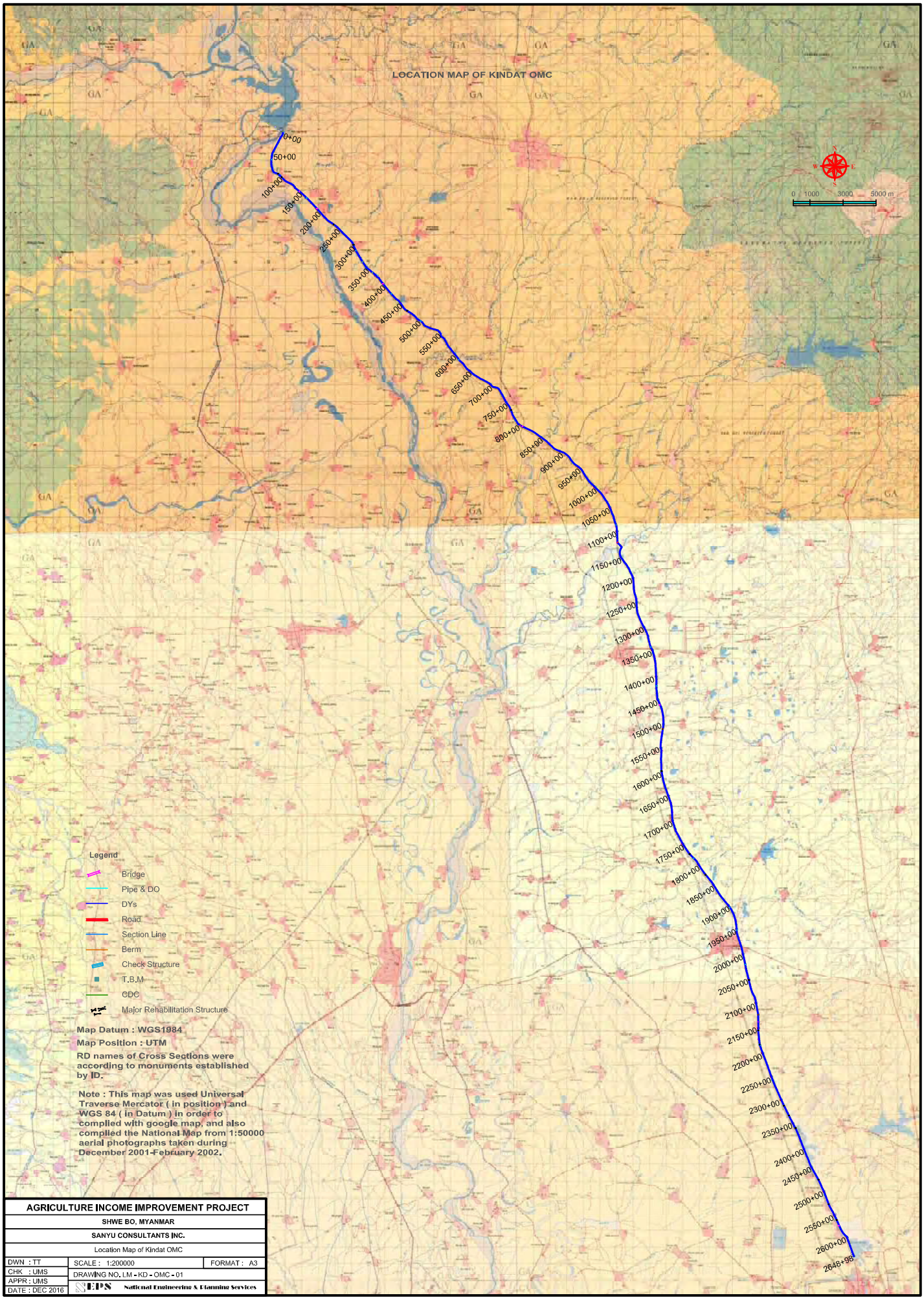
LOCATION MAP OF KINDAT OMC
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250+00
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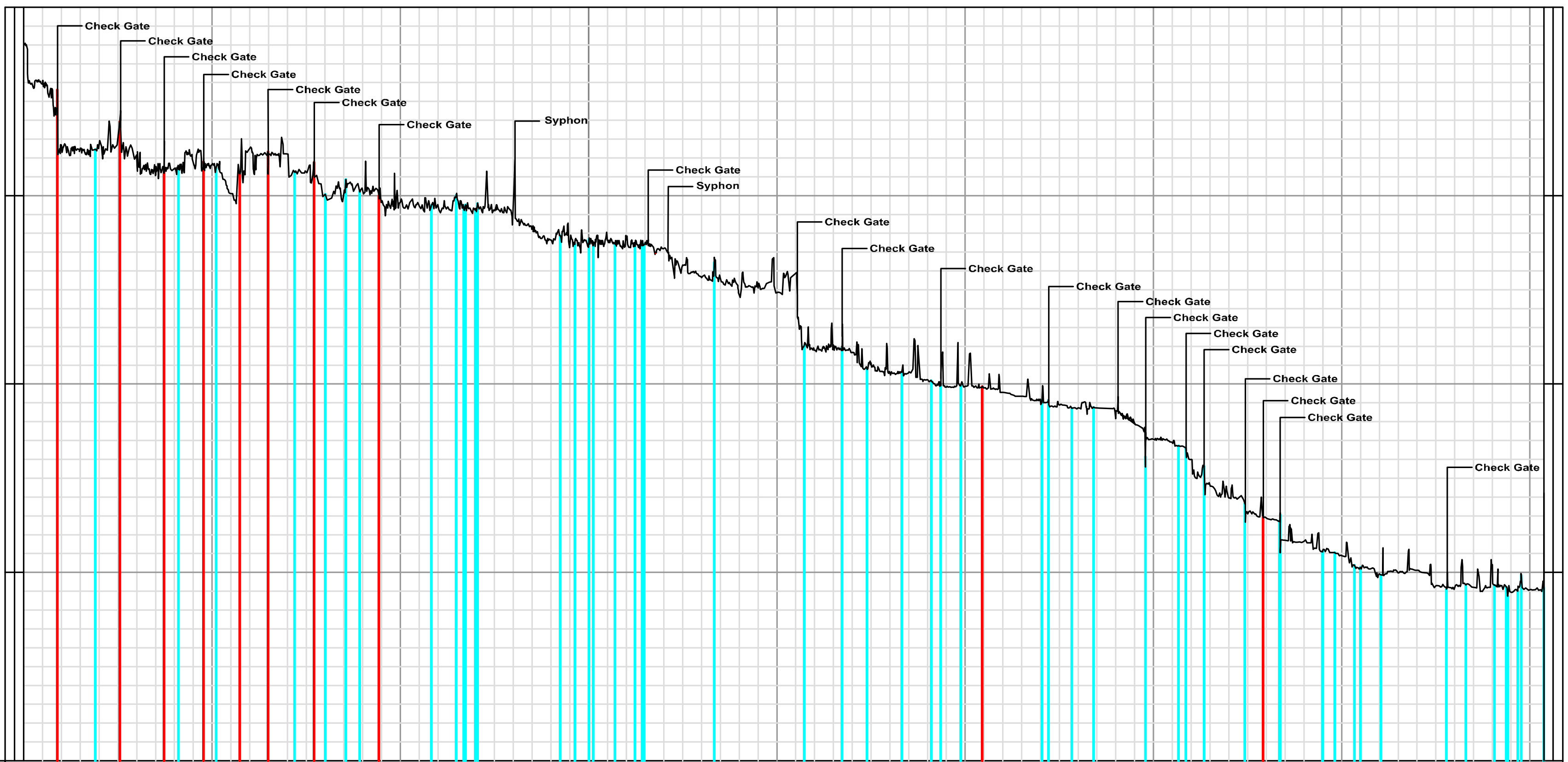
2250+00
2300+00
2350+00
2400+00
2450+00
2500+00
2550+00
2600+00
2648+98
0 1000 3000 5000 m
Legend
Bridge
Pipe & DO
DYs
Road
Section Line
Berm
Check Structure
T.B.M
CDC
Major Rehabilitation Structure
Map Datum : WGS1984
Map Position : UTM
RD names of Cross Sections were according to monuments established by ID.
Note : This map was used Universal Traverse Mercator (in position) and WGS 84 (in Datum) in order to complied with google map, and also complied the National Map from 1:50000 aerial photographs taken during December 2001-February 2002.
AGRICULTURE INCOME IMPROVEMENT PROJECT
SHWE BO, MYANMAR
SANYU CONSULTANTS INC.
Location Map of Kindat OMC
DWN : TT
CHK : UMS
APPR : UMS
DATE : DEC 2016
SCALE : 1:200000
FORMAT : A3
DRAWING NO. LM - KD - OMC - 01
NEPS National Engineering & Planning Services

LONGITUDINAL SECTION OF KINDAT OMC RD (0+000 TO 80+741)



REDUCED DISTANCE (m)	REDUCED LEVEL (m)
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6+000	133.050
7+000	132.177
8+000	132.419
9+000	132.733
10+000	132.658
11+000	131.110
12+000	133.004
13+000	132.730
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18+000	131.254
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20+000	130.658
21+000	130.448
22+000	130.491
23+000	131.001
24+000	130.317
25+000	130.216
26+000	129.548
27+000	129.257
28+000	128.633
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30+000	128.459
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32+000	128.737
33+000	128.485
34+000	128.203
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37+000	126.613
38+000	126.317
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43+000	123.081
44+000	122.672
45+000	122.103
46+000	121.608
47+000	121.622
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49+000	120.837
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62+000	118.005
63+000	116.639
64+000	115.956
65+000	115.121
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67+000	113.698
68+000	113.648
69+000	113.149
70+000	112.889
71+000	112.251
72+000	111.930
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74+000	112.105
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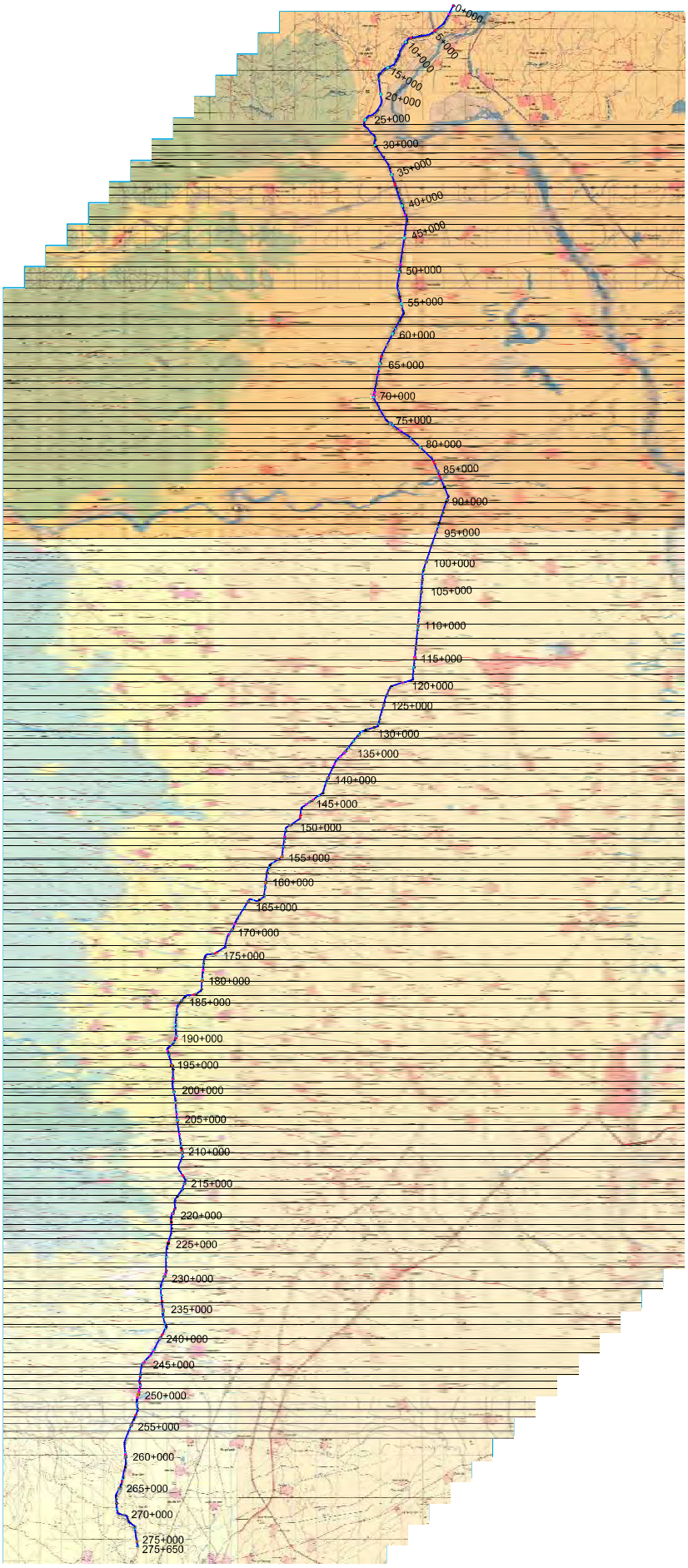
76+000	111.178
77+000	111.202
78+000	112.413
79+000	110.943
80+000	111.070
80+741	111.096

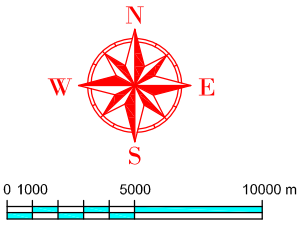
REMARK (RD OF ID) Feet: 0+000, 5+000, 10+000, 15+000, 20+000, 25+000, 30+000, 35+000, 40+000, 45+000, 50+000, 55+000, 60+000, 65+000, 70+000, 75+000, 80+000, 85+000, 90+000, 95+000, 100+000, 105+000, 110+000, 115+000, 120+000, 125+000, 130+000, 135+000, 140+000, 145+000, 150+000, 155+000, 160+000, 165+000, 170+000, 175+000, 180+000, 185+000, 190+000, 195+000, 200+000, 205+000, 210+000, 215+000, 220+000, 225+000, 230+000, 235+000, 240+000, 245+000, 250+000, 255+000, 260+000, 264+899

Legend

- Existing Canal Bed (black line)
- DY (red line)
- DO (cyan line)

LOCATION MAP OF KINDAT RMC





Legend

- Bridge
- TBM
- Pipe & DO
- DYs & Minors
- Structures
- Section Line
- Berm
- Check Structure
- Major Rehabilitation Structure

Map Datum : WGS1984

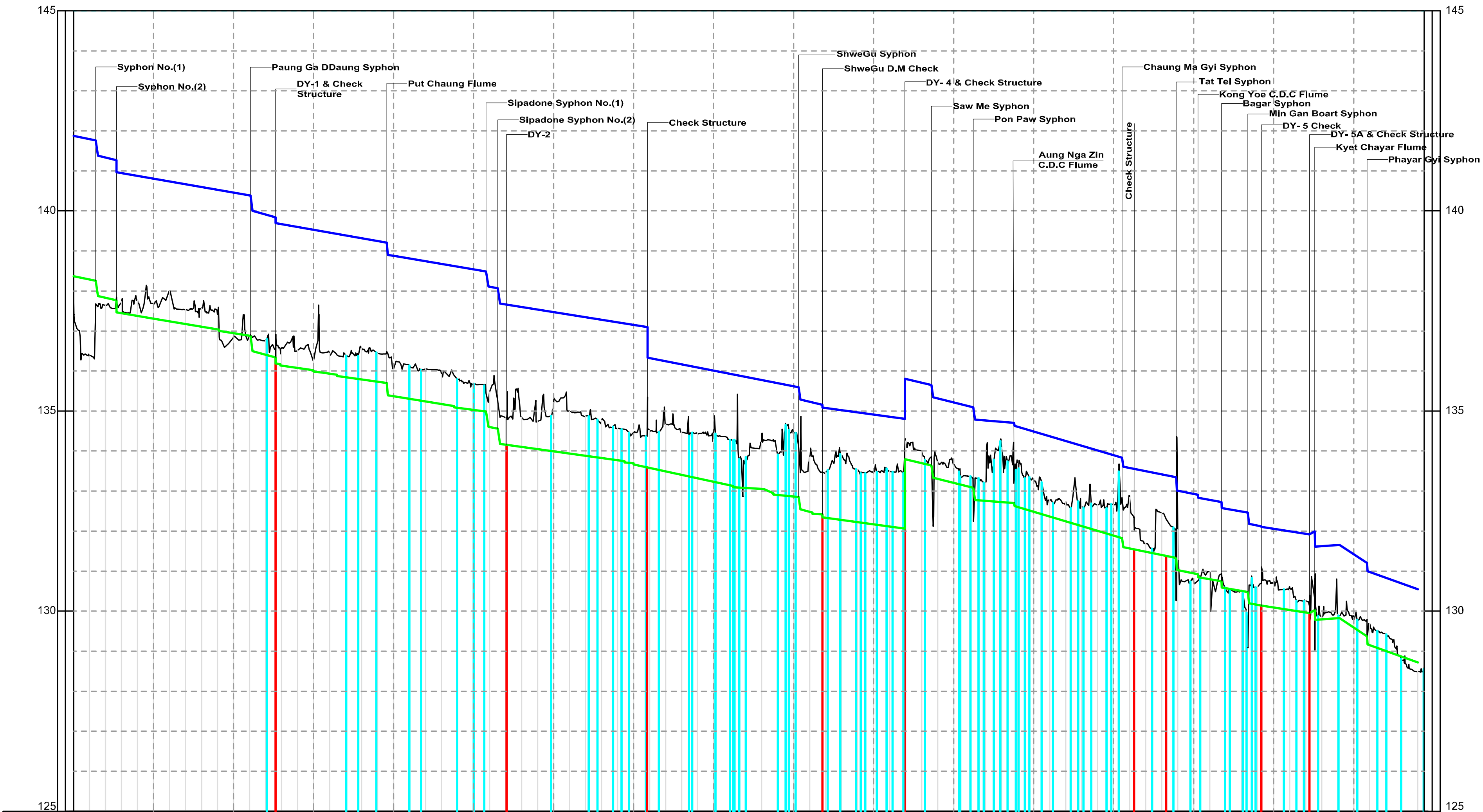
Map Position : UTM

RD names of Cross Sections were according to monuments established by ID.

Note : This map was used Universal Traverse Mercator (in position) and WGS 84 (in Datum) in order to complied with google map, and also complied the National Map from 1:50000 aerial photographs taken during December 2001-February 2002.

AGRICULTURE INCOME IMPROVEMENT PROJECT		
SHWE BO, MYANMAR		
SANYU CONSULTANTS INC.		
Plan Map of Kindat RMC		
DWN : WWA	SCALE : 1:200000	FORMAT : A3
CHK : UMS	DRAWING NO. PM - KD - RMC -01	
APPR : UMS	NEPS National Engineering & Planning Services	
DATE : DEC 2016		

LONGITUDINAL SECTION OF KINDAT RMC



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18+000	136.576
19+000	136.447
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21+000	136.135
22+000	136.048
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24+000	135.788
25+000	135.679
26+000	135.474
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29+000	134.740
30+000	135.134
31+000	134.996
32+000	134.866
33+000	134.759
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76+000	130.606
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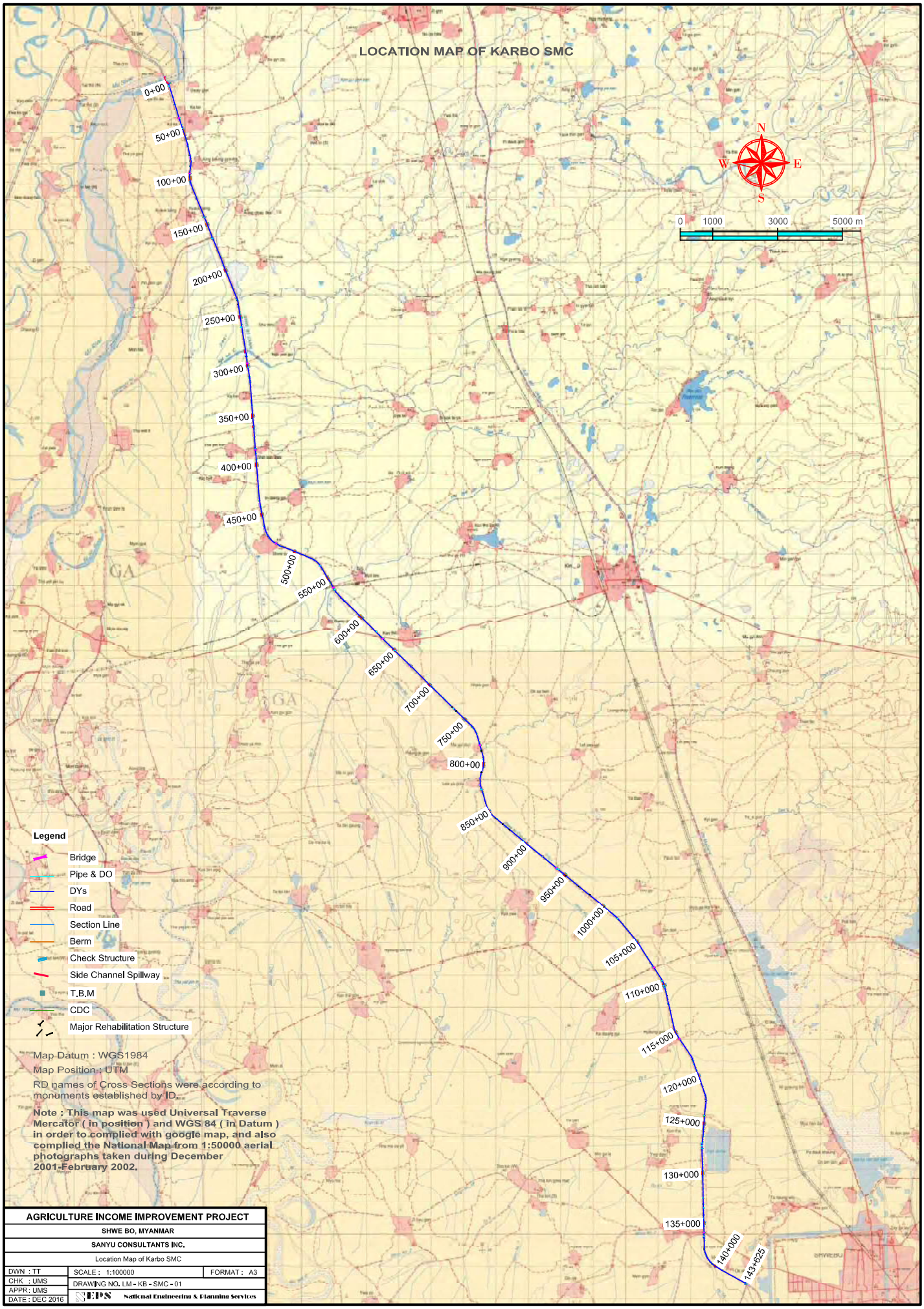
82+000	129.429
83+000	128.787
84+000	128.492
84+413	128.592

