Table J.3.14 SUMMARY OF CONSTRUCTION COST (CASE-B151)

Item No.	Work Items		Const. Cost Eq. Total US$ (10^6)	Economic Cost Eq. Total US$ (10^6)	Economic Cost Annual* US$ (10^6)	Pump Running Cost US$ (10^6)	O&M Cost US$ (10^3)	Replace Cost US$ (10^3)	Total Annual Cost US$ (10^6)
Water Resources Development									
1.	Watawala		44.2	42.8	-		450	10,450	-
2.	Ulapane		117.0	112.0	-		1,008	20,995	-
3.	Caledonia		156.4	149.3	-		1,194	14,535	-
4.	Talawakele		215.7	207.7	-		2,077	43,605	-
5.	Kotmale Extension		236.6	232.7	-		1,862	5,890	-
6.	Scheme-1000		249.1	240.0	-		1,920	43,320	-
7.	Scheme-500		228.5	220.5	-		1,764	45,980	-
8.	Sudu Ganga		83.1	80.8	-		1,050	25,650	-
	HYDROPOWER SCHEME		1,330.5	1,285.9	-		11,326	210,425	-
Direct cost									
I.	NCRB								
A.	Regulating Tank								
1.	Kalu Ganga		142.4	133.5	10.9		667	2,375	11.6
2.	Elahera Regulating Tank		4.8	4.4	0.4		22	171	0.4
3.	Kiri oya Level Crossing		13.5	12.6	1.0		63	466	1.1
4.	Horowupotana		67.1	62.8	5.1		314	8,835	5.4
5.	Yan Oya		72.5	68.0	5.6		340	11,400	5.9
6.	Tammannewa		47.0	43.2	3.5		216	105	3.7
7.	Malwatu Oya		37.7	35.9	2.9		179	12,806	3.1
B.	Transbasin canal	m^3/sec							
1.	Kalu Ganga-Elahera	80	42.6	40.9	3.3		307	409	3.6
2.	Elahera Head Works	90	13.4	12.7	1.0		96	2,185	1.1
3.	NCP Elahera-Kiri oya	90	101.7	97.5	8.0		731	247	8.7
4.	NCP Kiri oya-Hurulu wewa	90	73.4	70.4	5.8		528	646	6.3
5.	NCP Hurulu wewa-Tammannewa	60/40	47.6	45.1	3.7		338	466	4.0
6.	Minipe 0-74 km	65	38.8	36.3	3.0		273	485	3.2
7.	Minipe 74-113 km	65	0.0	0.0	0.0		0	0	0.0
C.	Pump station	m^3/sec							
1.	Hettipola 78 MW	65	434.5	427.8	34.9	24.2	10,694	58,169	69.8
D.	Downstream development	ha							
1.	System-F	1,900	7.7	7.2	0.6		54	285	0.6
2.	System-M	25,000	123.3	116.7	9.5		875	4,845	10.4
3.	System-MH	26,300	66.6	63.0	5.1		472	2,616	5.6
4.	System-H	42,400	11.7	11.2	0.9		84	463	1.0
5.	System-IH	4,700	1.3	1.3	0.1		9	52	0.1
6.	System-I	61,300	239.5	226.6	18.5		1,700	9,412	20.2
	NCP TOTAL	161,600	1,587.0	1,517.0	124.0	24.2	17,963	116,435	166.1
II.	NWDZ								
1.	Galgamuwa		16.1	14.9	1.2		75	342	1.3
2.	Additional Bowatenna Tunnel	24 m3/sec	15.7	15.2	1.2		114	200	1.4
3.	NWDZ Transbasin canal	25 m3/sec	21.0	19.8	1.6		148	485	1.8
4.	System-NWDZ	13,250	67.7	64.0	5.2		480	2,090	5.7
	Sub total	13,250	120.6	114.0	9.3		818	3,116	10.1
Grand Total		174,850	1,707.6	1,631.0	133.3	24.2	18,781	119,551	176.2
Power+Irrigation		174,850	3,038.1	2,916.9	-	24.2	30,107	329,976	-

Remarks: * Discount rate = 8%
US$ 1.00 = Rs.32.50 = ¥140

Table J.3.15 SUMMARY OF CONSTRUCTION COST (CASE-C145)

Item No.	Work Items		Const. Cost Eq. Total US$ (10^6)	Economic Cost Eq. Total US$ (10^6)	Economic Cost Annual* US$ (10^6)	Pump Running Cost US$ (10^6)	O&M Cost US$ (10^3)	Replace Cost US$ (10^3)	Annual Economic Cost US$ (10^6)
Water Resources Development									
1.	Watawala		44.2	42.8	-		450	10,450	-
2.	Ulapane		117.0	112.0	-		1,008	20,995	-
3.	Caledonia		156.4	149.3	-		1,194	14,535	-
4.	Talawakele		215.7	207.7	-		2,077	43,605	-
5.	Kotmale Extension		236.6	232.7	-		1,862	5,890	-
6.	Scheme-1000		249.1	240.0	-		1,920	43,320	-
7.	Scheme-500		228.5	220.5	-		1,764	45,980	-
8.	Sudu Ganga		83.1	80.8	-		1,050	25,650	-
	POWER SCHEME TOTAL		1,330.5	1,285.9	-		11,326	210,425	-
I.	NCRB								
A.	Regulating Tank								
1.	Kalu Ganga		142.4	133.5	10.9		667	2,375	11.6
2.	Elahera Regulating Tank		4.8	4.4	0.4		22	171	0.4
3.	Kiri oya Level Crossing		13.5	12.6	1.0		63	466	1.1
4.	Horowupotana		67.1	62.8	5.1		314	8,835	5.4
5.	Yan Oya		72.5	68.0	5.6		340	11,400	5.9
6.	Tammannewa		47.0	43.2	3.5		216	105	3.7
7.	Malwatu Oya		37.7	35.9	2.9		179	12,806	3.1
B.	Transbasin canal	m^3/sec							
1.	Kalu Ganga-Elahera	15	15.8	15.0	1.2		113	409	1.3
2.	Elahera Head Works	45	10.4	9.9	0.8		74	2,185	0.9
3.	NCP Elahera-Kirioya	45/90	94.3	90.5	7.4		679	247	8.1
4.	NCP Kiri oya- Hurulu wewa	90	73.4	70.4	5.8		528	646	6.3
5.	NCP Hurulu wewa- Tammannewa	60/40	47.6	45.1	3.7		338	466	4.0
6.	Minipe 0-74 km existing	65	38.8	36.3	3.0		273	485	3.2
7.	Minipe 74 km - Angamedilla	65	72.7	68.2	5.6		511	247	6.1
8.	Angamedilla-Wewala	45	48.1	46.2	3.8		346	247	4.1
9.	Angamedilla-Kaudula	20	23.8	22.4	1.8		168	247	2.0
10.	Kaudula-Kantalai	10	20.8	19.6	1.6		147	247	1.8
C.	Pump station	m^3/sec							
	Wewala 40 MW	45	221.6	218.2	17.8	10.6	5,456	58,169	33.9
D.	Downstream development	ha							
1.	System-F	1,900	7.7	7.2	0.6		54	285	0.6
2.	System-M	25,000	123.3	116.7	9.5		875	4,845	10.4
3.	System-MH	26,300	66.6	63.0	5.1		472	2,616	5.6
4.	System-H	42,400	11.7	11.2	0.9		84	463	1.0
5.	System-IH	4,700	1.3	1.3	0.1		9	52	0.1
6.	System-I	61,300	239.5	226.6	18.5		1,700	9,412	20.2
	NCRB TOTAL	161,600	1,502.4	1,428.2	116.7	10.6	13,628	117,423	140.8
II.	NWDZ								
1.	Galgamuwa		16.1	14.9	1.2		75	342	1.3
2.	Additional Bowatenna Tunnel	24 m3/sec	15.7	15.2	1.2		114	200	1.4
3.	NWDZ Transbasin canal	25 m3/sec	21.0	19.8	1.6		148	485	1.8
4.	System-NWDZ	13,250	67.7	64.0	5.2		480	2,090	5.7
	NWDZ TOTAL	13,250	120.6	114.0	9.3		818	3,116	10.1
Grand Total		174,850	1,622.9	1,542.3	126.0	10.6	14,448	120,539	151.1
Power+Irrigation		174,850	2,953.4	2,828.2	-	10.6	25,774	330,964	-

Remarks: * Discount rate = 8%
US$ 1.00 = Rs.32.50 = ¥140

Table J.3.16 SUMMARY OF CONSTRUCTION COST (CASE-A209)

Item No.	Work Items		Const. Cost Eq. Total US$ (10^6)	Economic Cost Eq. Total US$ (10^6)	Economic Cost Annual* US$ (10^6)	Pump Running Cost US$ (10^6)	O&M Cost US$ (10^3)	Replace Cost US$ (10^3)	Annual Cost US$ (10^6)
Water Resources Development									
1.	Watawala		44.2	42.8	-		450	10,450	-
2.	Ulapane		117.0	112.0	-		1,008	20,995	-
3.	Caledonia		156.4	149.3	-		1,194	14,535	-
4.	Talawakele		215.7	207.7	-		2,077	43,605	-
5.	Kotmale Extension		236.6	232.7	-		1,862	5,890	-
6.	Scheme-1000		249.1	240.0	-		1,920	43,320	-
7.	Scheme-500		228.5	220.5	-		1,764	45,980	-
8.	Sudu Ganga		83.1	80.8	-		1,050	25,650	-
	POWER SCHEME TOTAL		1,330.5	1,285.9	-		11,326	210,425	-
NCRB									
A	Regulating Tank								
1.	Kalu Ganga		142.4	133.5	10.9		667	2,375	11.6
2.	Elahera regulation tank		4.8	4.4	0.4		22	171	0.4
3.	Kiri oya Regulating Tank		13.5	12.6	1.0		63	466	1.1
4.	Horowupotana		67.1	62.8	5.1		314	8,835	5.4
5.	Yan Oya		72.5	68.0	5.6		340	11,400	5.9
6.	Tammannewa		47.0	43.2	3.5		216	105	3.7
7.	Malwatu Oya		37.7	35.9	2.9		179	12,806	3.1
B	Transbasin canal	m^3/sec							
1.	Kalu Ganga-Elahera	15	15.8	15.0	1.2		113	409	1.3
2.	Elahera Head Works	75	11.3	10.7	0.9		81	2,185	1.0
3.	NCP Elahera-Kirioya	75	93.0	89.2	7.3		669	247	8.0
4.	NCP Kiri oya- Hurulu wewa	90	73.4	70.4	5.8		528	646	6.3
5.	NCP Hurulu wewa- Tammannewa	60/40	47.6	45.1	3.7		338	466	4.0
6.	Minipe LB 0-62Km	55	52.0	48.9	4.0		367	485	4.4
7.	Minipe LB 62Km-113 Km	55	90.1	85.9	7.0		645	247	7.7
C	Pump station	m^3/sec							
1.	Minneriya 23 MW	15	77.3	75.9	6.2	3.4	1,897	58,169	11.5
D	Downstream development	ha							
1.	System-F	1,900	7.7	7.2	0.6		54	285	0.6
2.	System-M	25,000	123.3	116.7	9.5		875	4,845	10.4
3.	System-MH	26,300	66.6	63.0	5.1		472	2,616	5.6
4.	System-H	42,400	11.7	11.2	0.9		84	463	1.0
5.	System-IH	4,700	1.3	1.3	0.1		9	52	0.1
6.	System-I	61,300	239.5	226.6	18.5		1,700	9,412	20.2
	NCRB TOTAL	161,600	1,295.3	1,227.4	100.3	3.4	9,633	116,682	113.3
II.	NWDZ								
1.	Galgamuwa		0.0	0.0	0.0		0	0	0.0
2.	Additional Bowatenna Tunnel	24 m3/sec	0.0	0.0	0.0		0	0	0.0
3.	NWDZ Transbasin Canal	25 m3/sec	0.0	0.0	0.0		0	0	0.0
4.	System-NWDZ	0	0.0	0.0	0.0		0	0	0.0
	NWDZ TOTAL	0	0.0	0.0	0.0		0	0	0.0
Grand Total		161,600	1,295.3	1,227.4	100.3	3.4	9,633	116,682	113.3
Power+Irrigation		161,600	2,625.9	2,513.3	-	3.4	20,959	327,107	-

Remarks: * Discount rate = 8%
US$ 1.00 = Rs.32.50 = ¥140

Table J.3.17 SUMMARY OF OCNSTRUCTION COST (CASE-A242)

Item No.	Work Items		Const. Cost Eq. Total US$ (10^6)	Economic Cost Eq. Total US$ (10^6)	Economic Cost Annual* US$ (10^6)	Pump Running Cost US$ (10^6)	O&M Cost US$ (10^3)	Replace Cost US$ (10^3)	Annual Cost US$ (10^6)
Water Resources Development									
1.	Watawala		44.2	42.8	-		450	10,450	-
2.	Ulapane		117.0	112.0	-		1,008	20,995	-
3.	Caledonia		156.4	149.3	-		1,194	14,535	-
4.	Talawakele		215.7	207.7	-		2,077	43,605	-
5.	Kotmale Extension		236.6	232.7	-		1,862	5,890	-
6.	Scheme-1000		249.1	240.0	-		1,920	43,320	-
7.	Scheme-500		228.5	220.5	-		1,764	45,980	-
8.	Sudu Ganga		83.1	80.8	-		1,050	25,650	-
	POWER SCHEME TOTAL		1,330.5	1,285.9	-		11,326	210,425	-
NCRB									
A	Regulating Tank								
1.	Kalu Ganga		142.4	133.5	10.9		667	2,375	11.6
2.	Elahera regulation tank		4.8	4.4	0.4		22	171	0.4
3.	Kiri oya Regulating Tank		13.5	12.6	1.0		63	466	1.1
4.	Horowupotana		67.1	62.8	5.1		314	8,835	5.4
5.	Yan Oya		72.5	68.0	5.6		340	11,400	5.9
6.	Tammannewa		47.0	43.2	3.5		216	105	3.7
7.	Malwatu Oya		37.7	35.9	2.9		179	12,806	3.1
B	Transbasin canal	m^3/sec							
1.	Kalu Ganga-Elahera	15	15.8	15.0	1.2		113	409	1.3
2.	Elahera Head Works	70	11.1	10.6	0.9		79	2,185	0.9
3.	NCP Elahera-Kirioya	70	89.8	86.1	7.0		646	247	7.7
4.	NCP Kiri oya- Hurulu wewa	90	73.4	70.4	5.8		528	646	6.3
5.	NCP Hurulu wewa- Tammannewa	60/40	47.6	45.1	3.7		338	466	4.0
6.	Minipe LB 0-62Km	55	52.0	48.9	4.0		367	485	4.4
7.	Minipe LB 62Km-113 Km	55	90.1	85.9	7.0		645	247	7.7
C.	Pump station	m^3/sec							
1.	Minneriya 19 MW	20	100.2	98.4	8.0	4.1	2,460	58,169	14.6
D	Downstream development	ha							
1.	System-F	1,900	7.7	7.2	0.6		54	285	0.6
2.	System-M	25,000	123.3	116.7	9.5		875	4,845	10.4
3.	System-MH	26,300	66.6	63.0	5.1		472	2,616	5.6
4.	System-H	42,400	11.7	11.2	0.9		84	463	1.0
5.	System-IH	4,700	1.3	1.3	0.1		9	52	0.1
6.	System-I	61,300	239.5	226.6	18.5		1,700	9,412	20.2
	NCRB TOTAL	161,600	1,314.9	1,246.7	101.9	4.1	10,172	116,682	116.1
II.	NWDZ								
1.	Galgamuwa		16.1	14.9	1.2		75	342	1.3
2.	Additional Bowatenna Tunnel	24 m3/sec	15.7	15.2	1.2		114	200	1.4
3.	NWDZ Transbasin Canal	25 m3/sec	21.0	19.8	1.6		148	485	1.8
4.	System-NWDZ	13,250	67.7	64.0	5.2		480	2,090	5.7
	NWDZ TOTAL	13,250	120.6	114.0	9.3		818	3,116	10.1
Grand Total		174,850	1,435.5	1,360.7	111.2	4.1	10,989	119,798	126.3
Power+Irrigation		174,850	2,766.0	2,646.6	-	4.1	22,315	330,223	-

