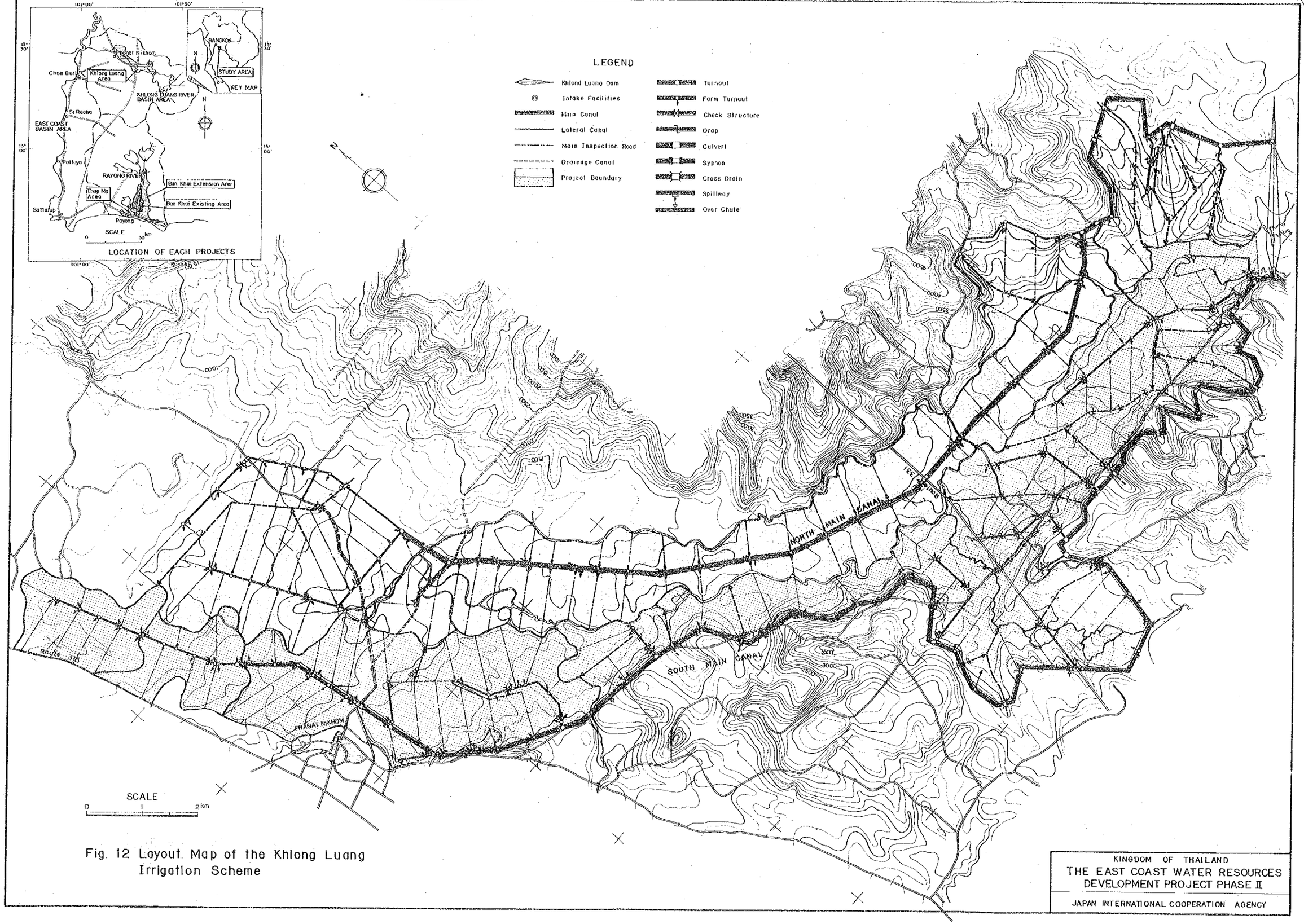

Fig. 12 Layout Map of the Khlong Luang Irrigation Scheme

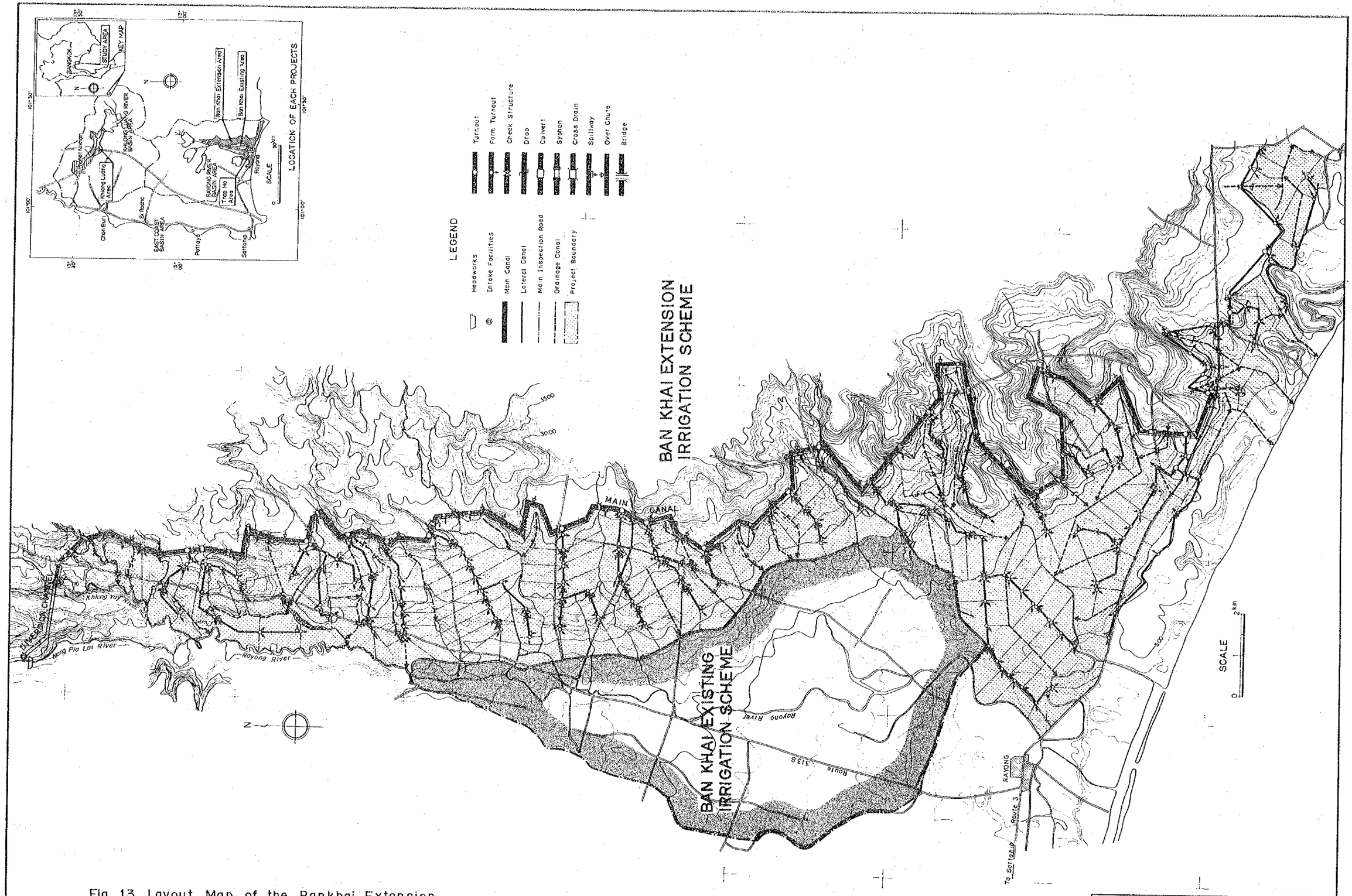

Fig. 13 Layout Map of the Bankhai Extension Irrigation Scheme

KINGDOM OF THAILAND
THE EAST COAST WATER RESOURCES DEVELOPMENT PROJECT PHASE II
JAPAN INTERNATIONAL COOPERATION AGENCY

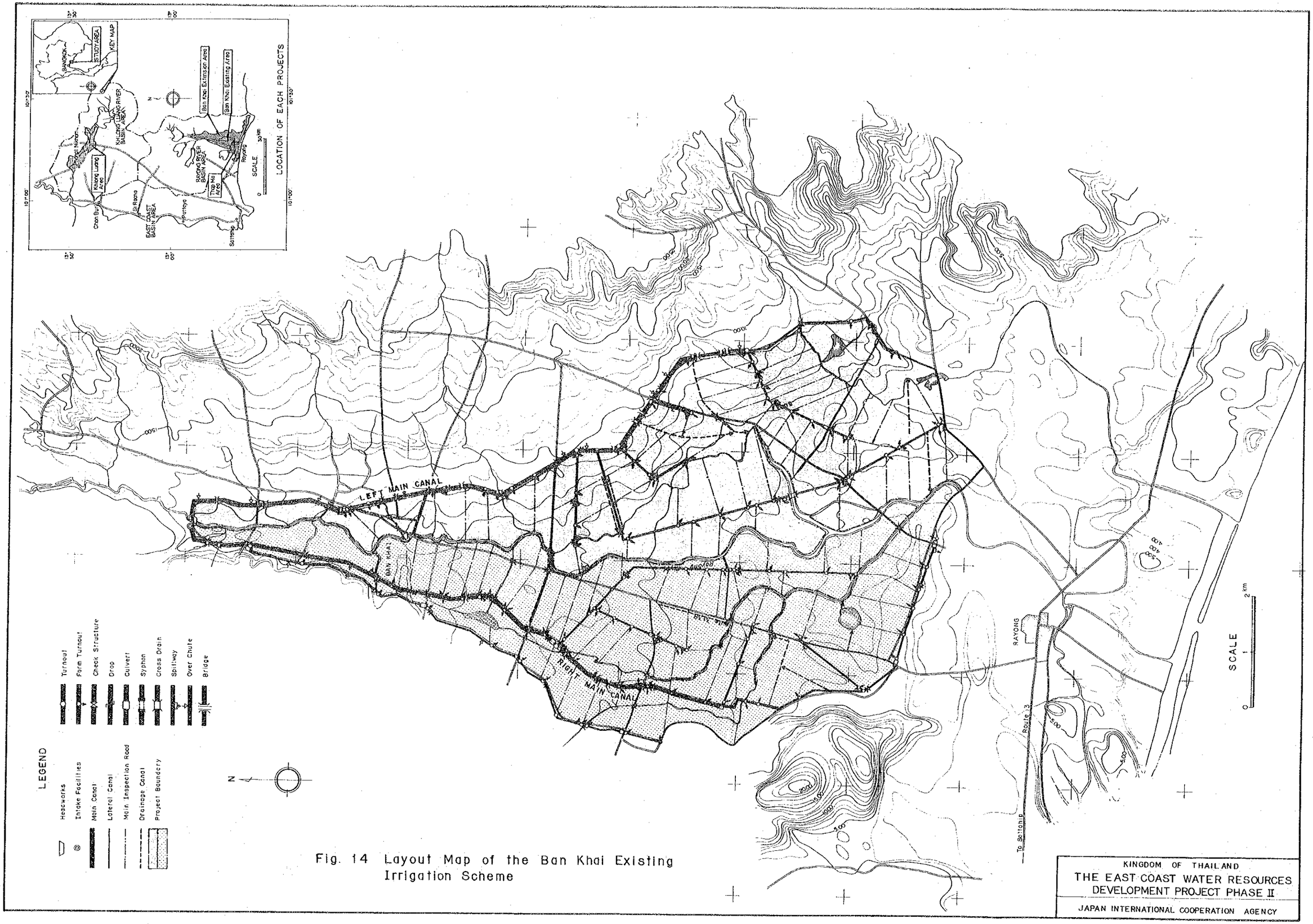

Fig. 14 Layout Map of the Ban Khai Existing Irrigation Scheme

KINGDOM OF THAILAND
THE EAST COAST WATER RESOURCES DEVELOPMENT PROJECT PHASE II
JAPAN INTERNATIONAL COOPERATION AGENCY

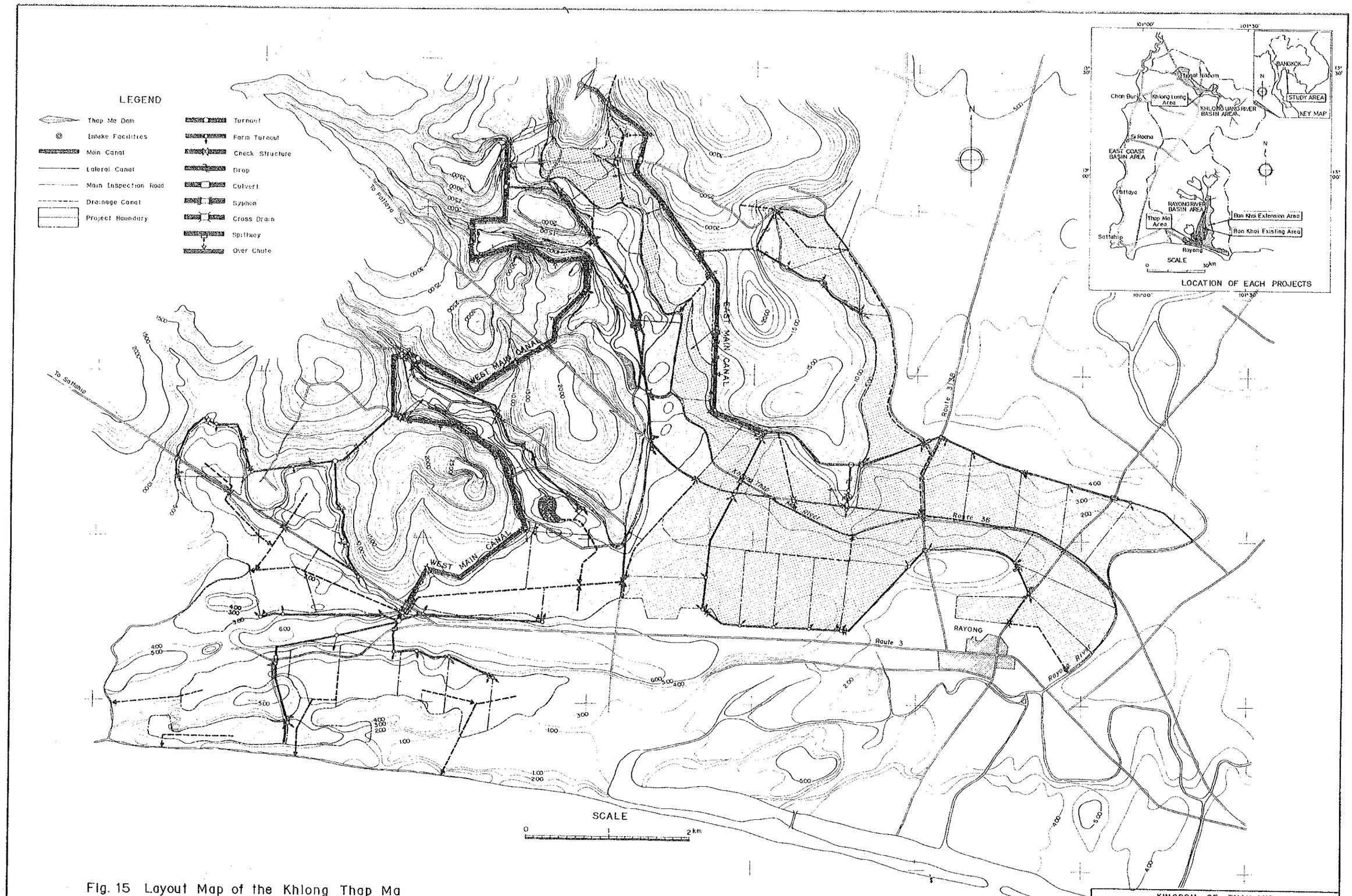

Fig. 15 Layout Map of the Khlong Thap Ma Irrigation Scheme

KINGDOM OF THAILAND
THE EAST COAST WATER RESOURCES DEVELOPMENT PROJECT PHASE II