REMARK (RD of ID) Feet: 0+000, 5+000, 10+000, 15+000, 20+000, 25+000, 30+000, 35+000, 40+000, 45+000, 50+000, 55+000, 60+000, 65+000, 70+000, 75+000, 80+000, 85+000, 90+000, 95+000, 100+000, 105+000, 110+000, 115+000, 120+000, 125+000, 130+000, 135+000, 140+000, 145+000, 150+000, 155+000, 160+000, 165+000, 170+000, 175+000, 180+000, 185+000, 190+000, 195+000, 200+000, 205+000, 210+000, 215+000, 220+000, 225+000, 230+000, 235+000, 240+000, 245+000, 250+000, 255+000, 260+000, 265+000, 270+000, 275+000, 276+947

Legend

- Existing Canal Bed
- Revised Design Canal Bed
- Full Supply Water Level Based on Revised Design
- DY
- DO


LOCATION MAP OF KARBO SMC
N
W
E
S
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1000
3000
5000 m
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100+00
150+00
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250+00
300+00
350+00
400+00
450+00
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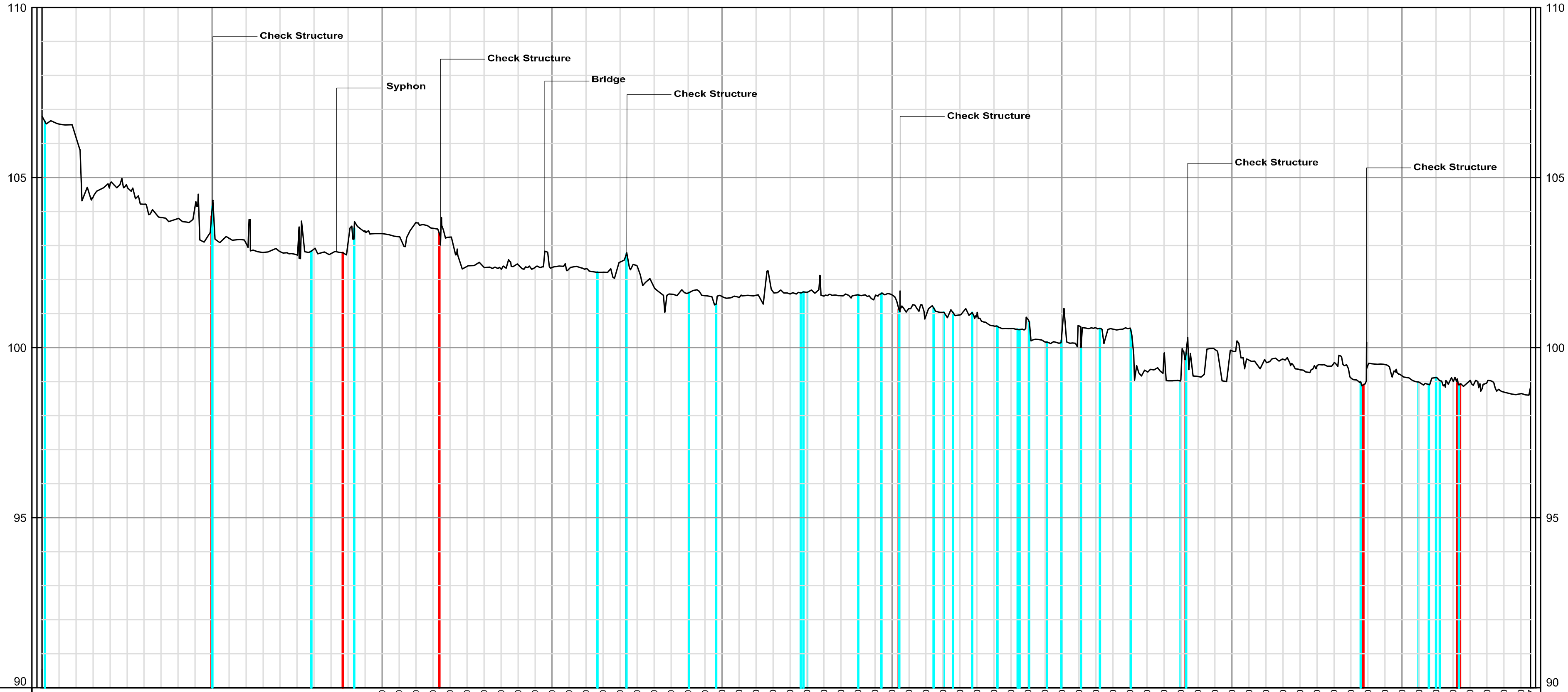
110+000
115+000
120+000
125+000
130+000
135+000
140+000
143+625
Legend
Bridge
Pipe & DO
DYs
Road
Section Line
Berm
Check Structure
Side Channel Spillway
T.B.M
CDC
Major Rehabilitation Structure
Map Datum : WGS1984
Map Position : UTM
RD names of Cross Sections were according to monuments established by ID.
Note : This map was used Universal Traverse Mercator (in position) and WGS 84 (in Datum) in order to complied with google map, and also complied the National Map from 1:50000 aerial photographs taken during December 2001-February 2002.
AGRICULTURE INCOME IMPROVEMENT PROJECT
SHWE BO, MYANMAR
SANYU CONSULTANTS INC.
Location Map of Karbo SMC
DWN : TT
CHK : UMS
APPR : UMS
DATE : DEC 2016
SCALE : 1:100000
FORMAT : A3
DRAWING NO. LM - KB - SMC - 01
NEPS National Engineering & Planning Services

LONGITUDINAL SECTION OF KARBO SMC



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4+000	103.790
4+500	104.144
5+000	104.076
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7+000	102.822
7+500	102.725
8+000	102.897
8+500	102.763
9+000	103.086
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19+500	101.525
20+000	101.507
20+500	101.478
21+000	101.537
21+500	101.637
22+000	101.577
22+500	101.623
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23+500	101.522
24+000	101.553
24+500	101.511
25+000	101.546
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26+000	100.941
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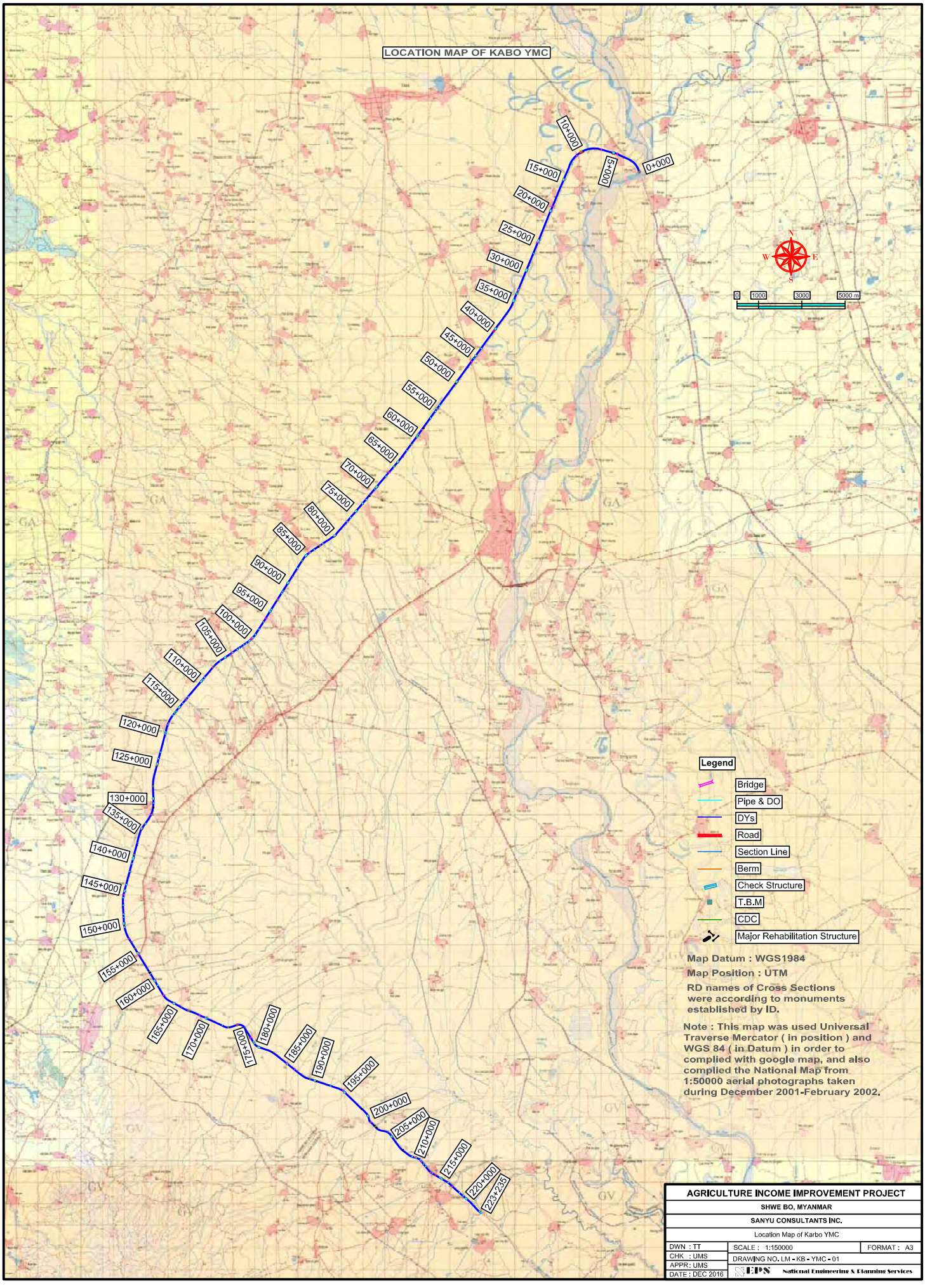
LOCATION MAP OF KABO YMC
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200+000
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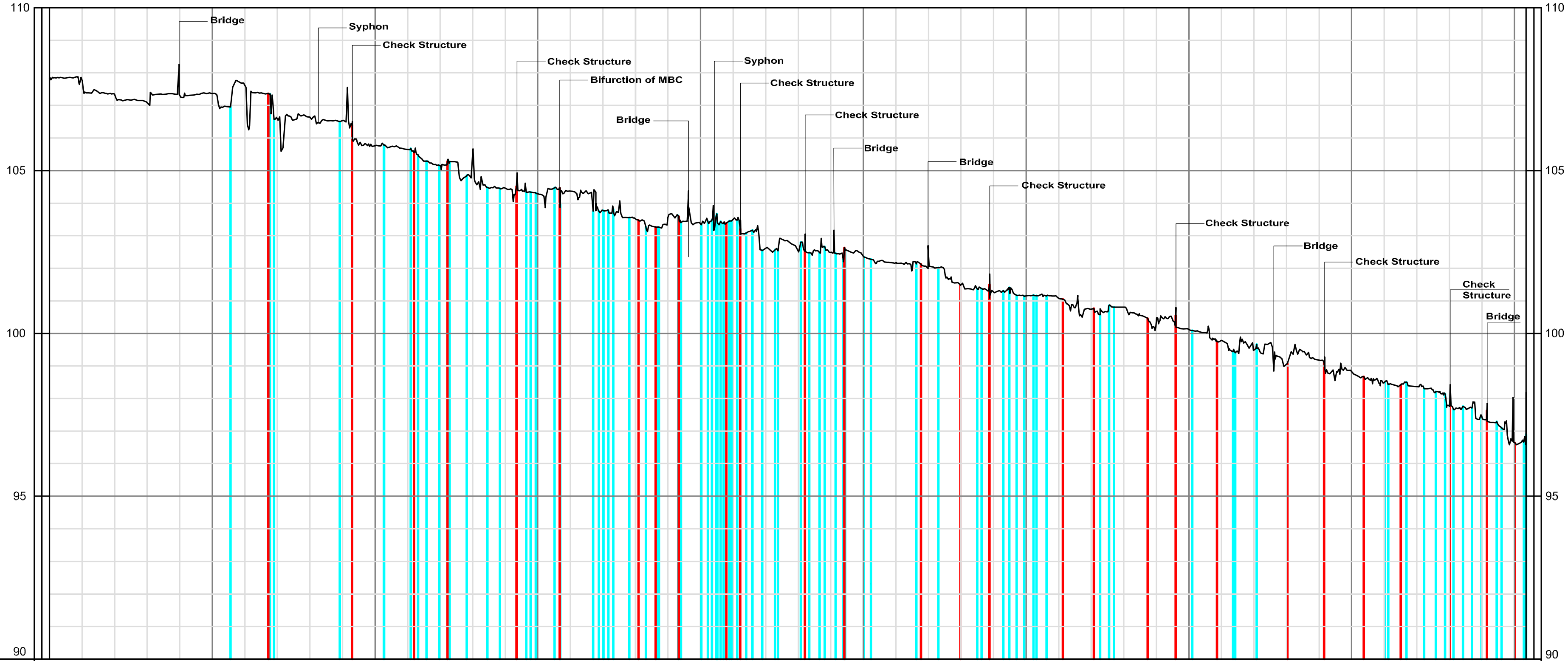
223+235
N
W
E
S
0
1000
3000
5000 m
Legend
Bridge
Pipe & DO
DYs
Road
Section Line
Berm
Check Structure
T.B.M
CDC
Major Rehabilitation Structure
Map Datum : WGS1984
Map Position : UTM
RD names of Cross Sections were according to monuments established by ID.
Note : This map was used Universal Traverse Mercator (in position) and WGS 84 (in Datum) in order to complied with google map, and also complied the National Map from 1:50000 aerial photographs taken during December 2001-February 2002.
AGRICULTURE INCOME IMPROVEMENT PROJECT
SHWE BO, MYANMAR
SANYU CONSULTANTS INC.
Location Map of Karbo YMC
DWN : TT
CHK : UMS
APPR : UMS
DATE : DEC 2016
SCALE : 1:150000
FORMAT : A3
DRAWING NO. LM - KB - YMC - 01
NEPS National Engineering & Planning Services

LONGITUDINAL SECTION OF KABO YMC



REDUCED DISTANCE	REDUCED LEVEL
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4+500	107.076
6+000	107.317
7+500	107.360
9+000	107.619
10+500	106.587
12+000	106.638
13+500	106.536
15+000	105.762
16+500	105.648
18+000	105.144
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21+000	104.458
22+500	104.286
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25+500	103.775
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51+000	100.347
52+500	100.123
54+000	99.783
55+500	99.485
57+000	99.058
58+500	99.178
60+000	98.829
61+500	98.488
63+000	98.363
64+500	97.763
66+000	97.422
67+500	96.646
68+054	98.065

REMARK (RD of ID) Feet: 5+000, 10+000, 15+000, 20+000, 25+000, 30+000, 35+000, 40+000, 45+000, 50+000, 55+000, 60+000, 65+000, 70+000, 75+000, 80+000, 85+000, 90+000, 95+000, 100+000, 105+000, 110+000, 115+000, 120+000, 125+000, 130+000, 135+000, 140+000, 145+000, 150+000, 155+000, 160+000, 165+000, 170+000, 175+000, 180+000, 185+000, 190+000, 195+000, 200+000, 205+000, 210+000, 215+000, 220+000, 223+235

Legend

- Existing Canal Bed
- DY
- DO

Verification of the safety of Thapanzeik dam against flood

(1) Basic information of Thapanzeik dam

Thapanzeik dam, one of the biggest dams in Myanmar, is the main water source for the target irrigation area. It is located in the upstream of Mu River and it has 3,552 million cum of storage capacity with irrigable area of 199,866 ha. This dam was constructed for irrigation purpose on Mu River located in Kyunhla township of Kanbalu district, Sagaing Region.

After the Mu River Irrigation Survey Feasibility Study, the detail design of Thapanzeik dam with related structures was conducted by ITALCONSULT in February 1972, more than 40 years ago. Based on this design, construction of the dam started in 1996 and completed in 2001, and then the water storage was started from January 2001. Water discharge from the dam for irrigation was commenced from June 2001 to supplementary irrigate monsoon paddy. Basic information of Thapanzeik dam is shown in the table below:

Table 1 Basic Information of Thapanzeik Dam

Location	Kyun Hla Township, Sagaing (N 23°18'26.29", E95°20'54.53")	
Project Started	1996-97	
Project to be Completed	2001-02	
Name of River	Mu River	
Catchment Area	8,961 Sq.km	3,460 Sq. Miles
Average Annual Rainfall	963 mm	37.91 inches
Average Annual Inflow	5,420 Million cubic -m	4.394 Million Acre-ft
Type of Dam	Zoned Earth Dam	
Height of Dam	32.9 m	108 ft
Length of Dam	6,884.5 m	22,587 ft
Storage Capacity	3,552 Million cubic -m	2,880,000 Acre ft
Dead Storage Capacity	118 Million cubic -m	95,800 Acre ft
Effective Storage Capacity	3,434 Million cubic –m	2,784,200 Acre ft
Water Spread Area at FTL	430 Sq-km	106,200 Acres
Elevation of the Dam Top	RL 170.69 m	RL 560 ft
Maximum Water Level of Reservoir	RL 168.25 m	RL 552 ft
Full Tank level (FTL) of Reservoir	RL 166.12 m	RL 545 ft
Service Spillway		
(a) Type of Spillway	Ogee Type with Radial Gate (spillway discharge can be control by gate)	
(C) Width of Spillway	133.2 m	437 ft
(C) Design Discharge	3,964 cubic -m /s	140,000 cusecs
(D) Elevation of the crest	RL 161.54 m	RL 530 ft
Auxiliary Spillway		
(a) Type of Spillway	Ogee Type (overflow type)	
(b) Width of Spillway	367.9 m	1,207 ft
(C) Design Discharge	1,133 cubic -m /s	40,000 cusecs
(D) Elevation of the crest	RL 166.73 m	RL 547 ft

Source: JICA survey team

(2) Design flood discharge and design discharge of spillway

The Mu River originates in the hills of upper Myanmar and flows towards south for a distance of 290 miles (467 km) finally to join the Ayeyarwady river. The total catchment basin of the Mu river covers 6,000 square miles (15,540 km^2), but at the Thapanzeik dam, 139 miles from its source, the catchment basin extends over an area of 3,460 square miles (8,961 km^2).

According to the final design report, runoff at Thapanzeik dam was computed on the basis of

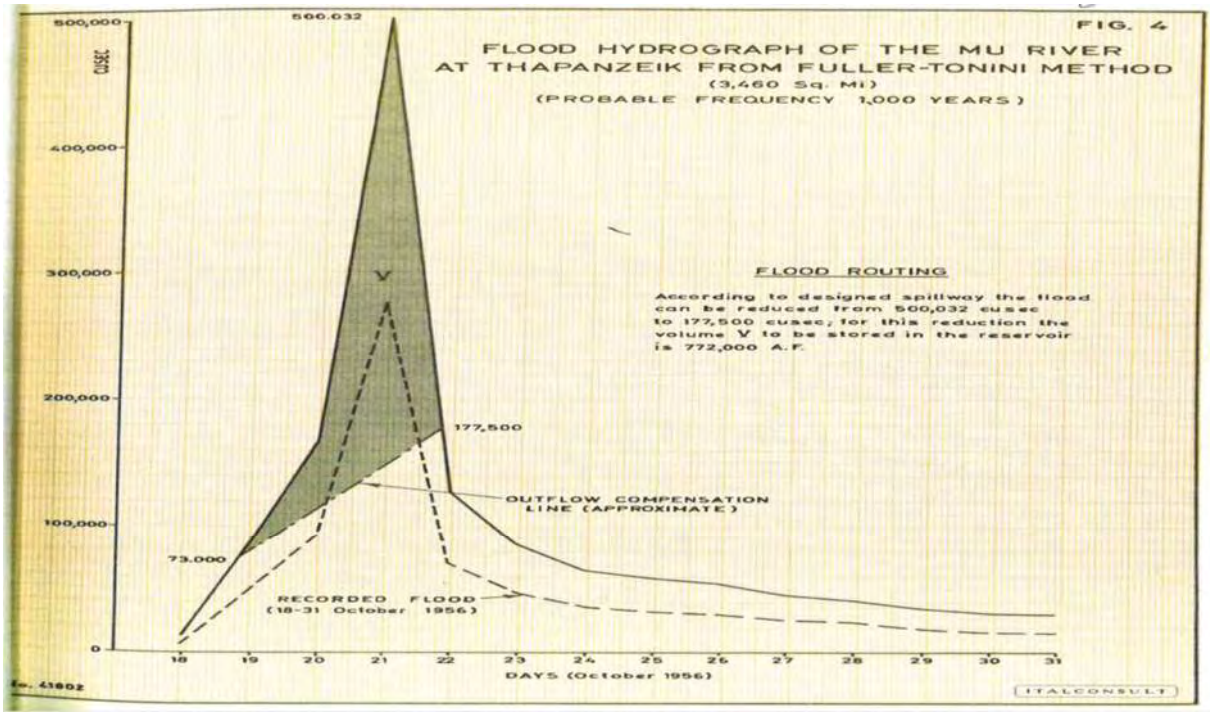
discharge data measured at Kabo weir location (catchment basin 4,826 square miles, 12,499 km^2) adjusted by means of measurement taken at Thapanzeik dam. Investigations were performed pertaining to the statistical processing of flood data recorded on Mu River at Kabo weir so as to ascertain the most probable 50, 100 and 1,000 year floods. Flood discharge ranking on Mu River at Kabo weir from 1946 to 1967 are shown in Table 2. All the Kabo weir values had been adjusted to the Thapanzeik dam location by applying a factor of 0.876.

The spillway design flood at Thapanzeik dam was assumed to be 500,032 cusecs (14,159 m^3/s), which is for 1,000 year flood. The hydrograph for this flood is given in Figure 1. The routing capacity of the reservoir between the full tank level of reservoir and maximum water level is such as to reduce the flood peak to 177,500 cusecs (5,026 m^3/s), which is 35.5 % of the spillway design flood at Thapanzeik dam.