Remarks: *Discount rate = 8%
US$ 1.00 = Rs.32.50 = ¥140

FIGURES

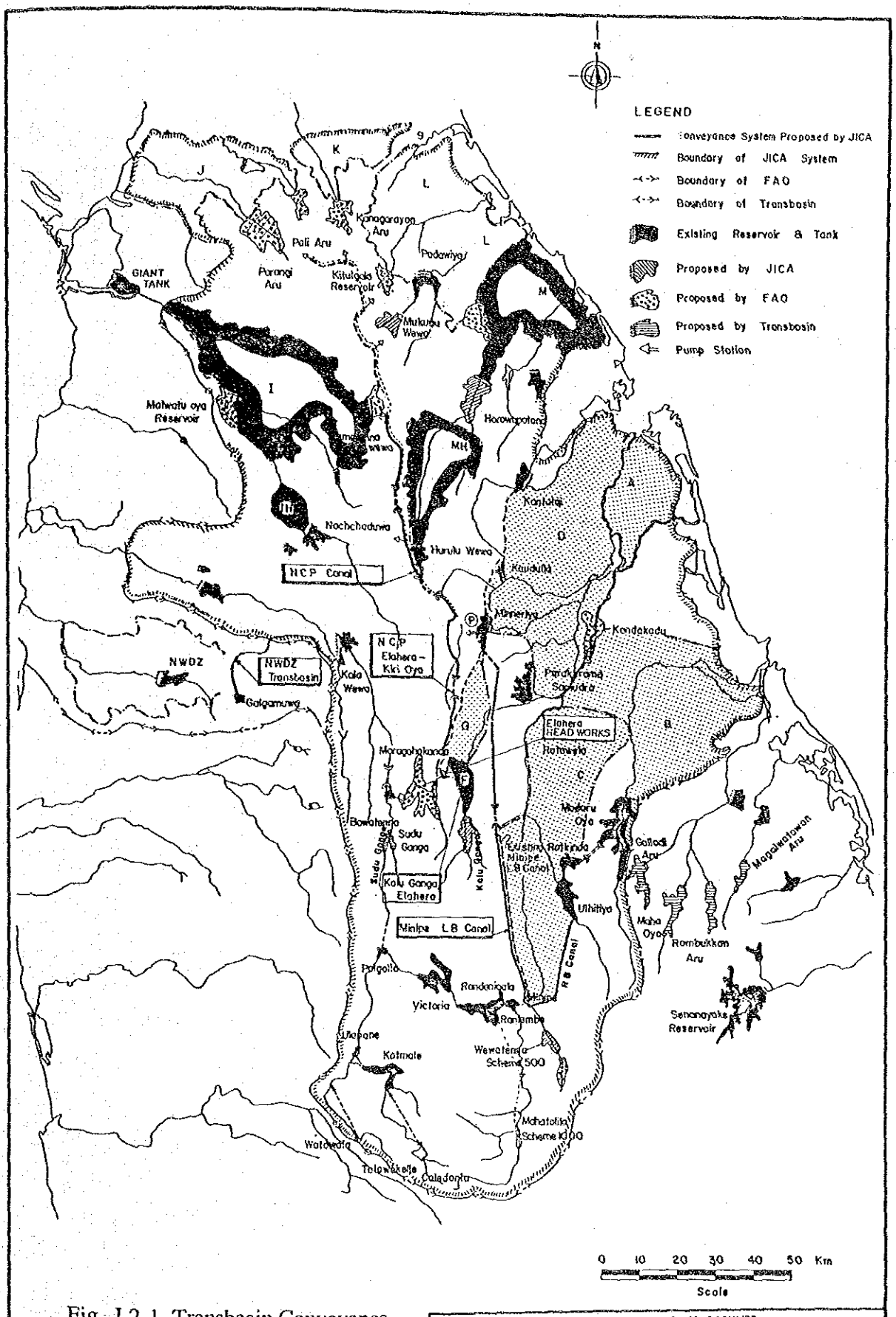


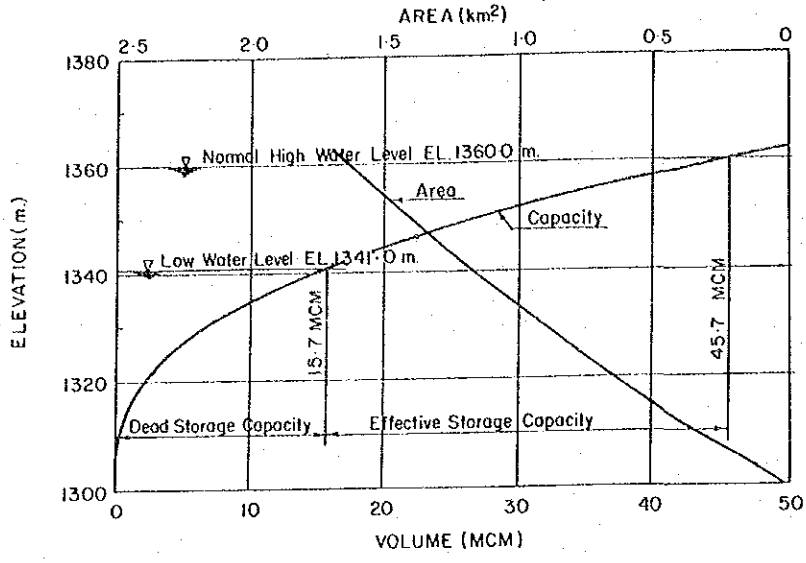
Fig. J.2-1 Transbasin Conveyance System (Case-A)

GOVERNMENT OF DEMOCRATIC SOCIALIST REPUBLIC OF SRI LANKA
MINISTRY OF LANDS, IRRIGATION AND MAHAWELI DEVELOPMENT

THE STUDY ON EXTENSION OF THE MORAGAHAKANDA AGRICULTURAL DEVELOPMENT PROJECT

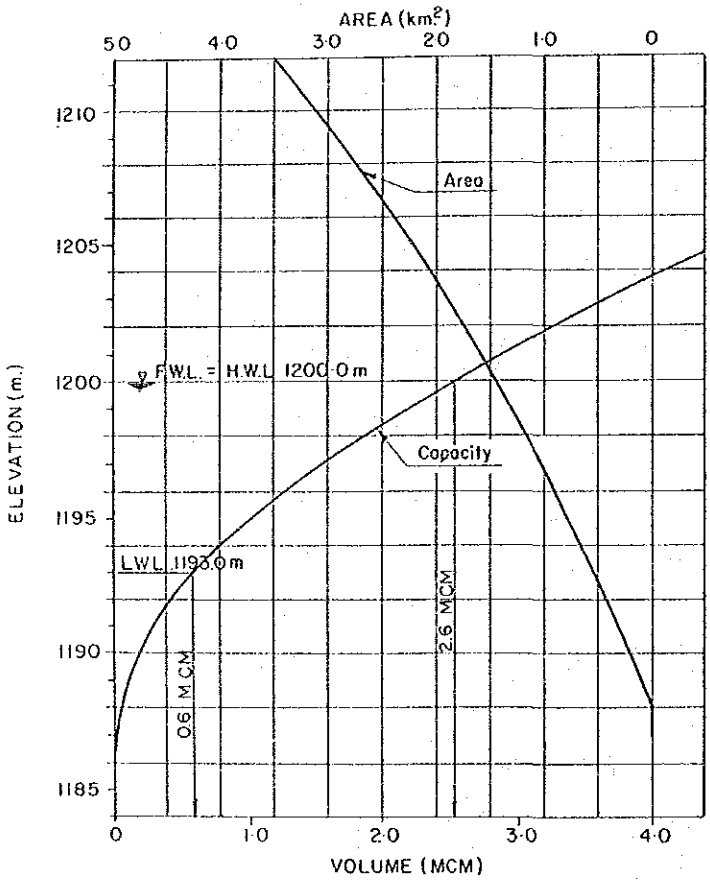
JAPAN INTERNATIONAL COOPERATION AGENCY

CALEDONIA RESERVOIR



Elevation (m.)	Area (km^2)	Volume (MCM)
1300	0	0
1320	0·64	2
1340	1·16	15
1360	1·64	45·7

TALAWAKELLE RESERVOIR



Elevation (m.)	Area (km^2)	Volume (MCM)
1185	0	0
1190	0·2	0·2
1195	0·8	1·2
1200	1·5	2·55

Fig. J.2-2 Area Storage Curve for Caledonia and Talawakelle

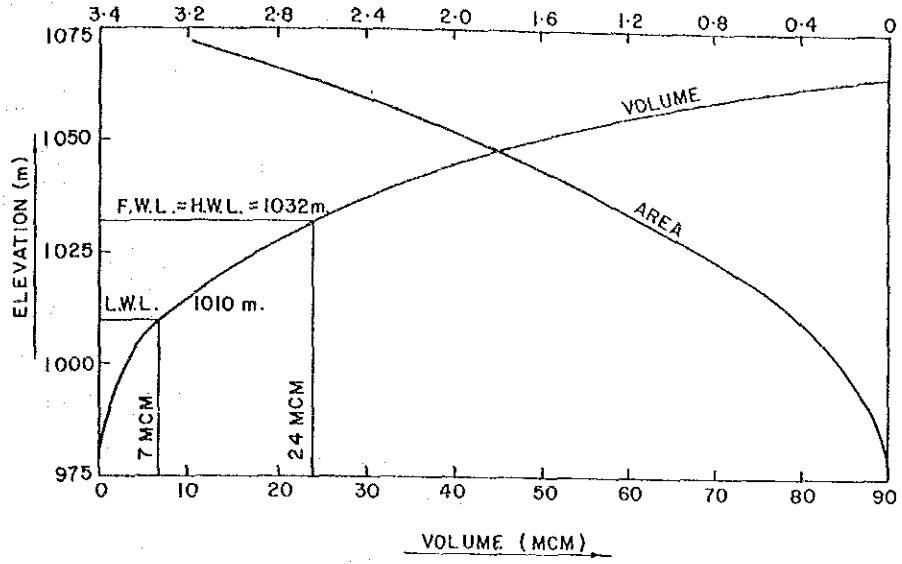
GOVERNMENT OF DEMOCRATIC SOCIALIST REPUBLIC OF SRI LANKA
MINISTRY OF LANDS, IRRIGATION AND MAHAWELI DEVELOPMENT

THE STUDY ON EXTENSION OF THE MORAGAHAKANDA AGRICULTURAL DEVELOPMENT PROJECT

JAPAN INTERNATIONAL COOPERATION AGENCY

WATAWALA NEW SITE

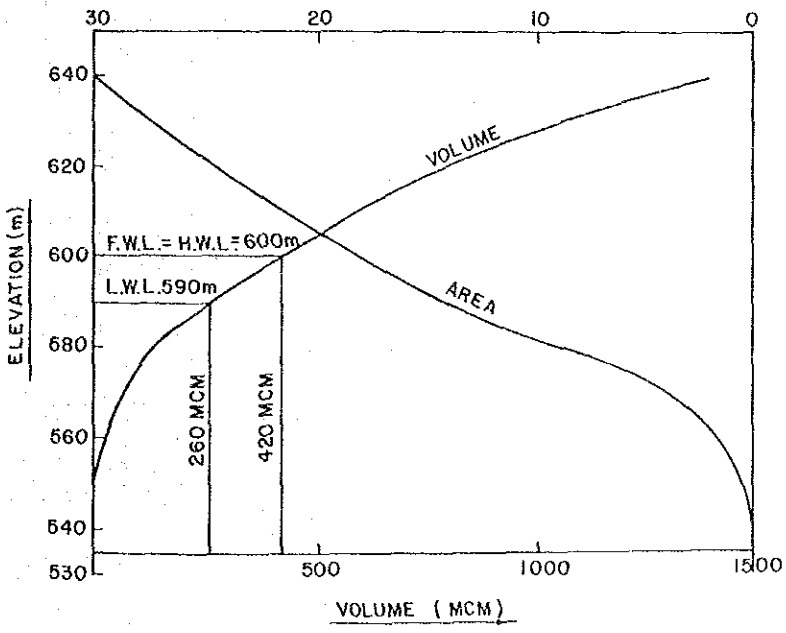
CATCHMENT AREA 69 km²



ELEVATION (m)	AREA (km²)	STORAGE (MCM)
975	0	0
990	0·08	1·0
1000	0·21	3·0
1010	0·39	7·0
1020	0·66	14·0
1030	1·03	22·5
1040	1·43	33·5
1050	1·9	49·5
1060	2·4	72·0

ULAPANE

CATCHMENT AREA 237 km²



ELEVATION (m.)	AREA (km²)	VOLUME (MCM)
535	0	0
560	1·7	25
580	8·8	130
600	18·3	420
620	24·6	790
640	30·8	1364

Fig. J.2-3 Area Storage Curve for Watawala and Ulapane

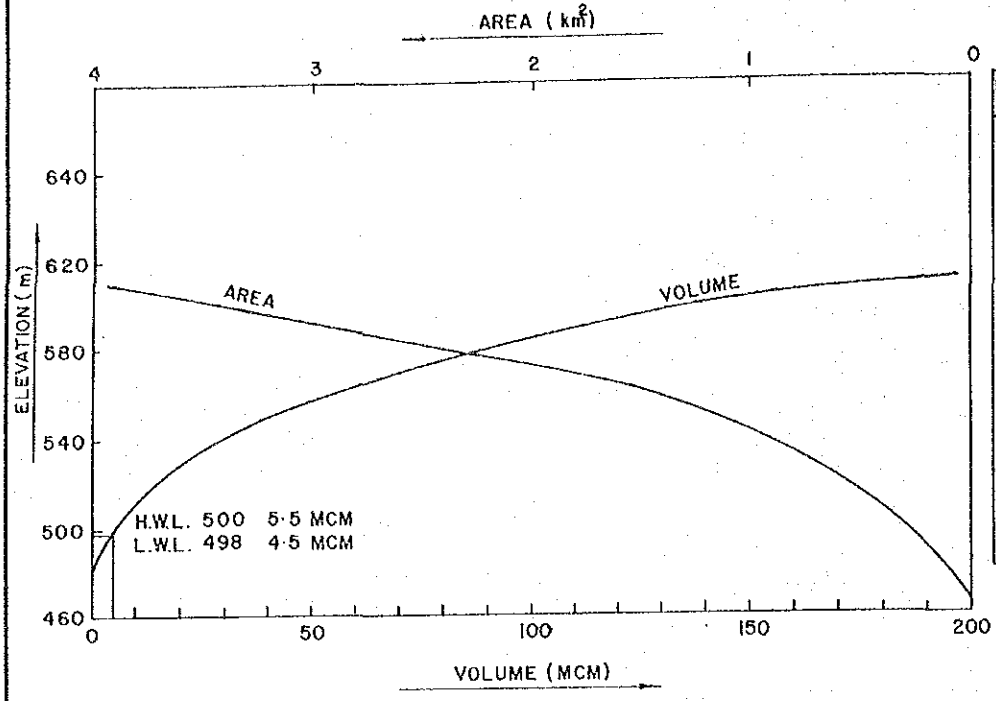
GOVERNMENT OF DEMOCRATIC SOCIALIST REPUBLIC OF SRI LANKA
MINISTRY OF LANDS, IRRIGATION AND MAHAWELI DEVELOPMENT

THE STUDY ON EXTENSION OF THE MORAGAHAKANDA AGRICULTURAL DEVELOPMENT PROJECT

JAPAN INTERNATIONAL COOPERATION AGENCY

LOWER UMA OYA
(SCHEME – 500)

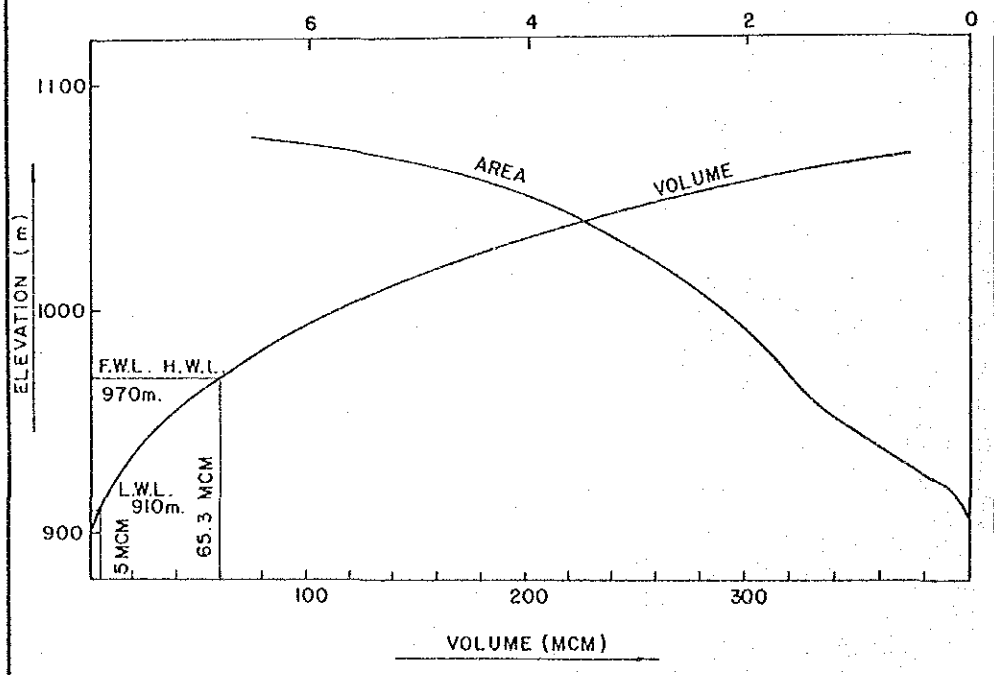
CATCHMENT AREA 622 km².



ELEVATION(m)	AREA (km²)	VOLUME (MCM)
466	0	0
480	0·1	0·5
500	0·3	5·5
520	0·6	15·0
540	0·9	30·0
560	1·5	56·5
580	2·4	92·0
600	3·4	143·0
610	3·9	190·0

UMA OYA
(SCHEME – 1000)

CATCHMENT AREA 421 km².