JAPAN INTERNATIONAL COOPERATION AGENCY

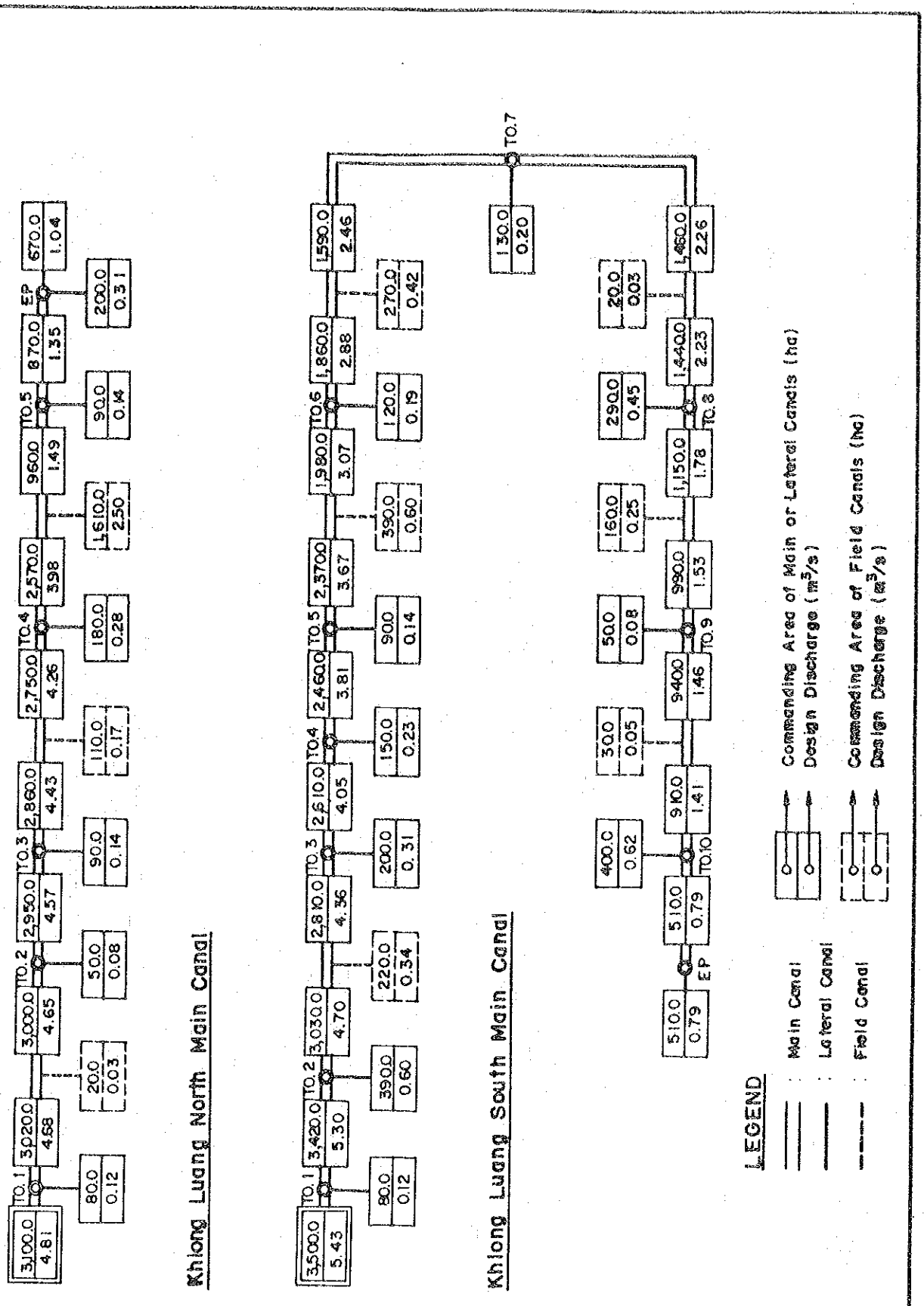

Fig. 16 Irrigation Diagram for the Khlong Luang Irrigation Scheme

KINGDOM OF THAILAND
THE EAST COAST WATER RESOURCES DEVELOPMENT PROJECT PHASE II
JAPAN INTERNATIONAL COOPERATION AGENCY

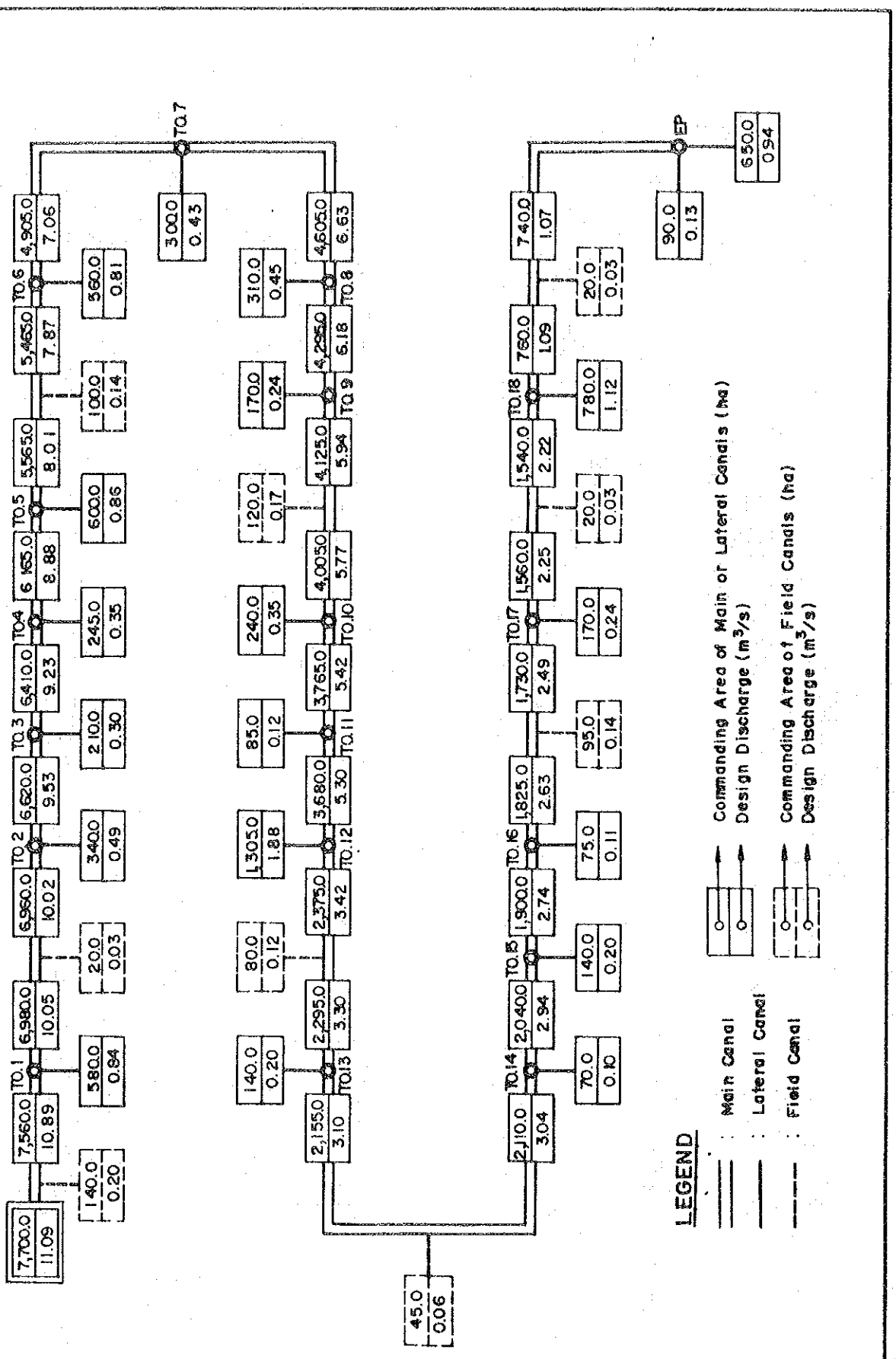

Fig. 17 Irrigation Diagram for the Ban Khai Extension Irrigation Scheme

KINGDOM OF THAILAND
THE EAST COAST WATER RESOURCES DEVELOPMENT PROJECT PHASE II
JAPAN INTERNATIONAL COOPERATION AGENCY

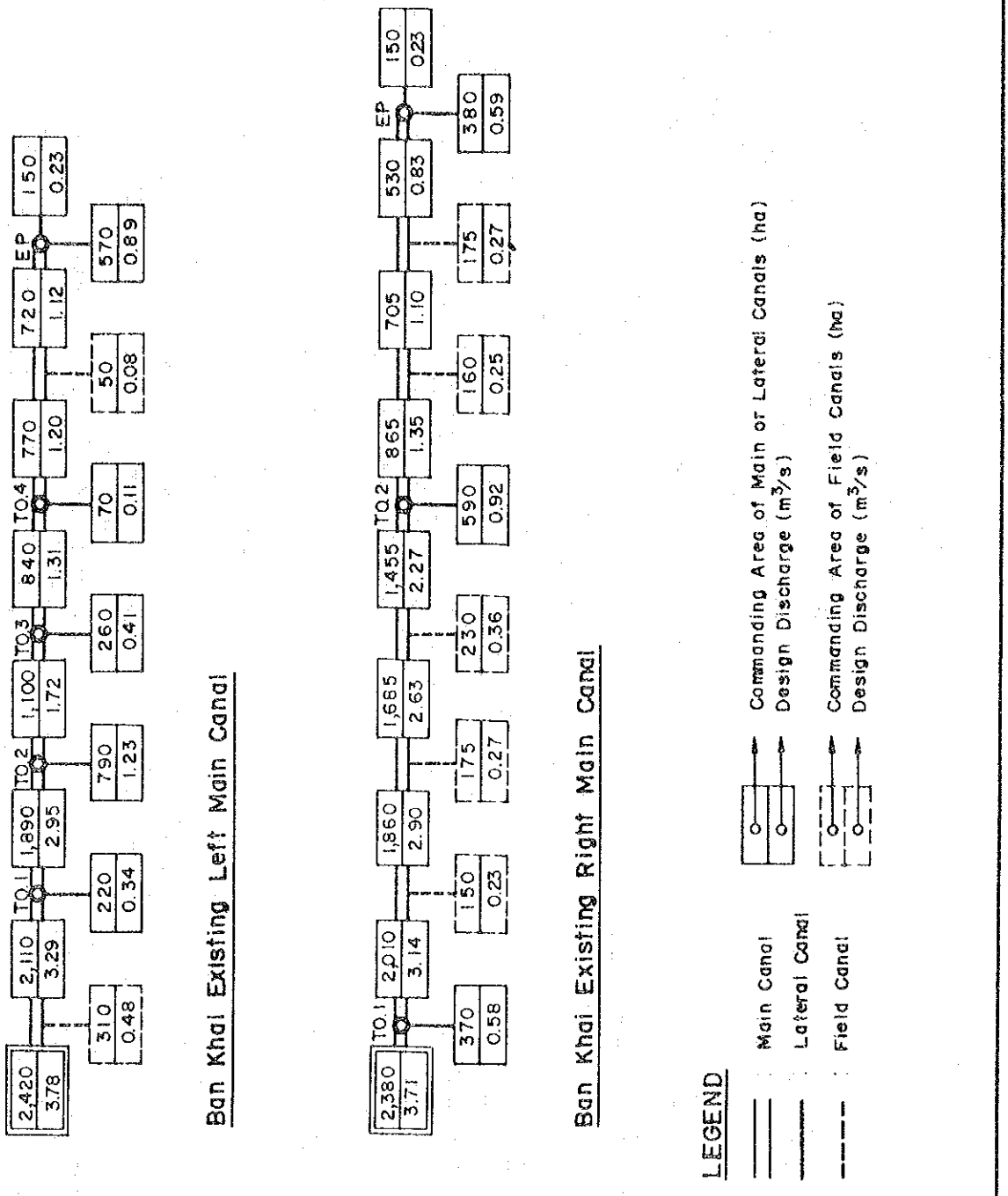

Fig. 18 Irrigation Diagram for the Ban Khai Existing Irrigation Scheme

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THE EAST COAST WATER RESOURCES DEVELOPMENT PROJECT PHASE II
JAPAN INTERNATIONAL COOPERATION AGENCY