Table 2　Ranking of flood discharge (runoff water of Mu River) at Kabo weir from 1946 to 1967

	Occurrence date	Flood discharge at Kabo weir		Estimated flood discharge at Thapanzeik dam	
		(cusec)	(m3/s)	(cusec)	(m3/s)
1	1956/10/12	277,515	7,858	243,103	6,884
2	1966/10/1	125,000	3,540	109,500	3,101
3	1956/5/30	111,550	3,159	97,718	2,767
4	1962/10/13	94,470	2,675	82,756	2,343
5	1967/10/24	91,400	2,588	80,066	2,267
6	1954/6/4	75,570	2,140	66,199	1,875
7	1964/8/31	72,400	2,050	63,422	1,796
8	1961/9/20	68,360	1,936	59,883	1,696
9	1966/6/21	66,700	1,889	58,429	1,655
10	1963/10/8	66,300	1,877	58,079	1,645

Date resource: Mu River Irrigation Survey, Thapanzeik dam final design, Volume I Design data and criteria



Source: Mu River Irrigation Survey, Thapanzeik dam final design, Volume I Design data and criteria

Figure-1　Flood hydrograph of the Mu river at Thapanzeik from fuller-Tonini method

Finally the maximum flood flow at Thapanzeik dam was estimated to be 500,032 cusecs (14,159 m^3/s) with 1,000-year frequency. Then, when designing the spillway structure, accounting has been taken of the routing effect of the reservoir. The spillways had been proportioned for the maximum overall discharge of 177,500 cusecs (5,026 m^3/s) at an elevation of 552' (168.25 m). Taking account of the routing effect of the reservoir, this is equivalent to the 1,000-yesr flood discharge of 500,032 cusecs (14,159 m^3/s).

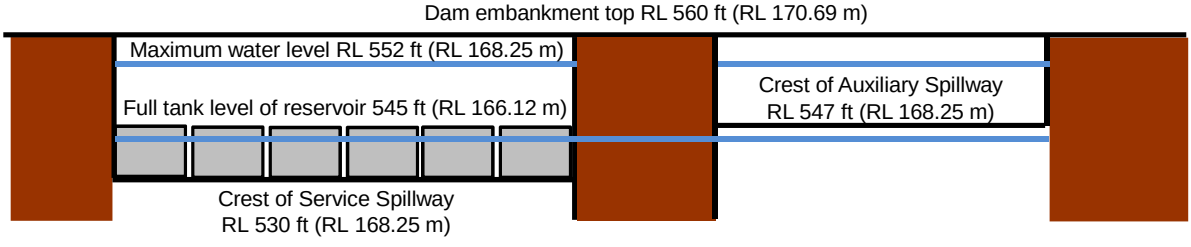
In detail, with the gates fully open, the gated spillway can discharge 73,000 cusecs (2,067 m^3/s) while maintaining the reservoir at an elevation 545' (166.12 m). At elevation of t 547' (166.73 m), it can discharge 88,000 cusecs, without the emergency spillway coming into operation; this corresponds to about 162,000 cusecs (4,587 m^3/s), taking account of the routing effect of the reservoir. When discharges attain higher water levels, the emergency spillway starts operating. This can discharge 47,500 cusecs (1,345 m^3/s) at the awter level of 552' (168.25 m) while the gated spillway can discharge 130,000 cusecs (3,681 m^3/s) at the same elevation.

Table-3 Spillway discharge which is taken account of the routing effect of the reservoir.

Water level of reservoir	Available maximum discharge from spillway					
	Service spillway		Auxiliary Spillway		Total	
	(cusecs)	(m^3/s)	(cusecs)	(m^3/s)	(cusecs)	(m^3/s)
~ RL 530 ft (RL 161.54 m)	0	0	0	0	0	0
~ RL 545 ft (RL 166.12 m)	~ 73,000	2,067	0	0	~ 73,000	2,067
~ RL 547 ft (RL 166.73 m)	~ 88,000	2,492	0	0	~ 88,000	~ 2,492
~ RL 552 ft (RL 168.25 m)	~ 130,000	3,681	~ 47,500	1,345	~ 177,500	~ 5,026

Service spillway

Auxiliary Spillway



(3) Evaluation of large flood after the completion of the Thapanzeik dam construction

In middle October 2015, there were heavy rains in the catchment basin of Thapanzeik dam, and then a large runoff water entered the dam reservoir. According to the data recorded by Thapanzeik office of IWUMD Shwebo maintenance office, the inflow to the dam was about 303,727 acre-ft/day (390 million m^3/day) on October 10, 2015, daily average flood discharge on per second was 153,129 cusecs (4,366 m^3/s) and the peak flood discharge was estimated to be 187,847 cusecs (5,319 m^3/s). This discharge is the 4th highest during the 15 years operation since 2001.

Although the highest flood discharge was 196,843 cusecs (5,574 m^3/s) on September 14, 2004, the flood discharge on October 12, 1956 was higher; it is 243,103 cusecs (6,884 m^3/s). However, since water level of dam reservoir was nearly full tank level, water level reached the maximum RL 548.10' on October 11, 2015. This water level of dam reservoir is highest for the 15 years operation since 2001. In this day, discharge from spillway also reached 64,538 cusecs (1,828 m^3/s), the biggest for 15 years.

Of course, this spillway discharge is the highest during the last 15 years, but compared with the design discharge of 177,500 cusec (5,026 m^3/s); it is only 34.4% of the design spillway discharge. It was not a flood that threatened the safety of the dam.

Table-4 Ranking of flood discharge at Thapanzeik Dam and high WL of dam reservoir from 2001 to2015

	Rank of the large flood			Rank of high WL of dam reservoir				
	Occurrence date	Daily average Flood discharge (cusec)	WL of the reservoir (RL ft)	Occurrence date	WL of the reservoir (RL ft)	Daily average Flood discharge (cusec)	height from spillway crest (ft)	Height till max WL (ft)
1	14-Sep-2004	196,843	542.50	11-Oct-2015	548.10	83,692	18.1	3.9
2	15-Sep-2004	177,360	544.50	10-Oct-2015	547.50	153,129	17.5	4.5
3	19-Jul-2015	159,271	532.75	12-Oct-2015	547.35	55,183	17.4	4.6
4	10-Oct-2015	153,129	547.50	13-Oct-2015	546.80	49,060	16.8	5.2
5	22-Jul-2015	142,097	541.85	14-Oct-2015	546.30	32,254	16.3	5.7
6	21-Jul-2015	135,972	539.20	23-Oct-2007	546.00	100,483	16.0	6.0
7	20-Jul-2015	129,761	535.90	16-Oct-2015	546.00	30,081	16.0	6.0
8	13-Sep-2004	124,015	538.40	24-Oct-2007	546.00	19,599	16.0	6.0
9	24-Jul-2015	109,607	544.10	3-Nov-2007	546.00	12,131	16.0	6.0
10	23-Oct-2007	100,483	546.00	19-Oct-2007	546.00	11,800	16.0	6.0

Table-4 Ranking of Spillway discharge from 2001 to2015

	Date	Discharge of spillway		WL of the reservoir		Flood discharge	
		(cusec)	(m^3/s)	(RL ft)	(RL m)	(cusec)	(m^3/s)
1	11-Oct-15	64,538	1,828	548.10	167.06	83,692	2,370
2	12-Oct-15	62,684	1,775	547.35	166.83	55,183	1,563
3	15-Sep-04	59,986	1,699	544.50	165.96	177,360	5,022
4	13-Oct-15	55,006	1,558	546.80	166.66	49,060	1,389
5	9-Oct-04	54,987	1,557	545.35	166.22	41,859	1,185
6	11-Oct-10	54,091	1,532	544.75	166.04	23,788	674
7	14-Oct-15	52,987	1,500	546.30	166.51	32,254	913
8	1-Aug-15	51,988	1,472	545.40	166.24	63,547	1,799
9	2-Aug-15	51,988	1,472	545.25	166.19	47,350	1,341
10	3-Aug-15	51,988	1,472	544.85	166.07	30,971	877

In addition, the highest flood discharge of 196,843 cusecs (5,574 m^3/s) for the last 15 years counts at 39% of the maximum flood flow of 500,032 cusecs (14,159 m^3/s). Likewise, the highest flood discharge of 243,103 cusecs (6,884 m^3/s), which is estimated based on the highest flood at Kabo weir in 1956, for the last 110 years from 1905 is 49% of the maximum flood flow.

Using the flood discharge data during 2001-2016 and the ranking data of flood discharge (runoff water of Mu River) at Kabo weir from 1946 to 1967, 1000 year flood is estimated to be 492,041 cusecs (13,933 m^3/s) as shown in Table 5. It is almost the same as original design flood discharge. In addition, it is found that 196,843 cusecs (5,574 m^3/s) of year 2004 equals to almost 25 year flood, and 243,103 cusecs (6,884 m^3/s) of year 1956 equals to almost 100 year flood.

Therefore, considering the above, the safety of the dam against flooding is judged secured, although there is a possibility that climate change may affect the rainfall and the flood volume. It is, however, noted that should the gates not be operated as designed due to some accidents (service spillway is gated type), auxiliary spillway can handle only 47,500 cusec (1,345 m^3/s). In this case, dam safety cannot be secured at all, even against only 2-year probability flood. Accordingly, the annual and periodical maintenance for the gates is very important.

Table-5 Re-estimated flood discharge of each probability year

Probability year	Flood discharge	
	(cusecs)	(m^3/s)
2	61,441	1,740
5	102,761	2,910
10	137,299	3,888
25	189,162	5,356
50	233,727	6,618
80	266,960	7,559
100	283,600	8,031
200	339,085	9,602
500	421,706	11,941
1000	492,041	13,933

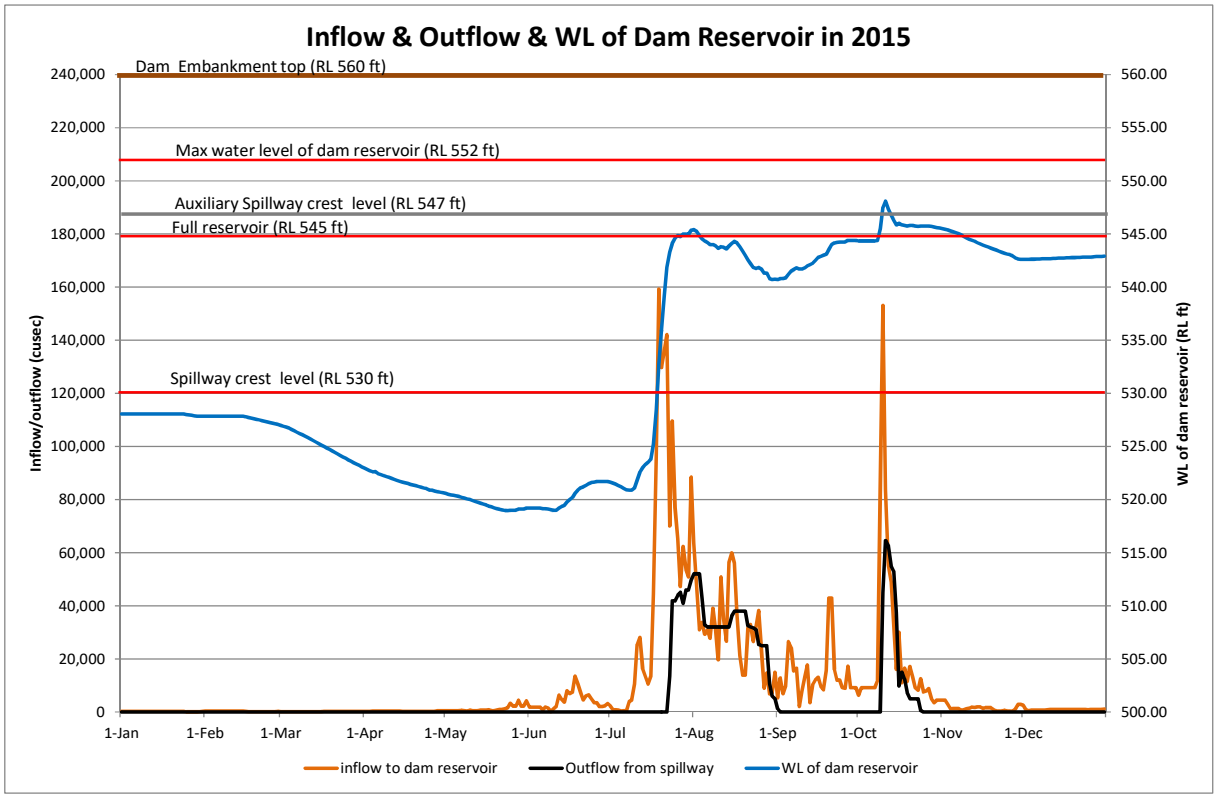


Figure-2 Inflow (runoff to dam reservoir) and outflow (spillway discharge) and water level of dam reservoir in 2015

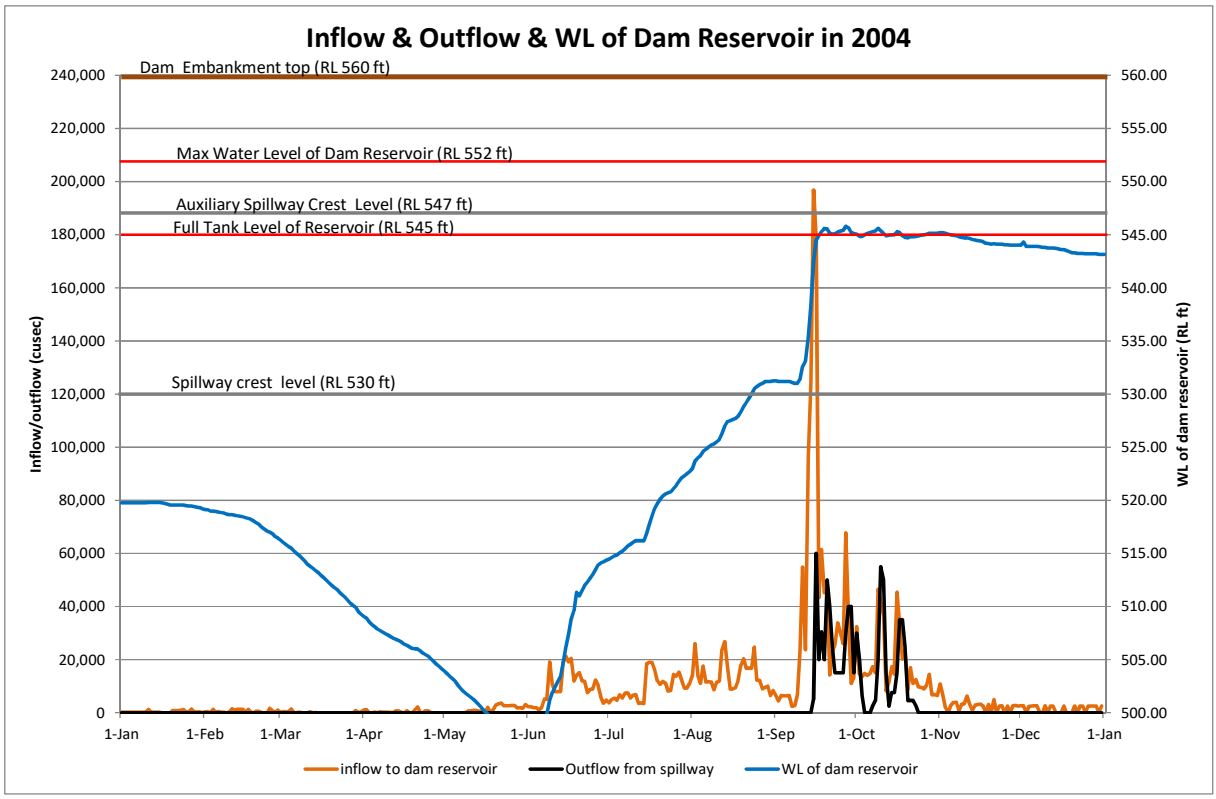


Figure-3 Inflow (runoff to dam reservoir) and outflow (spillway discharge) and water level of dam reservoir in 2004

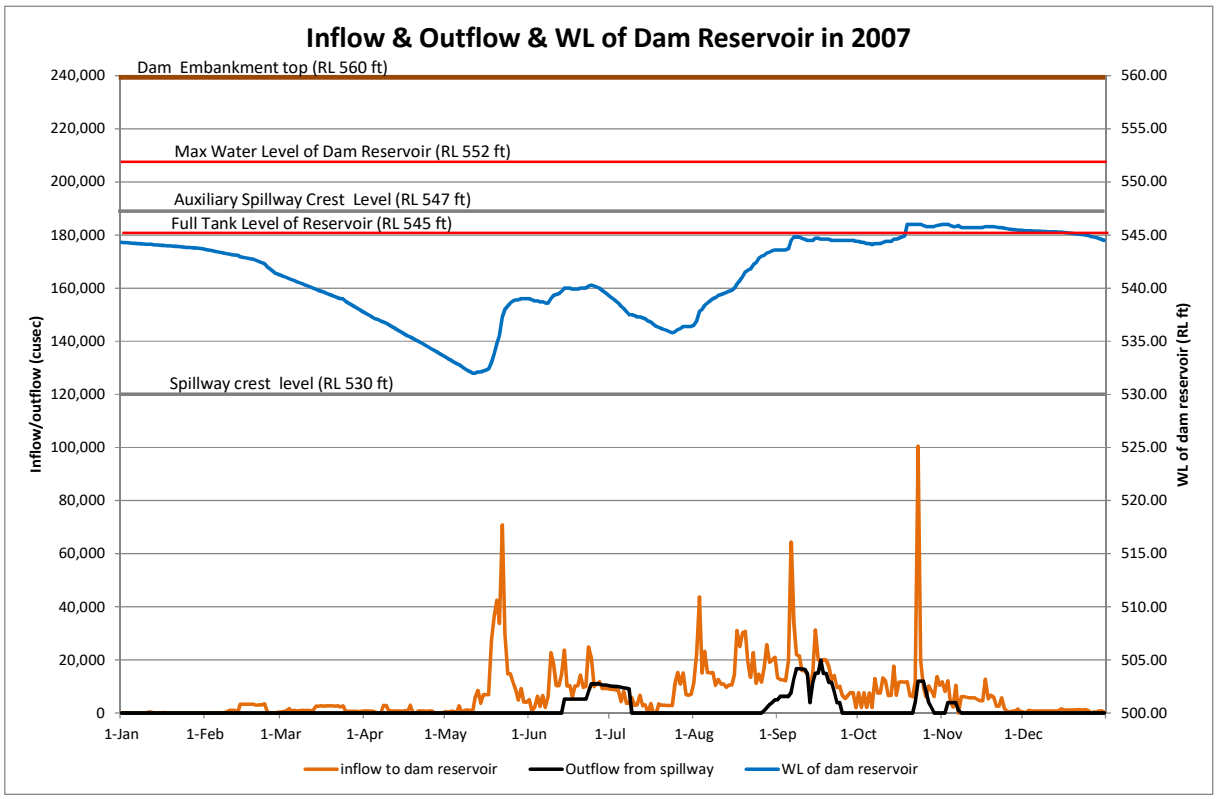


Figure-4 Inflow (runoff to dam reservoir) and outflow (spillway discharge) and water level of dam reservoir in 2007

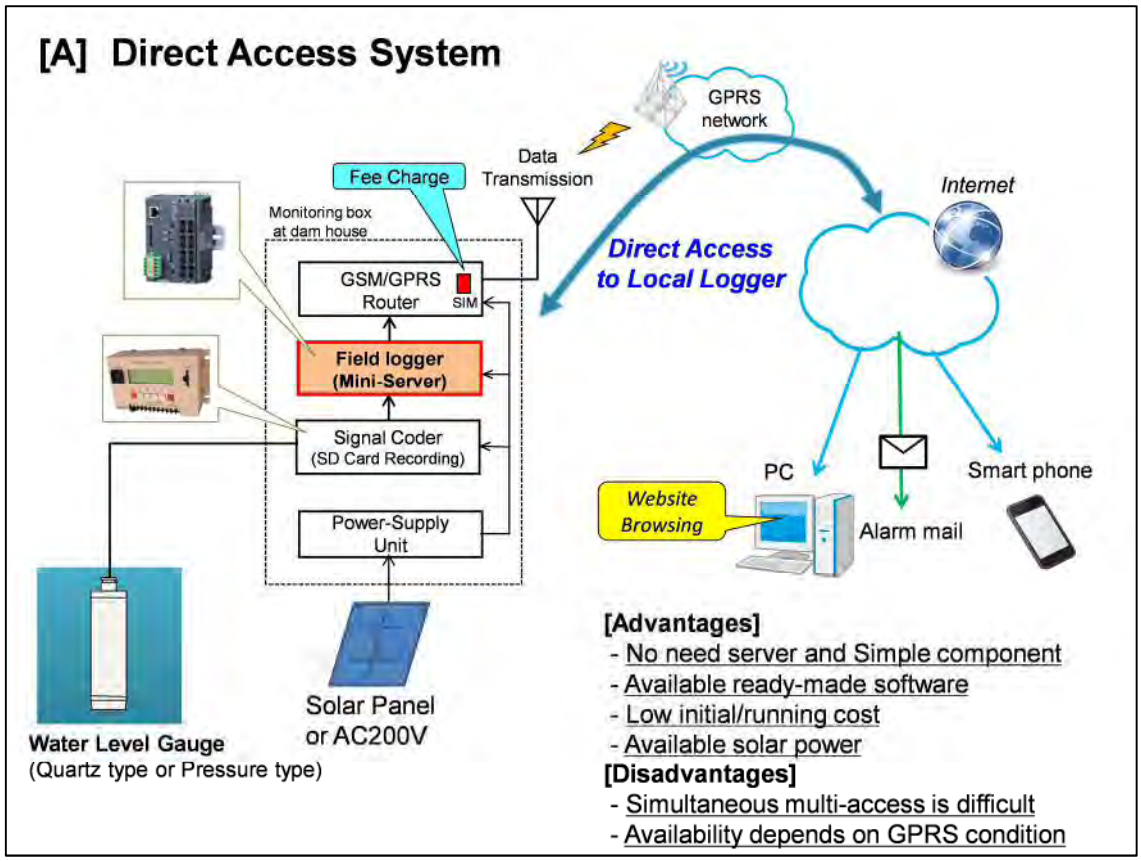
Comparison on Type of Water Measurement Equipment