ELEVATION(m)	AREA (km²)	VOLUME (MCM)
900	0	0
920	0·2	10·0
940	0·8	24·0
960	1·4	51·0
980	1·75	76·0
1000	2·2	114·0
1020	2·75	162·0
1040	3·50	246·0
1060	4·50	310·0

Fig. J.2-4 Area Storage Curve for Uma-500 and Uma-1000

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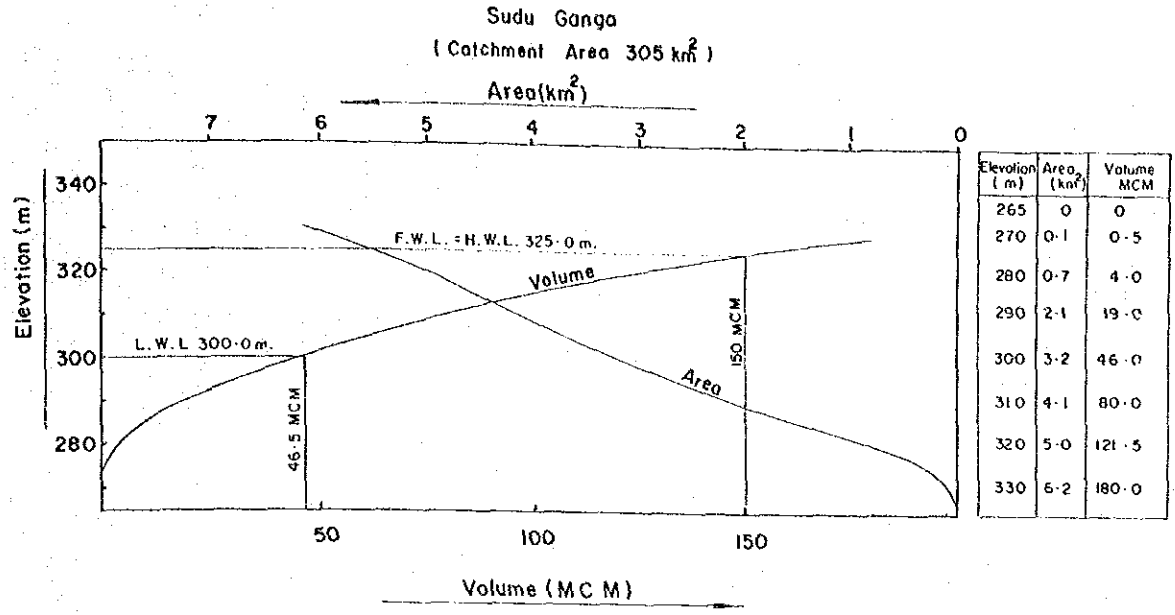
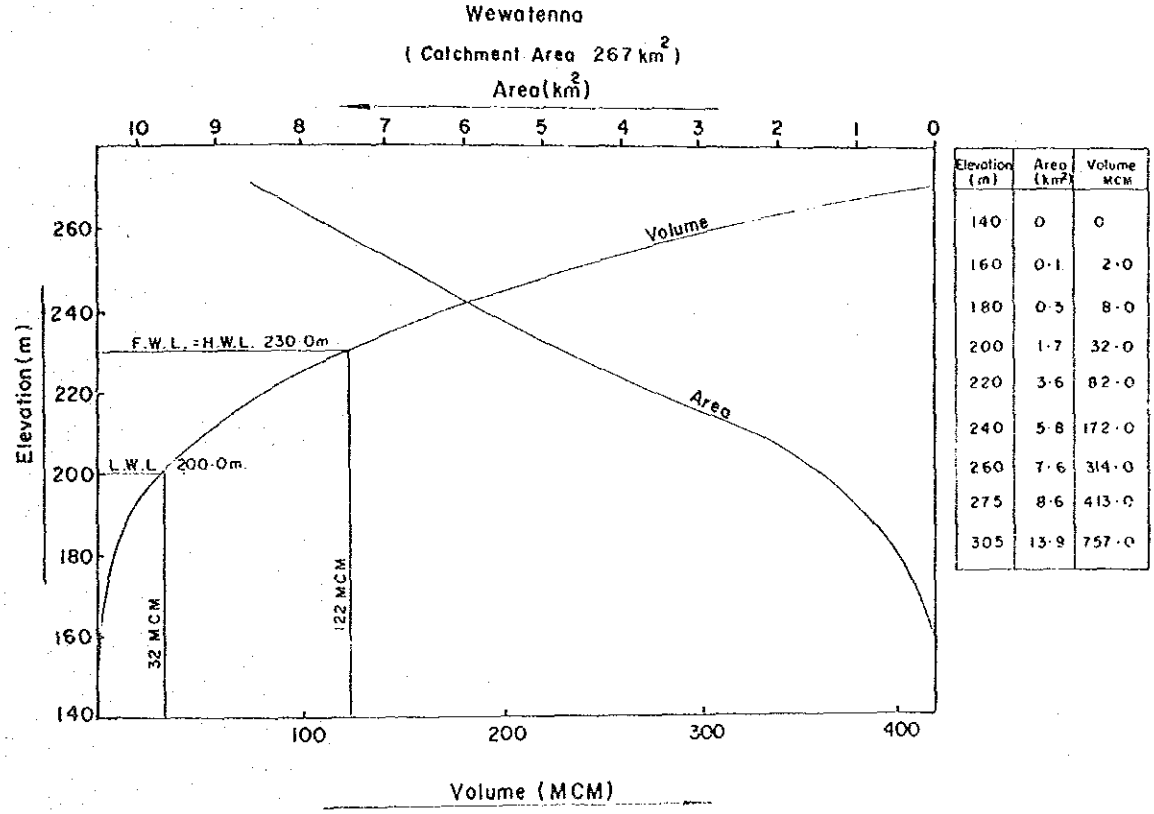


Elevation (m)	Area (km²)	Volume MCM
265	0	0
270	0·1	0·5
280	0·7	4·0
290	2·1	19·0
300	3·2	46·0
310	4·1	80·0
320	5·0	121·5
330	6·2	180·0



Elevation (m)	Area (km²)	Volume MCM
140	0	0
160	0·1	2·0
180	0·5	8·0
200	1·7	32·0
220	3·6	82·0
240	5·8	172·0
260	7·6	314·0
275	8·6	413·0
305	13·9	757·0

Fig. J.2-5 Area Storage Curve for Sudu Ganga and Wewatenna

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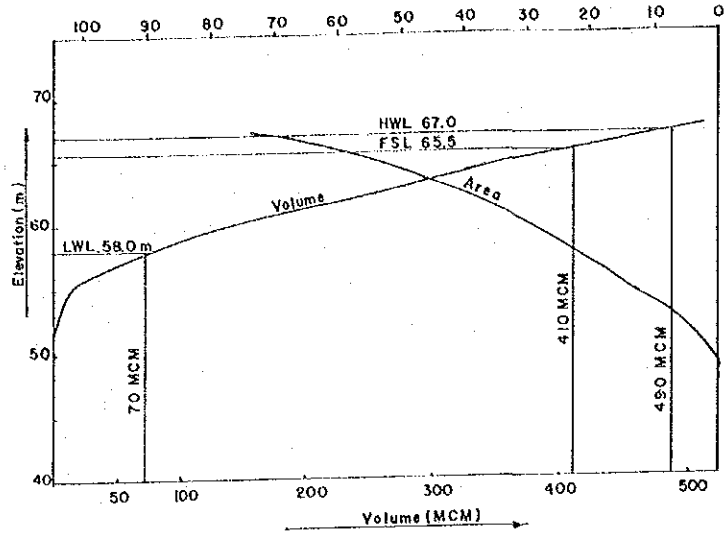
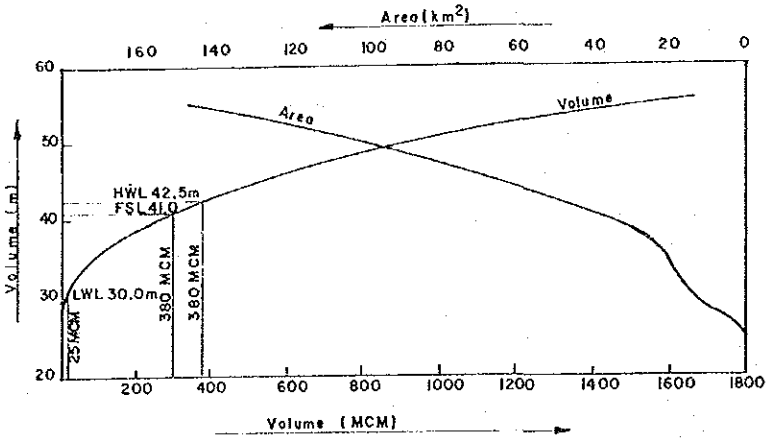


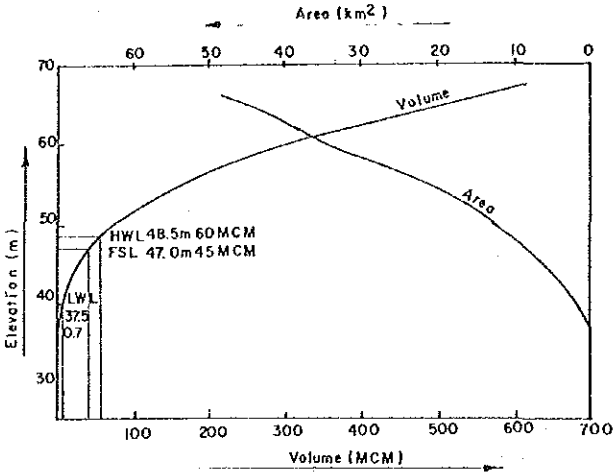
Elevation (m)	Area (km²)	Volume (MCM)
47.0	0	0
50.0	1.6	1.0
55	15.0	15.0
60	30.5	140.0
65	55.0	380.0
67.5	73.0	510.0

HOROWUPOTANA



Elevation (m)	Area (km²)	Volume (MCM)
25.0	0	0
30.0	14	15
35.0	21	90
40.0	37	260
45.0	63	420
50.0	99	820
55.0	146	1,580

YAN OYA



Elevation (m)	Area (km²)	Volume (MCM)
30.5	0	0
36.5	0.5	1.6
42.7	4.4	16.6
48.7	12.0	66.5
54.8	21.5	168.7
60.9	39.5	354.7
67.1	47.0	618.3

WAHALKADA (Not used)

Fig. J.2-6 Area Storage Curve for Horowupotana, Yan Oya and Wahalkada

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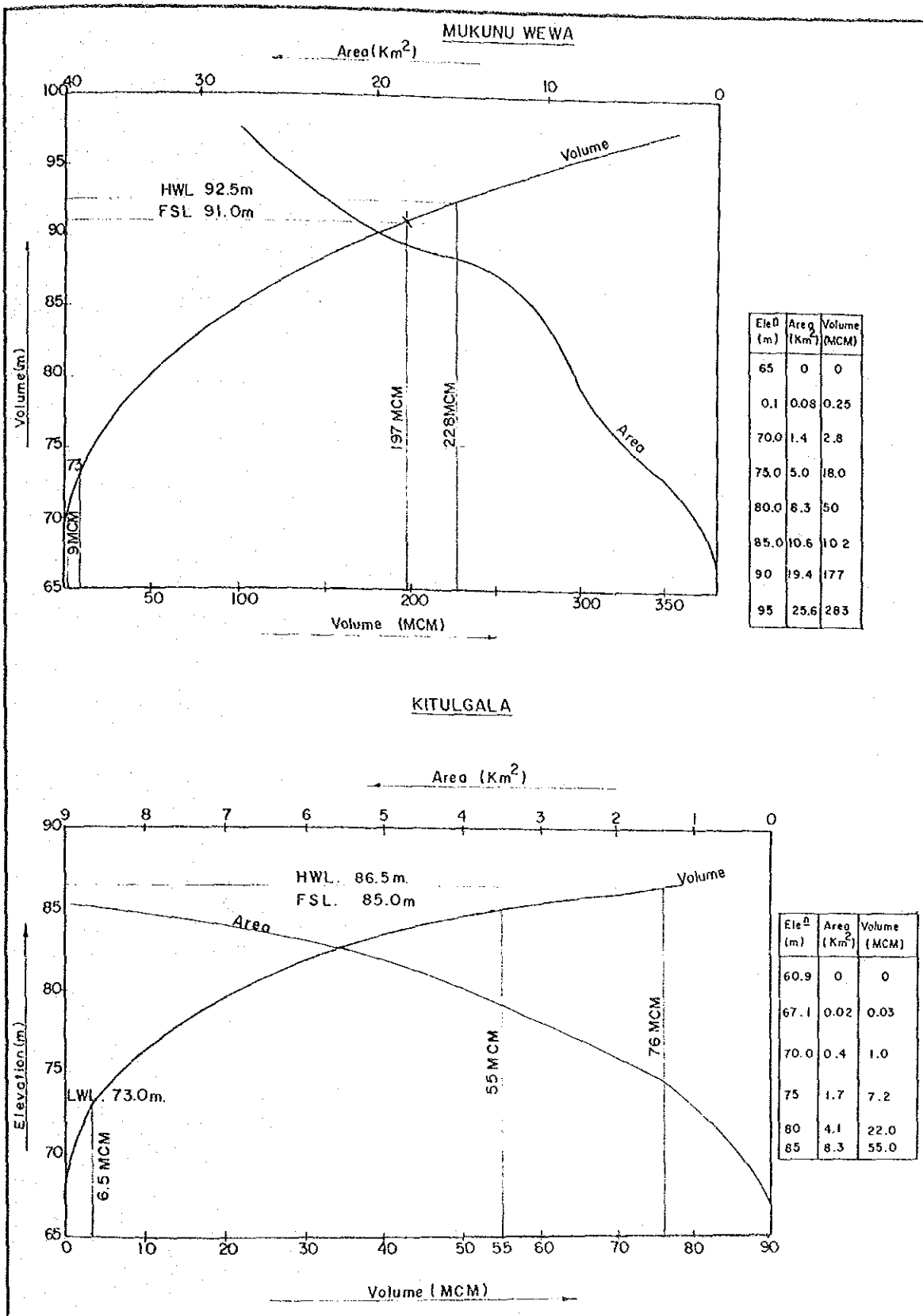

Elev (m)	Area (Km²)	Volume (MCM)
65	0	0
0.1	0.08	0.25
70.0	1.4	2.8
75.0	5.0	18.0
80.0	8.3	50
85.0	10.6	10 2
90	19.4	177
95	25.6	283

Elev (m)	Area (Km²)	Volume (MCM)
60.9	0	0
67.1	0.02	0.03
70.0	0.4	1.0
75	1.7	7.2
80	4.1	22.0
85	8.3	55.0

Fig. J.2-7 Area Storage Curve for Mukunuwewa and Kitulgala

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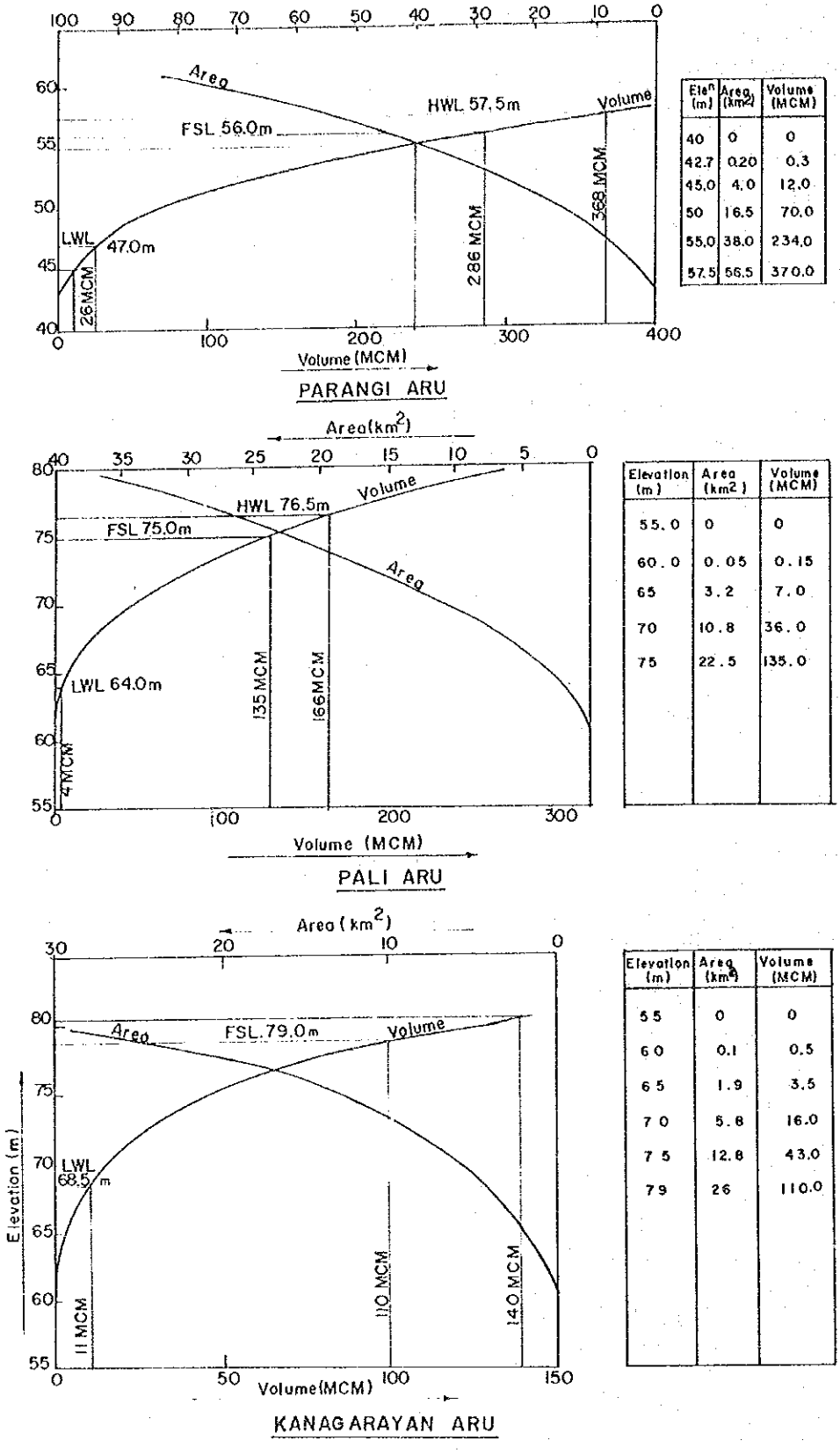