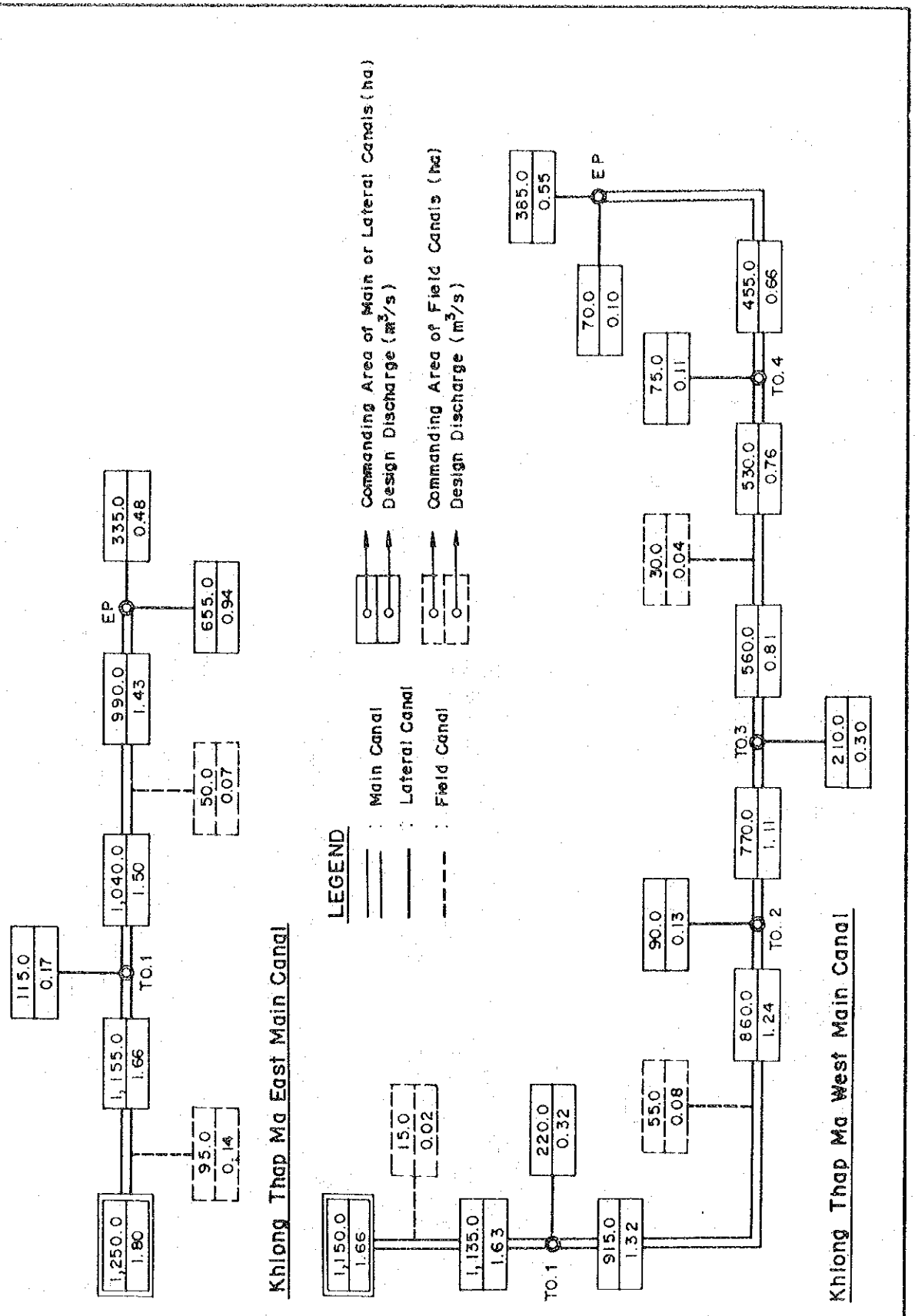
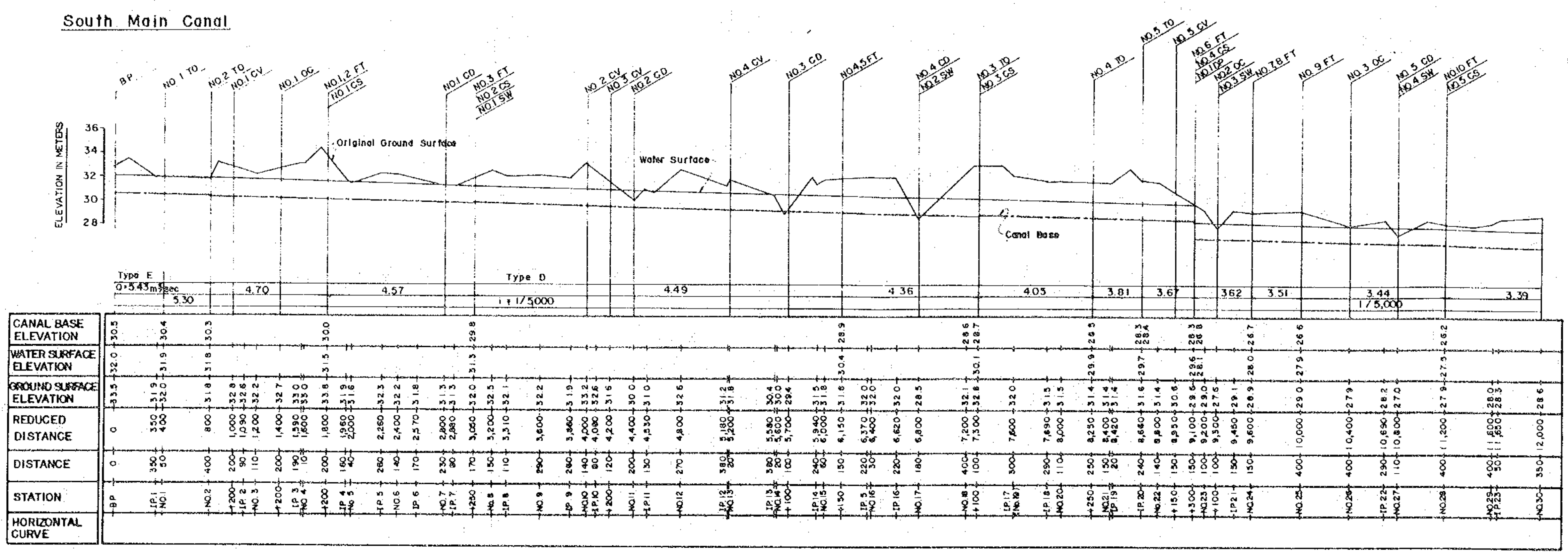
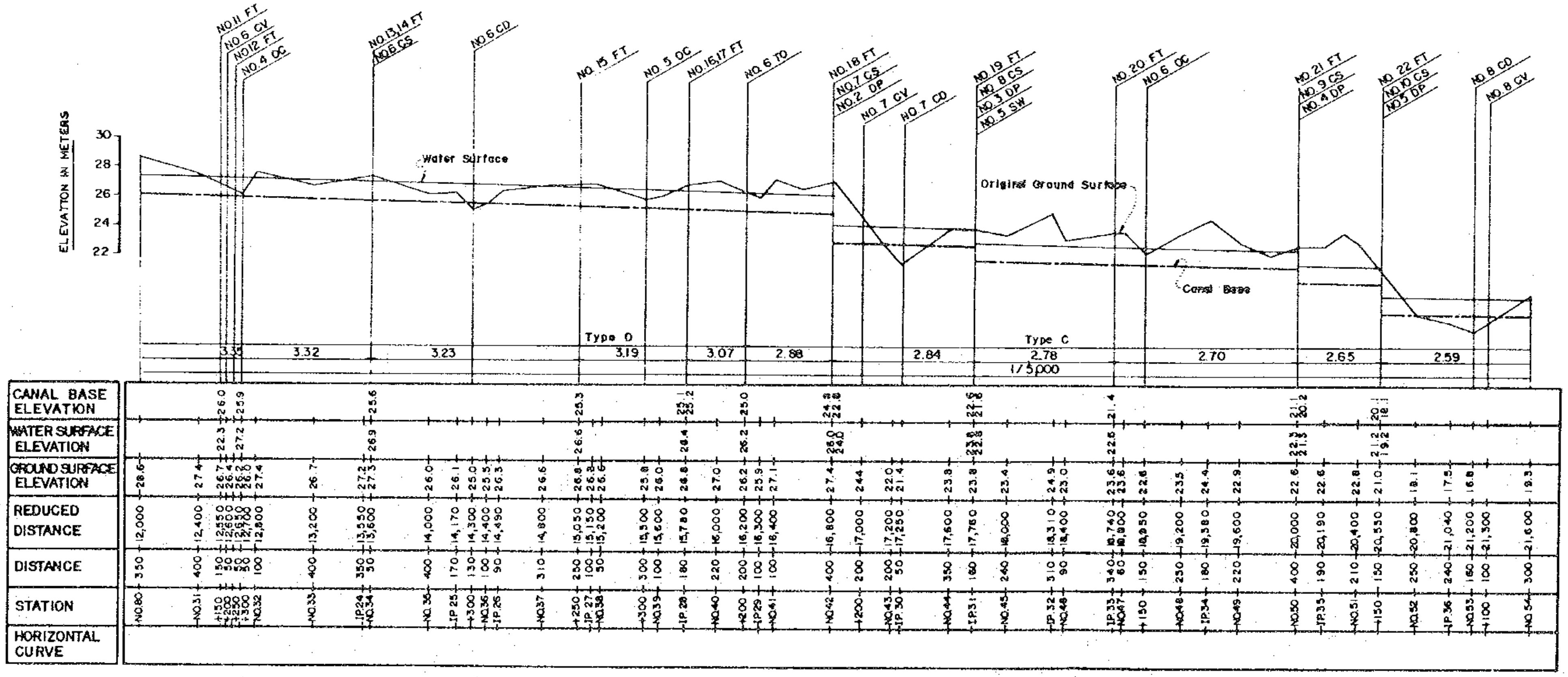


Fig. 19 Irrigation Diagram for the Khlong Thap Ma Irrigation Scheme

KINGDOM OF THAILAND
THE EAST COAST WATER RESOURCES DEVELOPMENT PROJECT PHASE II
JAPAN INTERNATIONAL COOPERATION AGENCY

South Main Canal





ABBREVIATION

TO	:	Turnout
FT	:	Farm Turnout
CS	:	Check Structure
DP	:	Drop Structure
SY	:	Inverted Syphon
BG	:	Bridge
CV	:	Culvert
SW	:	Spillway
OC	:	Over Chute
CD	:	Cross Drain
BP	:	Beginning Point
IP	:	Intersection Point
EP	:	End Point

Fig. 20 (1) Longitudinal Profile of Main Canal for the Khlong Luang Irrigation Scheme

SCALE 0 1.0 2.0km

KINGDOM OF THAILAND
THE EAST COAST WATER RESOURCES DEVELOPMENT PROJECT PHASE II
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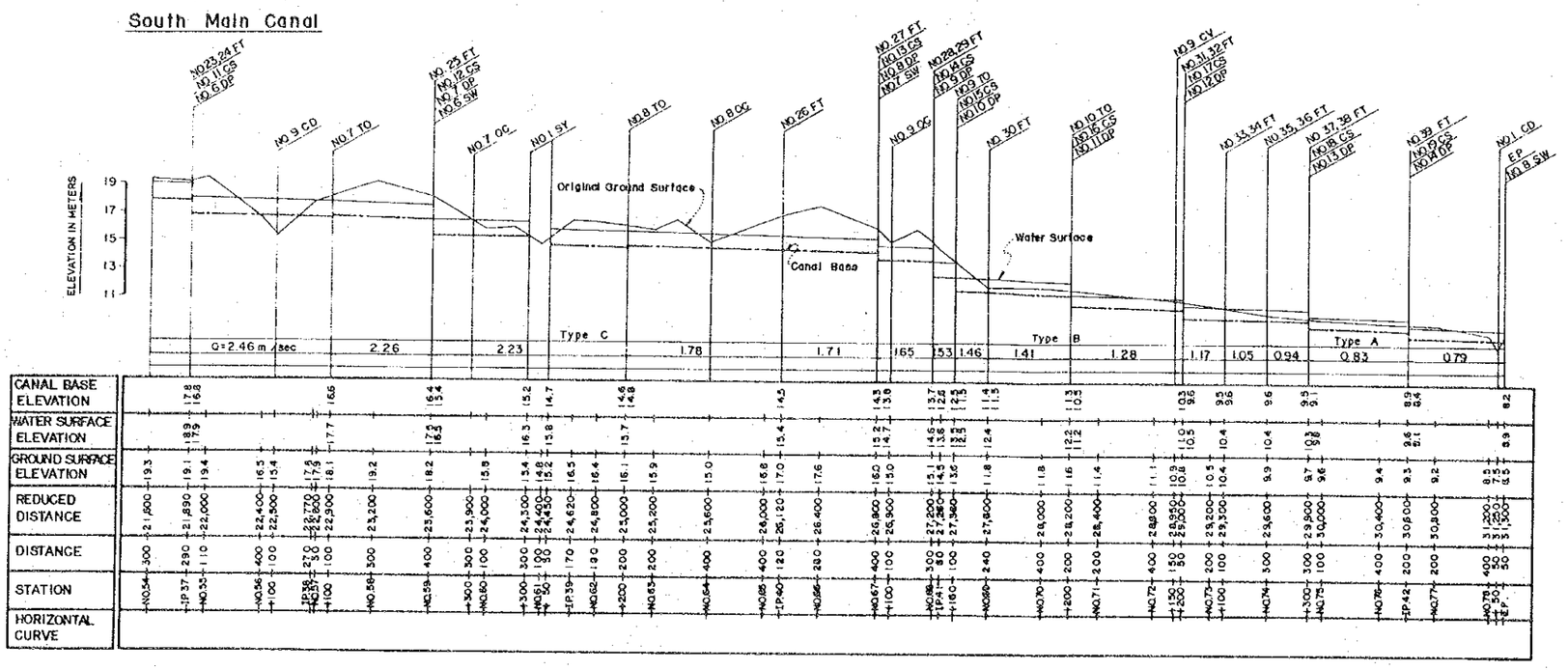