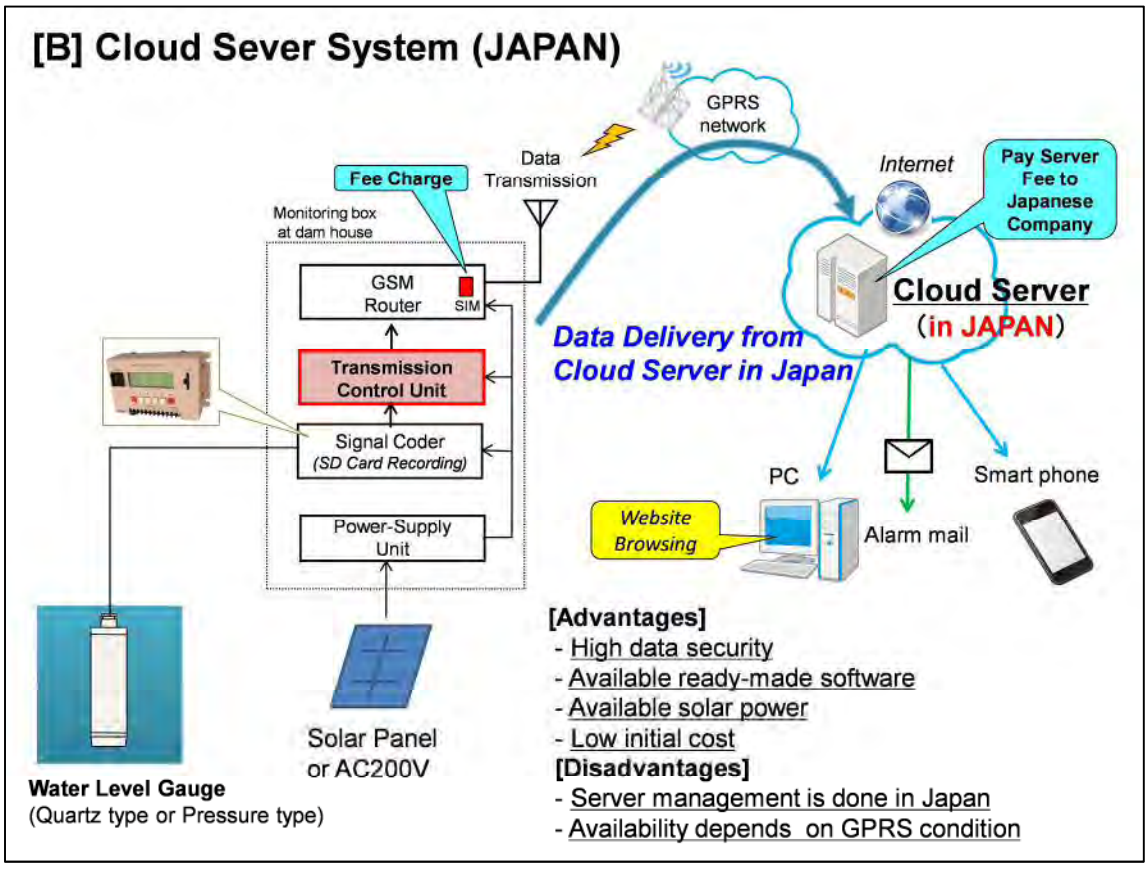
I. Comparison of Real-time Monitoring Systems

(Rate: 1US$ = 115JPY)

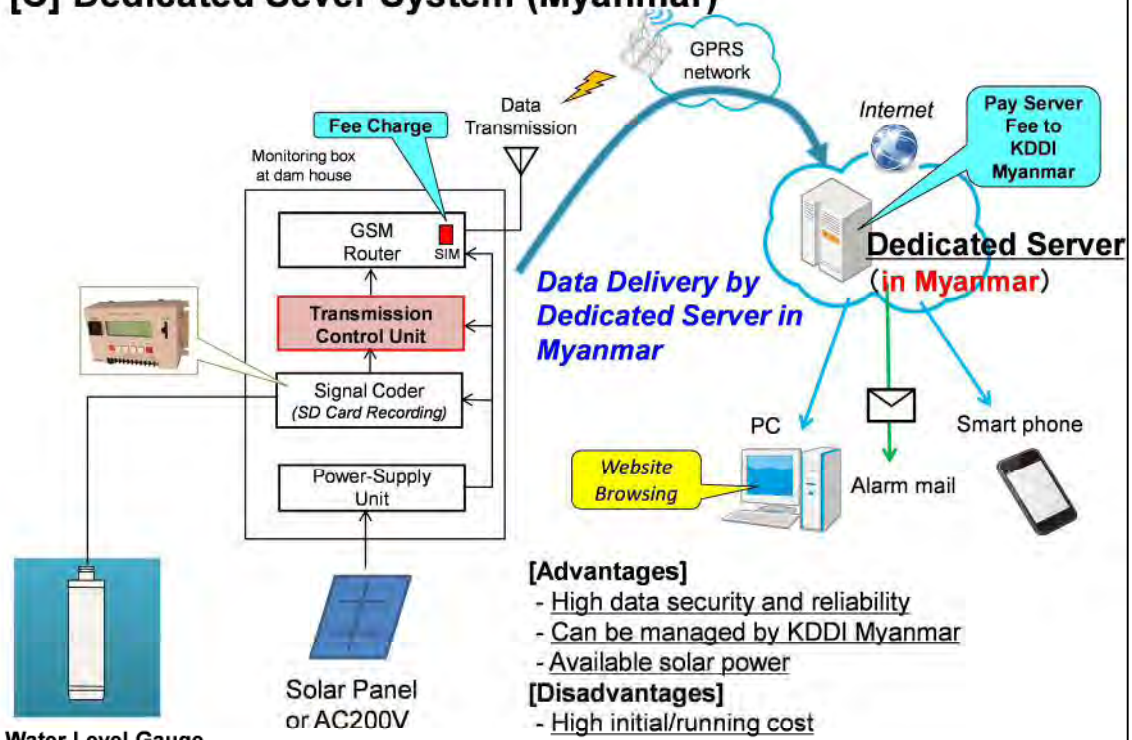
Type	[A]	[B]	[C]	[D]	[E]
System Name	Direct Access System	Cloud Server System (JPN)	Dedicated Server System (MMR)	E-Mail Delivery System	Satellite System
Using Line	GPRS	GPRS	GPRS	GPRS	Satellite
Using Server (Place)	—	Cloud Server (Japan)	Dedicated Server (KDDI Myanmar)	Available Mail Server (Gmail, Yahoo mail etc.)	Cloud Server (Canada)
Maintenance	- Signal/Data check - Equipment cleanup	- Signal/Data check - Equipment cleanup	- Signal/Data check - Equipment cleanup - Server check	- Signal/Data check - Equipment cleanup	- Signal/Data check - Equipment cleanup
Easiness of Maintenance	- Easy	- Easy	- Easy	- Easy	- Easy
Data Security	Medium	High	Very High	Middle	High
Monitoring Software	Can customize of ready-made software	Can customize of ready-made software	Need new architecture of server/software	Need new architecture	Can customize of ready-made software
Expandability of Station	Medium	High	High	Low	High
Monitorable Device	PC, Smartphone	PC, Smartphone	PC, Smartphone	PC only	PC, Smartphone
Power Supply	AC200V or Solar Panel	AC200V or Solar Panel	AC200V or Solar Panel	AC200V or Solar Panel	AC200V or Solar Panel
Advantage Point	- Low initial cost - Simple component - Available existing software	- Low initial cost - High data security - Available existing software	- High data security - Can maintain in Myanmar	- Low cost - No need of own server	- High data security - Available in mountain
Disadvantage Point	- Availability depends on GPRS condition	- Important irrigation data is managed by foreign server - Availability depends on GPRS condition	- High cost of new system architecture - Availability depends on GPRS condition	- Need new software - Availability depends on GPRS condition	- Important irrigation data is managed by foreign server
Recommend	○			△	

II. Images of the Monitoring Systems A - E





[C] Dedicated Sever System (Myanmar)

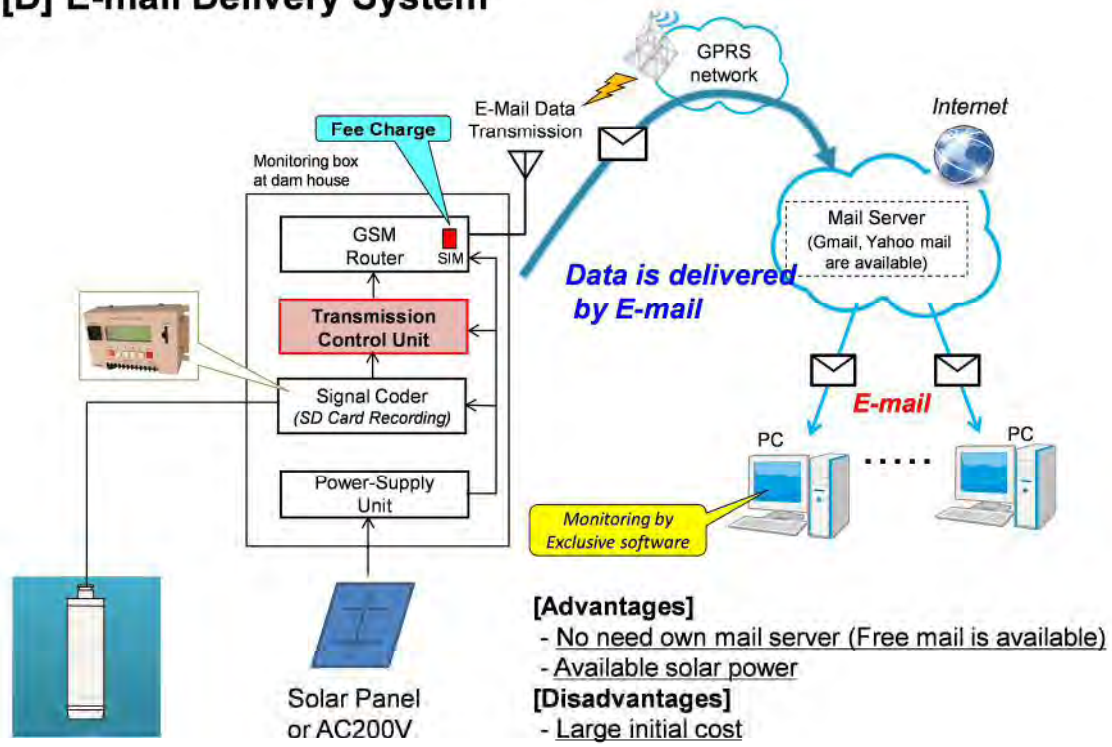


[Advantages]
- High data security and reliability
- Can be managed by KDDI Myanmar
- Available solar power

[Disadvantages]
- High initial/running cost
- Need new server system architecture
- Availability depends on GPRS condition

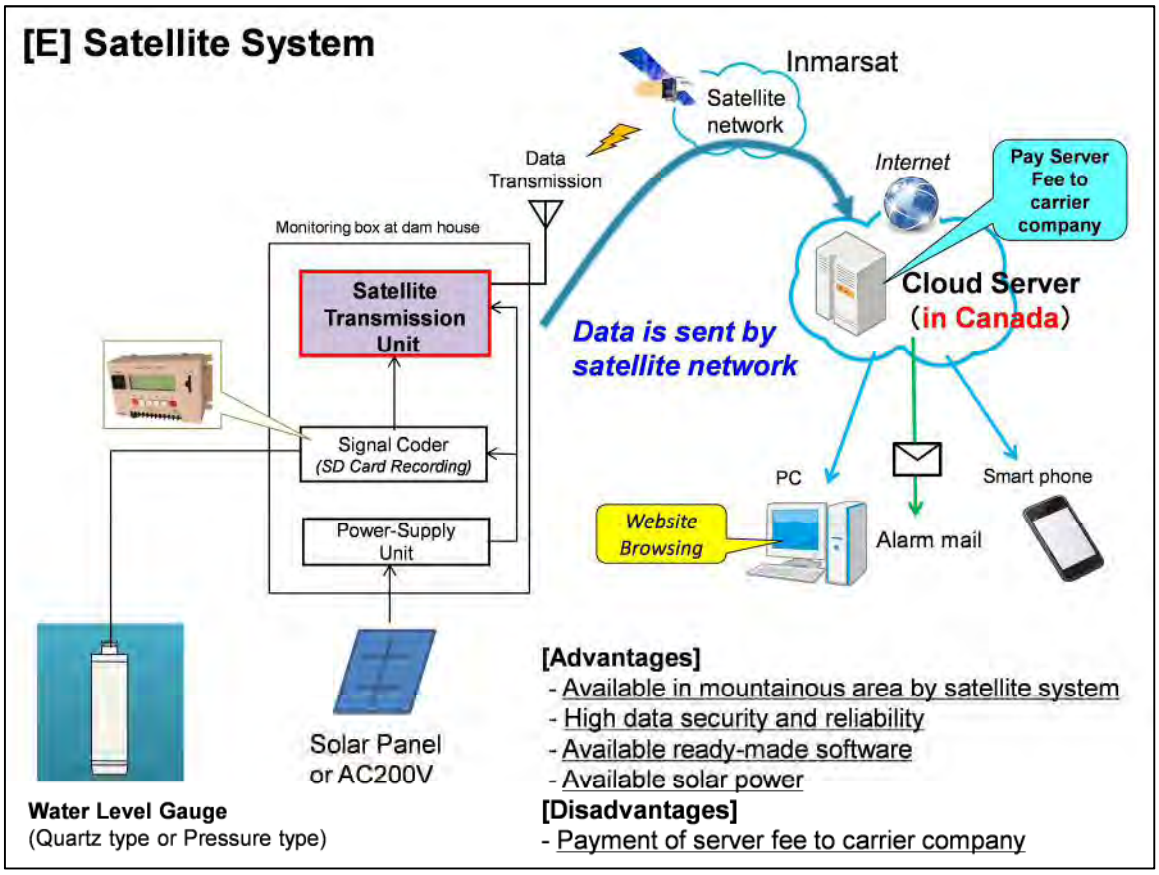
4

[D] E-mail Delivery System



[Advantages]
- No need own mail server (Free mail is available)
- Available solar power

[Disadvantages]
- Large initial cost
- Need a new software
- Availability depends on GPRS condition



III. Cost

1. Component List

No.	Equipment	No. of Types	Remarks
1	Water Level Gauge	6 types	A1-A6 of the following tables
2	Velocity Gauge	2 types/2 lines	B1-B2 of the following tables
3	Monitoring Box	2 types	C1-C2 of the following tables
4	Transmission System	5 types	D1-D5 of the following tables

2. Measuring Equipment Cost

2-1. Water Level Gauges

Selectable from the table below:

No.	Type	Unit	Unit Price	Remarks
A1	Quartz Type	1 pc	1,300,000 JPY	Range: 10m
A2	Pressure Type (Made in Japan)	1 pc	250,000 JPY	Range: 10m
A3	Pressure Type (Not Japan-made)	1 pc	150,000 JPY	Range: 10m
A4	Microwave Type	1 pc	800,000 JPY	Range: 10m
A5	Ultrasonic Type	1 pc	2,000,000 JPY	Range: 10m
A6	Floating Type (Reed-Switch type)	1 pc	2,000,000 JPY	Range: 3.5m

(NOTE) The prices include a sensor and a signal coder for the sensor.

2.2 Flow Velocity Meter

Selectable from the table below:

No.	Type	Unit	Unit Price	Remarks
B-1-1	Ultrasonic Type (Travel time difference)	1 set	5,000,000 JPY	1 measurement line
B-1-2		1 set	6,000,000 JPY	2 measurement line
B-2-1	Microwave Type (Doppler)	1 set	3,200,000 JPY	1 sensor
B-2-2		1 set	5,000,000 JPY	2 sensor (common controller)

(NOTE) The prices exclude the water level gauge for discharge calculation.

The water-level measuring station only needs the water level gauge (A), while the water discharge measuring station needs a combination of the water level gauge (A) and the velocity meter (B); the discharge is derived from computation using the water level and flow velocity observed.

2.3 Monitoring Box

No.	Type	Unit	Unit Price	Remarks
C1	For Water Level Station	1 pc	1,000,000 JPY	Outdoor Wall-mount type
C2	For Discharge Station	1 pc	1,000,000 JPY	Stand Cabinet type

(NOTE) The prices exclude the sensor and signal coder.

3. Transmission System Cost

3-1. Initial Cost

3-1-1. Site Equipment

No.	System Type	Unit	Unit Price	Remarks
D1-1	[A] Direct Access System	1 set	3,500 USD	per 1 sta.
D2-1	[B] Cloud Server System (JPN)	1 set	2,000 USD	per 1 sta.
D3-1	[C] Dedicated Server System (MMR)	1 set	2,000 USD	per 1 sta.
D4-1	[D] E-Mail Delivery System	1 set	2,000 USD	per 1 sta.
D5-1	[E] Satellite System	1 set	3,000 USD	per 1 sta.

3-1-2. Server / Software

No.	System Type	Unit	Unit Price	Remarks
D1-2	[A] Direct Access System	1 set	n.a.	
D2-2	[B] Cloud Server System (JPN)	1 set	5,000 USD	System total
D3-2	[C] Dedicated Server System (MMR)	1 set	50,000 USD	System total
D4-2	[D] E-Mail Delivery System	1 set	20,000 USD	System total
D5-2	[E] Satellite System	1 set	1,000 USD	System total

(NOTE) The software development cost is high for [C] and [D]. However, software necessary to be developed is only one. Therefore, the, the cost per measuring station decreases as the number of the stations increases.

3-2. Running Cost

3-2-1. Site Equipment

No.	System Type	Unit	Unit Price	Remarks
E1-1	[A] Direct Access System	1 set	1,800 USD	per 1 sta.
E2-1	[B] Cloud Server System (JPN)	1 set	1,800 USD	per 1 sta.
E3-1	[C] Dedicated Server System (MMR)	1 set	1,800 USD	per 1 sta.
E4-1	[D] E-Mail Delivery System	1 set	1,800 USD	per 1 sta.
E5-1	[E] Satellite System	1 set	1,800 USD	per 1 sta.

3-2-2. Communication Fee

No.	System Type	Unit	Unit Price	Remarks
E1-2	[A] Direct Access System	1 set	600 USD	1 sta./year
E2-2	[B] Cloud Server System (JPN)	1 set	600 USD	1 sta./year
E3-2	[C] Dedicated Server System (MMR)	1 set	600 USD	1 sta./year
E4-2	[D] E-Mail Delivery System	1 set	600 USD	1 sta./year
E5-2	[E] Satellite System	1 set	2,000 USD	Incl. server fee

3-2-3. Server Maintenance Fee

No.	System Type	Unit	Unit Price	Remarks
E1-3	[A] Direct Access System	1 set	n.a.	
E2-3	[B] Cloud Server System (JPN)	1 set	5,000 USD	Total system/year
E3-3	[C] Dedicated Server System (MMR)	1 set	6,000 USD	Total system/year
E4-3	[D] E-Mail Delivery System	1 set	n.a.	
E5-3	[E] Satellite System	1 set	5,000 USD	Total system/year

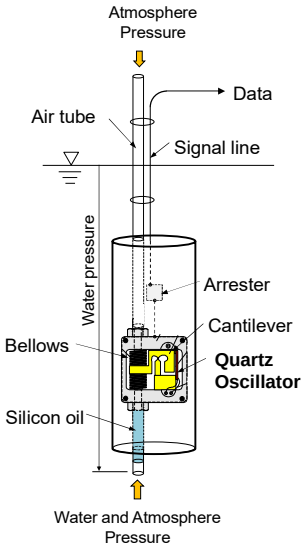
IV. Comparison / Specification of Equipment

1. Water Level Gauge (1/2)

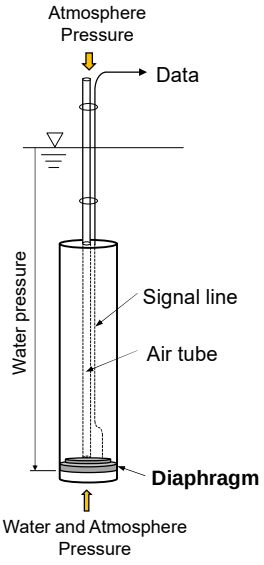
Type	Quartz type	Pressure type	
		Japan-made	Except for Japan-made
Measurement Principle	Water pressure detection (by Quartz-oscillator)	Water pressure detection (by strain of the membrane made of the Ceramic)	Water pressure detection (by strain of the membrane made of the Silicon)
Accuracy and its stability	0.01/0.02/0.05% FS[*1], stable (up to 1mm in 10m range)	0.1% FS[*1], few drift (max 1cm error in 10m range)	0.1%/0.3% FS[*1], frequent drift (max 3cm error in 10m range)
Measurement Max. Range	Selectable 10/20/30/50/70m	Selectable 10/20m	Selectable 10/20m
Expected Durability	15 years	10 years	3 to 5 years
Installation	Easy (in the protective pipe on the bank or the pile	Easy (in the protective pipe on the bank or the pile	Easy (in the protective pipe on the bank or the pile
Power supply	Solar or AC power	Solar or AC power	Solar or AC power
Maintenance	- Data and power supply check - Clean up	- Data calibration(if necessary) - Data and power supply check - Clean up	- Data calibration (frequently) - Data and power supply check - Clean up
Advantages	- High and stable accuracy - Lightning surge protection by arresters - High reliability backed by long time operation in rivers and dams of Japan	- Low initial cost - Lightning surge protection by arresters - Many installation records in irrigation channels of Japan	- Low initial cost
Disadvantages	---	---	- Accuracy drift by deformation of silicon membrane - Short durability
Suitable Target	Reservoir, Diversion dam	Channel	Channel (for temporary survey)
Installation Record in Japan	- Main river's FFWS of MLIT - Dams of MAFF, MLIT, JWA - Diversion weirs of MAFF	- Irrigation canals of MAFF - Pumping St. of MLIT - Dams of MAFF, MLIT, JWA	---
Installation Record in Myanmar	- Myo Gyi dam (2015) - Myittha dam (2016)	- Mezali sulice gate (under the designing)	---

[*1] FS: "Full Scale" of the sensor (Measurement range)