Elevation (m)	Area (km2)	Volume (MCM)
40	0	0
42.7	0.20	0.3
45.0	4.0	12.0
50	16.5	70.0
55.0	38.0	234.0
57.5	56.5	370.0

Elevation (m)	Area (km2)	Volume (MCM)
55.0	0	0
60.0	0.05	0.15
65	3.2	7.0
70	10.8	36.0
75	22.5	135.0

Elevation (m)	Area (km²)	Volume (MCM)
55	0	0
60	0.1	0.5
65	1.9	3.5
70	5.8	16.0
75	12.8	43.0
79	26	110.0

Fig. J.2-8 Area Storage Curve for Parangi Aru, Pali Aru and Kanagarayan Aru

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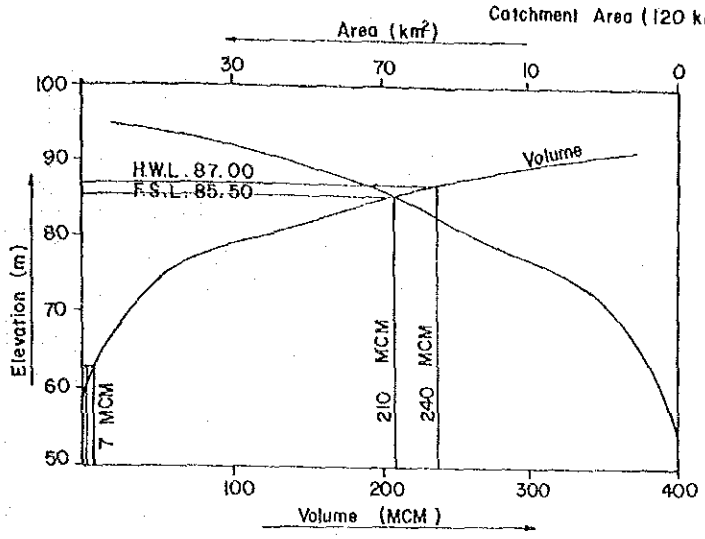
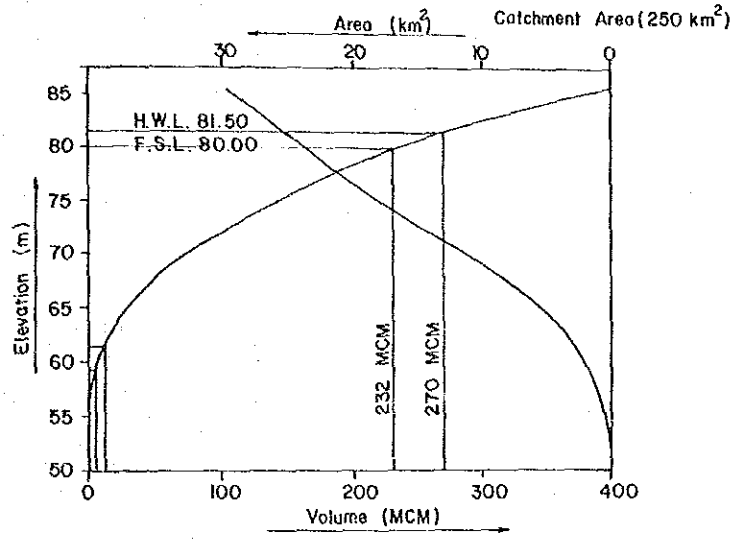


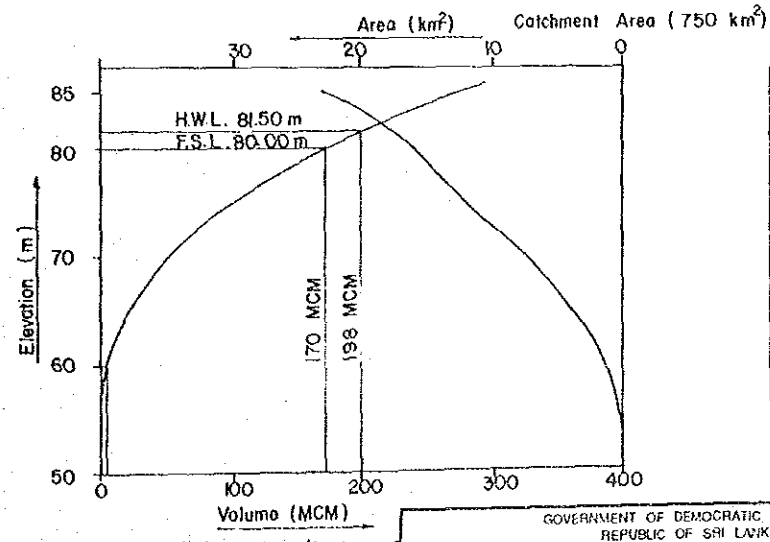
Elevation (m)	Area (km²)	Volume (MCM)
55	0	0
60	2.0	25
65	3.0	12.5
70	4.5	30
75	7.2	55
80	13.5	11.7
85	18.2	210
90	26.8	312
92	31.0	382

Gallodai Aru L.C. (Not used)



Elevation (m)	Storage Area (km²)	Volume (MCM)
50.0	0	0
55.0	0.7	2.0
60.0	2.0	8.0
65.0	5.3	28.0
70.0	11.0	73.0
75.0	17.6	142.0
80.0	23.6	232.0
85.0	29.2	368.0

Maha Oya Reservoir (Not used)



Elevation (m)	Area (km²)	Volume (MCM)
50.2	0	0
55.0	0.3	0.6
60.0	0.3	5.0
65.0	4.0	21.0
70.0	7.8	49.0
75.0	12.2	101.0
80.0	16.2	170.0
85.0	22.8	268.0

Rambukan Aru (Not used)

Fig. J.2-9 Area Storage Curve for Gallodai Aru, Maha Oya and Rambukan Aru

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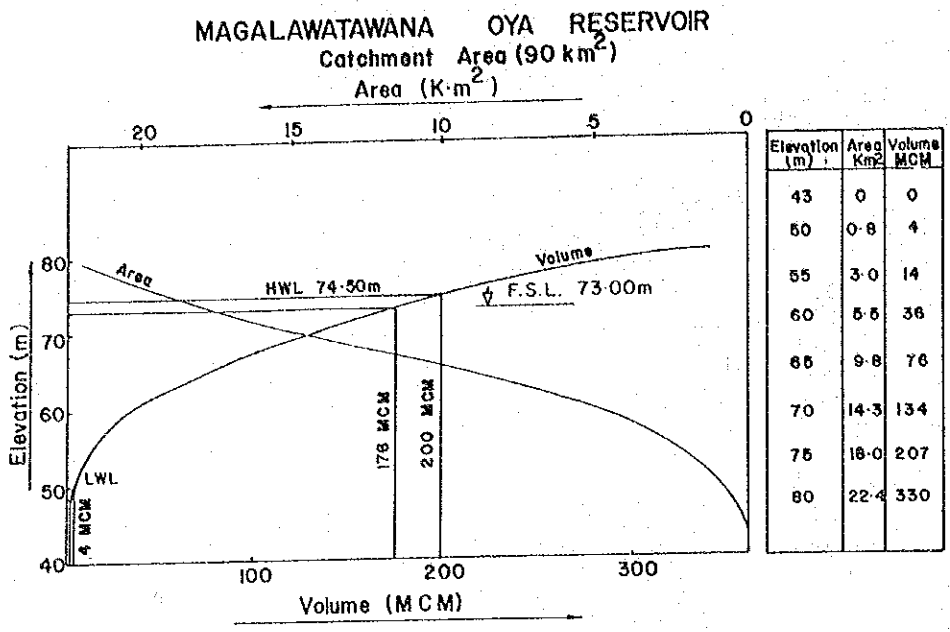
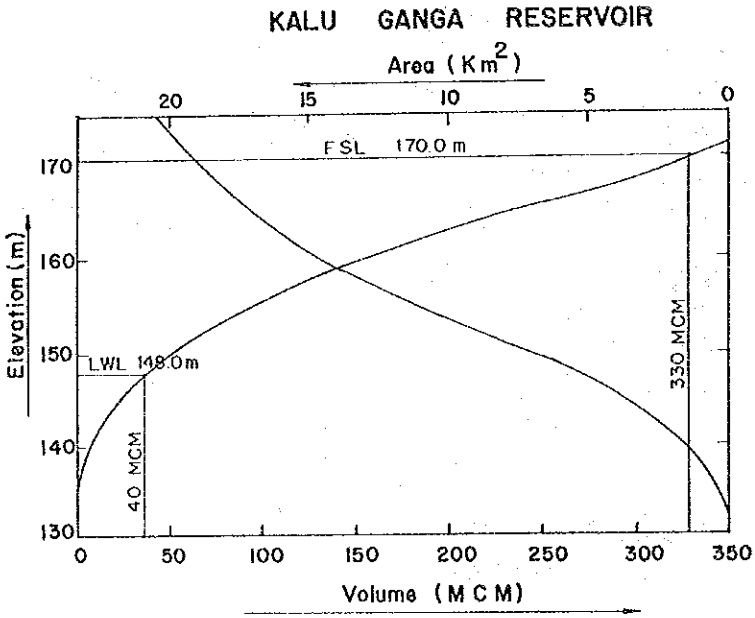


Elevation (m)	Area Km²	Volume MCM
43	0	0
50	0·8	4
55	3·0	14
60	5·5	36
65	9·8	76
70	14·3	134
75	18·0	207
80	22·4	330



Elevation m	Area Sqkm	Volume MCM
133	0	0
140	1·6	7
145	4·0	25
150	7·3	55
155	11·7	97
160	14·7	165
165	17·2	240
170	19·2	330

Fig. J.2-10 Area Storage Curve for Magalawatawan Oya and Kalu Ganga

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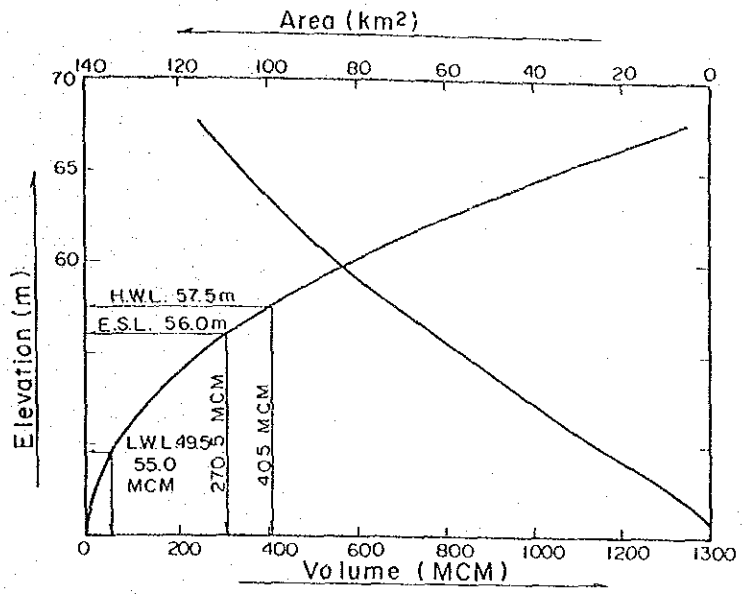
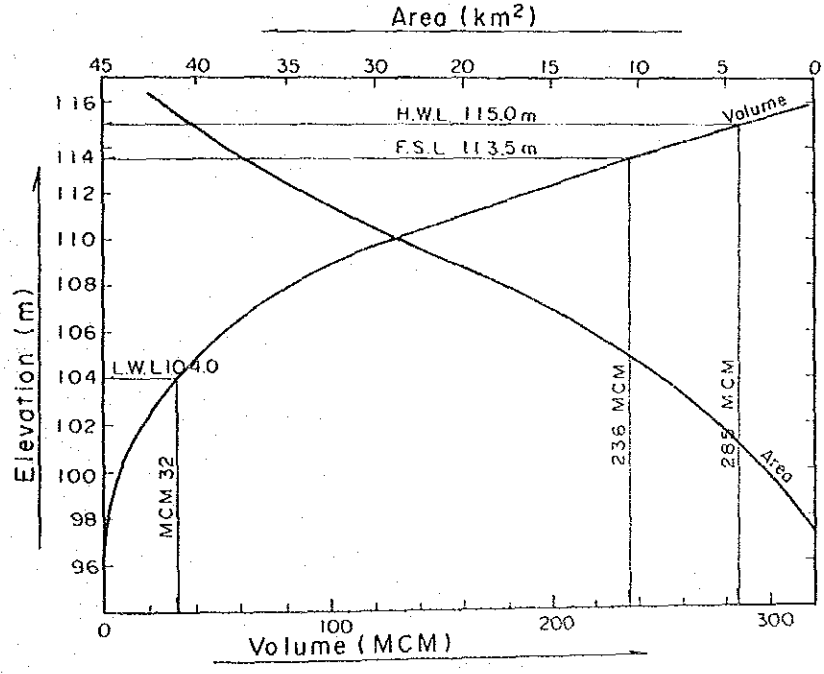
MALWATHU OYA



Elevation (m)	Area km	Volume (MCM)
45.0	0	0
50.0	25	65
55	52	245
60	84	590
65	106	1050

TAMMANE WEWA



Elevation (m)	Area km	Volume (MCM)
95	0	0
100	2.6	8
105	11.2	40
110	23.2	128
111	26.0	155
116	42.0	320

Fig. J.2-11 Area Storage Curve for Malwatu Oya and Tammannewa

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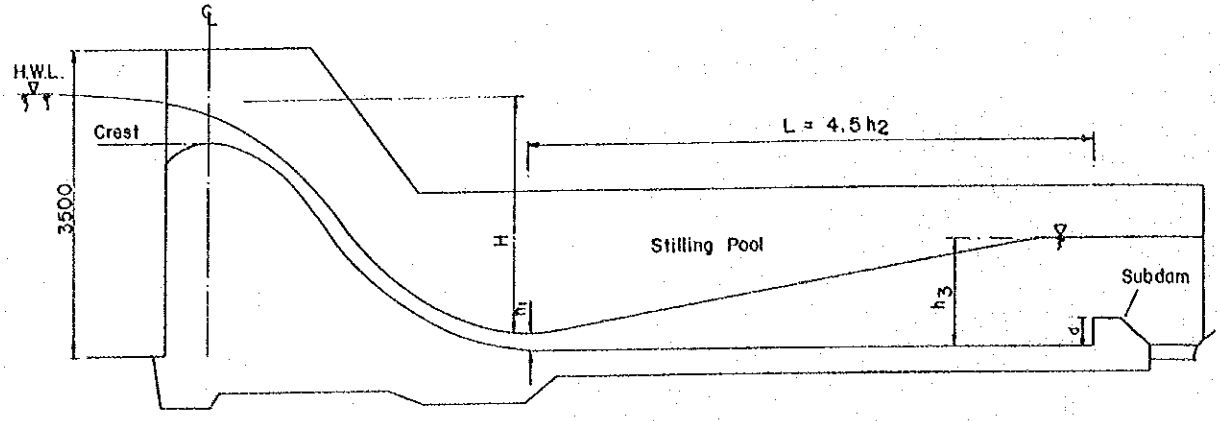