ABBREVIATION

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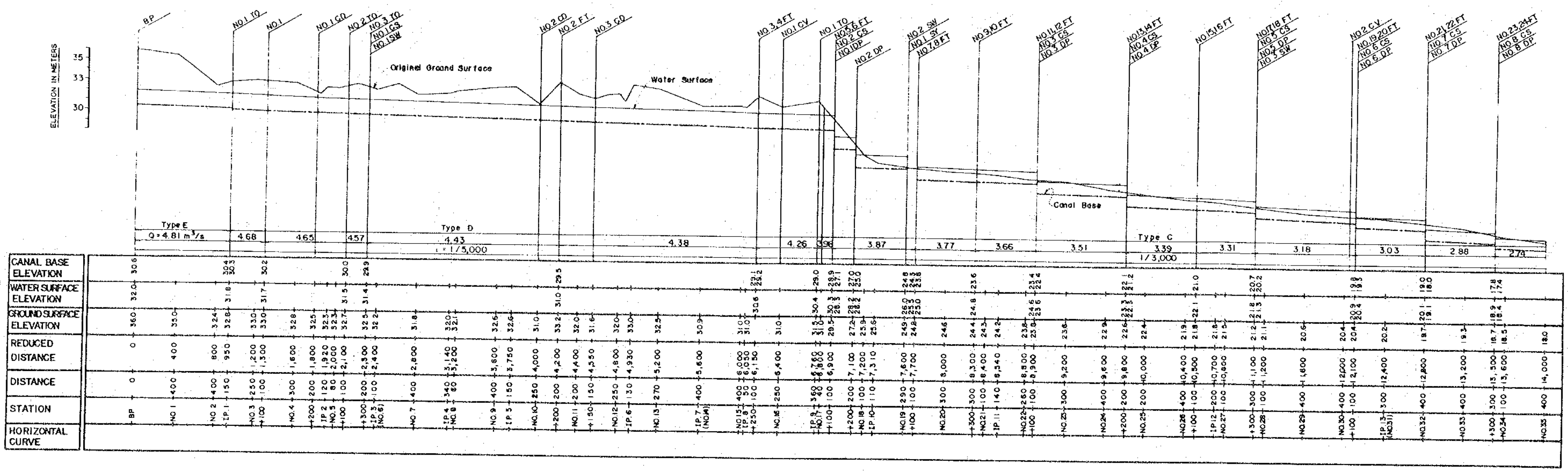
CV	:	Culvert
SW	:	Spillway
OC	:	Over Chute
CD	:	Cross Drain
BP	:	Beginning Point
IP	:	Intersection Point
EP	:	End Point

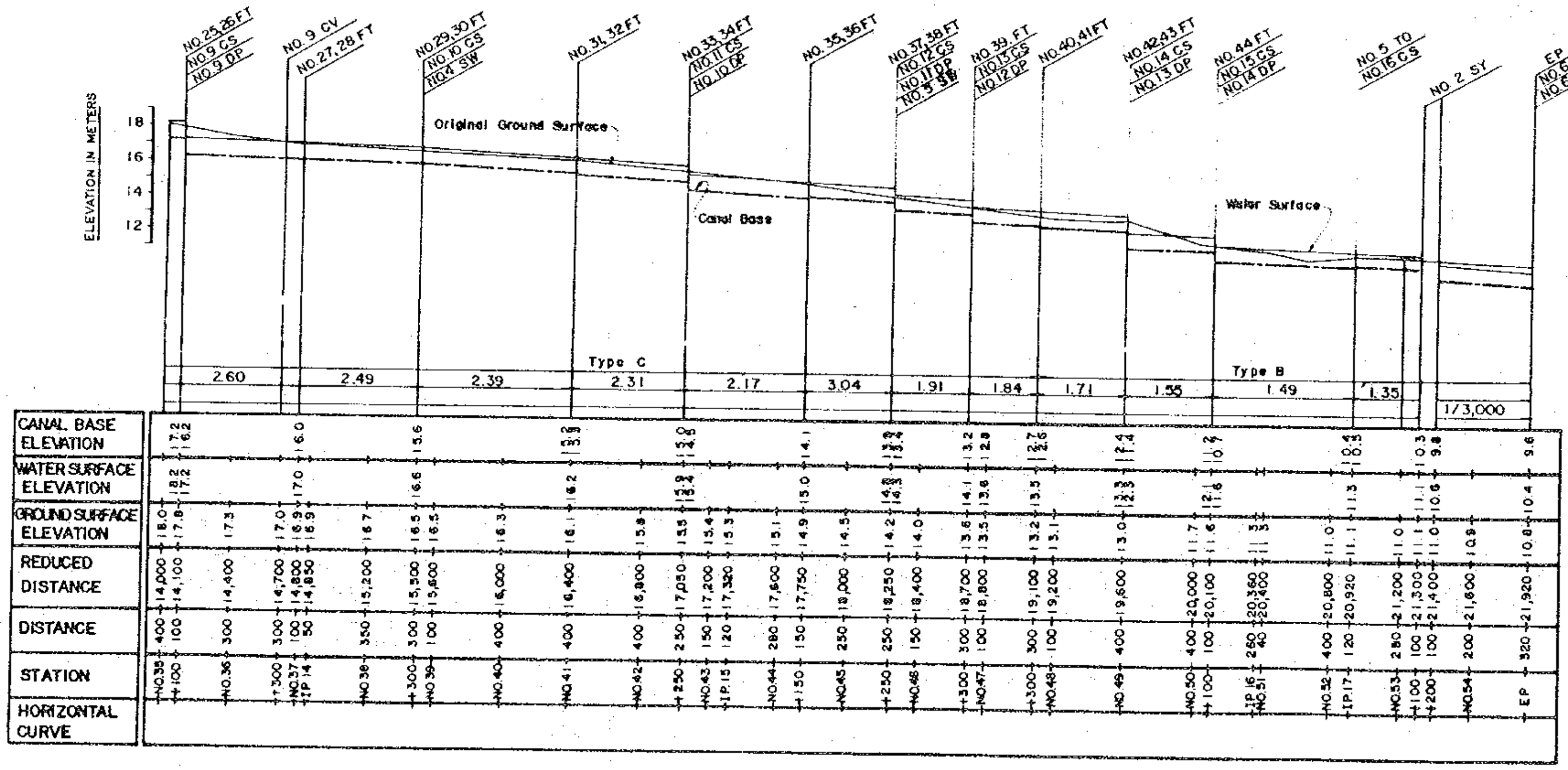
Fig. 20 (2) Longitudinal Profile of Main Canal for the Khlong Luang Irrigation Scheme

SCALE 0 1.0 2.0 km

KINGDOM OF THAILAND
THE EAST COAST WATER RESOURCES DEVELOPMENT PROJECT PHASE II
JAPAN INTERNATIONAL COOPERATION AGENCY

North Main Canal





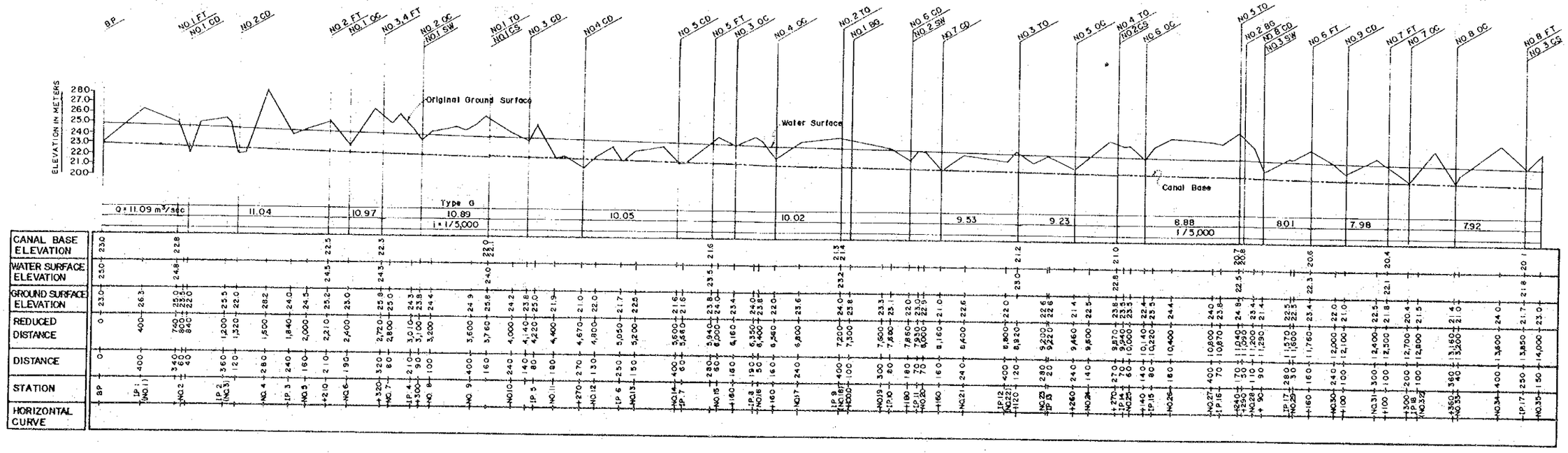
ABBREVIATION

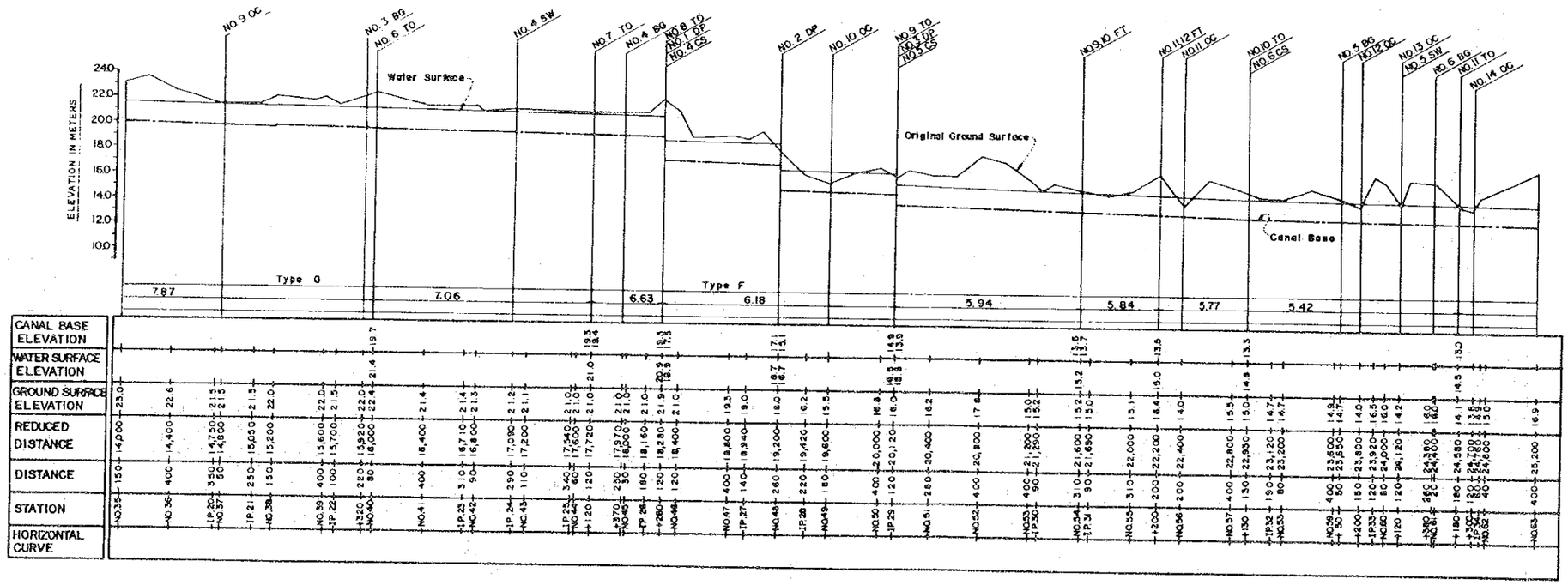
TO	:	Turnout
FT	:	Farm Turnout
CS	:	Check Structure
DP	:	Drop Structure
SY	:	Inverted Syphon
BG	:	Bridge
CV	:	Culvert
SW	:	Spillway
OC	:	Over Chute
CD	:	Cross Drain
BP	:	Beginning Point
IP	:	Intersection Point
EP	:	End Point

Fig. 20 (3) Longitudinal Profile of Main Canal for the Khlong Luang Irrigation Scheme

SCALE 0 1.0 2.0

KINGDOM OF THAILAND
THE EAST COAST WATER RESOURCES DEVELOPMENT PROJECT PHASE II
JAPAN INTERNATIONAL COOPERATION AGENCY





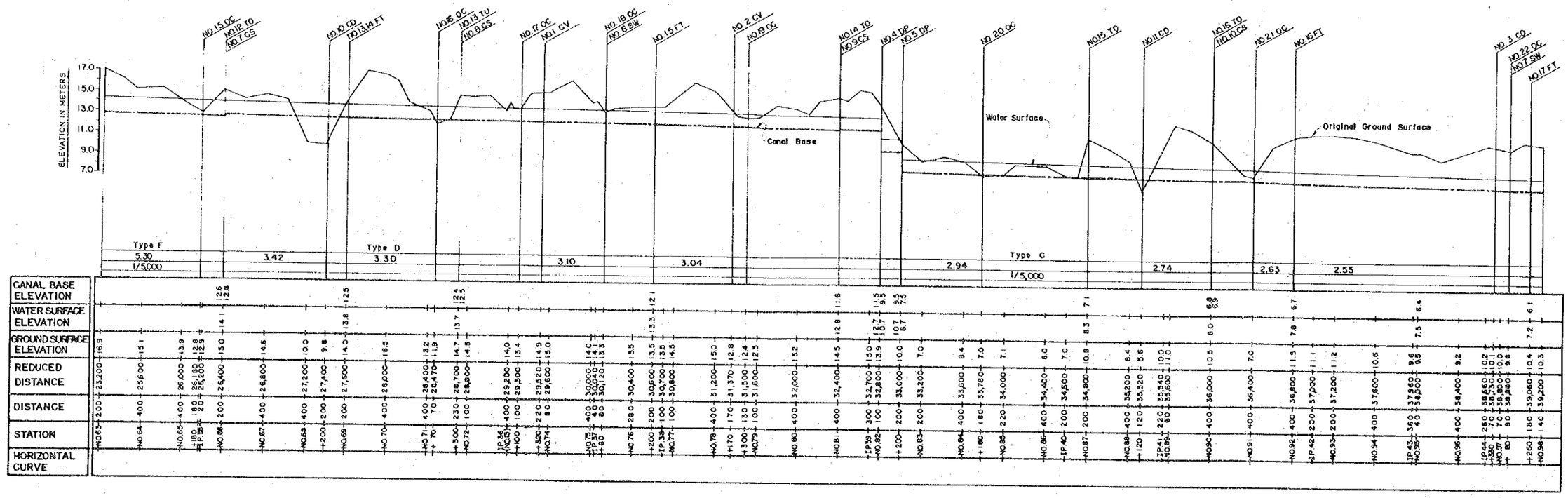
ABBREVIATION

TO	:	Turnout
FT	:	Farm Turnout
CS	:	Check Structure
DP	:	Drop Structure
SY	:	Inverted Syphon
BG	:	Bridge
CV	:	Culvert
SW	:	Spillway
OC	:	Over Chute
CD	:	Cross Drain
BP	:	Beginning Point
IP	:	Intersection Point
EP	:	End Point