Quartz Type



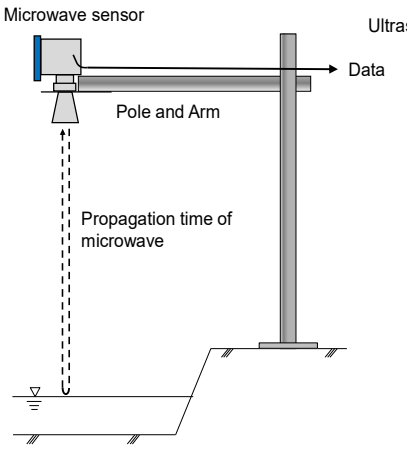
Pressure Type



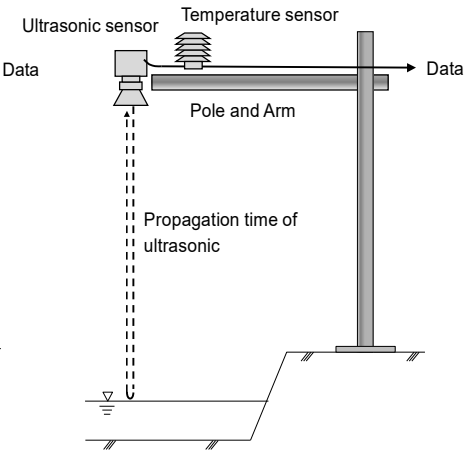
Type	Microwave type	Ultrasonic type	Floating type (Reed-Switch type)
Measurement Principle	Distance measurement between sensor and water surface by microwave propagation time	Distance measurement between sensor and water surface by microwave propagation time	Water surface measurement by detecting the position of the float with a magnet by reed switch
Accuracy and its stability	±1cm, stable	±1cm, possibility of error by temperature change	±1cm, stable
Measurement Max. Range	15m	15m	Selectable 1.0, 1.5, 2.0, 2.5, 3.0, 3.5m
Expected Durability	10 to 15 years	10 to 15 years	15 years to 20 years
Installation	Easy (on the bridge or the arm with pole)	Easy (on the bridge or the arm with pole)	Easy (on the vertical concrete bank or the pile)
Power supply	Solar or AC power	Solar or AC power	Solar or AC power
Maintenance	- Data and power supply check - Clean up Clean up	- Data and power supply check - Clean up	- Data and power supply check - Clean up
Advantages	- Accuracy is not affected by temperature - Non-contact measurement and safe from collision by sediment and driftwood - Lightning surge protection by arresters	- Non-contact measurement and safe from collision by sediment and driftwood. - Lightning surge protection by arresters	- Simple structure and high durability - Lightning surge protection by arresters - So many operation results in FFWS of Japan
Disadvantages	- Accuracy is affected by temperature - Visible sensor and possibility of vandalism/theft	- Accuracy is affected by temperature - Visible sensor and possibility of vandalism/theft	- Visible sensor and possibility of vandalism/theft
Suitable Target	Diversion dam, Channel	Diversion dam, Channel	Channel
Installation Record in Japan	- Irrigation canals of MAFF - Main river's FFWS of MLIT	- Main river's FFWS of MLIT	- Main river's FFWS of MLIT
Installation Record in Myanmar	---	---	---

*[1] FS: "Full Scale" of the sensor (Measurement range)

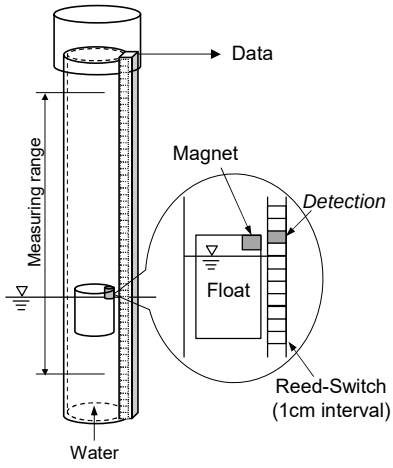
MAFF: Ministry of Agriculture, Forestry and Fisheries, MLIT: Ministry of Land, Infrastructure, Transport and Tourism,
FFWS: Flood Forecasting and Warning System



Microwave Type

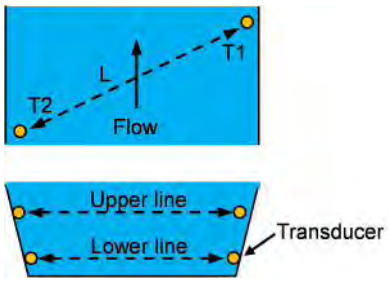
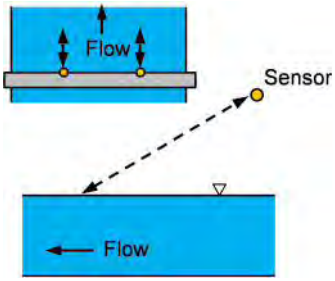


Ultrasonic Type



Floating Type
(Reed-switch type)

2. Flow Velocity Meter

Type	Ultrasonic type (Propagation time difference)	Microwave type (Doppler shift)
Measurement Outline		
Measurement Principle	Measures a difference of the ultrasonic propagation time in the water between two transducers which are installed in both banks.	Measures a Doppler shift between sensor and flow surface by microwave.
Target	Cross-sectional mean velocity of underwater	Point velocity of water surface
Accuracy	± 0.04m/s	± 2%
Measurable Range	- 4 to + 4m/s (width: 2.8 to 140 m)	+0.5 to +20 m/s
Error Factor	Air bubble, High turbidity	Low velocity (<0.5m/s) Backflow by pier downstream
Expected Durability	10 years	10 years
Installation	Fixing a pair of transducer in each concrete bank (under the water) obliquely.	Fixing required number of sensor on the bridge.
Power supply	AC power	AC power
Maintenance	- Data and power supply check - Clean up	- Data and power supply check - Clean up
Advantages	- Accurate discharge calculation by cross-sectional mean velocity of underwater - Measurable low velocity and backflow	- Non-contact measurement and safe from collision by sediment and driftwood. - Easy installation
Disadvantages	- Affected by air bubble and high turbidity. - Need an installation in dry condition of channel	- Need a correction take into account the underwater velocity distribution of depth and cross-section direction. - Unmeasurable low velocity and backflow - Visible sensor and possibility of vandalism/theft
Installation Record in Japan	- Downstream river including tidal area	- Upstream river, Debris flow torrent

3. Monitoring Box

Function:	Data display/Recording/ Transmission
Dimensions:	700W×700H×200D mm or less
Weight:	30kg or less
Power Supply:	AC170V to 264V
Major Component:	Field Logger/Transmission Control Unit, Router, Power supply unit

4. Signal Coder

Input Signal	Frequency signal (Quartz type) 4-20mA (Pressure type)
Output Signal	4-20mA, RS485
Operation:	6 key switch
Data Display:	LCD
Data Recording:	Media: SD Card (CSV format recording) Interval: (Min.) 1min., (Max.) 1 hour
Operating Power Supply	DC12V
Current Consumption:	300mA or less
Ambient Temperature:	-10 to 50 °C
Relative Humidity:	30% to 90% (No condensing)
Dimensions:	180W×100H×50D mm
Weight:	1.5kg or less

5. Router

Processor/Memory:	ARM9/256MB Flash memory
Communication:	3G: 800/850/900/1900/2100 MHz 2G: 850/900/1800/1900 MHz
Interface:	10/100Base-TX port×1, Serial Port×1, Mini USB 2.0 OTG×1
Power Supply	DC8 to 40V
Ambient Temperature:	-20 to 70 °C
Dimensions:	110W×150H×40D mm
Weight:	230g or less

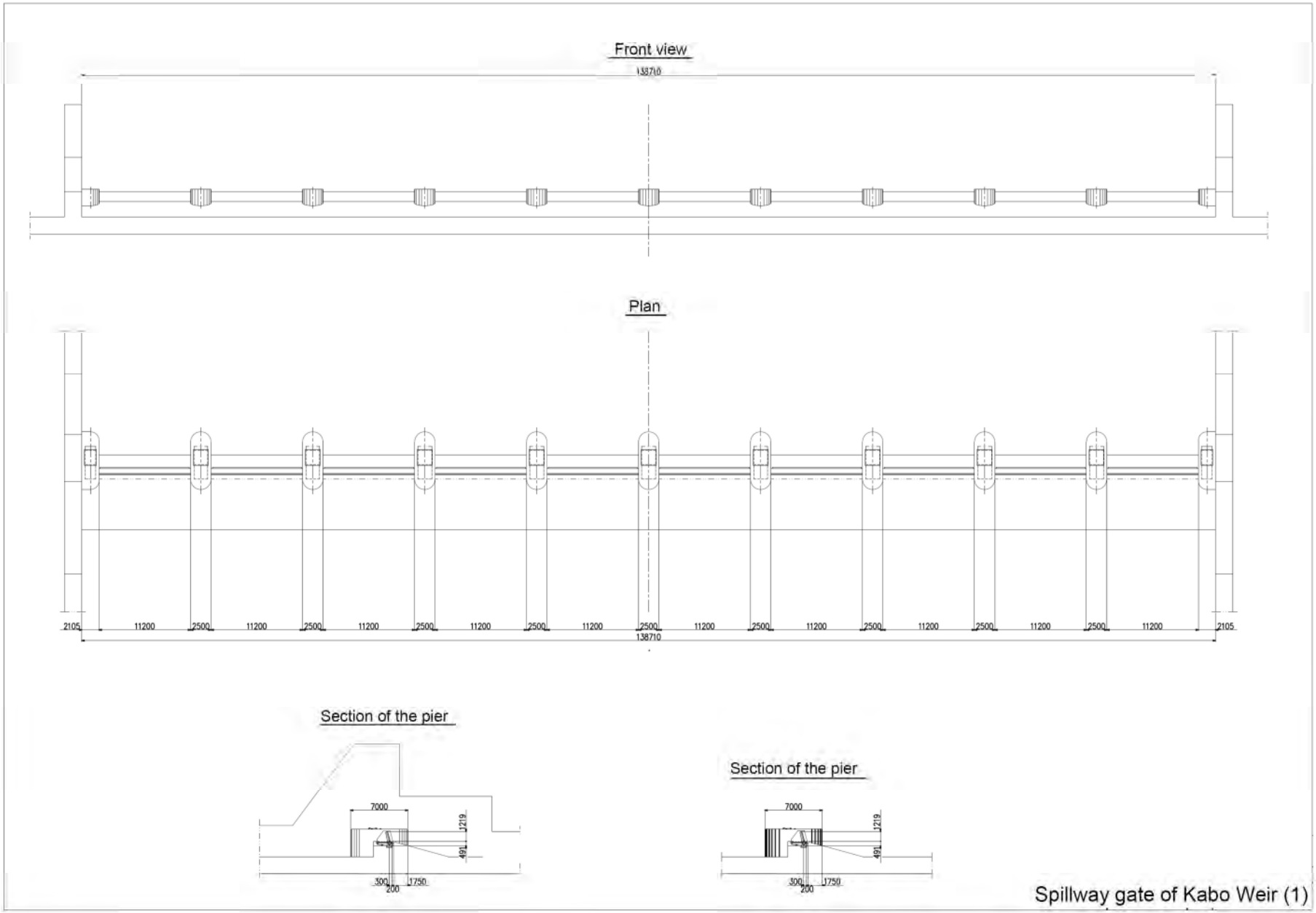
6. Field Logger

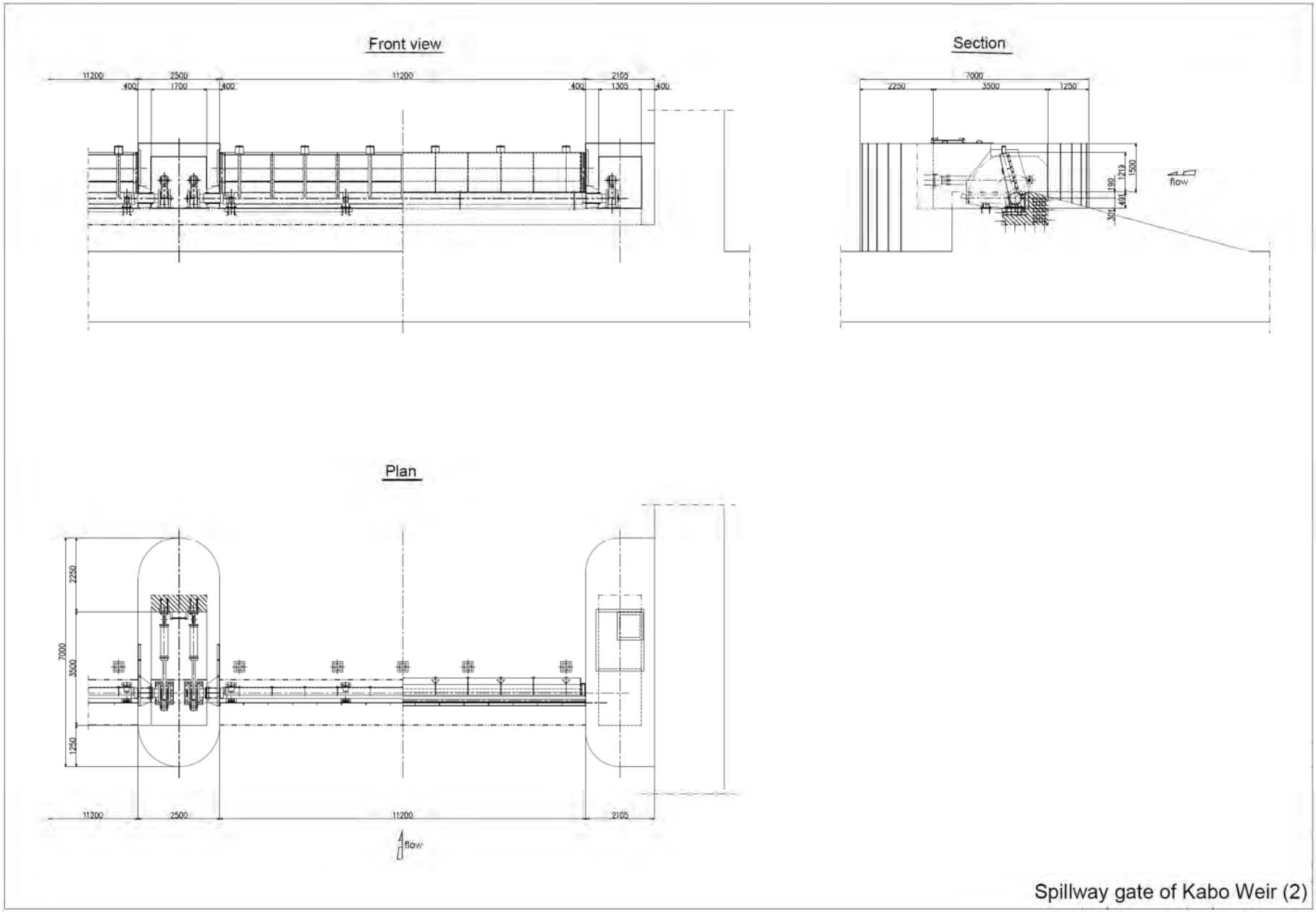
Communication:	DHPC (Dynamic Host Configuration Protocol)
Ethernet:	10BASE-T/100BASE-TX
Input:	Analog, Digital
Function:	Simple server (Web browsing for data table and trend graph) Alarm e-mail (to max 32 addresses)
Power supply:	DC 24V (12W)
Ambient Temperature:	-10 to 55C
Relative Humidity:	30% to 90% (No condensing)
Available OS/Browser:	1) PC: - OS: Windows Vista, Windows7(32bit/64bit),Windows8.1(32bit/64bit) - Browser: Internet Explorer 10/11, Firefox 13.0.1, Chrome 26.0.1410.43m 2) Tablet - OS: iPad (iOS5 or new), Android (Android4.0 or new) - Browser: iOS : Safari, Android: Chrome 3) Smartphone - OS: iPhone (iOS5 or new), Android (Android4.0 or new) - Browser: iOS : Safari, Android: Chrome

7. Transmission Control Unit

Type	Transmission control unit
Function	・Protocol conversion ・Router control
Interface	LAN : 100BASE-TX/10BASE-T x 1ch Input/Output ： Analog or Digital In/Out x2ch Serial：RS-485 or RS-232C x1ch
Power supply	DC5V or DC12V
Ambient Temperature	-20 to 60℃

Rehabilitation of Kabo Weir




Front view
11200
2500
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2105
400
1700
400
400
1305
400
Section
7000
2250
3500
1250
1500
1219
190
490
300
flow
Plan
2250
7000
3500
1250
11200
2500
11200
2105
flow
Spillway gate of Kabo Weir (2)

Comparison table on the hydraulic overturning flap gate for Spillway gate of Kabo Weir

		Normal steel gate	Stainless steel gate	Duplex stainless steel gate
Characteristic	Material	Rolled steel for welded structure (SM400)	Austenitic stainless steel (SUS304)	Alloy-saving Duplex Stainless Steel (SUS821L1)
	Tensile strength (N / mm 2)	400	520	600
	Yield point or yield strength	245	205	400
	Corrosion resistance	0.05 – 0.12 mm/year facing on water	It is hard to rust in air, freshwater.	It is harder than SUS304 to rust in air, freshwater.
	Weldability	It is a steel material developed considering weldability, and welding is relatively easy	Welding is easy in stainless steel, but it is difficult compared with ordinary steel. Particularly, upward welding requires skilled welder. In addition, corrosion resistance (sensitization) may decrease as welding heat input increases.	It is almost same as SUS304. "Sensitization" which is a deterioration phenomenon of corrosion resistance need not be considered.
Merit		➢ Easy to obtain materials ➢ Easy fabrication (cutting, assembly, welding, machining) ➢ Painting is necessary, but color design is free. ➢ Fabrication cost is low.	➢ Painting is unnecessary, so coating paint replacement is not necessary. ➢ Maintenance cost is cheap. ➢ Because stainless steel is hard and has abrasion resistance, it is difficult to wear by flowing gravel and sand. (steel thickness is difficult to decrease)	Same as SUS304 In addition It is possible to reduce the weight by reducing thickness, because tensile strength and yield point is higher than SUS304.
Demerit		➢ Gate leaf need Update pain ➢ Maintenance is high. ➢ There is a risk of corrosion on the damaging painted surface due to driftwood and sweeping gravel on the upstream side. ➢ · It is difficult to repaint the paint at the bottom and edge of the gate	➢ Fabrication (cutting, welding, machining) is difficult, compared with SM400· ➢ Processing at the site is even more difficult. ➢ There is no freedom of color. ➢ Because the design standard strength (yield strength) is low, the	Same as SUS304 However, Since the weight can be reduced, compared with SUS304 & SM400, fabrication cost including material is cheaper than SUS304. Moreover, operation cost is cheapest.

		Normal steel gate	Stainless steel gate	Duplex stainless steel gate
		leaf.	equipment weight becomes heavy. ➢ Fabrication cost is high.	
Gate span and gate size		21 m x 6 spans + 5 pears (w=2.7m) = Total 138.7m Considered the possibility to weld the gate at the project site, gate span can be longer as much as possible.	11.2 m x 10 spans + 9 pears (w=2.5m) = Total 138.7m Considered the difficulty to weld the gate at the project site, gate span is a size which can be transported by track.	Same as SUS304
Size of Machine room in pier		Width 2.5m x length 7.0m x height 2.0m	Same as SM404	Same as SM404
Weight of the gate		14.0 ton/ gate x 6 = 84.0 ton	6.0 ton/gate x 10 = 60.0 ton	5.0 ton/gate x 10 = 50.0 ton
Output of lifting device (hydraulic facilities)		3.7 kw	3.7 kw	3.7 kw
Life span of gate		50 years under proper maintenance	More than 50 years	More than 50 years
Life span of lifting device (hydraulic facilities)		25 years	25 years	25 years
Necessary days	fabrication	2 month for design, 2 month for procurement of material, 10 month for fabrication, total 14 month	2 month for design, 2 month for procurement of material, 9 month for fabrication, total 13 month	2 month for design, 2 month for procurement of material, 10 month for fabrication, total 14 month
	installation	10 month	8 month	8 month
Fabrication cost	Gate leaf and guide flame	137 Million JPY	171 Million JPY	152 Million JPY
	Lifting device	150 Million JPY	150 Million JPY	150 Million JPY
	Total	287 Million JPY	321 Million JPY	307 Million JPY
Maintenance cost	Gate leaf and guide flame	90 Million JPY/50 years	50 Million JPY/50 years	50 Million JPY/50 years
	Lifting device	367 Million JPY/50 years	367 Million JPY/50 years	367 Million JPY/50 years
Total cost including 50 years maintenance cost		744 Million JPY	738 Million JPY	719 Million JPY
Selection				✓

Alloy-saving Duplex Stainless Steel : Chemical composition and Mechanical Properties

1.Chemical composition

		C	Si	Mn	Cr	Ni	Mo	Cu	N
SUS821L1	Standard	≦0.030	≦0.75	2.00 ~ 4.00	20.50 ~ 21.50	1.50 ~ 2.50	≦0.60	0.50 ~ 1.50	0.15 ~ 0.20
	Typical	0.02	0.4	3.0	20.7	2.0	0.3	1.1	0.18
SUS 304 (ref.)	Standard	≦0.08	≦1.00	≦2.00	18.00 ~ 20.00	8.00 ~ 10.50	-	-	-
	Typical	0.05	0.4	0.8	18.2	8.1	-	-	-
SUS323L	Standard	≦0.030	≦1.00	≦1.20	21.50 ~ 24.50	3.00 ~ 5.00	0.05 ~ 0.60	0.05 ~ 0.60	0.05 ~ 0.20
	Typical	0.01	0.5	1.0	23.6	3.9	0.3	-	0.14
SUS 316L (ref.)	Standard	≦0.030	≦1.00	≦2.00	16.00 ~ 18.00	12.00 ~ 15.00	2.00 ~ 3.00	-	-
	Typical	0.02	0.6	0.8	17.5	12.1	2.1	-	-