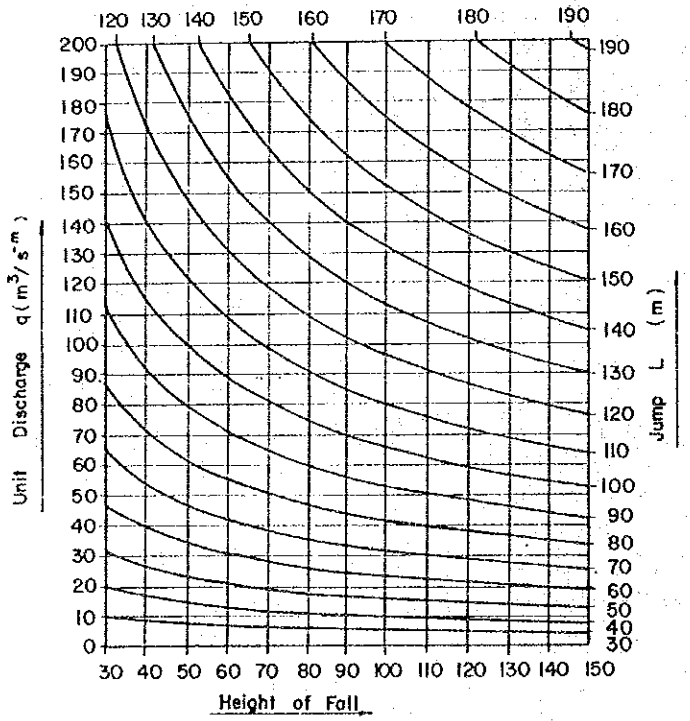

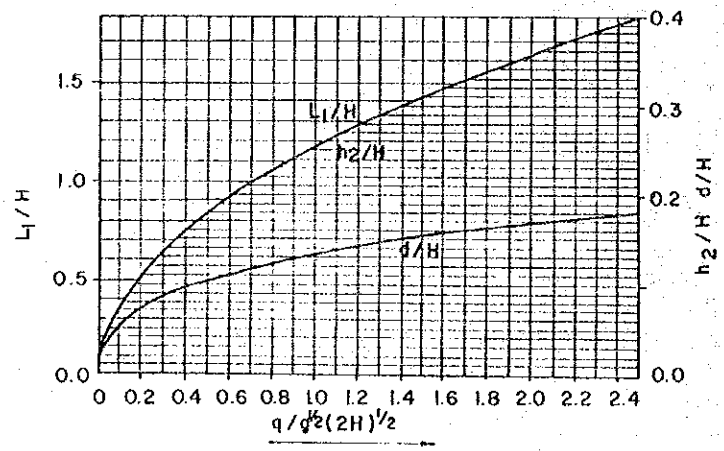

Fig. J.2-12 General Features of Spillway and Dimensional Figure

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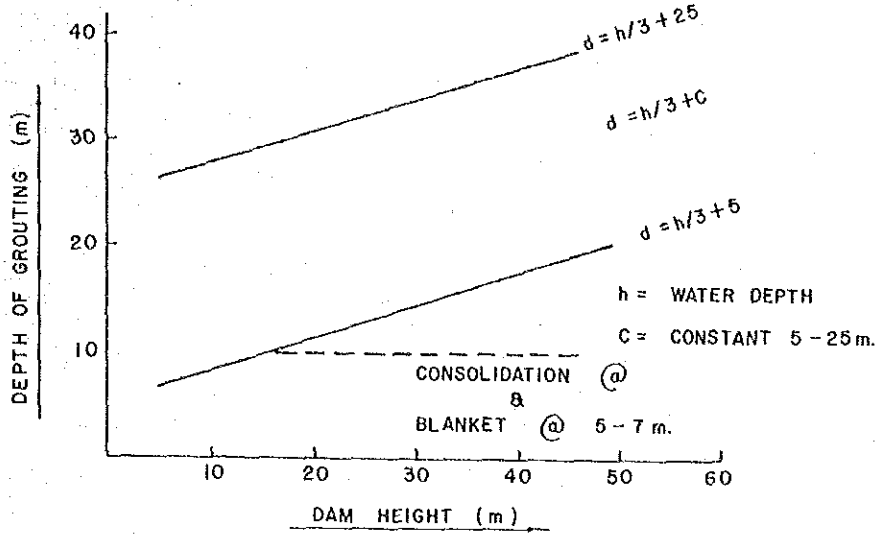
CURTAIN GROUT REQUIRED DEPTH



ARRANGEMENT OF CURTAIN GROUT

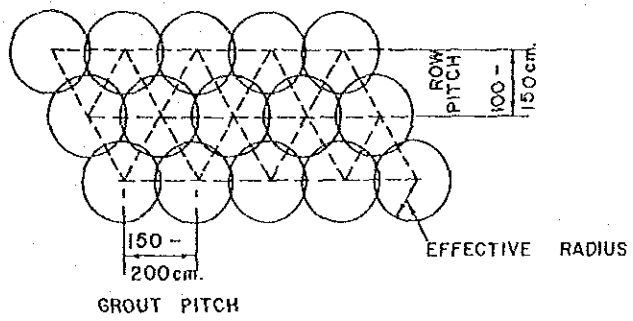


Fig. J.2-13 Requirement of Grout

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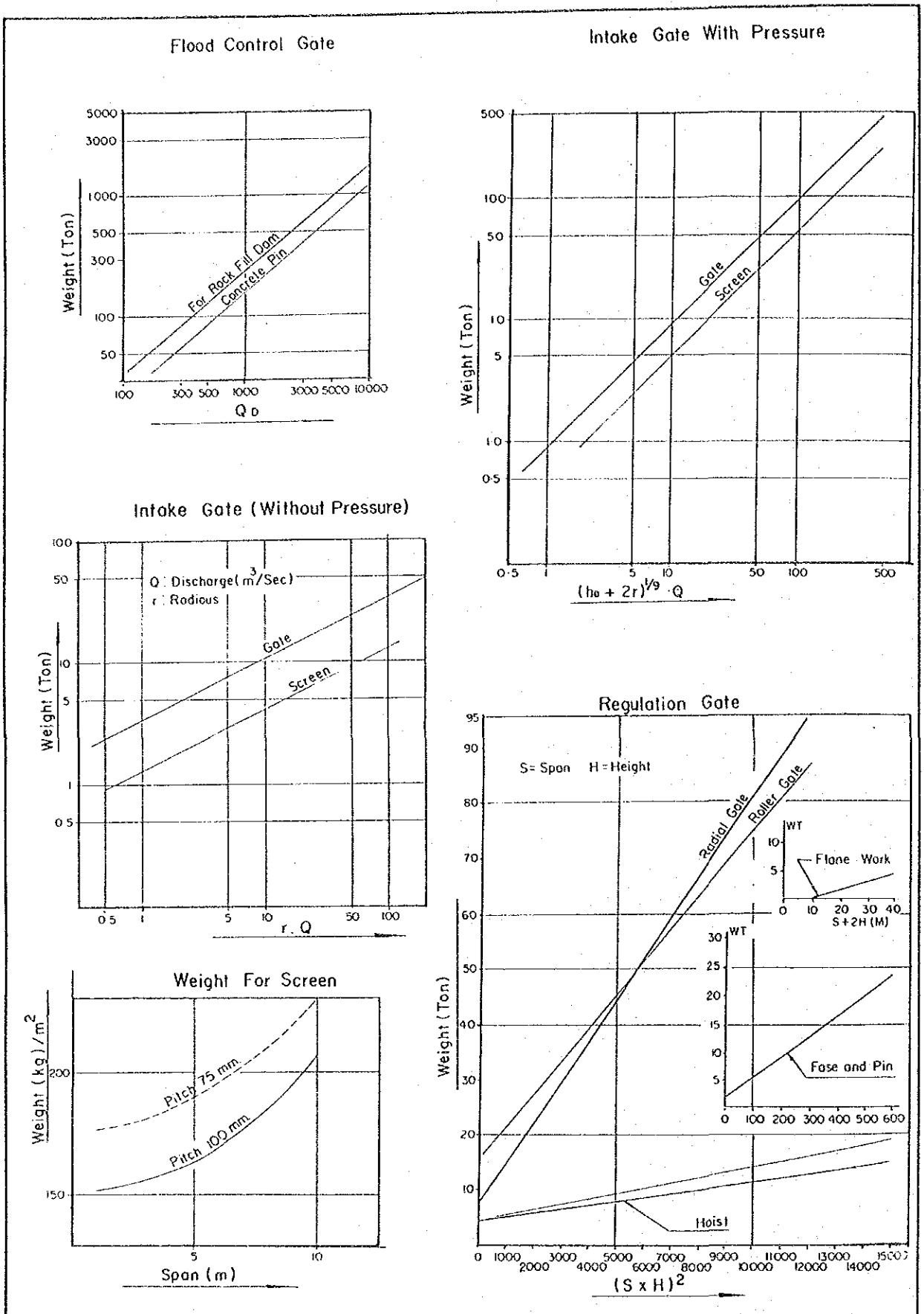

Fig. J.2-14 Estimation of Weight for Gate and Screen

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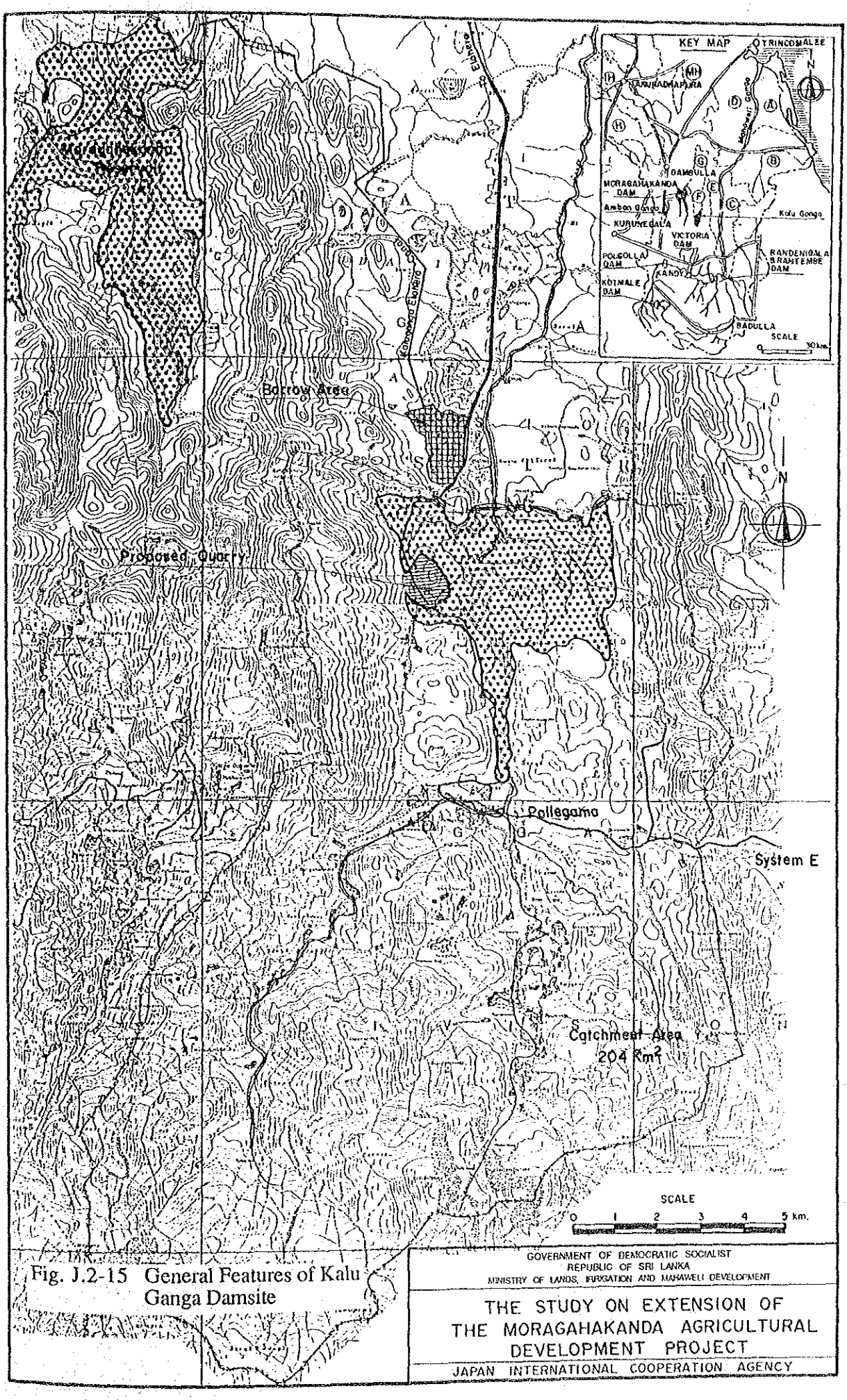

Fig. J.2-15 General Features of Kalu Ganga Damsite

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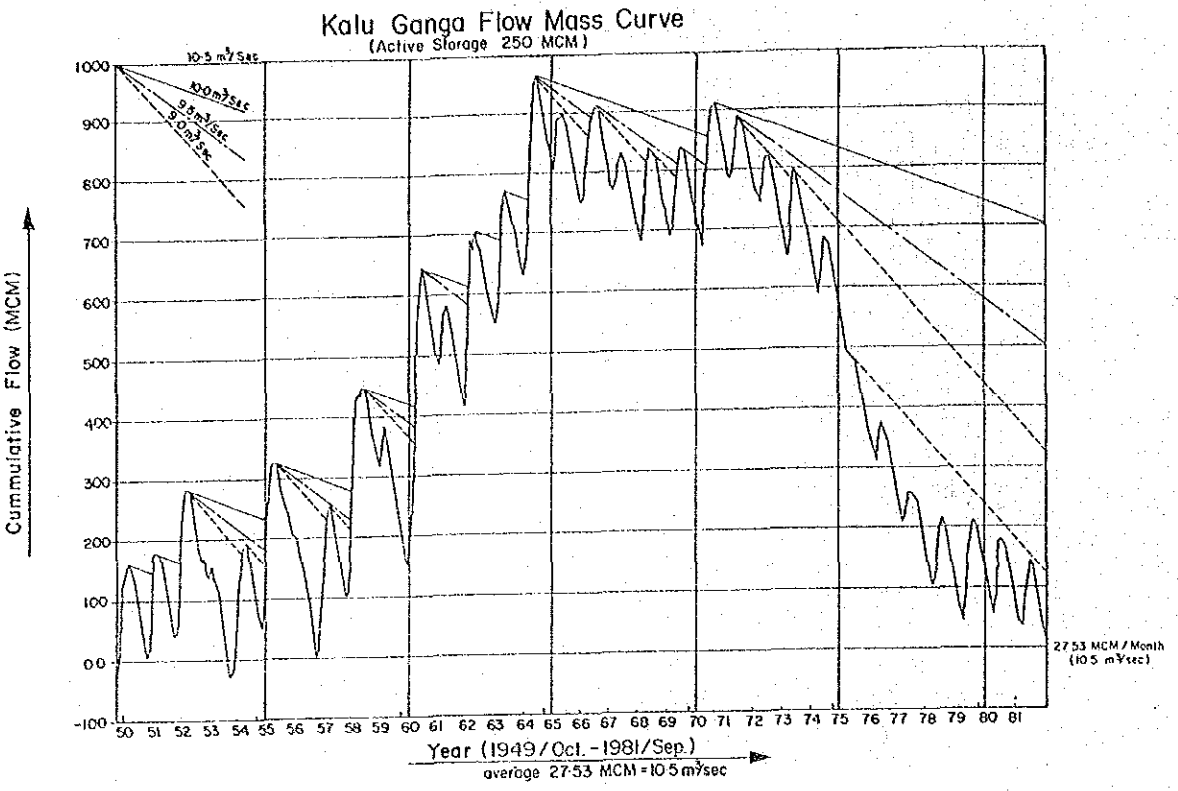

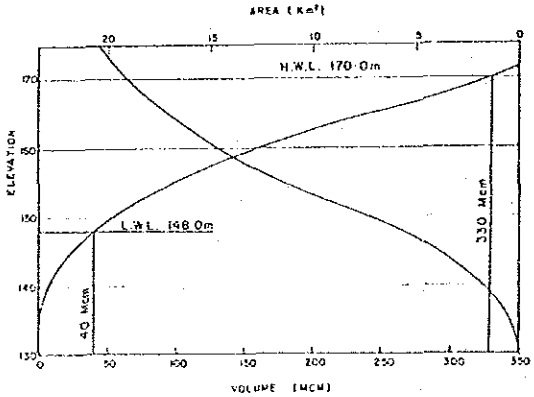

ELEVATION m	AREA Sq.km	VOLUME mcm
155	0	0
160	1.6	7
165	4.0	25
170	7.3	55
175	11.7	97
180	16.7	165
185	17.2	240
190	19.2	330