Fig. 21 (1) Longitudinal Profile of Main Canal for the Ban Khai Extension Irrigation Scheme

SCALE 0 1.0 2.0 km

KINGDOM OF THAILAND
THE EAST COAST WATER RESOURCES DEVELOPMENT PROJECT PHASE II
JAPAN INTERNATIONAL COOPERATION AGENCY



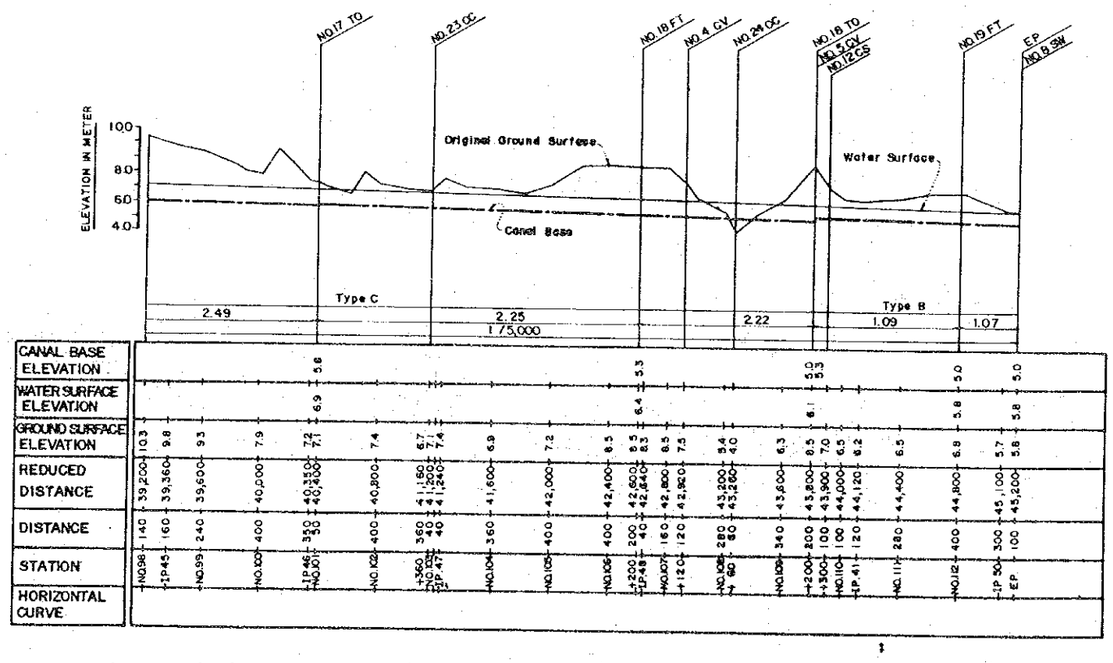


Fig. 21 (2) Longitudinal Profile of Main Canal for the Ban Khai Extension Irrigation Scheme

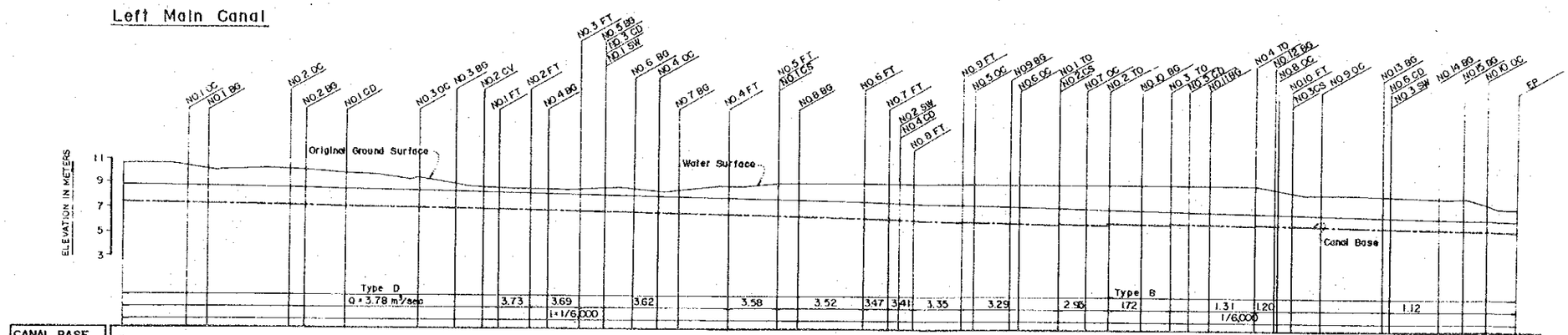
ABBREVIATION

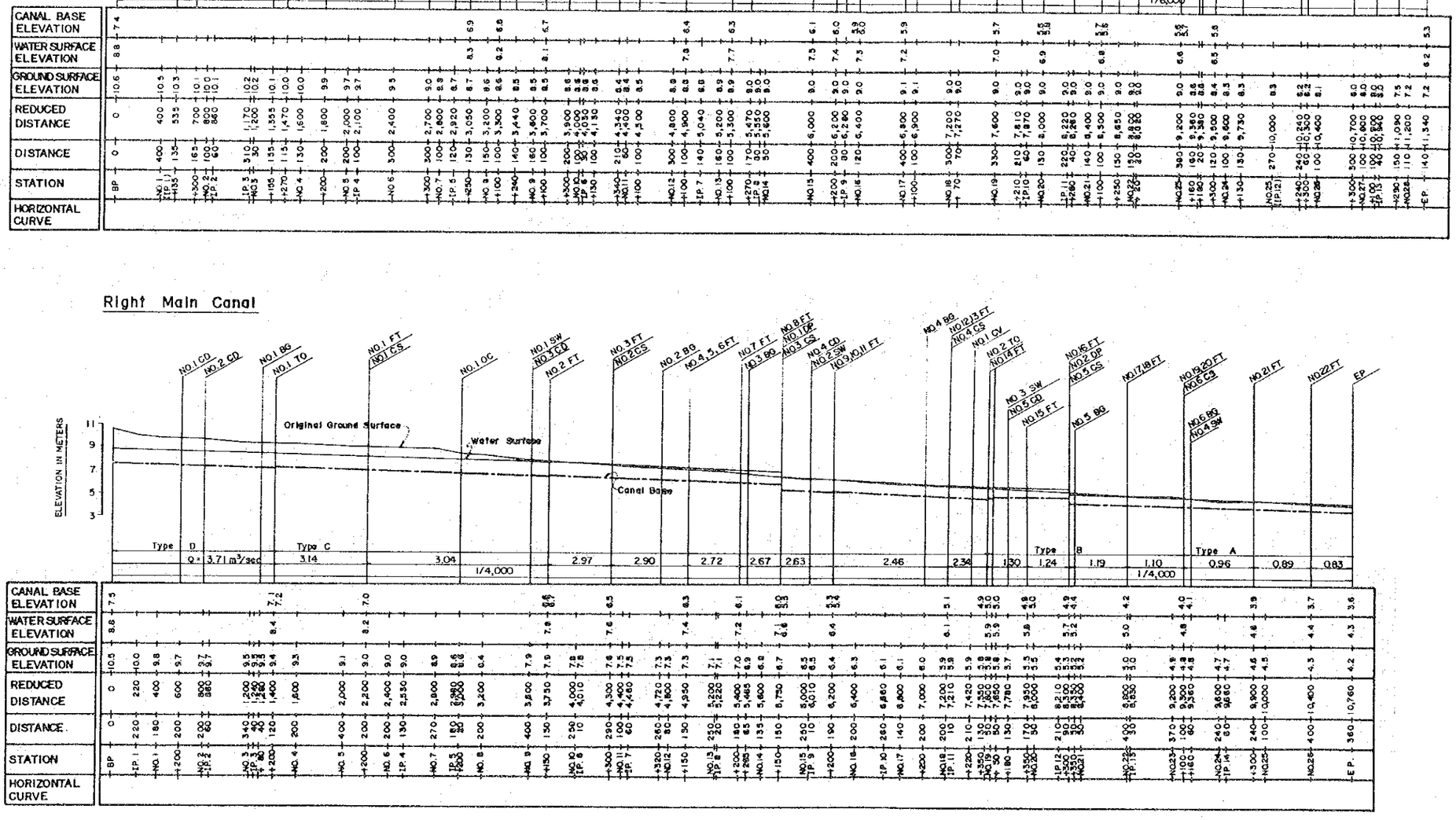
TO	:	Turnout
ET	:	Farm Turnout
CS	:	Check Structure
DP	:	Drop Structure
SY	:	Inverted Syphon
BG	:	Bridge
CV	:	Culvert
SW	:	Spillway
OC	:	Over Chute
CD	:	Cross Drain
BP	:	Beginning Point
IP	:	Intersection Point
EP	:	End Point

SCALE
0 1.0 2.0 km

KINGDOM OF THAILAND
THE EAST COAST WATER RESOURCES DEVEVOPMENT PROJECT PHASE II
JAPAN INTERNATIONAL COOPERATION AGENCY

Left Main Canal





Right Main Canal

ABBREVIATION

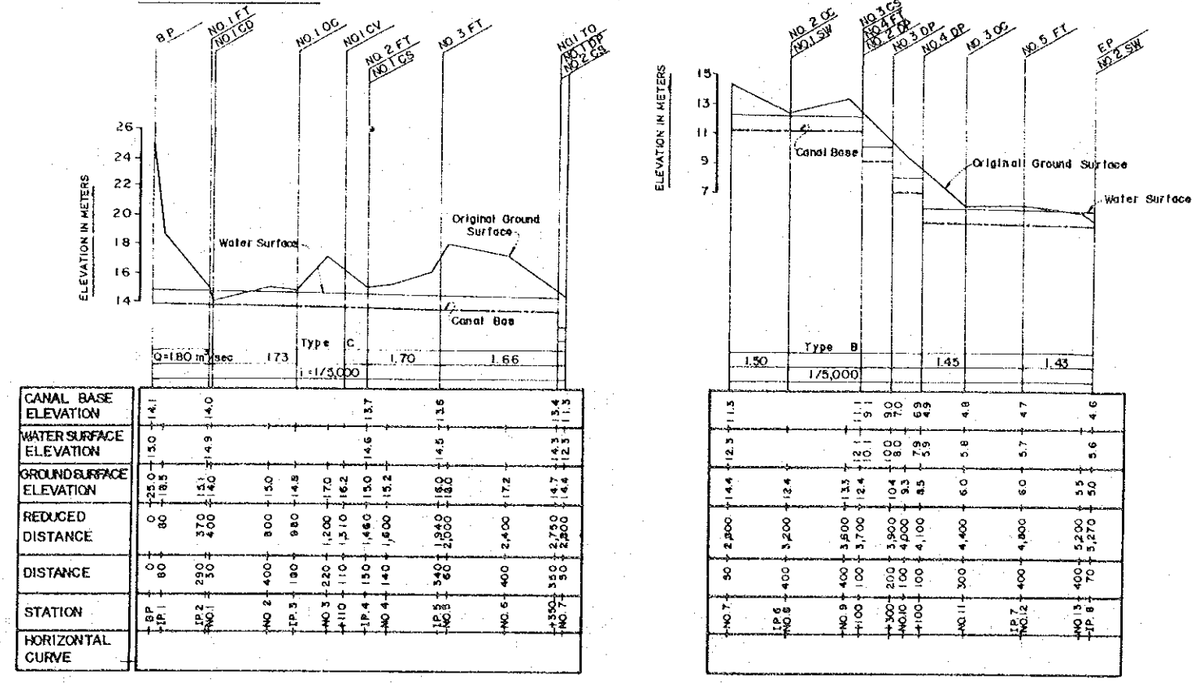
TO	:	Turnout
FT	:	Farm Turnout
CS	:	Check Structure
DP	:	Drop Structure
SY	:	Inverted Syphon
BG	:	Bridge
CV	:	Culvert
SW	:	Spillway
OC	:	Over Chute
CD	:	Cross Drain
BP	:	Beginning Point
IP	:	Intersection Point
EP	:	End Point

Fig. 22 Longitudinal Profile of Main Canal for the Ban Khai Existing Irrigation Scheme