2. Mechanical properties

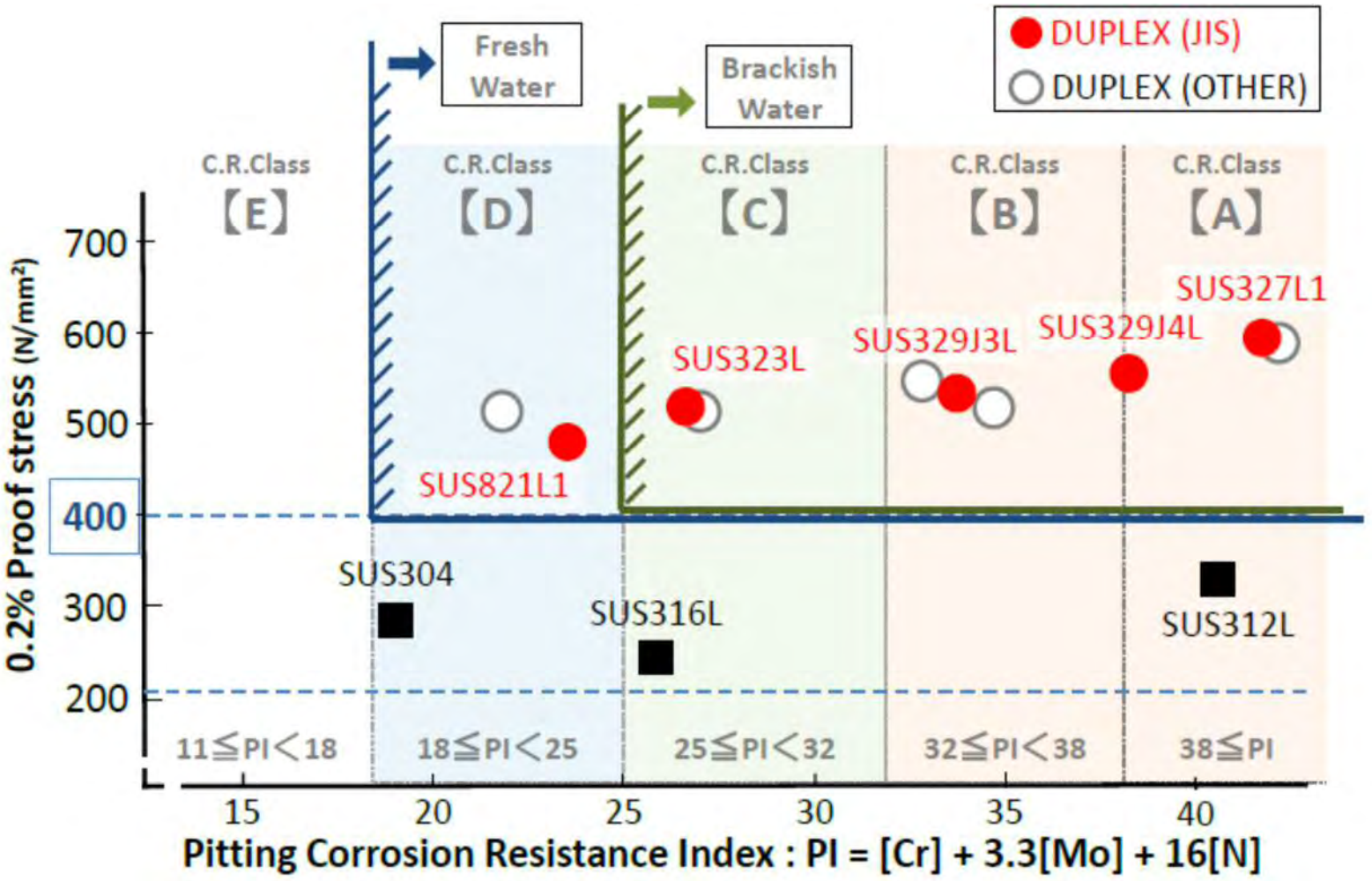
	Thickness (mm)	0.2%YS(N/mm²)	TS(N/mm²)	EL(%)	HB
SUS821L1	Standard	400≦	600≦	25≦	≦290
	Typical (t=10)	492	701	44	213
SUS 304 (ref)	Standard	205≦	520≦	40≦	≦187
	Typical (6≦t<15 ave.)	314	645	59	159
SUS323L	Standard	400≦	600≦	25≦	≦290
	Typical (t=8mm)	536	726	38	222
SUS 316L (ref.)	Standard	175≦	480≦	40≦	≦187
	Typical (6≦t<15 ave)	292	551	58	141

3. Physical Properties

	Density (R.T.) (g/cm^2)	Specific heat (R.T.) (kJ/kg/℃)	Thermal conductivity (R.T.) (W/m·℃)	Average Thermal expansion (R.T.~100℃) (×10^{-6}/℃)	Longitudinal erastic modulus (R.T.) (GPa)	Electric resistivity (R.T.) (×10^{-2}Ωm)	Magnetism
SUS821L1	7.80	0.5	16.0	13.0	206	80	magnetic
SUS 304 (ref.)	7.93	0.5	16.3	16.3	193	72	Non-mag.
SUS323L	7.80	0.5	16.0	13.0	206	80	magnetic
SUS316L(ref.)	7.98	0.5	16.1	16.0	193	74	Non-mag.

(Reference)	Density (g/cm^3)	Specific heat (kJ/kg/°C)	Thermal conductivity (W/m·°C)	Average Thermal espansion (× 10^{-6}/°C)	Longitudinal Erastic modulus (kN/mm^2)	Electric resistivity (× 10^{-2}Ωm)	Magnetism
SS400 SM490	7.85	0.48	74.6	12.6	206	13	magnetic

Corrosion resistance classification of Stainless Steel



V.9.3 Rehabilitation Plan of Kabo Weir (Bed Protection Works)

(1) Bed Protection Work of Kabo Weir

The structure type of bed protection work (riprap) of Kabo weir should be selected after consideration of 1) construction experiences of IWUMD, 2) procurement of construction materials at construction site, 3) construction machinery of IWUMD and 4) employment of workers. And three material types (concrete brock protection, concrete slab protection and gabion protection) are considered as the structure of bed protection work. Table 1 shows the characteristics of each structure of those bed protection works.

Maximum flood discharge of Mu River at Kabo weir reached 7,858m^3/s and the flood caused large-scale bed scouring at the downstream side of Kabo weir in 2015. Bed protection work should have safety against the flood, durability against the sediment transport, and sufficient adaptability with the riverbed evolution. Considering the above-mentioned conditions, the concrete block bed protection work seems to be the most suitable structure for Kabo weir at present. In this regard, after the investigation of river conditions (river flow and riverbed conditions etc.) in detailed design stage, a structure type of the bed protection work should be selected based on the durability and safety against flood, efficiency of construction, maintenance, management and construction cost, etc. And the most suitable structure of the bed protection work can be combined with different type as needed.

The dimension of a large-scale bed scouring, caused by the flood in 2015, has been measured by topographic survey in this project. And backfilling material of this scouring is planned to be gabion, rubble and sediments at the upstream of weir, because these materials can be quarried around the project site. In case the sediments are not suitable as backfilling material due to high silt content, the utilization of this sediments should be considered as a mixed material (sediments and cement) or large-sized sand bags with the mixed material. And selection of the backfilling material needs the comparison of procurement cost, which depends on the location of quarry site and deposit area.

Table 1 Comparison of Construction Methods for Bed Protection Work

	Concrete Brock Protection Work	Concrete Slab Protection Work	Gabion Protection Work
Structure	Laying precast concrete block which are made at the site, at river bed and jointing them by reinforcing bar.	Laying the cast-in-place concrete (reinforced) at river bed. And another method should be selected at lower dissipating portion.	Laying the gabion with cobble/ rubble stone at river bed and joining by iron wire.
Safety/ Durability	It has enough adaptability to settlement of river bed. And it is safe against the sediment-laden flow due to the enough energy dissipating effect against the flow.	Comparing with the other 2 methods, It has a low adaptability to settlement of river bed. However it is quite effective against erosion (sand outflow). And this method should be combined with other methods because of low energy dissipating effect against the flow.	It has enough adaptability to settlement of river bed and also has friction resistance against the river bed. Compared with the other two methods, wear resistance against the heavy sediment-laden flow is low.
Construction method	To prevent erosion of riverbed, countermeasures should be taken such as cobble stone filling between the blocks, laying mats against sand outflow or laying the concrete slab under the block etc.	Construction period will be longer than the other two methods due to the cast-in-place concrete (reinforced) work. And the joint structure should have some adaptability and strength.	Compared with the other two methods, it has high efficiency of construction. The structure of riverbed should be safe against the sediment-laden flow and external force, etc.
Maintenance	The removal or repair of the broken member will be relatively easy and less expensive.	Repair work of broken concrete slab tends to be large scale and costly very much.	The removal or repair of the broken member will be relatively easy and less expensive.
Construction Cost	High	High	Low
Comprehensive	Concrete brock is most suitable	If the energy dissipating	The safety and durability against

Evaluation	structure for the bed protection at the downstream side of Kabo weir. Because concrete brock has the characteristics of safety against the flood, durability against the sediment-laden flow, and adaptability enough for the riverbed evolution. In this case, large-sized concrete brock will be required and cobble stones filled between the blocks may flow out due to the heavy flood of river. Therefore double structural bed protection work, which is 1) laying the mat against sand outflow under the block and 2) laying the gabion under the block, is the one of the option to keep the safety.	(hydraulic jump) is not expected at the existing apron duo to the river conditions (longitudinal incline, cross section of river, flood discharge), energy dissipater or concrete slab should be laid. However concrete block or gabion is required to lay at the downstream of concrete slab in order to coordinate the roughness coefficient with that of natural river.	flood are inferior to the other two methods. And it is necessary to use large-sized gabion and thick iron wire and to give rust resistance. However gabion is expected to prevent sand outflow, or the foundation of bed protection built with concrete blocks. And gabions can be laid as a buffer zone at downstream of bed protection in order to coordinate the roughness coefficient with that of natural river.
	◎	△	○

The cost of these protection works was estimated assuming the concrete brock protection work (including temporary works), whose cost is considered to be highest.

(2) Necessary Investigations for Rehabilitation Plan of Kabo Weir

The following investigations should be conducted with importance on the detailed design stage in order to make a rehabilitation plan and a construction plan of Kabo weir.

(a) Topographic & river surveys: Confirmation of topography and site (property), condition of river bed and gut, forecasting future river bed evolution. These items will be used for layout of facilities and temporary work plan etc.

(b) Geological survey: Design for the foundation of bed protection, calculation for creep length etc.

(c) Survey of river conditions: Observation of discharge and water level, confirmation of maintenance flow and sediment amount, etc. The following items will be used for layout of facilities, planning for temporary work (cofferdam) and turbid water treatment facility etc.

(d) Inspection of existing structures: Confirmation of gate facilities, bed protection works, foundation of facilities and related structures (slope protection etc.).

(e) Environmental survey: Plants, birds, fish etc.

(3) Plan of Temporary Works

Gate facility, bed protection and bank protection will be repaired during the dry season (from December to June: 7 months). And the construction site must be enclosed by temporary cofferdam. And the temporary cofferdam should not prevent the SMC & YMC from intake of the irrigation water. The temporary road (access road) will be constructed from the national road, which lies at 3,000ft downstream of Mu River, through the right bank of Mu River to Kabo wire (Figure 1).

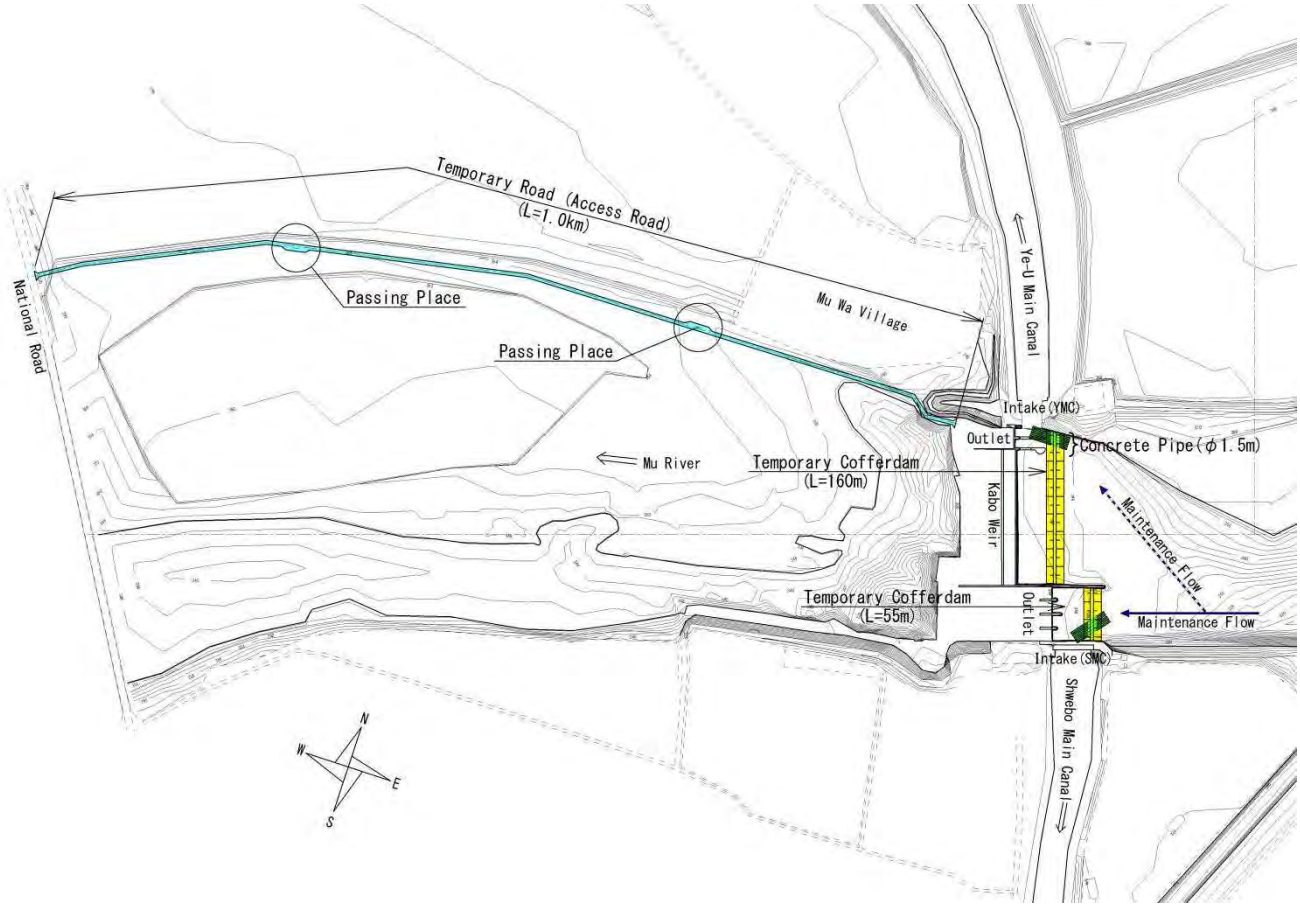


Figure 1 Plan of Temporary Road

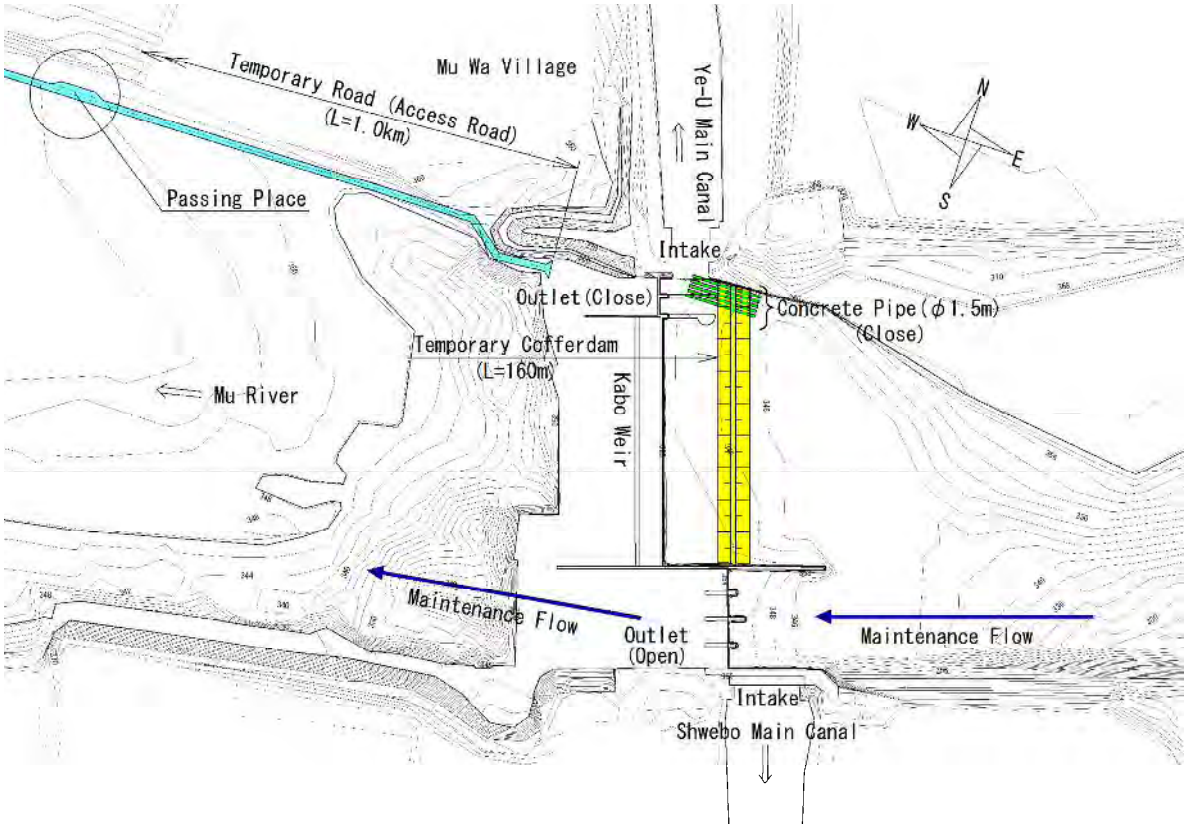


Figure 2 Plan of Cofferdam (Construction of Right bank Side)

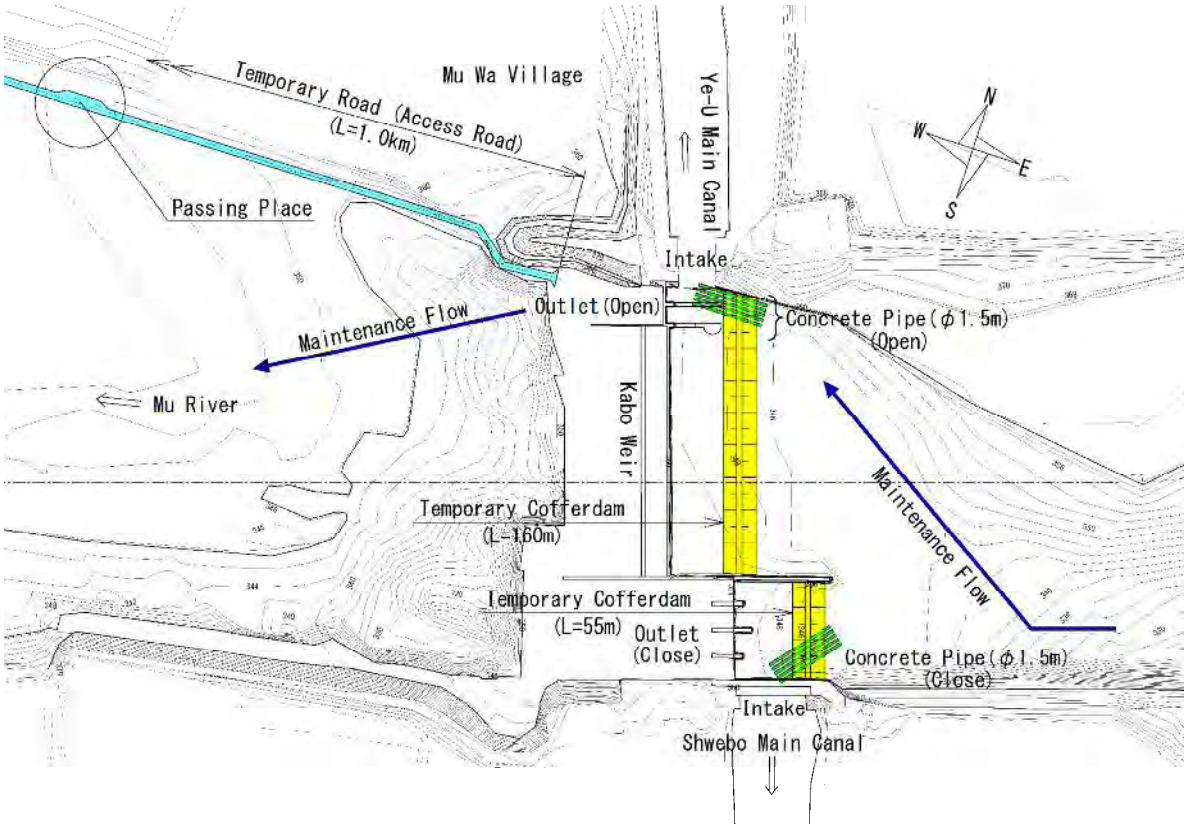


Figure 3 Plan of Cofferdam (Construction of Left bank Side)

V.10 Implementation Schedule on Irrigation and Drainage Improvement

The Basic policy of the construction schedule on the rehabilitation of the irrigation system is the follow.

Overall policy

- Based on the results of the interview survey to the famer, it is principle that irrigation for summer paddy will be stopped only once for each irrigation system for the construction.
- Since SMC, RMC and YMC have branch canal with long canal length, they are divided into two areas for the construction and stopping irrigation for summer paddy is only one time in different years.
- Among the four irrigation systems, the RMC irrigation system is the most problematic, and irrigation is not sufficient at AEC and BEC which is downstream of RMC. For this reason, the construction for the rehabilitation starts from RMC irrigation system.
- The construction schedule on the rehabilitation for the Kindat Diversion Dam and Kabo weir will be coordinated with the schedule for the rehabilitation of canals and schedule of gate procurement.

Rehabilitation of the canals and canal structures

- Regarding small rehabilitation works which can be completed during the annual water stop period (from December until beginning February), mainly the both Shwebo and Ye-U maintenance office will carrier out the construction work within the annual water stop period in the 5 years.
- Regarding large rehabilitation works which need longer period than the annual water stop period, the construction circle 4 will carrier out the construction work by using one time of the long-term water stop period (December to June). If construction circle 4 will not have enough capacity for the works, the construction circle which is in charge of other districts will be assigned.

Kindat Diversion Dam

- The construction of the emergency spillway will starts from December 2019 which is the first year of construction in order to secure the sound of diversion dam as soon as possible.
- Considering the procurement period of the gate, starting construction for gate installation will start from December 2021.

Kabo weir

- Considering the procurement period of the gate, gate installation will start from December, 2021.
- Construction of the riverbed protection at D/S, which needs urgent to secure soundness of the weir, will start in the dry season from December of 2020.

Maintenance road

- Regarding the improvement of Inspection Path (IP) along OMC and MBC, it is assumed that experienced contractors will carry out, because IWUMD doesn't have enough experience on the asphalt pavement road construction.
- Other IP will be implemented as part of normal maintenance by IWUMD from December 2018.
- Rehabilitation of canal will be given the priority. Rehabilitation of IP is implemented according to the amount of water channel construction.