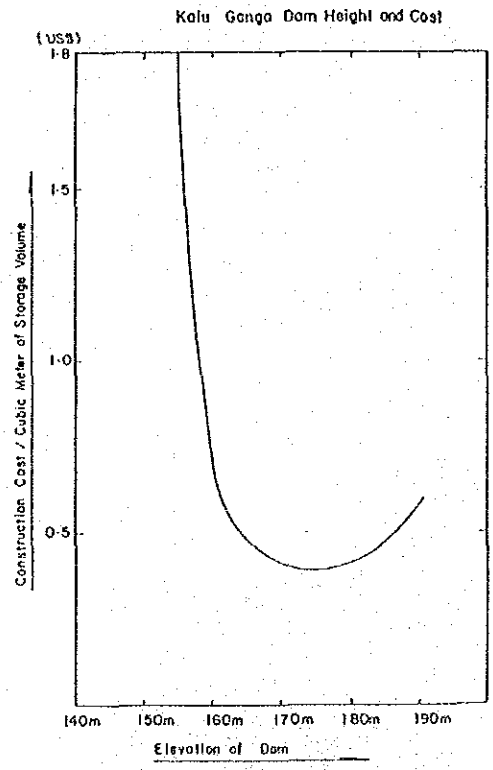

Fig. J.2.16 Mass Curve and Area Storage Curve of Kalu Ganga Dam

Fig. J.2-17 Cost per Cubic Meter of Storage Volume

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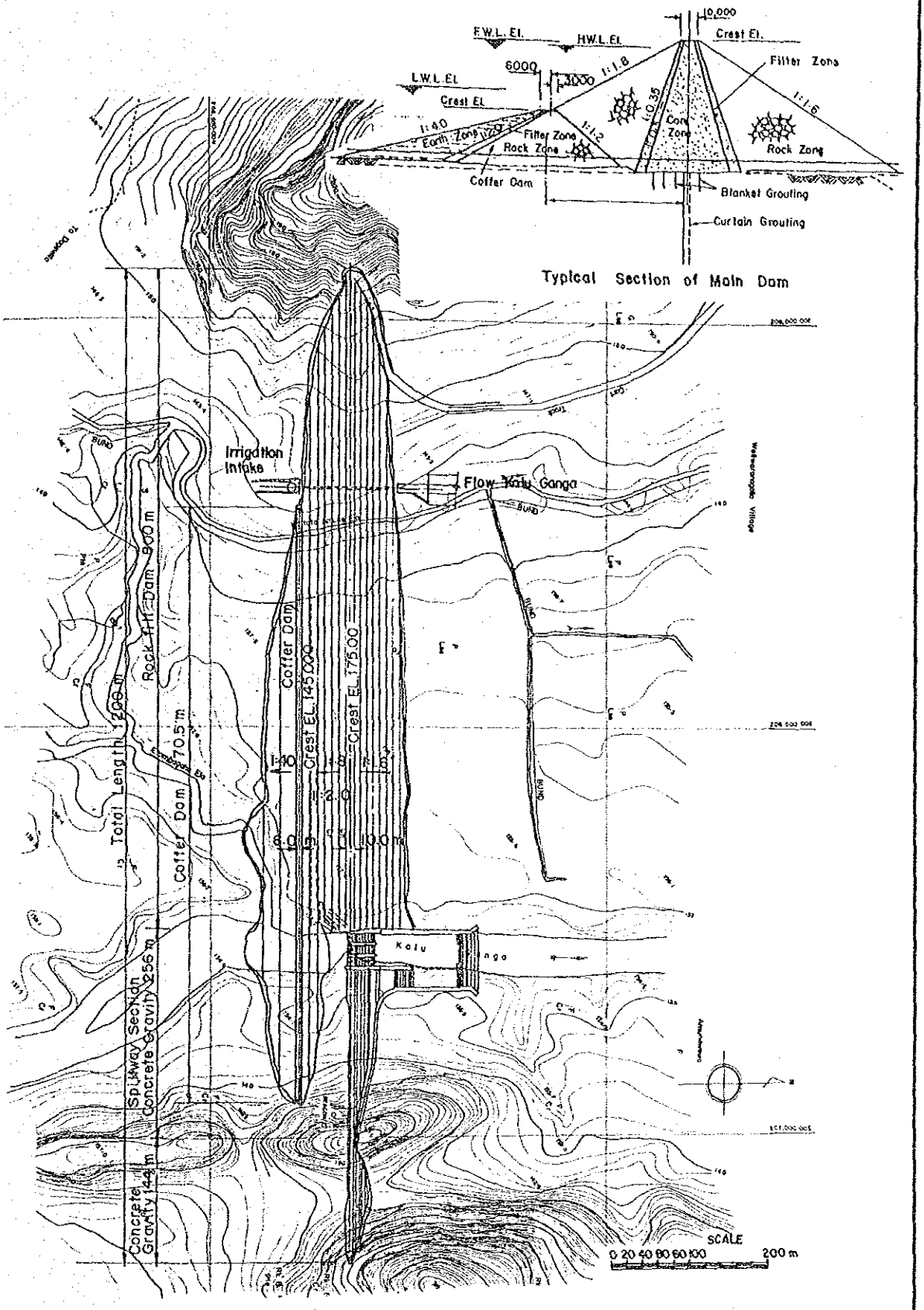

Fig. J.2-18 Preliminary Design of Kalu Ganga Dam

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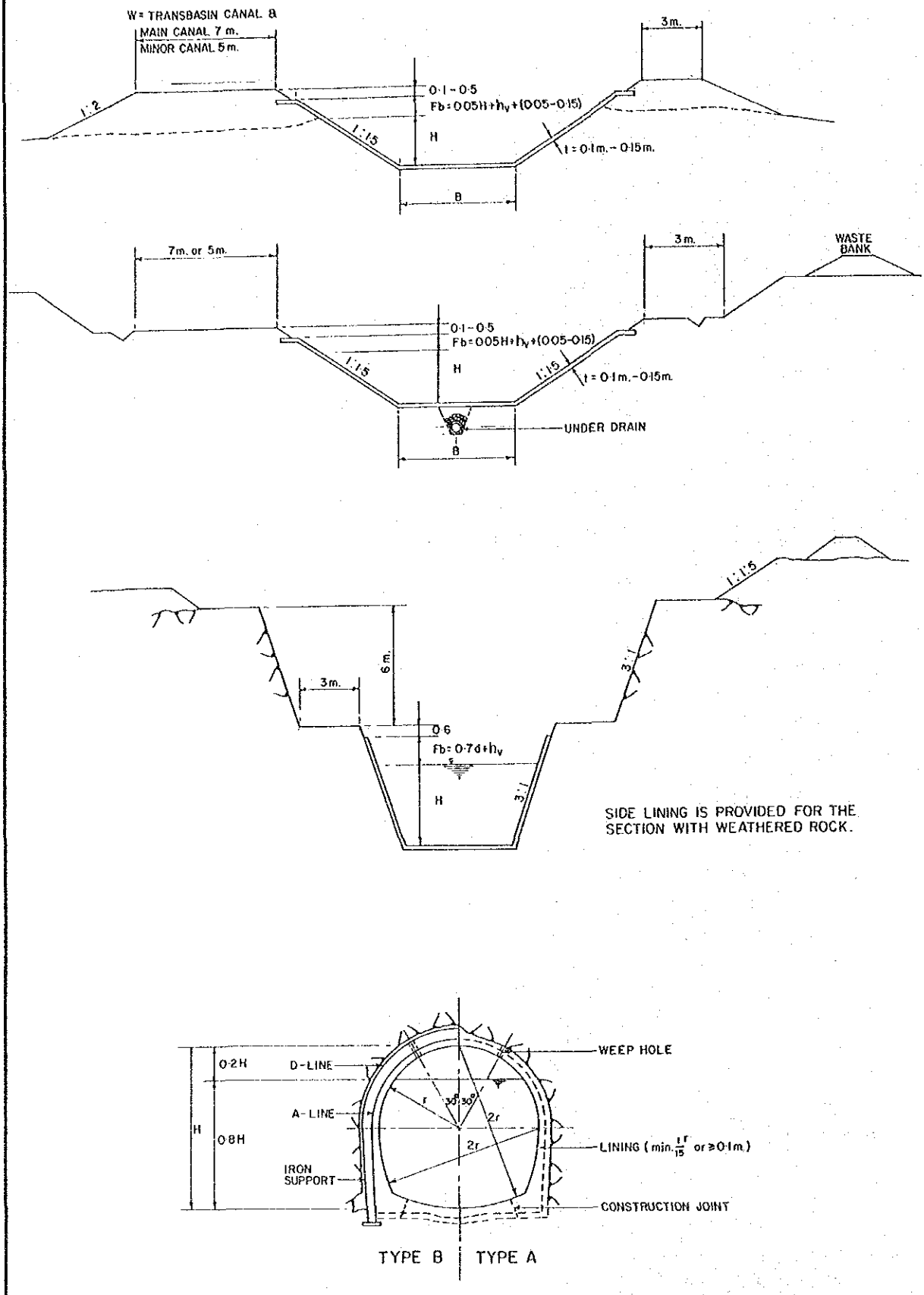

Fig. J.2-19 Typical Section of Transbasin Canal

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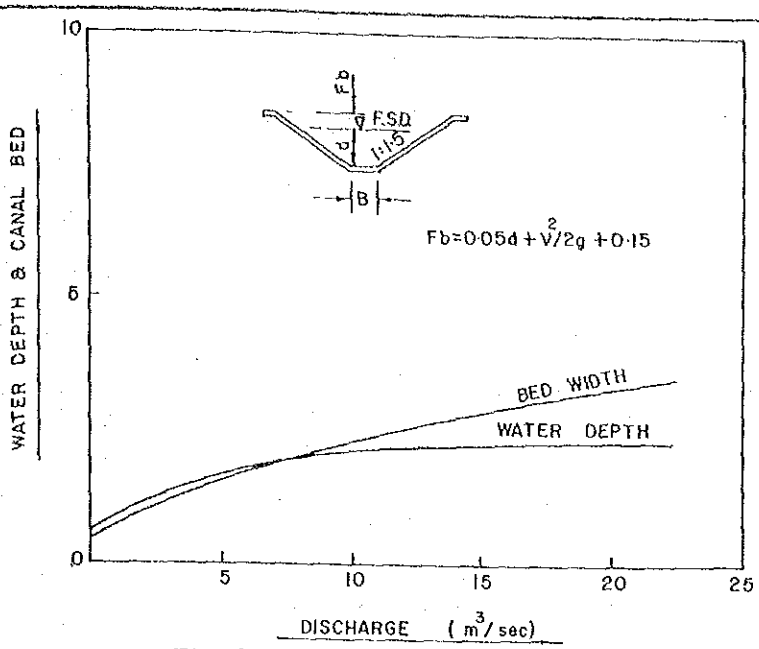

Fig. J.2-20 Relation between Discharge and Water Depth

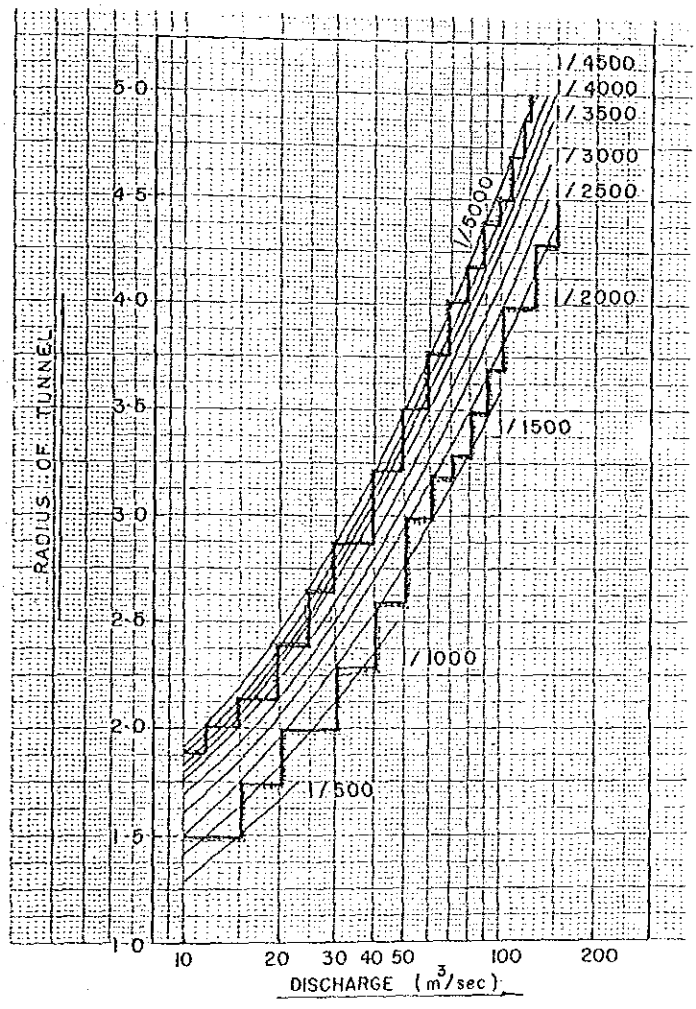

Fig. J.2-21 Determination of Hydraulic Design of Tunnel

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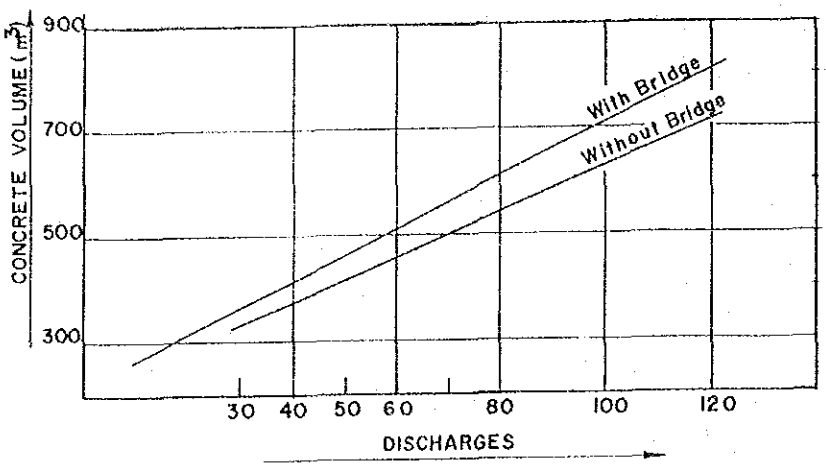
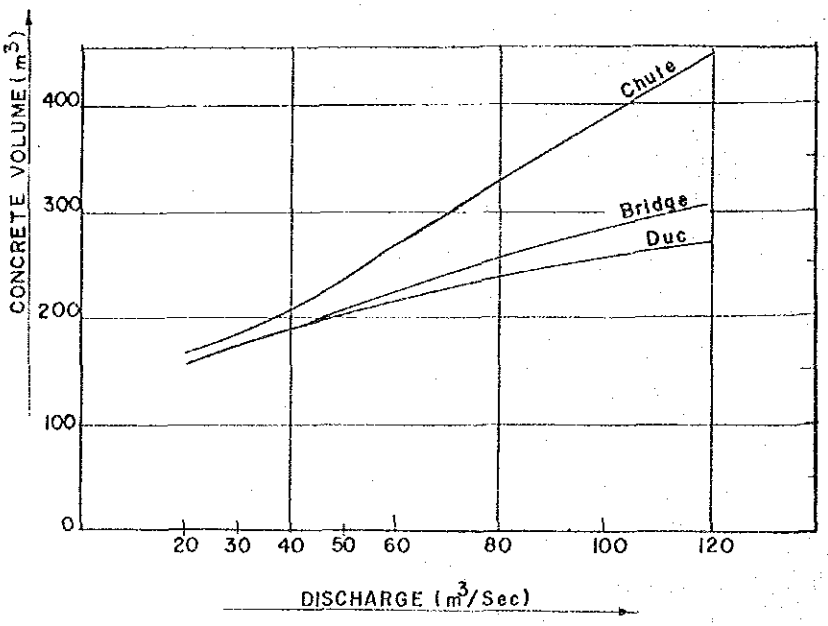


CONCRETE VOLUME FOR CHECK STRUCTURE



CONCRETE VOLUME; CHUTE(6m), BRIDGE , DUC(2x 2x 1)

Fig. J.2-22 Design Quantity for Structure (1/2)

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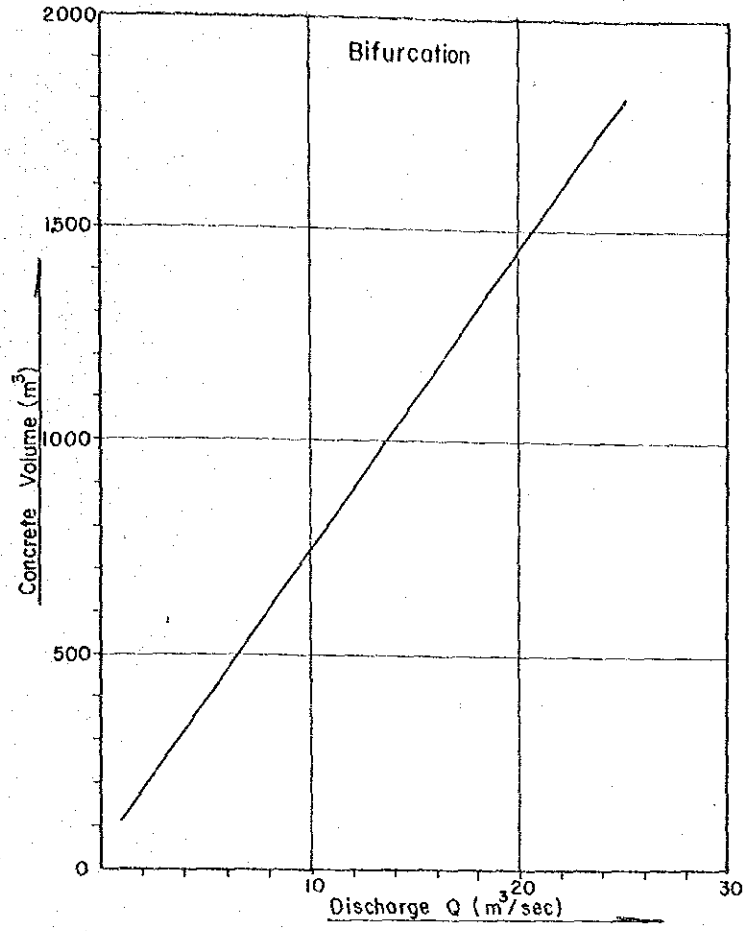