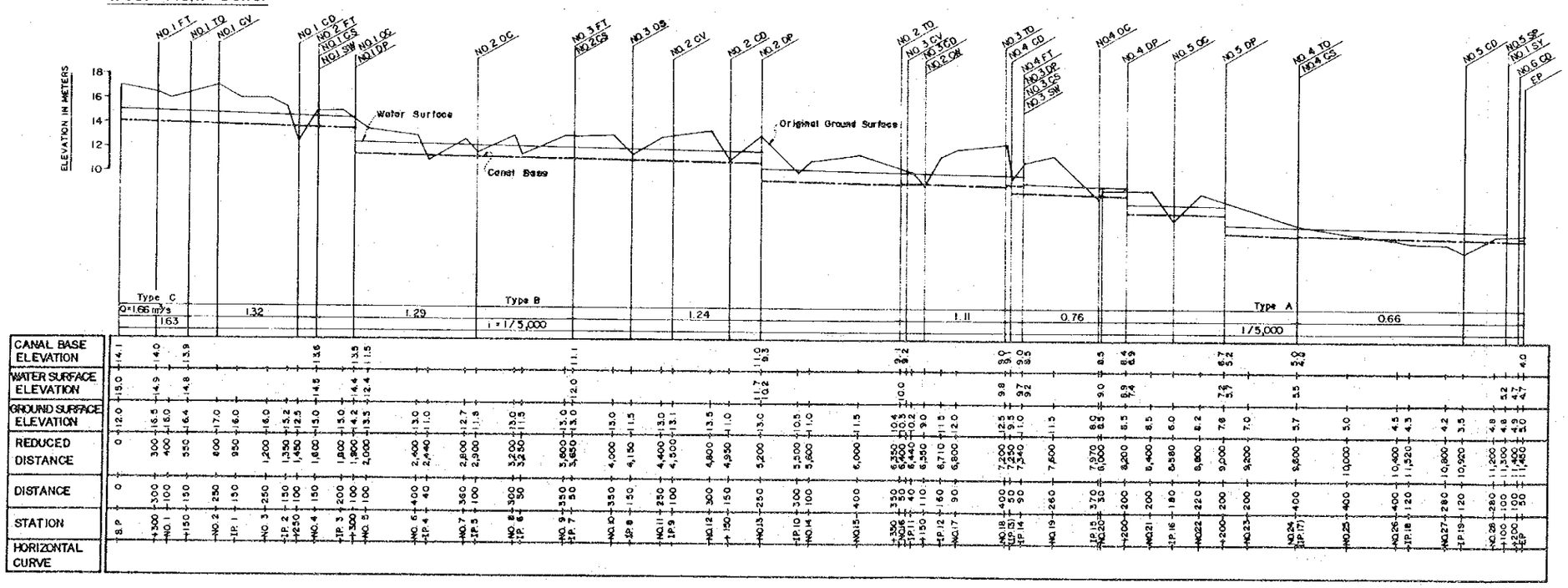
SCALE 0 1.0 20 km

KINGDOM OF THAILAND
THE EAST COAST WATER RESOURCES DEVELOPMENT PROJECT PHASE II
JAPAN INTERNATIONAL COOPERATION AGENCY

East Main Canal



West Main Canal



ABBREVIATION

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CV	:	Culvert
SW	:	Spillway
OC	:	Over Chute
CD	:	Cross Drain
BP	:	Beginning Point
IP	:	Intersection Point
EP	:	End Point

Fig. 23 Longitudinal Profile of Main Canal for the Thap Ma Irrigation Scheme

SCALE 0 10 20km

KINGDOM OF THAILAND
THE EAST COAST WATER RESOURCES DEVELOPMENT PROJECT PHASE II
JAPAN INTERNATIONAL COOPERATION AGENCY

(Unit : m)

Canal Type	B	H	Wb
A	1.0	1.0	0.2
B	1.0	1.2	0.2
C	1.5	1.5	0.3
D	1.5	1.8	0.3
E	2.0	1.8	0.3
F	2.0	2.0	0.5
G	2.5	2.3	0.5

(Unit : m)

Canal Type	B	H	Wb
A	0.5	0.6	0.2
B	0.6	0.7	0.2
C	0.8	0.9	0.2
D	1.0	1.0	0.3
E	1.2	1.2	0.3
F	1.4	1.4	0.3

Fig. 24 Typical Cross Section of Canal and Inspection Road

KINGDOM OF THAILAND
THE EAST COAST WATER RESOURCES DEVELOPMENT PROJECT PHASE II
JAPAN INTERNATIONAL COOPERATION AGENCY

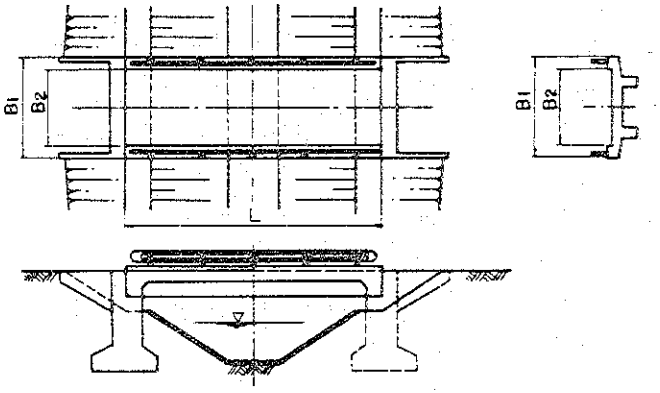
DIMENSIONS OF BRIDGES (Unit : mm)

TYPE	Discharge (m^3/sec)	L	B1	B2
A – 1	15.0 ~ 12.0	12,000	4,000 ~ 6,000	3,000 ~ 5,000
A – 2	12.0 ~ 8.0	11,000	4,000 ~ 6,000	3,000 ~ 5,000
A – 3	8.0 ~ 5.0	10,000	4,000 ~ 6,000	3,000 ~ 5,000

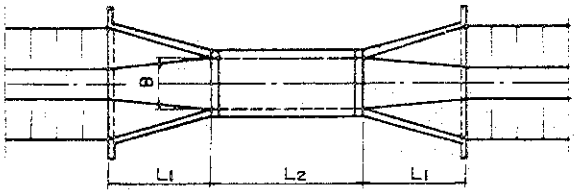
DIMENSIONS OF CULVERTS (Unit : mm)

TYPE	Discharge (m^3/sec)	L	L	W	H	B	D
A – 1	5.00 ~ 4.00	4,000	3,000 ~ 5,000	2,250	2,000	2,000	—
A – 2	4.00 ~ 3.20	〃	〃	2,050	1,800	1,800	—
A – 3	3.20 ~ 2.50	〃	〃	1,850	1,600	1,600	—
A – 4	2.50 ~ 1.80	〃	〃	1,600	1,400	1,400	—
A – 5	1.80 ~ 1.30	〃	〃	1,400	1,200	1,200	—
A – 6	1.30 ~ 1.00	〃	〃	1,200	1,000	1,000	—
B – 1	1.00 ~ 0.83	3,000	〃	1,900	—	—	1,000
B – 2	0.83 ~ 0.64	〃	〃	1,800	—	—	900
B – 3	0.64 ~ 0.50	〃	〃	1,700	—	—	800
B – 4	0.50 ~ 0.36	〃	〃	1,600	—	—	700
B – 5	0.36 ~ 0.26	〃	〃	1,500	—	—	600
B – 6	0.26 ~ 0.16	〃	〃	1,400	—	—	500
B – 7	0.16 ~ 0.09	〃	〃	1,300	—	—	400
B – 8	0.09 ~	〃	〃	1,200	—	—	300

BRIDGE



CULVERT, TYPE-A



CULVERT, TYPE-B

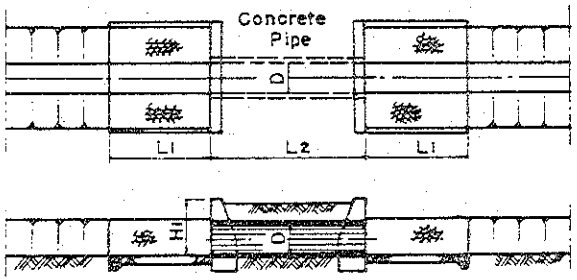


Fig. 25 Typical Dimensions of Bridges and Culverts

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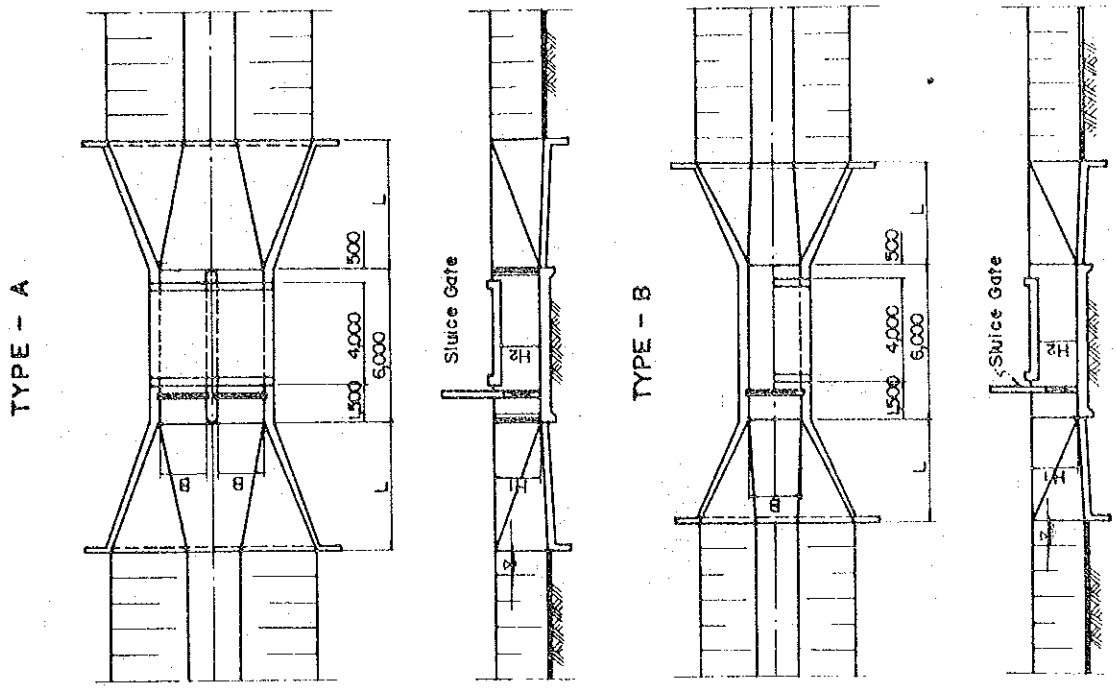
THE EAST COAST WATER RESOURCES DEVELOPMENT PROJECT PHASE II
JAPAN INTERNATIONAL COOPERATION AGENCY



DIMENSION OF CHECK STRUCTURES (Unit: mm)

TYPE	Discharge (m^3/sec)	L	B	H1	H2	Sluice Gate
A-1	8.0 ~ 6.4	5,000	1,800	2,000	1,800	1,800 x 1,600
A-2	6.4 ~ 5.0	5,000	1,600	1,800	1,600	1,600 x 1,400
B-1	5.0 ~ 4.0	4,000	2,000	2,200	2,000	2,000 x 1,700
B-2	4.0 ~ 3.2	4,000	1,800	2,000	1,800	1,800 x 1,600
B-3	3.2 ~ 2.5	4,000	1,600	1,800	1,600	1,600 x 1,400
B-4	2.5 ~ 1.8	4,000	1,400	1,600	1,400	1,400 x 1,300
B-5	1.8 ~ 1.3	4,000	1,200	1,400	1,200	1,200 x 1,100
B-6	1.3 ~ 1.0	4,000	1,000	1,200	1,000	1,000 x 900
B-7	1.0 ~ 0.6	3,000	800	1,200	1,000	800 x 800
B-8	0.6 ~ 0.4	3,000	600	1,000	800	600 x 500
B-9	0.4 ~ 0.25	3,000	500	1,000	800	500 x 500
B-10	0.25 ~	3,000	400	800	600	400 x 500

Fig. 26 Typical Dimension of Check Structures

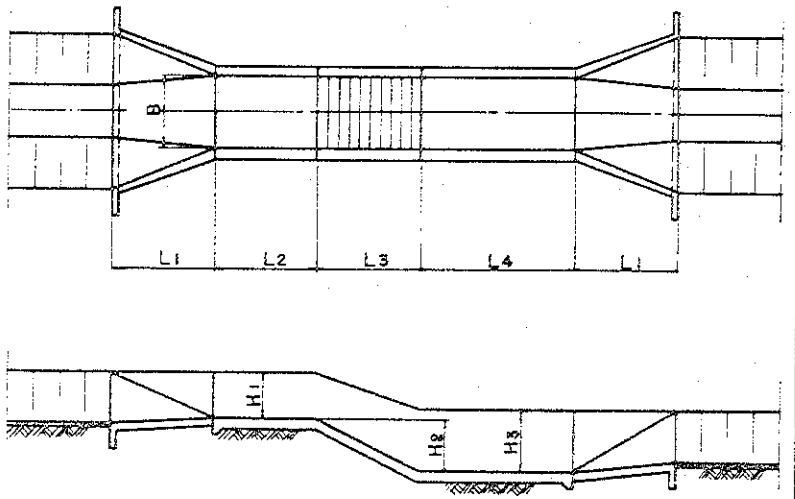
KINGDOM OF THAILAND
THE EAST COAST WATER RESOURCES DEVELOPMENT PROJECT PHASE II
JAPAN INTERNATIONAL COOPERATION AGENCY

DIMENSIONS OF DROPS

(Unit : mm)

TYPE	Discharge (m^3/sec)	L	L1	L3	L4	B	H1	H2	H3	H4
A – 1	8.0 ~ 6.4	5,000	5,000	4,000 ~9,000	6,000	3,600	2,000	2,000 ~ 4,500	2,500	—
A – 2	6.4 ~ 5.0	5,000	5,000	4,000 ~9,000	6,000	3,200	2,000	2,000 ~ 4,500	2,500	—
A – 3	5.0 ~ 4.0	4,000	4,000	4,000 ~9,000	6,000	2,000	2,000	2,000 ~ 4,500	2,500	—
A – 4	4.0 ~ 3.2	4,000	4,000	4,000 ~9,000	6,000	1,800	2,000	2,000 ~ 4,500	2,500	—
A – 5	3.2 ~ 2.5	4,000	4,000	4,000 ~9,000	5,000	1,600	1,800	2,000 ~ 4,500	2,300	—
A – 6	2.5 ~ 2.0	4,000	4,000	4,000 ~9,000	5,000	1,400	1,600	2,000 ~ 4,500	2,100	—
B – 1	8.0 ~ 6.4	5,000	5,000	3,500 ~4,500	—	3,600	2,000	900 ~ 1,400	2,000	400
B – 2	6.4 ~ 5.0	5,000	5,000	3,500 ~4,500	—	3,200	2,000	900 ~ 1,400	2,000	400
B – 3	5.0 ~ 4.0	4,000	4,000	3,500 ~4,500	—	2,000	2,000	900 ~ 1,400	2,000	400
B – 4	4.0 ~ 3.2	4,000	4,000	3,500 ~4,500	—	1,800	2,000	900 ~ 1,400	2,000	400
B – 5	3.2 ~ 2.5	4,000	4,000	3,500 ~4,500	—	1,600	1,800	900 ~ 1,400	1,800	400
B – 6	2.5 ~ 2.0	4,000	4,000	3,500 ~4,500	—	1,400	1,600	900 ~ 1,400	1,600	400
B – 7	2.0 ~ 1.3	4,000	4,000	3,500	—	1,200	1,400	800 ~ 2,300	1,400	300
B – 8	1.3 ~ 1.0	4,000	4,000	3,500	—	1,000	1,200	800 ~ 2,300	1,200	300
B – 9	1.0 ~ 0.6	3,000	3,000	3,000	—	800	1,200	800 ~ 2,300	1,200	300
B –10	0.6 ~ 0.4	3,000	3,000	3,000	—	600	1,000	800 ~ 2,300	1,000	300
B – 11	0.4 ~0.25	3,000	3,000	2,500	—	500	1,000	800 ~ 2,300	1,000	300
B –12	0.25 ~	3,000	3,000	2,500	—	400	800	800 ~ 2,300	800	300