V.10 Implementation Schedule on Irrigation and Drainage Improvement

	2018												2019												2020												2021												2022												2023												2024												Month
	4	5	6	7	8	9	10	11	12	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3	
Land Acquisition																																																																																						
IWUMD-1.1 Rehabilitation of Kindat Diversion Dam (Procurement)																																																																																						
IWUMD-1.2 Rehabilitation of Kindat Diversion Dam (Construction)																																																																																						
IWUMD-1.3 Rehabilitation of Kindat Diversion Dam (Dredging)																																																																																						
IWUMD-1.4 Rehabilitation of Kindat Diversion Dam (Gate Installation)																																																																																							
IWUMD-2.1 Rehabilitation of Kabo Weir (Procurement)																																																																																						
IWUMD-2.2 Rehabilitation of Kabo Weir (Construction)																																																																																							
IWUMD-2.3 Rehabilitation of Kabo Weir (Gate Installation)																																																																																							
IWUMD-3 Rehabilitation of OMC Irrigation System																																																																																							
IWUMD-4.1 Rehabilitation of SMC Irrigation System (U/S)																																																																																							
IWUMD-4.2 Rehabilitation of SMC Irrigation System (M/S & D/S)																																																																																							
IWUMD-5.1 Rehabilitation of RMC Irrigation System (U/S)																																																																																							
IWUMD-5.2 Rehabilitation of RMC Irrigation System (AEC & BEC)																																																																																							
IWUMD-6.1 Rehabilitation of YMC Irrigation System (U/S & MBC)																																																																																							
IWUMD-6.2 Rehabilitation of YMC Irrigation System (M/S & D/S)																																																																																								
IWUMD-7 Flood monitoring & water management system																																																																																								
IWUMD-8 Preparation Work and Quality Control and Maintenance of Machinery																																																																																								

V.11 Topographic survey for detail design

V.11.1 Outline of the Survey and the responsibility of IWUMD and JICA Survey Team

Topographic survey and geological survey for detail design are necessary before or upon the deployment of the Consultants for the detail design. Therefore the surveys were agreed with the JICA appraisal mission in early July 2017, and recorded in the Minutes of Discussions (MD), and to be carried out during the coming dry season, say from early December 2017.

In November, 2017 the consultant team had detail discussions with the Irrigation and Water Utilization Management Department (hereafter called "IWUMD") to carry out the Topographic Survey and Structure Survey for detail design for AIIP which will be implemented under Japan ODA loan. Detail design is planned to start from December 2018. Accordingly, IWUMD is expected to conduct some parts of the topographic survey and structure survey in this coming dry season from December 2017. Remaining surveys shall be conducted during next dry season from December 2018 and completed at an earliest time for the detail design without any delay. Items to be conducted in dry season of 2017/18 and 2018/19 are shown in the table below. Additional investigation for design/ construction shall be conducted by IWUMD during design/ construction stage, when necessary.

Target of survey	Implementation	
	2017/18	2018/19
Kindat Diversion Dam	✓	
Kabo Weir	✓	
Canals under RMC,	✓	✓
Canals under SMC, OMC, YMC		✓
Structure observation survey for canal structures under RMC	✓	✓
Structure observation survey for canal structures under SMC, OMC, YMC		✓
Drainage Canals which need improvement of capacity		✓
Inspection Path along the OMCl, and Ma Ya Kan Branch Canal of YMC		✓

According to the discussion, topographic survey and structure survey for detail design will be conducted based on the followings;

1) IWUMD Investigation Branch and both Shwebo and Ye-U Maintenance office shall, till the end of March 2018, conduct topographic survey and structure survey in the table below. The detail of the work is shown in next section "V.11.2 TOR on topographic survey and structure survey".

i) Kindat Diversion Dam

Item	Investigation Branch	Maintenance Office
Plane survey at emergency spillway (up to main dam body)	✓	
Longitudinal survey for the direction of dam axis from emergency spillway	✓	
Cross section survey along the direction of dam axis at emergency spillway	✓	
Longitudinal survey on centerline of emergency spillway (extension part)		
Cross section survey along centerline of emergency spillway (extension part)		
Longitudinal survey and cross section survey for the lead canal for RMC	✓	
Contour line (topo) survey in the reservoir around head regulator of RMC	✓	

ii) Kabo Weir

Item	Investigation Branch	Maintenance Office
Detail structure survey on the structure of Kabo Weir		✓
Plane survey of Kabo Weir (Already conducted)		
Longitudinal & cross section drawing of the river (making based on top map)		✓

iii) Canals under

Item	Investigation Branch	Maintenance Office
Longitudinal survey for all canals	✓	
Cross section survey for all canals	✓	
Location and spot elevation survey for inlet & outlet of all Head regulator	✓	

Target canal: Main canal, Extension canals, DY canals and Minor canals of RMC

iv) Structure observation survey for canal structures including bridges

Item	Investigation Branch	Maintenance Office
Detail structure survey and make sketch		✓
Plane survey at the structures which need large scale rehabilitation		✓
Section survey of structures		✓

Target canal: RMC, SMC, YMC, OMC

2) The survey cost is estimated as approx. 81,000,000 Kyat (approx. 60,000 US$) based on the regulation of IWUMD.

3) JICA Survey Team will support IWUMD by covering some of the costs for the surveys which will be conducted until March of 2018. Items of costs for the support are the following DIRECT COSTS only; Fuel for cars, rental of cars, allowance for staff/surveyors of IWUMD, labor cost for survey, and material necessary for the surveys. Budget is 60,000 US$ (approximately 81 million Kyats). It is noted that JICA Survey Team cannot cover the extra expenditure beyond the budget; namely, extra expenditure shall be covered by IWUMD.

4) IWUMD shall submit all the receipts of expense, and necessary supplemental document. Upon the submission of the receipts and checking, JICA Survey Team will reimburse.

5) IWUMD shall submit to the JICA Survey Team the electric files of output such as the drawings and calculation sheet instead of hard copy. IWUMD may print hard copies for its reference purpose.

6) The work item and quantity can be changed and/or modified by the mutual consent of the two parties.

7) Should problems concerning the work and event not mentioned above occur, both parties will discuss and seek solutions in order to complete the work.

V.11.2 TOR on topographic survey and structure survey

1. Survey items for detail design

Items to be conducted under this MOU are below.

1) Kindat Diversion Dam

- Plane survey at emergency spillway (up to main dam body)
- Longitudinal survey for the direction of dam axis from emergency spillway to the main dam body
- Cross section survey along the direction of dam axis at emergency spillway
- Longitudinal survey on centerline of emergency spillway (have been done)
- Cross section survey along centerline of emergency spillway (have been done)
- Longitudinal survey and cross section survey for the lead canal for RMC
- Contour line (topo) survey in the reservoir around head regulator of RMC

2) Kabo Weir

- Detail structure survey (length, width, height, material, condition) on the structure of Kabo Weir
- Center line profile survey for the river dike (both sides)
- Longitudinal survey on centerline of the river dike (both sides)
- Cross section survey along the river dike (both sides)
- Plane survey of Kabo Weir
- Longitudinal & cross section drawing of the river

3) Canals (RMC)

- Longitudinal survey for Main Canal (26 Miles), Ayataw Extension Canal, Butalin Extension Canal, Dy and Minor canal (103 Miles)
- Cross section survey for Main Canal (26 Miles), Ayataw Extension Canal, Butalin Extension Canal, Dy and Minor canal (103 Miles)
- Location and spot elevation survey for inlet & outlet of all Head regulator including DO & turn-out

4) Structure observation survey for canal structures including bridges

- Detail structure survey (length, width, height, gate size, material, condition, etc.) and make sketch
- Plane survey at the structures which need large scale rehabilitation
- Section survey of structures

Remaining survey items to be conducted in future are below.

5) Canals (SMC, OMC, YMC, part of RMC)

- Longitudinal survey for all canals
- Cross section survey for all canals
- Location and spot elevation survey for inlet & outlet of all Head regulator including DO & turn-out

6) Structure observation survey for canal structures including bridges (SMC, OMC, YMC, part of RMC)

- Detail structure survey (length, width, height, gate size, material, condition, etc.) and make sketch
- Plane survey at the structures which need large scale rehabilitation
- Section survey of structures

7) Drainage Canals which need improvement of capacity

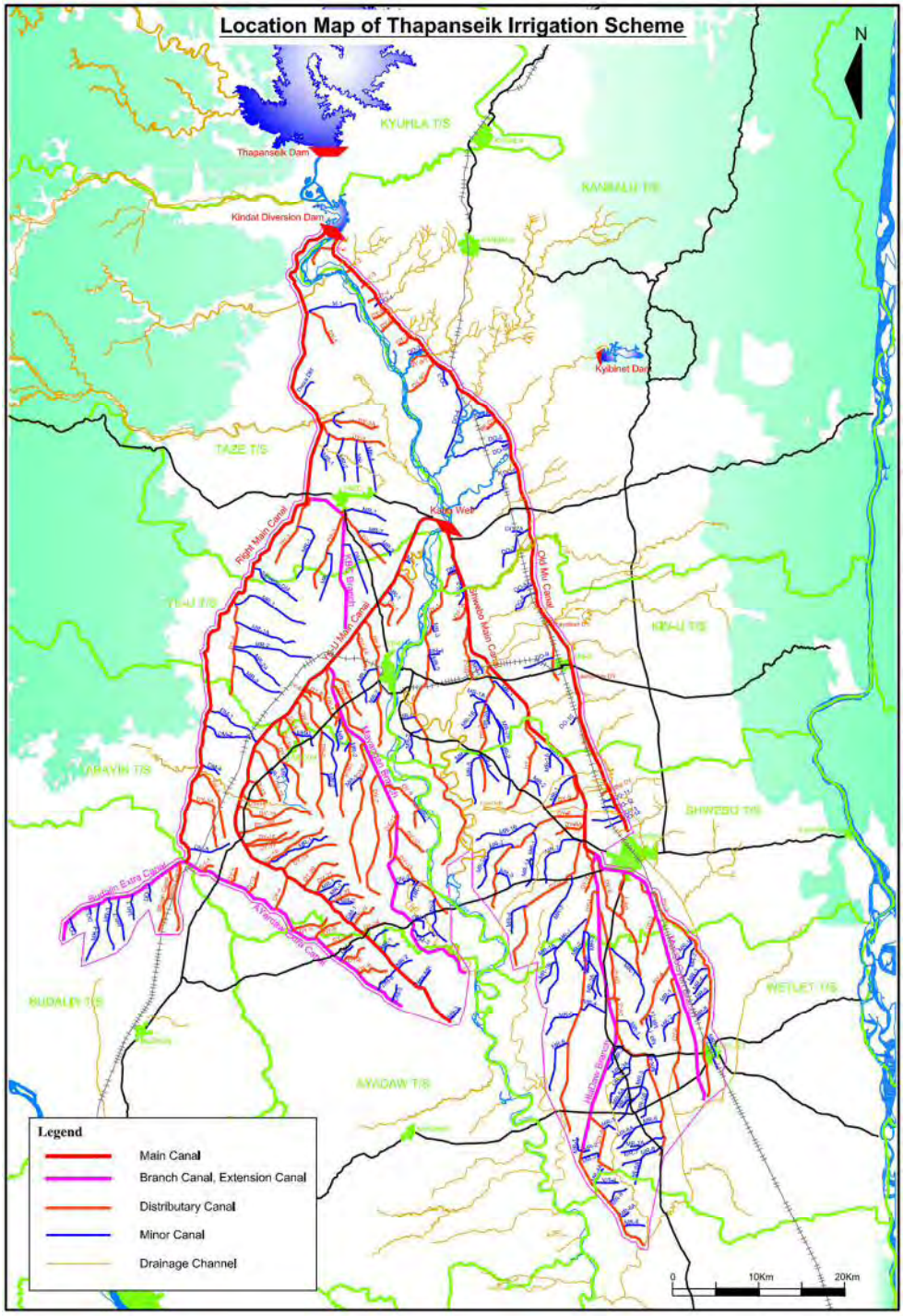
- Center line profile survey for the drainages
- Longitudinal survey of the drainages

- Cross section survey along the drainages
- Plane survey at the particular point such as joint points
- Structure survey (length, width, height, gate size, material, condition, etc.) in drainage such as culvert, bridge, intake wire

8) Inspection Path along the Old Mu Canal, and Ma Ya Kan Branch Canal of YMC

- Plane survey along the inspection paths
- Longitudinal survey on centerline of inspection paths
- Cross section survey along inspection paths

2. Location Map of the project (survey)



3. Detail of Surveys

1) Kindat Diversion Dam

The IWUMD shall conduct the topographic survey for the detail design of emergency spillway in Kindat Diversion Dam. The survey items to be carried out are mentioned in the table below. Although longitudinal survey and cross section survey on centerline of emergency spillway has been already conducted by Ye-U maintenance office of IWUMD, it is necessary to check the starting point (coordination) and extend the longitudinal & cross section survey of emergency spillway up to inlet of emergency spillway (200ft from dam axis).

Detail of survey items

No	Item	Quantity and Description
1-1	Plane survey at emergency spillway (upto main dam body)	3,000ft x 2,000ft
1-2	Longitudinal survey for the direction of dam axis from emergency spillway to main dam body	Length: 3,000 ft, interval of station: 100 ft Width of cross section: 150ft Note: It is necessary to confirm alignment of the dam axis line at the site.
1-3	Cross section survey along the direction of dam axis at emergency spillway	
1-4	Longitudinal survey on centerline of emergency spillway	Since IWUMD had been already surveyed, IWUMD shall check the starting point (coordination) and add the longitudinal & cross section drawing of emergency spillway up to inlet of emergency spillway (200ft from dam axis) based on result of the plane survey.
1-5	Cross section survey along centerline of emergency spillway	
1-6	Longitudinal survey and cross section survey for the lead canal for RMC	Length: 6,000 ft, interval of station: 100 ft Width of cross section: 150ft
1-7	Contour line survey in the reservoir around head regulator of RMC	1,700ft x 1,000ft

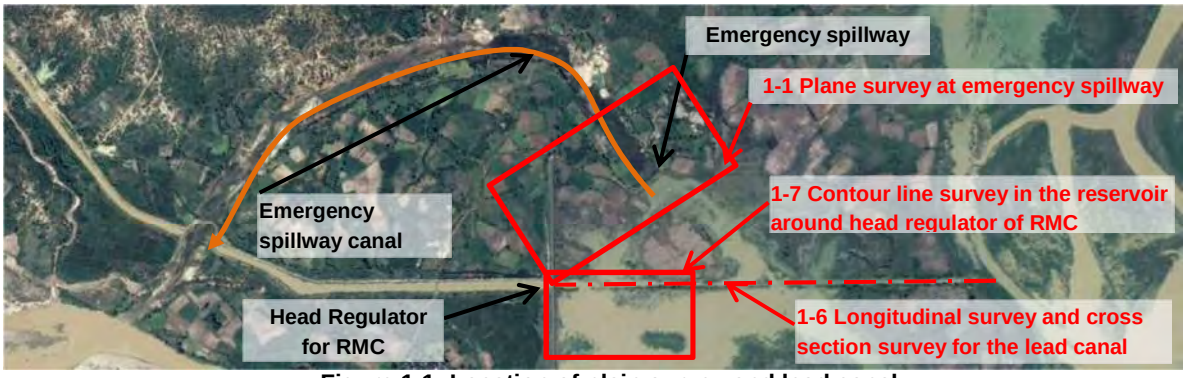


Figure 1-1: Location of plain survey and lead canal

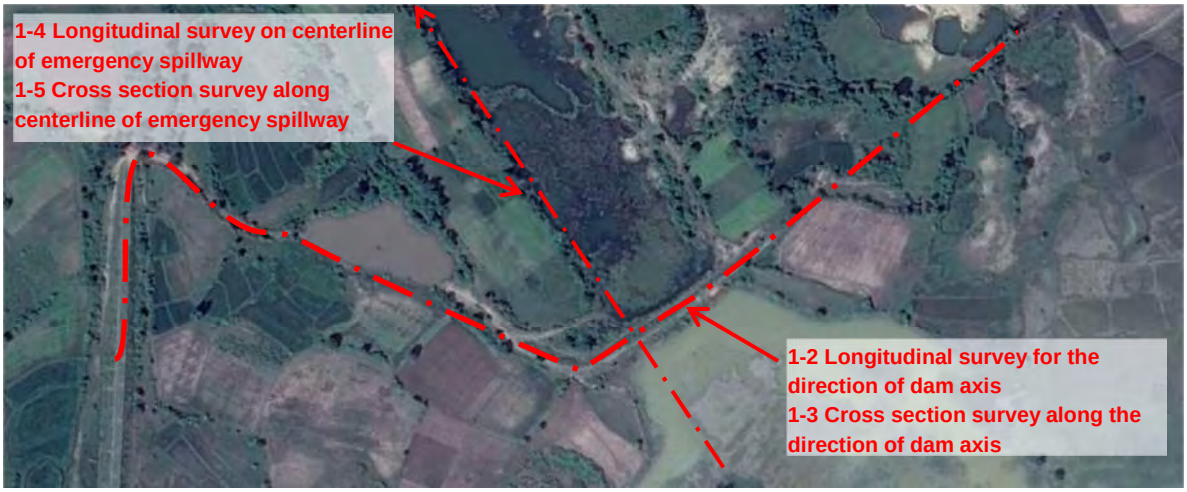


Figure 1-2: Location of centerline of dam axis and emergency spillway

Kabo Weir

The IWUMD survey team shall conduct the topographic survey for the detail design of rehabilitation of Kabo weir. The survey items to be carried out are mentioned in the table below:

Detail of survey items

No	Item	Quantity and Description
2-1	Detail structure survey (length, width, thickness, height, elevation, material, condition) on the structure of Kabo Weir	Drawing as shown in Figure 2-1 had been already made by IWUMD. However, IWUMD will conduct the detail structure survey (length, width, thickness, height, elevation, material, condition) on the structure of Kabo Weir especially superstructure and make report with detail drawings of each structure.
2-2	Center line profile survey for the river dike (both side)	Location of survey: see figure -2-1 Length: 2,800 ft at right bank 4,500 ft at left bank Interval of station: 100 ft Width of cross section: 150ft including river edge Note: Stating point of survey is at U/S of intake for SMC and YMC Note: Center line of the river dike will be mentioned in the topographic map
2-3	Longitudinal survey on centerline of the river dike (both side)	
2-4	Cross section survey along the river dike (both side)	
2-5	Plane survey of Kabo Weir	IWUMD had already conducted. (topographic map: see figure -2-3)
2-6	Longitudinal & cross section drawing of the river	JICA survey team had already made the longitudinal section drawing as shown in Figure 2-1 based on the topographic map. IWUMD shall finalize and add make cross section drawing for detail design,

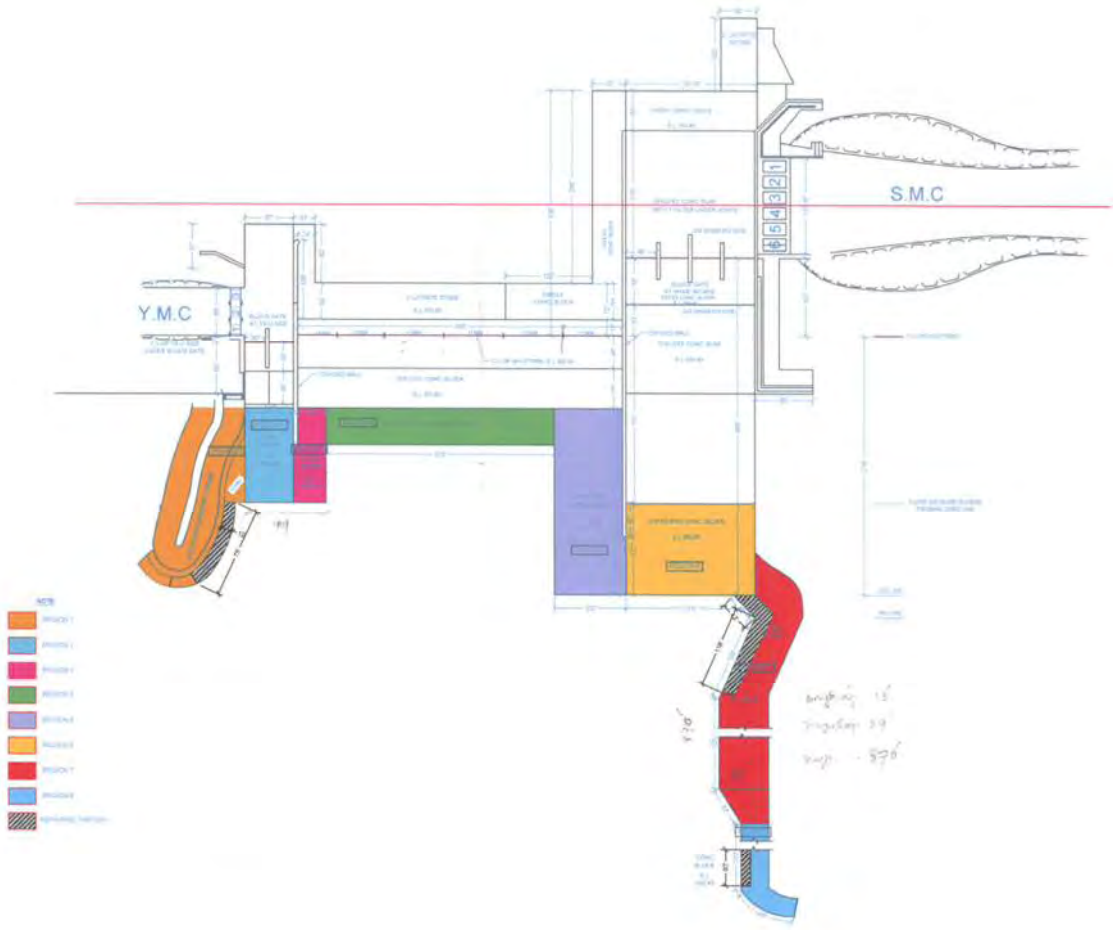


Figure 2-1: Drawing on the structure dimension of Kabo wire

Figure 2-2: Location of Center line profile survey & longitudinal cross section survey along the river dike