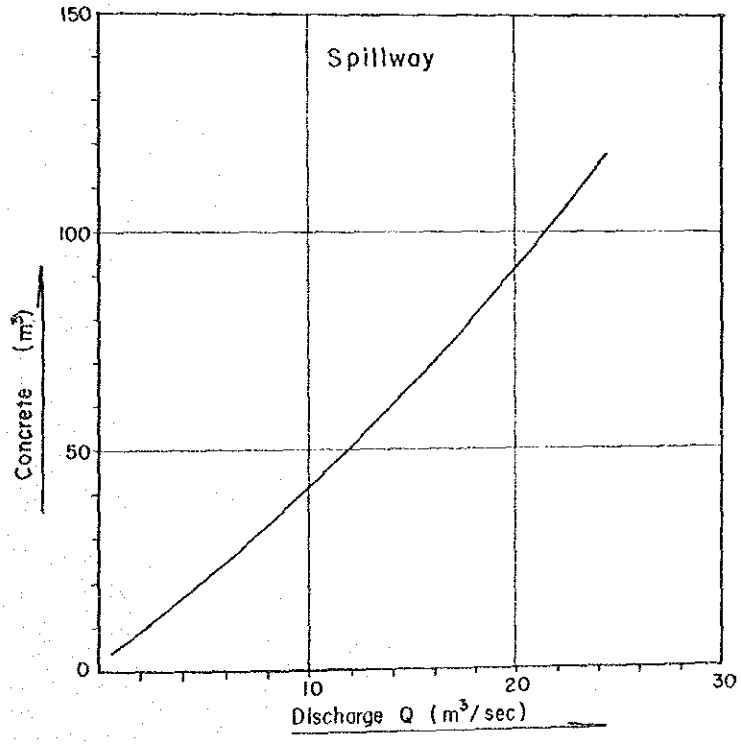

Fig. J.2-22 Design Quantity for Structure (2/2)

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THE STUDY ON EXTENSION OF THE MORAGAHAKANDA AGRICULTURAL DEVELOPMENT PROJECT

JAPAN INTERNATIONAL COOPERATION AGENCY

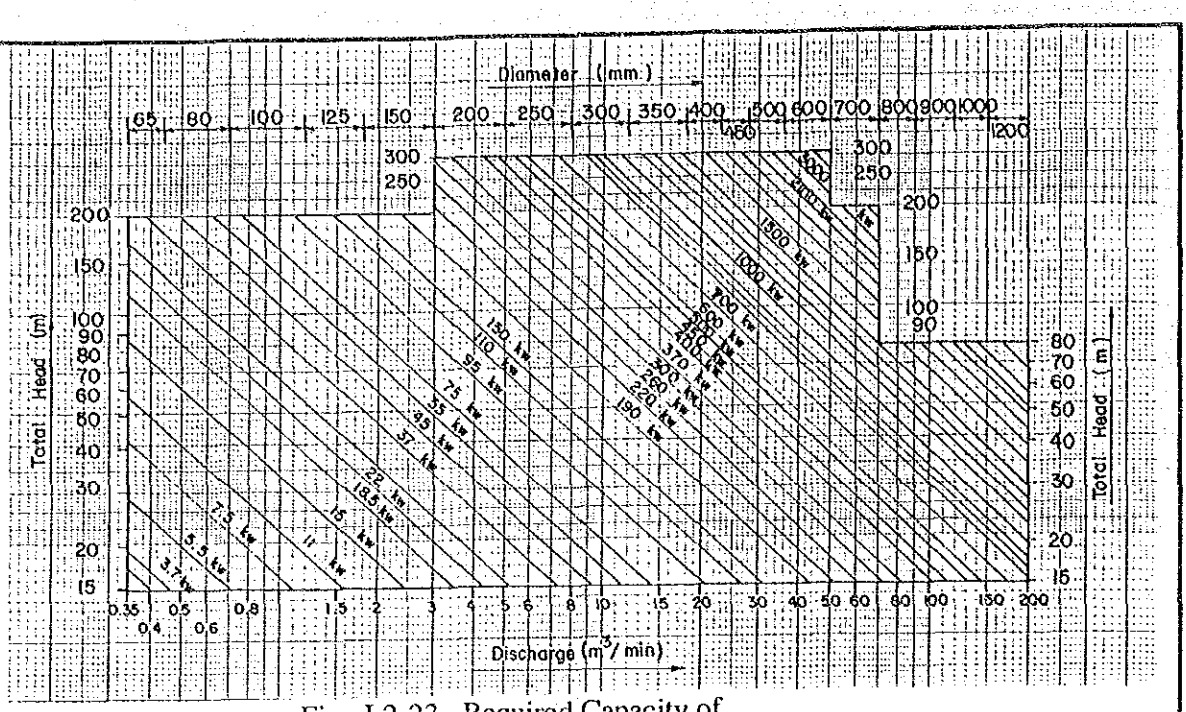

Fig. J.2-23 Required Capacity of Pump Station

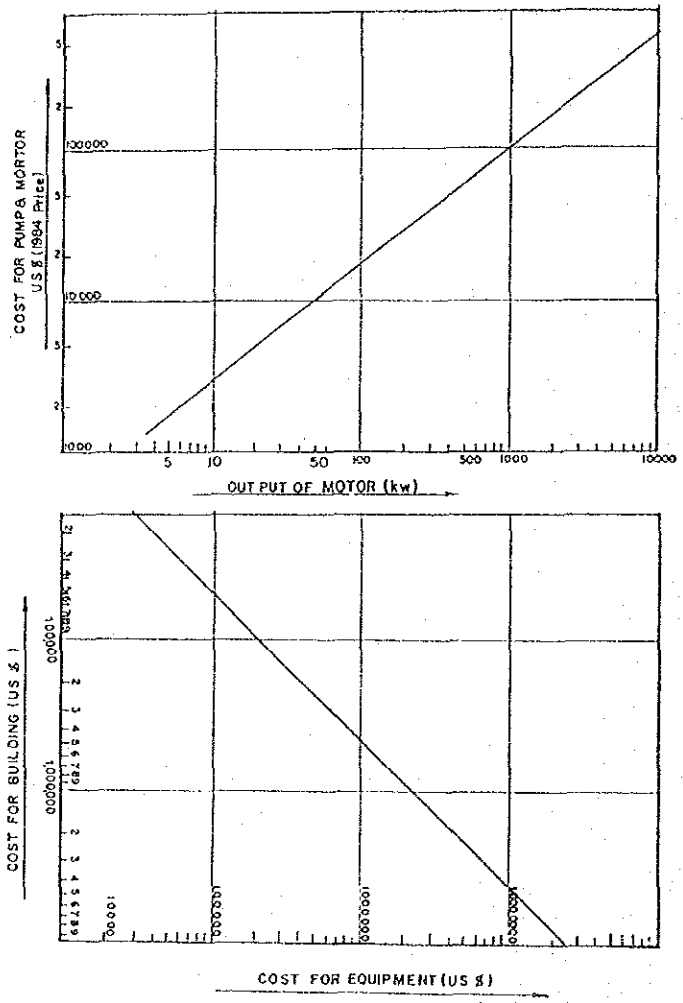

Fig. J.2-24 Cost for Pump and Buildings

GOVERNMENT OF DEMOCRATIC SOCIALIST REPUBLIC OF SRI LANKA
MINISTRY OF LANDS, IRRIGATION AND MAHAWELI DEVELOPMENT

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ANNEX–K

ENVIRONMENT ASPECTS

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ENVIRONMENT ASPECTS

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K.1 INTRODUCTION

This Master Plan Study envisage potential irrigable areas in the North Central River Basin (NCRB) and North West Dry Zone (NWDZ). Possible conveyance systems between the Mahaweli Ganga, NWDZ and NCRB were also studied. This ANNEX presents a broad range of environmental aspects and issues in the project area.

This ANNEX is devoted to reviewing the status of the terrestrial and aquatic natural resources in the project area with the aim of identifying any major environmental issues that should be addressed before project implementation. In addition, a brief chapter is also devoted to the impacts on human health as a possible consequences of project implementation.

K.2 TERRESTRIAL ENVIRONMENT

This chapter deals with the terrestrial natural systems such as forests and its associated wildlife habitats and attendant plant and animal species.

K.2.1 Status of Protected Areas

Protection areas in Sri Lanka largely fall into two major categories, namely Forest Reserves which are administered by the Forest Department (FD) under the Forest Ordinance of 1907 and Wildlife Reserves administered by the Department are placed under the Ministry of Lands and Land Development. This Ministry is also responsible for land development and settlement activities usually under major development schemes. The Department of Wildlife Conservation (DWLC) is placed under the Ministry of State, which under other functions is also responsible for tourism development.

The natural forests in this country receive different degrees of protection depending on legislation and the convictions of the authorities who administer them. Both of the FD and the DWLC have somewhat differing management policies which are reflected in the way the forests are administered. The FD is mainly concerned with the utility value of forests in terms of timber potential and in the establishment of economic forest plantations. In recent years, however, some effort has gone into the establishment and conservation of catchment forests and in management of some biologically diverse natural forests. The DWLC's role so far has been almost entirely confined to law enforcement, although in the last few years with the implementation of USAID supported Mahaweli Environment Project, management of reserve resources is increasingly being pursued.

The extent of natural forests remaining in the country are presented below:

Item	Wet Zone (1,000 ha)	Intermediate & Dry Zone (1,000 ha)	Total (1,000 ha)	Percent-age (%)
Forest Department Reserves	92	589	681	44
Other Natural Forests (Crown forests)	-	118	118	8
Small Natural Forests	22	-	22	1
Wildlife Department Reserves	27	586	613	40
Forest in Mahaweli System A-D	-	115	115	7
Total	141	1,408	1,549	100
Percent (%)	9	91	100	100

Source : Ref. 5

The forests that are being administered by the FD fall into following three categories:

(1) Reserved Forests

These forest areas are protected from development activities and largely managed for sustained yield of one or more products such as water, timber, recreation etc., where the conservation of nature is primarily oriented to the support of the economic activities. Under this category, there are two types of reserves namely Forest Reserves and Proposed Reserves. However, in both these reserve categories, scientific timber exploitation is permitted upon an order made by the Conservator of Forests. These forests are usually of extends in excess of 200 ha. The Forest Reserves and Proposed Reserves in the project area are provided in Fig. K-1 and Table K.1.

(2) Village Forests

These are small forests that are located close to villages that are managed to supply fuelwood and timber for the local people.

(3) Other State Forests

Any forest not included in the Reserved Forest or Village Forest category is classified as other State Forests or Crown Forests. Such forests are usually under 20 ha in the wet zone and under 200 ha in the dry zone. These forests are administered by the FD until a better or more productive use is found for them.

Over 12% of the land area of the island or over 40% of the forest area of the island is administered by the DWLC under the provisions of the Fauna and Flora Protection Ordinance. Reserves administered by the DWLC fall into two major categories namely National Reserves and Sanctuaries. When wildlife reserves are proclaimed as National Reserves, they are given one of five legal statuses and afforded different degrees of protection. These statuses are Strict Natural Reserves, National Parks, Nature Reserves, Jungle Corridors and Intermediate Zones.

(1) Strict Natural Reserves (SNR)

A Strict Natural Reserve provides the greatest degree of protection amongst all categories of Natural Reserves. In these reserves, neither plant or animal can be disturbed in any way and entry to the reserve is strictly prohibited except on a permit obtained specifically for the purpose of conducting scientific research. Within the project there are two SNRs namely Ritigala Strict Natural Reserve and Hakgala Strict Natural Reserve.

(2) National Parks

A National Park also provides full protection to plant and animals and contains no permanent human settlements, but people may enter a national park on the payment

of a fee to observe wildlife. This category occupies the largest extent of land amongst the reserves administered by the DWLC.

(3) Nature Reserves

A Nature Reserve affords the same protection to wildlife similar to national park for wildlife observations. It allows existing rights to human land usage to remain. Thriconamadu Natural Reserve (24,740 ha) and Proposed Minneriya Giritale Natural Reserve are located in the project area.

(4) Jungle Corridors

A jungle corridor mainly provides animals, particularly the far-ranging species such as the elephant with safe passage, and like a natural reserve affords full protection to fauna and flora. Existing rights to land usage is permitted within a jungle corridor. Jungle corridors have been established to link major reserves and protect the migratory routes of the elephant. Within the Project area one Jungle Corridor exists. The effectiveness of this Nelugala Corridor starting from Somawathie Park is doubtful, because it is not leading towards any National Park.

(5) Intermediate Zone

An intermediate zone has the lowest degree of protection among all categories, where hunting for wildlife animals were permitted in the past. Today, hunting in all national reserves and sanctuaries is not permitted and this classification has now been eliminated.

(6) Sanctuary

A sanctuary is a wildlife reserve, where animals cannot be disturbed in any way, but where all other human activities including habitat elimination and private ownership of land are allowed. Sanctuaries are usually demarcated as buffer zones to national parks or within inhabited catchments of reservoirs. The distribution of Wildlife Reserves in the project area are presented in Fig. K-2.

Moreover there are 36 Man and Biosphere Reserves (MAB) in Sri Lanka, two of which namely Sinharaja and Hurulu have international status. The Hurulu MAB is located entirely within the project area. The MAB Reserves in Sri Lanka is given in Fig. K-3.

A final category of protection area is the Archaeological Reserves which are demarcated with the objective of preserving unique historical and cultural sites.

K.2.2 Natural Vegetation

The vegetation for almost entire of the country is the closed tropical forest, varying composition and character. The composition of the many different natural forest types is largely governed by the specific local combination of the location, climate and topographical

features. In addition to the forests, other natural vegetation types are the grasslands and the different wetland (both terrestrial, coastal and marine) types.

K.2.2.1 Vegetation in Project Area

The project area falls almost exclusively in the dry zone. This zone is generally characterized as lowlands receiving upto 1,800 mm of annual rainfall, most of which falls during the months of October to February. The climate is characterized by a relatively long period (4 months) of drought conditions. The larger part of the remaining natural vegetation in this zone is represented by the Tropical Dry Mixed Evergreen Forest. The forest has been disturbed by chena (shifting) cultivation for several centuries and in more recent times by illicit felling, clearing for development projects and village expansion.

The forest in the project area is usually characterized with valuable trees. Isolated hills in the project area such as Ritigala, Dimbulagala, Westminister Abbey and others are known to have a rich and interesting plant and animal composition, which have evolved through isolation. These hills have a large number of species that are endemic to the country, and therefore are of both evolutionary and ecological significance.

On the banks of rivers, the forest is tall and more dense than the rest of the area. Dominant trees reach a height of 8 - 11 m. Those forests are important habitat for many wildlife species including the elephant and some of the endemic birds. Species like endemic tree Madora in the riverine forest has now become almost extinct.

Another important vegetation type in the project area is the swamps in the floodplains of the Mahaweli Ganga. These swamps are seasonally inundated areas. They support the greatest besoms density of all habitat types found within the project area. The aquatic medium of the villus and the grassy areas that surround them sustain an abundance of wildlife. The most numerous of fauna are fish, birds and elephants. These floodplain within the area maybe considered as high quality wildlife habitats (Ref. 5). In view of their importance, the entire floodplain of the Mahaweli Ganga has been protected as the Floodplains National Park.

The balance of the project area comprises vastly chena lands scattered among pockets of damana grasslands. Damana grasslands are extensive in the south eastern part of the project area, provide dry season habitats for elephants.

K.2.3 Wildlife Diversity

There are many varieties of animals in the project area. The vertebrate fauna consists of several species of fish, amphibians and reptiles, a majority of the 251 resident bird species found in Sri Lanka and large mammals, such as the elephant, leopard, bear, deer and sambhur. In addition during the winter months, about 75 bird species migrate into these area from northern countries and other distant places.

K.2.3.1 Endangered and Endemic Species

The fauna of the dry zone exhibits a great affinity with the fauna of the Indian sub-continent. About 86 endemic plant species have been found in the dry zone of Sri Lanka. These species are mostly in the understory of the forest. At this stage no specific studies are available to indicate the number of endemic species of fauna in the project area, but according to the DWLC's information available for the dry zone, around 35 - 40 endemic faunal species may be found in the project area.

These species occupy a wide range of habitats from open grasslands to high forests, but each species appears to have a narrow range of preferred habitat. Riverine habitats seemed to be the preferred habitat of the majority of the species. It is however, clear that many endemics such as the Red-faced malkoha (Phaenicophaeus pyrrhocephalus), Ceylon spur-fowl (Galloperdix bicalcarata), Purple-faced langur (Presbytis senex) and an agamid lizard (tocryptis weigmanni) are in general much less abundant now than before. Most of these species are also absent from some areas of their previous range of distribution. The conversion of their natural habitat to agricultural land seems to be the reason for the reduction in numbers and area of distribution. The fauna of the project area contains seven or more endangered species and two threatened species.