TYPE - A (Inclained Drops)



TYPE - B (Vertical Drops)

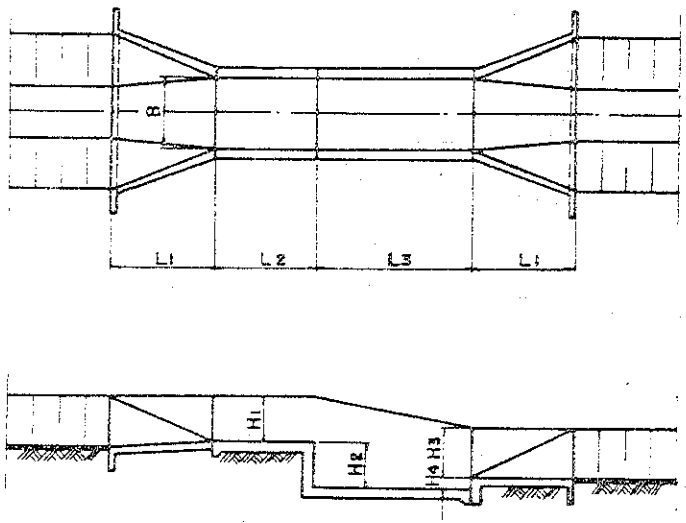
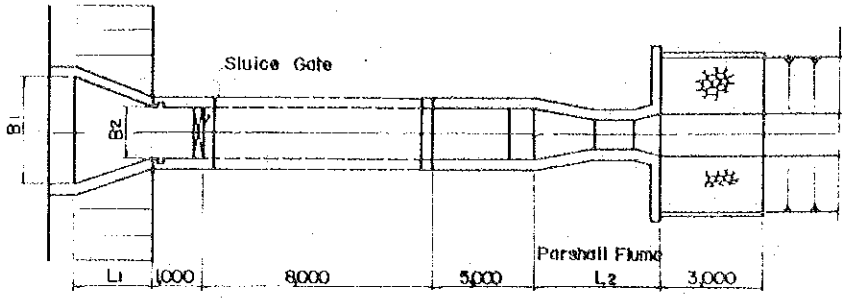
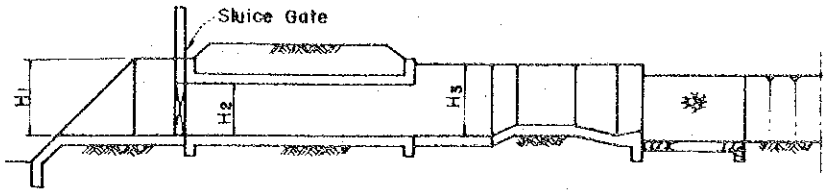


Fig. 27 Typical Dimensions of Drops

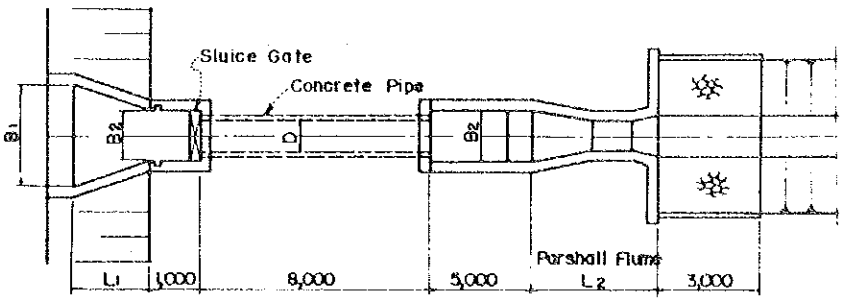
KINGDOM OF THAILAND
THE EAST COAST WATER RESOURCES DEVELOPMENT PROJECT PHASE II
JAPAN INTERNATIONAL COOPERATION AGENCY

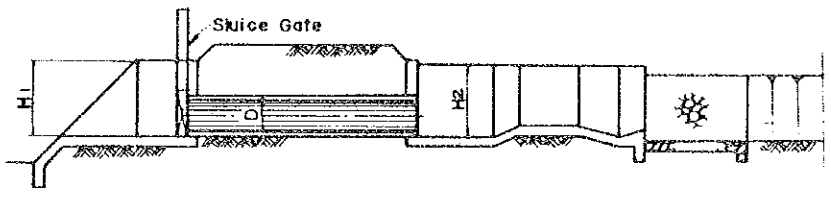
TYPE - A





TYPE - B





DIMENSION OF TURNOUTS

(Unit : mm)

TYPE	Discharge (m^3/sec)	L1	L2	B1	B2	D	H1	H2	H3	Sluice Gate	Parshall Flume Type
A-1	2.50 ~ 1.80	2,850	3,467	2,400	1,400	—	1,900	1,400	1,800	1,400x 1,400	5 ft
A-2	1.80 ~ 1.30	2,550	3,318	2,200	1,200	—	1,700	1,200	1,600	1,200x 1,200	4 ft
A-3	1.30 ~ 1.00	2,250	3,169	2,000	1,000	—	1,500	1,000	1,400	1,000x 1,000	3 ft
B-1	1.00 ~ 0.83	2,250	3,169	2,200	1,200	1,000	1,500	1,400	—	1,000x1,000	3 ft
B-2	0.83 ~ 0.64	2,100	3,019	2,100	1,100	900	1,400	1,300	—	900 x 900	2 ft
B-3	0.64 ~ 0.50	1,950	2,943	2,000	1,000	800	1,300	1,200	—	800 x 800	1ft 6in
B-4	0.50 ~ 0.36	1,800	2,943	1,900	900	700	1,200	1,100	—	700 x 700	1ft 6in
B-5	0.36 ~ 0.26	1,650	2,867	1,800	800	600	1,100	1,000	—	600 x 600	1 ft
B-6	0.26 ~ 0.16	1,500	1,625	1,700	700	500	1,000	1,000	—	500 x 500	9 in
B-7	0.16 ~ 0.09	1,350	1,625	1,600	600	400	900	1,000	—	400 x 400	9 in
B-8	0.09 ~	1,200	1,525	1,500	500	300	800	1,000	—	300 x 300	6 in

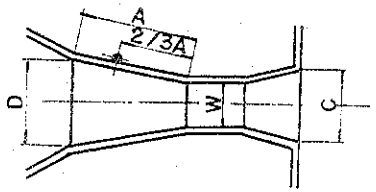
Fig. 28 Typical Dimensions of Turnouts

KINGDOM OF THAILAND
THE EAST COAST WATER RESOURCES DEVELOPMENT PROJECT PHASE II
JAPAN INTERNATIONAL COOPERATION AGENCY

DIMENSION OF PARSHALL FLUMES

(Unit : mm)

TYPE	Discharge (m^3/sec)	W	A	B	C	D	E	F	G	K	N	X	Y
5 ft.	2.42 ~ 0.045	1,524	1,981	1,943	1,829	2,302	914	610	914	76	229	51	76
4 ft.	1.92 ~ 0.037	1,219	1,829	1,794	1,524	1,937	914	610	914	76	229	51	76
3 ft.	1.43 ~ 0.017	914	1,676	1,645	1,219	1,572	914	610	914	76	229	51	76
2 ft.	0.94 ~ 0.012	610	1,524	1,495	914	1,206	914	610	914	76	229	51	76
1ft. 6in	0.70 ~ 0.004	457	1,448	1,419	762	1,025	914	610	914	76	229	51	76
1 ft.	0.46 ~ 0.003	305	1,372	1,343	610	844	914	610	914	76	229	51	76
9in	0.28 ~ 0.003	229	879	863	381	575	762	305	457	76	114	51	76
6in	0.11 ~ 0.001	152	792	610	397	397	610	305	610	76	114	51	76



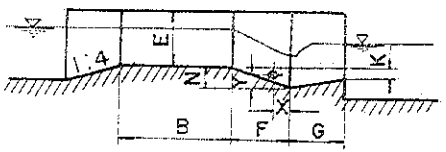


Fig. 29 Typical Dimensions of Parshall Flumes

KINGDOM OF THAILAND
THE EAST COAST WATER RESOURCES DEVELOPMENT PROJECT PHASE II
JAPAN INTERNATIONAL COOPERATION AGENCY

DIMENSIONS OF SPILLWAYS (Unit : mm)

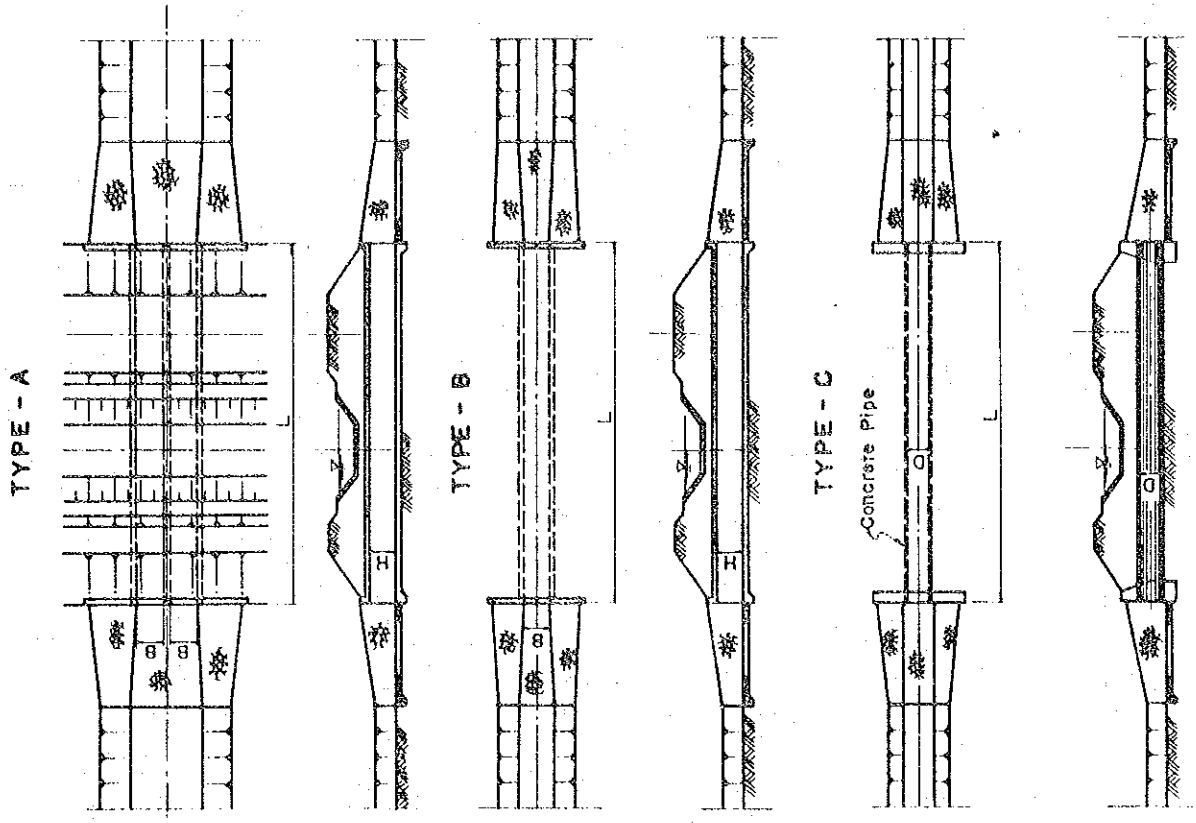
TYPE	Discharge (m^3/sec)	L	B	H	D	Sluice Gate
A-1	2.18 ~	15,000	1,800	2,000	1,000	1,800x 1,800
A-2	1.74 ~	12,000	1,800	2,000	1,000	1,800x 1,800
A-3	1.45 ~	10,000	1,600	1,800	1,000	1,600x 1,600
A-4	1.16 ~	8,000	1,400	1,800	800	1,400x 1,400
A-5	0.73 ~	5,000	1,200	1,800	800	1,200x 1,200
A-6	0.44 ~	3,000	1,000	1,800	800	1,000x 1,000

DIMENSIONS OF OVER CHUTES

TYPE	Discharge (m^3/sec)	L (mm)
A-1	1.60 ~	10,000
A-2	1.28 ~	8,000
A-3	0.80 ~	5,000
A-4	0.48 ~	3,000

Fig. 30 Typical Dimensions of Spillway and Over Chute

KINGDOM OF THAILAND
THE EAST COAST WATER RESOURCES DEVELOPMENT PROJECT PHASE II
JAPAN INTERNATIONAL COOPERATION AGENCY



DIMENSIONS OF CROSS DRAINS (Unit: mm)

TYPE	Discharge (m^3/sec)	L	B	H	D
A — 1	16.0~12.0	20,000 ~ 30,000	2,000	2,000	—
A — 2	12.0~ 8.0	"	1,500	2,000	—
B — 1	8.0~ 6.5	"	2,000	2,000	—
B — 2	6.5~ 5.0	"	1,800	1,800	—
B — 3	5.0~ 4.0	"	1,600	1,600	—
B — 4	4.0~ 3.0	"	1,400	1,400	—
B — 5	3.0~ 2.0	"	1,200	1,200	—
B — 6	2.0~1.6	"	1,000	1,000	—
C — 1	1.6~1.0	"	—	—	1,000
C — 2	1.0~0.6	"	—	—	800
C — 3	0.6~	"	—	—	600

Fig. 31 Typical Dimensions of Cross Drains

KINGDOM OF THAILAND
THE EAST COAST WATER RESOURCES DEVELOPMENT PROJECT PHASE II
JAPAN INTERNATIONAL COOPERATION AGENCY

ITEM	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996
Ban Khai Existing Scheme														
(1) Aerial photo mapping & engineering services														
(2) Loan arrangement & preparatory works														
(3) Construction														
— Main canal														
— Lateral canal														
— Drainage canal														
Ban Khai Extension Scheme														
(1) Aerial photo mapping & engineering services														
(2) Loan arrangement & preparatory works														
(3) Construction														
— Nong Pla Lai headworks														
— Khlong Yai headworks														
— Main canal														
— Lateral canal														
— Drainage canal														
Khlong Luang Scheme														
(1) Aerial photo mapping & engineering services														
(2) Loan arrangement & preparatory works														
(3) Construction														
— Intake structure														
— Main canal														
— Lateral canal														
— Drainage canal														
Khlong Thap Ma Scheme														
(1) Aerial photo mapping & engineering services														
(2) Loan arrangement & preparatory works														
(3) Construction														
— Intake structure														
— Main canal														
— Lateral canal														
— Drainage canal														

Fig. 32 Construction Time Schedule

KINGDOM OF THAILAND
THE EAST COAST WATER RESOURCES DEVELOPMENT PROJECT PHASE II
JAPAN INTERNATIONAL COOPERATION AGENCY

SECTORAL REPORT IV
DOMESTIC AND INDUSTRIAL WATER DEMAND

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

1. INTRODUCTION

This sectoral report presents the result of water demand projection for domestic and industrial use until the Target Year of 2001. The result will be used as the basis of the water demand and supply balance study together with the agricultural water demand. Total water demand, will be compared with the available water resources and where deficit arises, development plan of water resources and water conveyance system is proposed.

With reference to the future water demand projection, two previous studies are available, namely East Coast Water Resources Development Project Phase I (hereafter called Phase I Study) and interim report of Eastern Seaboard Study (hereafter called ESS). In order to avoid the confusion among studies of similar kinds, the present study has adopted the methodology and results of ESS to a fairly good extent in agreement with RID. ESS has been chosen because the study was conducted more recently when compared with Phase I Study and was able to take policy amendments into account.

However, some parts of the results in ESS had to be amended so as to be used as the basis of the water balance study. The study area is divided into 10 zones for the purpose of the water balance study and accordingly projected population in ESS is rearranged to present the figure by each zone.

Projected water demand for domestic and industrial use is also adjusted and complemented so as to present the projection by each zone.

2. PROJECTED SOCIO-ECONOMIC FRAMEWORK

2.1 Industrial Development

The Fifth National Economic and Social Development Plan (hereafter called the Fifth National Plan) spells out the balanced economic development of all the regions of Thailand as its one of the major targets. Eastern Seaboard, which comprises three provinces, Chon Buri, Rayong and Chachoengsao was selected as the new industrial development centers in view of its good locational and economic factors. This region is located in the vicinity of Bangkok and North Eastern region which is the supplier of raw materials and labour forces to the region. It is also provided with relatively good infrastructural facilities. This region is planned to become new growth centers and the location of future basic industries. With implementation of the Eastern Seaboard Development, such targets as diffusion of growth from Bangkok, generation of new employment opportunities and creation of new gateway for the North Eastern region, are expected to be attained.

Since Eastern Seaboard Development owes much to the investment by private sector, several measures to be taken are under consideration to attract private investors, among which are provision of investment incentives and development of such infrastructural facilities as water resources and transportation networks.

Planned industrial development centers in the Study Area are, Chon Buri, Laem Chabang, Rayong, Map Ta Phut and Sattahip. Although Chachongsao is also one of the industrial centers selected by ESS, it is not included in the present study since it is located outside of the Study Area. The types of industries planned to be developed and development schedule at each center are summarized hereunder.

Industrial Center	Type of Industry	Starting Year	Year of full Operation
Chon Buri	Small Urban Industry	Existing	-
Laem Chabang	Industrial Estate	1985	2001
	Port	1996	2001
Si Racha	Industrial Estate	Existing	1990
Sattahip	Naval Base	1984	1990
	Port	1984	1984
Map Ta Phut	Gas separation/Petro-chemical	1983	1983
	Soda Ash	1985	1985
	Fertilizer	1982	1984
	Industrial Estate	1984	2001
Rayong	Agro-processing	Existing	-

2.2 Population

2.2.1 Population by Urban and Rural Areas

Future population of the Study Area is projected until the year 2001 based on the administrative boundaries in the Sectoral Report Vl. I (Socio-Economy). The projected population is divided into urban and rural areas in this report. Urban area is the municipal areas and sanitary districts whose population are projected to exceed 5,000 by the year 2001 and rural areas the rest of the study area.

The standard of 5,000 is adopted in accordance with the Fifth Five Year Plan of Provincial Water Works Authority (PWWA) which plans to supply relatively developed areas with the population of more than 5,000 with piped water by large scale water works.

Projected population for urban and rural areas is summarized as follows:

PROJECTED POPULATION BY URBAN AND RURAL AREAS

Unit: 10^3

	1981	1986	1991	1996	2001
Urban	358	419	501	603	738
Rural	570	619	659	669	645
Total	928	1,038	1,160	1,272	1,383

2.2.2 Demand Center and Zoning

There are 13 urban areas in the study area, out of which 6 are specified as development areas (hereafter called DA) and the rest as non-development areas (hereafter called NDA). DA will be new industrial centers of Eastern Seaboard as discussed in the precedent section. Since population is concentrated in urban areas, they are treated as demand centers. As shown in Fig. 1, the Study Area is divided into ten zones for the purpose of water balance study considering such factors as the location of demand centers, river basin boundaries, and the location of existing, planned and proposed water works. Zone 1 and Zone 10 include sub-zone 1-1 and 10-1 respectively. Accordingly future population and water demand is projected by each zone.

Name of demand centers and population by each zone are summarized in the table below.

NAME OF DEMAND CENTER

Zone		Name
1		Phanat Oikhom Than Bun Mi Nong Tamlung Bang Bung
2	DA	Chon Buri
3		-
4	DA	* Laem Chabang
5	DA	Pattaya
6		Huai Yai
7	DA	Sa-tahip
8		Ban Chang
9	DA	Map Ta Phut
10	DA	Rayong Ban Khai

* Hereafter Laem Chabang includes Si Racha

Historical and projected population of the Study Area is given in Table 1 and Fig. 2 and is presented by zone in Table 2 and Fig. 3.

3. WATER DEMAND PROJECTION

3.1 Basis of the Study

This chapter presents the results of domestic and industrial water demand projection. Domestic water demand is divided into urban and rural water demand. Urban water demand is composed of the amount for residential and commercial use.

Projected demand in this report is consumer demand, which takes into account the water loss and unaccounted loss between consumer and water works. It is the amount of water to be supplied by water works. Loss between intakes and water works and in the purification process is determined to be 10 % of consumer demand and included in source demand.

Methodology for projecting the urban water demand refers to ESS. Such basic figures as consumption per capita and service factor are compared with the recorded figure collected by the Study Team and used in the projection.

Since ESS does not refer to NDA and rural water demand, projection for these areas was done by the Study Team. The consumption per capita is determined with reference the ESS.

Industrial water demand is projected in ESS. It is adopted in the present study with some adjustments based on data on industrial water supply by existing source facilities.

3.2 Domestic Water Demand Projection

3.2.1 Methodology

Domestic water demand is calculated by the following equation.

$$DWD = (CPC \times Pn \times SF) \times 365 \times 10^{-6}$$

where, DWD : Domestic Water Demand (10^6 m^3/yr)
CPC : Consumption Per Capita (m^3/d)
Pn : Population
SF : Service Factor

(1) Consumption Per Capita

Consumption per capita is determined to be 180 lit./d for urban areas and 140 lit./d for rural areas. 180 lit. for urban areas can be divided into 140 lit. and 40 lit. The former is consumed for domestic use and the latter is the allowance for commerce and light industry of which amount are too small to be treated separately. This allowance is not included in the water demand in rural areas since it is considered to be negligibly small.

Detail of 180 lit./d and past record of water consumption per capita are shown in Tables 3 and 4 respectively.

Based on the definition of consumer demand, unaccounted loss in the distribution system is taken into consideration and the following figures are determined as consumption per capita.

Unit: lit./d/c.

Year	Urban		Rural
	DA	NDA	
1981	360	225	175
1991	323	225	175
2001	276	225	175

Source: ESS and PWWA

The figures for DA are taken from ESS and the one for NDA and rural areas are determined based on the collected data. 180 lit./d for NDA nad 140 lit./d for rural areas are adjusted to the figures above with 25% of loss in the distribution systems. Data on water loss is presented for recent five years in Table 5.

(2) Service Factor

Service factor is determined to be the ratio of the population supplied with piped water to the total population in the area.

Service factor is determined for each area as follows:

(Unit: %)

Year	Urban		Rural
	DA	NDA	
1981	53	53	3
1991	60	60	15
2001	100	70	30

Source: ESS and PWWA

Service factor of urban areas in the Study Area for recent five years is summarized as follows:

(Unit: %)

1977	1978	1979	1980	1981
50.0	51.7	54.4	52.8	53.6

Source: PWWA

Service factor grew at the annual rate of 1.8 % in recent five years.

Future growth is determined with reference to ESS for DA, while the one for NDA is determined at lower level in view of more concentrated development in DA.

Service factor for rural areas is determined based on the estimated service factor at present and PWWA's program for rural water supply projects in the Fifth National Plan. Since sufficient data is not available for the present service factor in rural areas, it is estimated considering such factors as plant capacity, assumed consumption per capita in rural areas and rural population. (Refer to Sectoral Report IX, Water Transmission Engineering).

For rural water supply, small scale projects have been implemented by the government for sanitary districts and residential area with population between 1,500 and 5,000. At the end of the Fourth National Plan, 663 systems were completed supplying water to 324 villages.

In the Fifth National Plan, the program to construct and expand water works systems are planned to be implemented. In the five years 250 water works are planned to be constructed with the government budget of $1,004.62 \times 10^6$ Baht and local finance of 133.0×10^6 Baht as well as development and expansion of existing water works with 401.90×10^6 Baht from central government and 57.0×10^6 Baht from local area.

Service factor for rural area is determined until the year 2001 on the basis that the government will continue to make effort on expanding water supply networks in rural areas.

(3) Population

In the precedent section, future population is projected for each demand center and rural area. These figures are applied to the domestic water demand projection.

3.2.2 Projected Water Demand

Domestic water demand is projected for each demand center and rural area for the year of 1991 and 2001 based on the methodology explained in the precedent subsection. For intermediate years 1986 and 1996, figures are obtained based on the figures of 1981, 1991 and 2001. That is to say, average amount of water demand in two years, 1981 and 1991 for instance, is adjusted to take into account the projected population growth rate. This is summarized by the following equation:

$$D_{86} = (D_{81} + D_{91})/2 \times P_{86} / (P_{81} + P_{91})/2$$

where, D_{86} = Water demand in 1986

D_{81} = Water demand in 1981

D_{91} = Water demand in 1991

P_{86} = Population in 1986

P_{81} = Population in 1981

P_{91} = Population in 1991

Historical and projected domestic water demand of the Study Area is summarized in the table below and presented in Table 6 and Fig. 4. Water demand by each zone is presented in Table 7 and Fig. 5.

(Unit: 10^6 m^3/yr)

Area	1981	1986	1991	1996	2001
Urban	19.0	26.5	34.7	51.1	71.0
Rural	0.8	3.6	6.4	9.8	12.2
Total	19.8	30.1	41.1	60.9	83.2

3.3 Industrial Water Demand Projection

3.3.1 Water Use in Industry

In industrial activities water is used for such various purposes as raw material cleaning, boiler, cooling and controling of the temperature and humidity.

Amount of water used varies considerably depending on such factors as purpose of used water, kind and scale of industry, degree of recycling and water tariff. The tables below present cases of Japan that amount of water consumed is different to a great extent depending on the kind and scale of industry.

Kind of Industry	Amount of Water per Production ($m^3/d/10^8$ Yen)
Food	48.4
Textile	94.6
Pulp	386.6
Petroleum	151.2
Leather	11.0

(Unit: 10^3/d)

No. of Employee	Water Used Per Worker
30 - 49	3.6
50 - 99	5.5
100 - 199	9.5
200 - 299	15.3
300 - 499	28.7
500 - 999	43.4
1000 -	123.8

For industrial water demand projection, there are three kinds of methodology in general: 1) Per capita method 2) Percentage of domestic water demand method 3) Per acreage method. Although, "3) Per acreage method" seems to be theoretically most justifiable, it can be applied only when sufficient data is available for kinds and area of industry.

3.3.2 Projected Water Demand

In the present study, industrial water demand is projected with reference to ESS and is adjusted based on the collected data on industrial water supply by existing water source facilities.

Both Phase I Study and ESS put forward the industrial water demand projection and their figures favorably compare with each other as shown in Table 8. In Phase I Study, projection was made based on previous reports and above-mentioned methodology; "3) per acreage method", for Laem Chabang and Rayong area. It is assumed in the study that the industrial area is 320 ha and 448 ha for Laem Chabang and Rayong respectively. Water requirement per hectare is assumed to be 90 ton.

The present study, however, adopts the figure of ESS considering that the ESS was conducted more recently and therefore could incorporate the recent policy amendments into the study. Sponge iron project is no more under consideration and the location of soda ash project was changed from Sattahip to Map Ta Phut. Industrial water demand projected by ESS is presented in Table 9.

Some adjustments is made to those figures based on the data on water supplied by existing source facilities. At present, there are several enterprises and facilities which are taking water directly from such existing reservoirs as Ban Phra, Map Prachan, Ban Bung and Dok Krai. Amount of water which should be guaranteed even in future is determined for these users based on the past record of water supply and is added to the demand projected by ESS at each zone. Water to be supplied by existing source facilities is presented in Table 10.

Total industriral water demand until the year 2001 is summarized in the table below.

(unit: 10^6 m^3/yr)

1981	1986	1991	1996	2001
9.2	51.3	64.5	70.2	80.3

Historical and projected industrial water demand of the Study Area is presented in Table 11 and Fig. 6.

3.4 Total Water Demand

Historical and projected water demand for domestic and industrial use is presented in Table 12 and Fig. 7. As shown below total water demand is projected to increase more than five fold in 20 years from 28.7×10^6 m^3/yr in 1981 to 163.5×10^6 m^3/yr in 2001. After consumer demand in this report is adjusted to source demand, it is used as the basis of the water supply and demand balance study together with agricultural water demand.

(Unit: 10^6 m^3/yr)

1981	1986	1991	1996	2001
29.0	81.4	105.6	131.1	163.5

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