Of the above species the distribution of elephant, leopard, toque macaque and purple-faced langur is much reduced than in former times. This has largely been due to habitat elimination. These species have been partly or totally excluded from all areas of human activity. The restricted distribution of the crocodile is probably due to their ecological needs of an aquatic environment. They are located along the major rivers in the project area.

K.2.3.2 Elephant Populations

The elephant has been protected in Sri Lanka since the 12th century. The elephant was given full legal protection in 1937. But the numbers have declined due largely to the attrition of the animal's habitat. Except for a small number of elephants (about 10) in the Sinharaja forest, all the elephants are restricted to the dry lowlands. Over the past 150 years, disruptive land practices have forced the animals from the wet and fertile regions of the island to the much drier parts in the north, north - east, east and southeast. Until recent times the elephant was numerous in the project area. However, wit the rapid combat of malaria and the subsequent colonization of the area by man, the elephant has been squeezed out from a number of places.

The core of the elephant problem stems from rapid loss of forest cover for development, particularly large scale water resources programme. As agricultural areas expand, elephant populations face the danger of becoming pocketed. The result is that conflict between man and beast arises. These elephants then disperse into the villages and raid crops. In desperation, some villagers take to shooting at the elephant indiscriminately. The elephant populations therefore are gradually decimated.

According to the DWLC's informations, the distribution of elephants in the project area were estimated as follows:

Area	Minimum	Maximum
Lower Mahaweli basin	650	700
North Eastern Region	100	120
Northern Region	225	275
Anuradhapura district	100	125
Wilpattu Northern Sector	225	250
South Eastern Region	300	325
Total	1,600	1,795

Distribution of elephants in Sri Lanka is shown in Fig. K-4.

In the project area traditionally elephants have been migrating seasonally between different types of feeding grounds outside these national parks. These habitats outside the national parks are gradually getting reduced and fragmented while cultivations and settlements continue to extend nearer and nearer to the park boundaries. A more serious problem is the location of the development areas of the Mahaweli Project close to the boundaries of the National Parks and Reserves. The result is severe crop damage at the initial stages of the development of these projects. Elephants are compelled to move out and raid croplands, causing severe conflict between man and elephant.

In the proposed project area, areas of high elephant activity include the Wasgamuwa, Gal Oya, Somawathie, Maduru Oya, National Park and the forests in the North Central Reserve.

K.3 AQUATIC ENVIRONMENT

K.3.1 General

The Mahaweli Ganga is the longest river in Sri Lanka. It originates in the hilly area of Horton Plains and flows north easterly, entering into Koddiyar bay near Trincomalee (see Fig. K-1). The major tributary is the Amban Ganga confluence near Manampitiya. The Maduru Oya is much smaller river in the study area adjacent to the east of the Mahaweli river basin.

The mean annual flow of the Mahaweli Ganga at Manampitiya is approximately 8,400 MCM and the animal inflow at the Maduru Oya dam is about 340 MCM. According to TAMS (Ref. 5), tidal influence of both rivers is around 6 km from the sea outfalls.

There are several hundred small and large tanks with perennial water are prevailing in the study area. Major tanks are Parakrama Samudra, Kaudulla, Minneriya etc., but most of the small tanks are often dryout during dry season. Substantial amount of surface water has accumulated in floodplains during rainy season and drains slowly during dry spell.

According to TAMS, generally the quality of water in study area is fairly good for irrigation purposes. The water cwasan generally classified as very low salinity and Sodium Adsorption Ratio. A few water samples showed iron toxicity in Mahaweli Ganga and Maduru Oya but not on a consistent basis. Relatively high salinity levels were observed near coastal areas. TAMS (1980) recommended that the ground and surface water in project area were apparently suitable drinking water sources for livestock, swimming, bathing, laundry etc. but verification with coliform bacteria and metal toxicity is required for human consumption.

Surface water generally shows qualities which are above standards normally associated with a healthy fish fauna. However, discharging of industrial pollutant and pesticides may cause damages to aquatic life. Special attention to be given to releasing of poorly treated waste into Maduru Oya from Valaichchenai paper mill.

There are about 60 species of fish found in the freshwater of Sri Lanka: of these there are 20 species valued as food fish. According to TAMS, Sri Lanka's fisheries catch was estimated at around 180 kg/ha/year. But many of the smaller tanks in the study area produce only upto subsistence level.

Fishing activities are well developed in the esturine portions of the Mahaweli Ganga and Maduru Oya. These areas are very good breeding and feeding places for shrimps and other valuable food fish species.

K.3.2 Water Quality

There have been very few comprehensive water quality studies conducted for surface and ground water in the project area. TAMS, 1980 analyzed available water quantity for the AMDP area. The study indicated that in general the water quality in the AMDP area (this perhaps can be applied for the project area) were suitable for irrigation use

with the exception of some tanks which had high salinity level, and which were downstream tanks located near coast. The floodplains generally had water which was suitable for irrigation purpose, although high salinity levels have been recorded as a result of high evaporation during the extensive dry period that occur annually.

Similarly several coastal well waters have high salinity levels which limits their use for irrigation. The surface water in the project area could be expected to be generally above standard associated with healthy fish faunas except in rare circumstances. In east areas, nutrient and pesticide in well water may be expected to be below dangerous levels.

K.3.3 Fisheries

There are 16 endemic fresh water fish species in Sri Lanka, most of them are found in the Wet Zone of the country. There are no commercial fisheries operations in rivers or streams in the project area. Only occasional landlines are used. Production in rivers was estimated at less than 5 kg/ha/year.

However, floodplains however, are excellent spawning and nursing ground for many fish species. There are a number of fishermen who operate in these floodplains. An average fish yield was estimated at 35 - 75 kg/ha/year.

Substantial fishing operation takes place along estuaries. These estuaries provide nursing ground for shrimps and other fish species and are extremely valuable from an economic point of view.

K.3.4 General Considerations on Aquatic Environment

Construction of reservoirs and the subsequent transfer of water will result in hydrological alterations in both river and estuaring systems in the area. Therefore, it is recommended that measures be taken to reduce impact on the river and estuarine living resources against these alterations.

K.3.4.1 Mahaweli Ganga Basin

When water diversion schemes modify the flow regimes of a river, then the fish populations in the river and estuarine systems would be affected. River maintenance flows as conservation flows will be maintained along the rivers below the impoundments, duly in consideration of the ecology and status of the endemic freshwater fauna of the basin, as well as the past river flow at the estuary.

The negative impact of river and estuarine fisheries resources due to decreased outflows and the accumulation of runoff chemicals will be mitigated in part by the maintenance of downstream conservation flows and the proper application of fertilizers in the irrigable tracts. Dry season conservation flows should be maintained where necessary for the following reasons:

- dilution of saline returns flows,
- keeping the salinity/freshwater boundary at the estuary intact,

- prevention of the formation of isolated pools in the river bed which is prime mosquito breeding habitat, and
- maintenance of riverine habitats for aquatic life.

Specific conservation flows should be formulated in consideration of the above aspects as well as the past flow records available.

The proposed irrigation scheme may result in a significant accumulation of pesticides in the receiving waters which could have serious effects due to the cumulative magnification of pesticides through the food chain on fish, wildlife, cattle and humans. It is therefore recommendable that the use of persistent organochlorine pesticides be curtailed or even banned in the project area. It is further recommended that a multi-purpose water quality monitoring programme be implemented in the project area under the control of the Water Management Secretariat (WMS) of the MASL. For the water quality monitoring programme to be effective, it is essential that a baseline survey on present conditions be obtained prior to project implementation. This will enable subsequent monitoring to reflect the various water quality changes as each phase of the development project is inaugurated. With this approach, adverse effects on, or of water quality, as well as the cause of these effects may be identified and resolved in sufficient time to limit further detrimental impacts on a specific resource.

Background or baseline samples should be collected for analysis a minimum of twice per annum to represent dry and wet seasons a the following locations:

- major rivers,
- existing major irrigation tanks,
- existing canals and drainage systems, and
- lagoons and estuaries.

Background parameters should include temperature, pH, dissolved oxygen, major cations and anions, conductivity, nutrient salts, heavy metals, pesticides, coliform bacteria, etc.

K.3.4.2 Fisheries Benefits

The formation of reservoir and other water bodies under the project will enhance fisheries production, although reduced yield could be expected from the floodplains. It is suggested that measure be taken to capitalized on the increased potential for fisheries in the project area.

It is also possible that construction of dam can effect certain species of fish that prefers fastflowing waters and those that migrate upstream to spawn. It is difficult however to adequately assume the overall effects on fish movement because little is known of the migration patters in the inland waters.

The alteration of river flows along with accumulation of agrochemicals is likely to have an overall negative effect on estuaries fishing resources. This may be particularly evident for shrimp species that breed in the estuaries. Changes in nutrient loading of

estuaries could upset the balance of organic matter cycling in these waters with an overall detrimental affect upon the shrimp populations. However, by keeping the river maintenance flow at the estuary specially during the dry season, such negative effect may be reduced.

K.3.4.3 Floodplain Systems

The impacts on the floodplains will be closely linked with the resultant alterations of existing river flows. This is because river flows are largely responsible for the recharge of floodplain.

The reduced flood flows of the Mahaweli Ganga could result in the reduction of the surface area of the already affected floodplain. The reduction of river flows means that extent of the land that would be flooded will decrease. Consequently the productivity of the floodplain ecosystem will be lowered. This will reduce the habitat available for wildlife and reduce its carrying capacity. Prolonged exposure of the floodplain fringes could result in an even larger area losing their character as wetlands. Consequently the livestock carrying capacity of the floodplain grasslands will be affected.

K.4 PUBLIC HEALTH

The hazards to public health due to waterborne diseases is roughly divided into three categories:

a) Water breeding insect vectors,
b) Contamination of drinking water, and
c) Exposure of non-resistant people to certain diseases,

K.4.1 Insect Vectors

At least four diseases namely, Malaria, Filariasis, Dengue and Haemorrhagia Fever, are transmitted by mosquitoes in Sri Lanka.

(1) Malaria

The vector of malaria is Anopheles calicifacies. It breeds in temporary pools which are free of vegetation, or at the fringes of paddy fields. It is therefore of great importance that paddy fields are well drained after harvest to avoid the occurrence of temporary stagnant water.

According to the DWLC, half a million cases of malaria are reported each year. Control programmes are focussed around house-spraying four times a year, using malathion. Spraying programmes have proved successful in the past, but great care has to be taken to avoid the building up of resistance. Therefore, a careful plan for the alternation of different insecticides should be implemented. In addition to this, it is recommended that a system of uniform labelling of insecticides should be adopted and stringent instructions as to their use provided.

Mention should also be made of an other activity threatening human health and wildlife in future settlement areas, illicit gemming. Abandoned gem pits are usually not filled up with the dug up material and soon fill partly with water. These water pools are ideal breeding places for malaria mosquitoes and hazardous traps for wildlife.

(2) Dengue Fever and Haemorrhagia Fever

The vector for dengue and haemorrhagia fever is the mosquito Aedes aegyptic. This mosquito breeds in small, water filled containers like empty cans, coconut shells, tyres and the like. As a consequences it is commonly found around human habitation. Aedes aegypti is mostly found along the coastal belt because climatic conditions and a dense population are favourable. The population of this mosquito is expected to increase in the project area, because of the increase in human population and availability of breeding sites. Spraying, cleanliness and a good waste disposal system are of the utmost importance for the control of this mosquito.

(3) Filariasis

Filariasis is transmitted by mosquitoes of the genus Cultex. Like the Aedes mosquito, its breeding habitat is around human habitation and it occurs mainly along the coastal belt. Fortunately, filariasis is on the decline.

K.4.2 Drinking Water

Contaminated drinking water is the cause of many diseases like cholera, enteric fever, hepatitis, amoebic dysentery and polio. Contamination of the open water bodies is to a large extent caused by poor sanitation facilities causing human waste to reach the water without being filtered or purified biologically. The provision of latrines and boiling of drinking water would improve public health considerably. Also, the construction of wells or the provision of piped water would be advisable. The wells should be dug well away from irrigation waters, to allow natural filtering of the ground water. The quality of the well water should be regularly monitored, to detect pathogenic organisms before a large number of people are infected. Education of the settlers on the causes of the different diseases is of the utmost importance.

K.5 RECOMMENDATIONS

TAMS report recommended certain actions to minimize the detrimental impacts of the project and for effective management of the National Resources for sustainable development in the region. On the recommendation of TAMS, important wildlife habitats were excluded from development and included within a contiguous protected area system. These protected areas were demarcated in areas of high wildlife quality, reservoir catchment and along the major river banks of the AMDP.

The Government of Sri Lanka accepted the recommendation of TAMS and established these protected areas in the AMDP so as to ensure the protection of forest and associated wildlife and investments on the AMDP.

In 1982, the cabinet approved the legal definition and establishment of these protected area system within the AMDP and the participation of USAID in financing the establishment and management of the Reserve System. Cabinet approval and subsequent USAID funding for the Mahaweli Environment Project (MEP) was based on the premise that these protected areas would remain inviolate and be excluded from future land and water, and other settlement projects.

The MEP programme is implemented with a US$5 million grand fund and all the above listed reserves (Fig. K-2) have been legally defined and established. In addition, the project has also been instrumental in habitat enrichment, buffer zone development, infrastructure development and other management programmes within those reserves.

K.5.1 Impact Analysis

The proposed project would involve construction of reservoirs, canals and associated water conveyance systems for agricultural production through the transbasin diversions. Environmental impacts due to project implementations may arise from the consequences of habitat alterations, hydrological changes and project related activities such as resettlement and associated infrastructure development.

The elimination of natural, semi-natural and man-altered habitats in the proposed project programme is one of the major concerns of the project. It is suggested that detailed survey would be conducted prior to project implementation in order to provide a better understanding of the factors and counter measures to minimize issues that could effect the environment.

In addition to agricultural expansion, human needs for firewood will have a serious impact on wildlife habitats and animal populations. Encroachment will also bring human activity closer to remaining forests and wildlife habitats and increase pressure due to hunting for food and commercial purposes.

K.5.2 Hydrological Changes

Since the proposed development will entail additional diversion from the Mahaweli Ganga (over existing diversion needs of the AMDP) to supplement transbasin, reduced

water flows down the Mahaweli Ganga causing impacts on floodplain. Floodplain are biological systems that are re-charged and revitalized by overflows from the river during highflood peak condition. Decreased floodplain recharges would deplete the ecological resources required by several wildlife species. This would further be aggravated by weed proliferation on more fringe areas become permanently exposed.

K.5.3 Construction Activities

The construction of canal to convey the water to different irrigation areas would have environmental consequence. The exact nature of impact can only be ascertained after a through study and understanding of the geometry and alignment of these canals in relation to wildlife distribution and irrigation pattern. Their modifications includes, diversion of canal, creation of underground tunnel, basic changes in alignment, restrictions on construction methods and restrictions on the seasons during which the construction can take place. The water levels of floodplains to be kept at their minimum levels without reducing the productivity of floodplains. This can be achieved by having barriers across the river to inundate water at certain levels during low flows periods.

K.5.4 Management of Protected Areas

All reasonable means of conserving as much of the fauna and flora affected by the project should be incorporated into the development scenarios.

Riverine forests along major rivers in the development area should be preserved intact as much as possible. These forests are preferred habitat for endemic species and also help to stabilize the river banks against soil erosion. Therefore, it is recommended that narrow strips of natural vegetation (at least 100 meter on either bank) should be left along major rivers in the project area. Other small streams should have statutory reservations as stipulated by the Crown Lands Ordinance.

An additional concern is the possible conflicts that may arise from crop damage by wildlife particularly in areas that are immediately adjacent to wildlife reserve and jungle corridor boundaries. It is therefore recommended that the proposed wildlife reserve/corridor system be buffered to minimize conflicts arising from crop damage. This is particularly important in the target irrigation areas located near the National Parks. This is accomplished by establishing a certain zone for livestock grazing, fuelwood plantations and human settlements between wildlife reserves and areas of intensive agriculture. The most advisable measure would be to establish grazing areas next to the wildlife reserve and a combination of fuelwood plantations and settlements between the grazing land and the zone of intensive agriculture. The objective is to establish a gradient of decreasing human activity towards the wildlife reserve. It is seen from other parts of the dry zone particularly in the Polonnaruwa District the elephants and livestock can use these grasslands with very little conflict.

K.5.5 Reduction of Construction Related Impacts

It is recommended that construction of the major irrigation structures be carried out with the minimum damages to the natural resources. Access roads, housing for construction workers, quarry sites etc., should be planned and located with utmost care to

avoid ecologically vulnerable forest and wildlife habitats, migratory routes and important aquatic habitats. Forest clearing should be restricted as far as possible especially on vulnerable hill slopes, sensitive wildlife habitats, river banks and watersheds of the proposed reservoirs.

Due to an extremely unavoidable reason, if a canal has to be run through a protected area, it can be utilized to provide water for wild habitats by filling abandoned tanks in the natural reserve. On the other hand this may prevent animals leaving away from reserve for searching water during dry periods.

A concomitant program to reforest degraded lands, resettlement sites and programmes to provide fuelwood plantations, enrich riverine forests and reduce soil erosion should be initiated. All new roads constructed should avoid erosion-prone slopes, have soil conservation measures incorporated into their design and construction and have adequate drainage. The cut and fill slopes of the roads should be consolidated with engineering measures or vegetation cover.