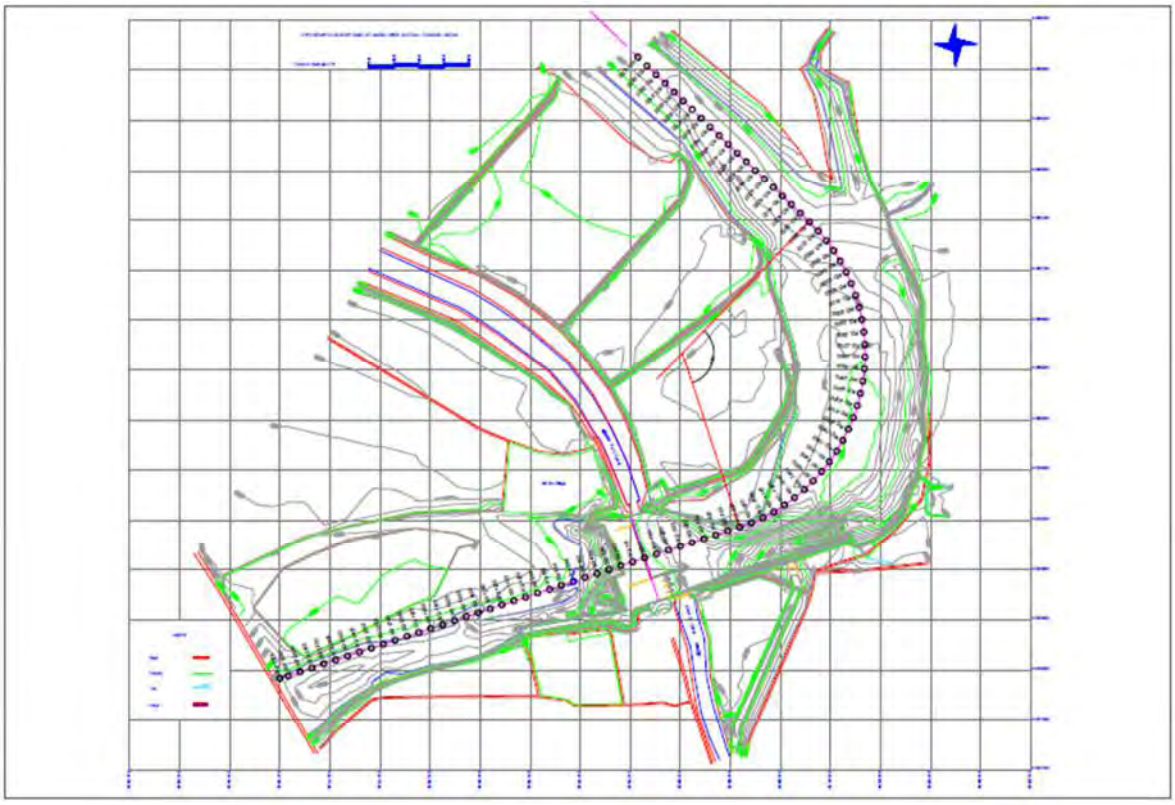


Figure 2-3: Topographic map at Kabo wire

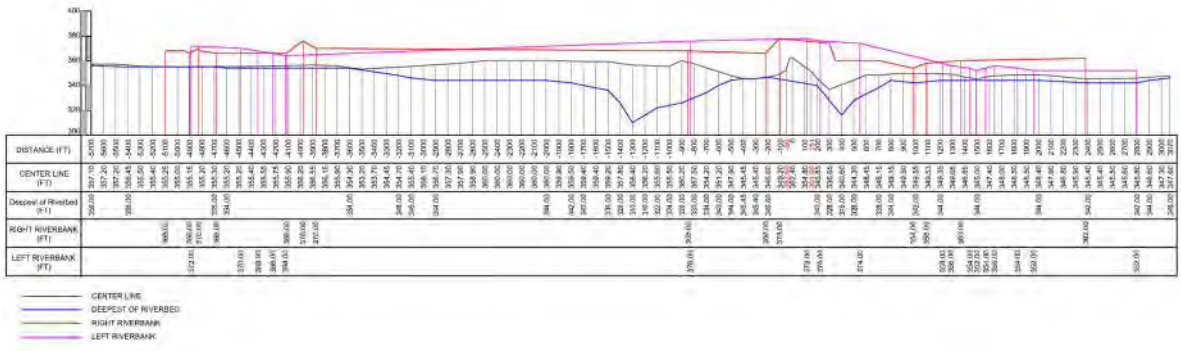


Figure 2-4: Longitudinal section drawing of the river at Kabo wire

2) Canals

The IWUMD shall conduct the topographic survey for canals. The survey items to be carried out are mentioned in the table below. Main canal of OMC, RMC, YMC, SMC had been already conducted by a local company employed by JICA survey team. However, interval of longitudinal survey and cross section survey were basically 1000 ft and 5000 ft respectively. Accordingly, the IWUMD survey team shall conduct the additional survey according to the site condition. Regarding Mainor canals, if it is target for desilting and re-sectioning, it shall be included in the survey works. The IWUMD survey team shall confirm with Shwebo and Ye-U maintenance offices.

Detail of survey items

No	Item	Quantity and Description
3-1	Center line profile survey for all canals	Target canal: main canal, extension canal, branch canal, Dy canal, DO canal of OMC system, Length: 3,000 ft, Interval of station: 100 - 500 ft (depend on the site condition) Width of cross section: IWUMD's land property area of the canal + minimum 10 ft at both side
3-2	Longitudinal survey for all canals	
3-3	Cross section survey for all canals	
3-4	Location and spot elevation survey for inlet & outlet of all Head regulator including DO & turn-out	Target canal: main canal, extension canal, branch canal, Dy canal, DO canal of OMC system,

Number of Canal and Total length of Canal (km) by category

Canal category	OMC		SMC		RMC		YMC		Total	
	Nos	km	Nos	km	Nos	km	Nos	km	Nos	km
Main canal	1	76.2	1	43.7	1	84	1	68	4	271.9
Branch canal	0	0	2	63.5	3	73.4	1	29.1	6	166
Sub total	1	76.2	3	107.2	4	157.4	2	97.1	10	437.9
Dy Canal	21	44.4	21	267.1	21	125.8	38	241.7	101	679
DO canal	23	90.4								90.4
Sub total	44	134.8	21	267.1	21	125.8	38	241.7	101	769.4
Total	45	211	24	374.3	25	283.2	40	338.8	111	1,207.3
Minor Canal	35	106.8	76	246	46	193.2	27	59.8	184	605.8

Bench Mark (BM) and Monument of Temporary Bench Mark (TBM)

The IWUMD survey team shall find and check the physical existence of Bench Marks (BM) for irrigation systems and/or BM established by local company employed by JICA survey team. The IWUMD survey team shall establish concrete monuments or metal rivet on the existing concrete structures or stable rock surface as the Temporary Bench Mark (TBM) for the plane survey and longitudinal section survey at each head regulator.

The IWUMD survey team shall take photograph of each TBM and plot the location of TBM in the Topographic Map with appropriate mark. The IWUMD survey team shall prepare the description of coordination and elevation of TBM with sketch and photograph. The IWUMD survey team shall measure elevation of TBM including BM for the design/construction based on the existing BM. The leveling shall start from one existing BM and another existing BM. If the existing BM is not available at the other end, a loop back may be accepted.

Center line profile survey and base map

The IWUMD survey team shall conduct center line profile survey against the centerline of canal. The IWUMD survey team will make plan (base map) by using google earth of drone picture and mention the center line of canal on it. Plain map (base map) shall be placed together with longitudinal section drawing.

Longitudinal Survey

The IWUMD survey team shall conduct longitudinal survey along centerline of canal. Survey point of the

longitudinal line shall be basically 100ft interval and also at structure point as well as at the point wherever there is intersection, cross drainage, box culvert, bridges and the other structure. Structures shall be indicated by a flag with the name over the longitudinal line. When canal section is long straight, interval can extend up to maximum 500ft.

Cross Section Survey

The IWUMD survey team shall conduct cross section survey along centerline of canal. Interval of dike cross section survey shall be same as the Longitudinal Survey.

3) Structure observation survey for canal structure including bridge

Although the number of the canal structure proposed for rehabilitation by preparatory survey is shown in the table below, detail structure survey for all canal structures to categorize the condition of the structures shall be conducted by IWUMD before commencement of the Yen-loan consultant service. Based on the results, IWUMD will make the draft repair plan (repair method, cost, and prioritization) for the structures needing minor repair, while the Yen-loan Consultants will conduct design for the structures requiring large scale rehabilitation and for new constructions.

Accordingly, the IWUMD survey team shall conduct structure observation survey for canal structure including bridges. The survey items to be carried out are mentioned in the table below. Main canal of OMC, RMC, YMC, SMC and 8 Dy canals (Hla Taw DY and DY1 of SMC, Thayetkan DY and DY5 of OMC, DY2 and DY4 of RMC, DY7 and DY18 of YMC) had been already conducted by a local company employed by JICA survey team. Accordingly, the survey team shall confirm whether plane survey and cross section survey to the canal structures in above canals is necessary with Shwebo and Ye-U maintenance offices.

Detail of survey items

No	Item	Quantity and Description
4-1	Detail structure survey (length, width, thickness, height, gate size, material, condition, etc.) and make sketch with photo	All canal structures shall be categorized based on the condition of the structures All canal structures shall be measured and sketch Based on the result, IWUMD will make the repair plan (repair method, cost, and prioritization) for the structures needing minor repair, while the Consultant will conduct design for the structures requiring large scale rehabilitation and for new construction.
4-2	Plane survey at the structure needs large scale rehabilitation	Regarding the structure which the Consultant will conduct design for the structures requiring large scale rehabilitation and for new construction, plane survey and section survey shall be conducted.
4-3	Section survey of structure	

Number of the Canal Structure Proposed for rehabilitation in 4 Irrigation System

Item		Unit	OMC	RMC	SMC	YMC	Total
Main canal	Rehabilitation of the Cross Regulator	Nos	13	6	6	7	32
	Rehabilitation of the Bifurcation	Nos	-	1	1	1	3
	Rehabilitation of the Head Regulator	Nos	40	14	15	29	88
	Rehabilitation of the Direct outlet	Nos	-	65	60	142	267
	Rehabilitation of the Drop Structure	Nos	1	-	-	-	1
	Rehabilitation of the Syphon	Nos	2	13	4	2	21
	Rehabilitation of the flume (canal bridge)	Nos	-	2	2	-	4
	Rehabilitation of the Spill-in structure	Nos	-	4	4	-	8
	Construction of the Spill-in structure	Nos	8	-	-	1	9
	Rehabilitation of the Spill-out structure	Nos	17	3	1	-	21
	Rehabilitation of the Cross Drainage	Nos	-	10	-	14	
	Rehabilitation of the Bridge	Nos	4	21	2	9	36
Branch & Extension canal	Rehabilitation of the Cross Regulator	Nos		11	-	-	11
	Rehabilitation of the Head Regulator	Nos		30	9	13	52
	Rehabilitation of the Direct outlet	Nos		75	77	79	231
	Rehabilitation of the Check Drop	Nos		10	25	8	43
	Rehabilitation of the Syphon	Nos		5	1	-	1
	Rehabilitation of the flume (canal bridge)	Nos		1	-	-	1

Item		Unit	OMC	RMC	SMC	YMC	Total
	Rehabilitation of the Spill-in structure	Nos		18	-	-	18
	Rehabilitation of the Spill-out structure	Nos		8	-	-	8
	Rehabilitation of the Cross Drainage	Nos		19	-	-	19
	Rehabilitation of the Bridge	Nos		9	9	8	26
Dy & Minor canal	Rehabilitation of the Check Structure	Nos	36	10	12	10	78
	Rehabilitation of the Head Regulator	Nos	39	29	75	23	166
	Rehabilitation of the Outlet (Turn-out)	Nos	917	717	1,589	1,065	4,288
	Rehabilitation of the Drop Structure	Nos	114	80	173	75	472
	Rehabilitation of the Syphon	Nos	1	1	5	-	7
	Rehabilitation of the flume (canal bridge)	Nos	2	-	-	-	2
	Rehabilitation of the Spill-in structure	Nos	3	-	-	-	3
	Rehabilitation of the Spill-out structure	Nos	-	-	-	-	-
	Rehabilitation of the Cross Drainage	Nos	10	3	9	17	39
	Rehabilitation of the Bridge	Nos	31	10	18	9	68

4) Drainage Canal need to improvement of capacity

(It is not included in the work of this MOU)

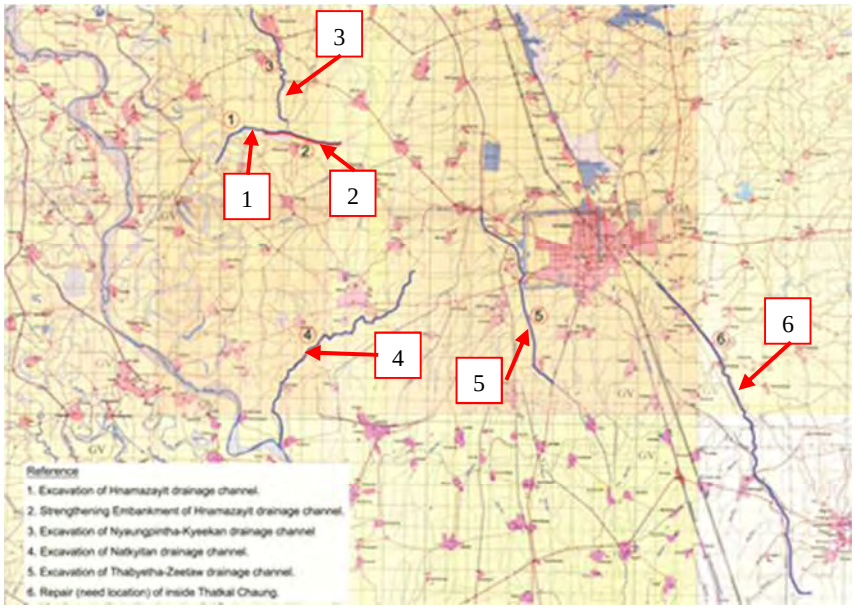
The survey items to be carried out are mentioned in the table below. The IWUMD survey team shall confirm whether plane survey and section survey of structure are necessary with Shwebo and Ye-U maintenance offices.

Detail of survey items

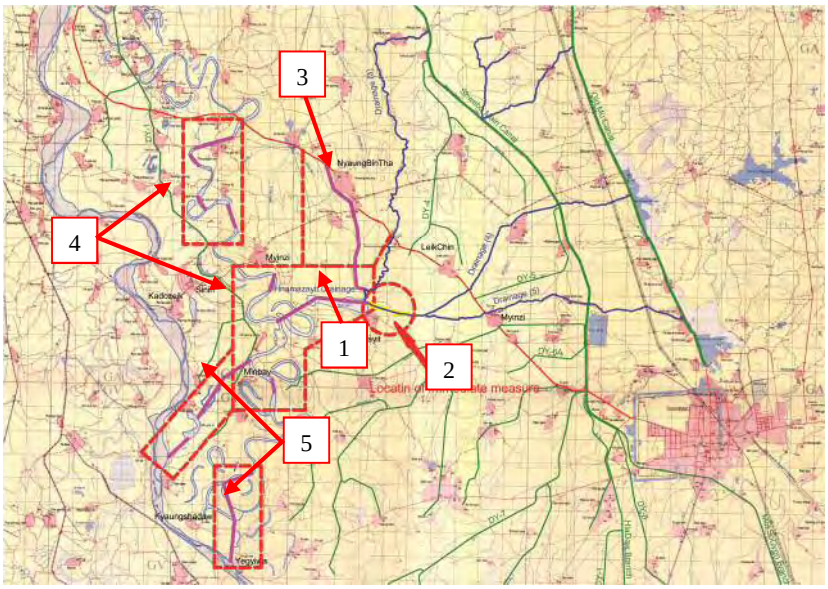
No	Item	Quantity and Description
5-1	Center line profile survey for the drainage	Target canal: Hnamazayit drainage channel, Hnamazayit drainage channel, Nyaungpintha - Kyeekan drainage channel, Natkyitan drainage channel, Thabyetha – Zeetaw drainage channel, Thatkal chaung, new bypass drainage channels Interval of station: 100 ft
5-2	Longitudinal survey of the drainage	
5-3	Plane survey at the particular point such as joint point	
5-4	Structure survey (length, width, height, gate size, material, condition, etc) in drainage such as culvert, bridge, intake wire	All drainage canal structures shall be categorized based on the condition of the structures All drainage canal structures for rehabilitation shall be measured and sketch Based on the result, IWUMD will make the repair plan (repair method, cost, and prioritization) for the structures needing minor repair, while the Consultant will conduct design for the structures requiring large scale rehabilitation and for new construction.

Proposed Drainage Excavation and Strengthening of Embankment

1 Excavation of Hnamazayit drainage channel	5m
2 Strengthening of embankment of Hnamazayit drainage channel	2km
3 Excavation of Nyaungpintha - Kyeekan drainage channel	7km
4 Excavation of Natkyitan drainage channel	15km
5 Excavation of Thabyetha – Zeetaw drainage channel	3km
6 Excavation of Repair of inside Thatkal chaung	20km



Work Plan of Flood Mitigation by Drainage Channel near Hnamazayit

1 Excavation of Hnamazayit drainage channel	5m	
2 Strengthening of embankment of Hnamazayit drainage channel	2km	
3 Excavation of Nyaungpintha - Kyeekan drainage channel	7km	
4 Excavation of drainage channel	8km	
5 Construction of new bypass drainage channels	11km	

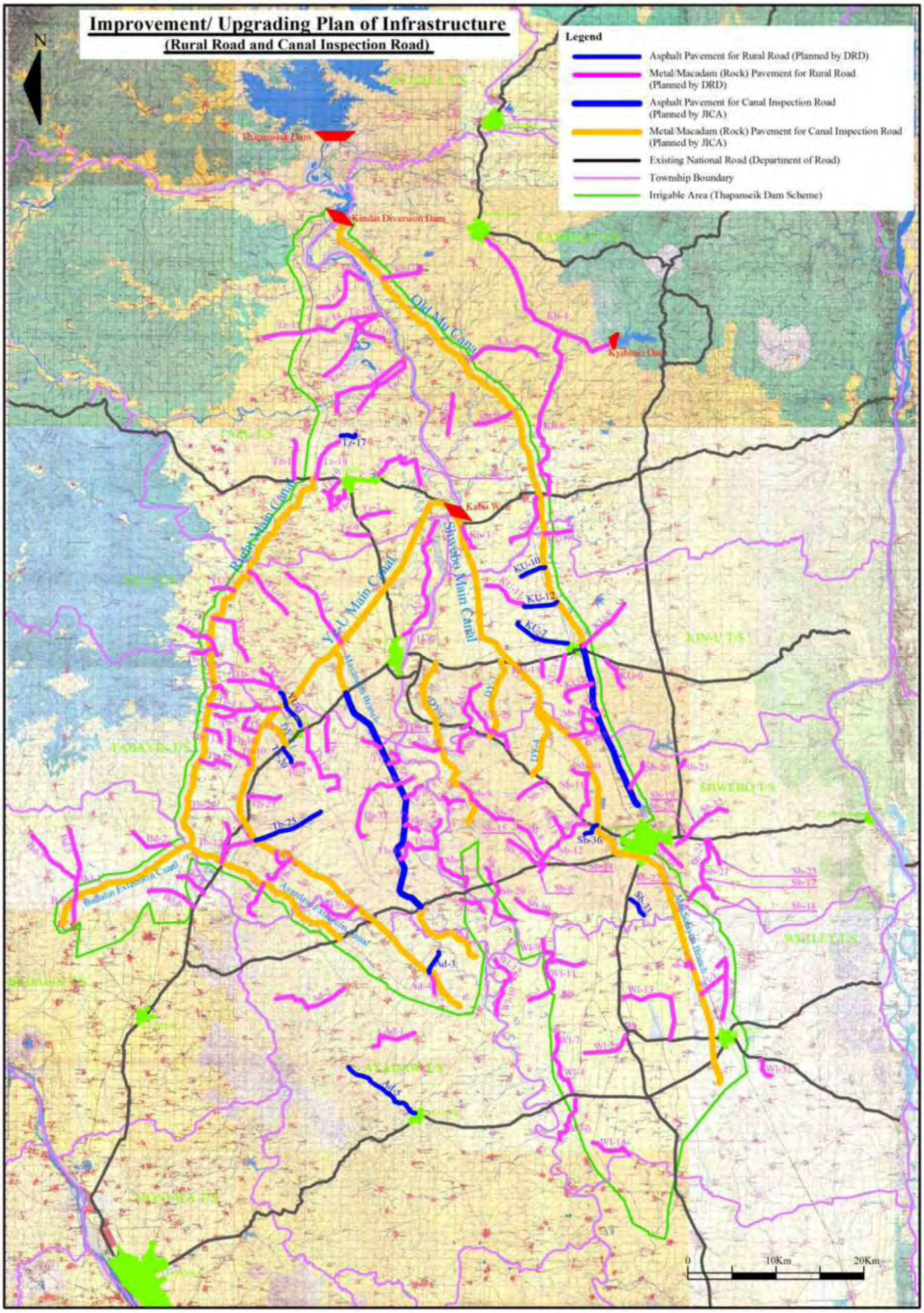
5) Inspection Path along the Old Mu Canal, and Ma Ya Kan Branch Canal of YMC

(It is not included in the work of this MOU)

Old Mu Canal (OMC) RD 184 + 300 - RD 264 + 000 and Ma Ya Kan Branch of YMC RD 11 + 400 - RD 72 + 300 will be improved to asphalt road and constructed by road Construction Company. The survey items to be carried out are mentioned in the table below:

Detail of survey items

No	Item	Quantity and Description
6-1	Plane survey along the inspection path	Target: Old Mu Canal (OMC) RD 184 + 300 - RD 264 + 000
6-2	Longitudinal survey on centerline of inspection path	L= 24.29 km Ma Ya Kan Branch of YMC RD 11 + 400 - RD 72 + 300 L= 18.56km
6-3	Cross section survey along inspection path	Interval of station: 100 ft


Improvement/ Upgrading Plan of Infrastructure
(Rural Road and Canal Inspection Road)
N
Legend
Asphalt Pavement for Rural Road (Planned by DRD)
Metal/Macadam (Rock) Pavement for Rural Road (Planned by DRD)
Asphalt Pavement for Canal Inspection Road (Planned by JICA)
Metal/Macadam (Rock) Pavement for Canal Inspection Road (Planned by JICA)
Existing National Road (Department of Road)
Township Boundary
Irrigable Area (Thapanseik Dam Scheme)
Thapanseik Dam
Kindat Diversion Dam
Kabo Weir
Old Mu Canal
Right Main Canal
Ye-U Main Canal
Shwebo Main Canal
Budalin Extension Canal
Ayadaw Extension Canal
KIN-U T/S
SHWEBO T/S
TABAYIN T/S
AYADAW T/S
0
10Km
20Km

V.11.3 Completion of survey items in dry season of 2017/18

Survey Items, which has been completed until the end of March 2018 are below. The detail structure survey (length, width, height, material, condition) on the structure of Kabo Weir which was planned to conduct in this dry season of 2017/18 was canceled, and will be conducted in next dry season of 2018/19.

1) Kindat Diversion Dam

- Plane survey at emergency spillway
- Longitudinal survey for the direction of dam axis from emergency spillway to the main dam body
- Cross section survey along the direction of dam axis at emergency spillway
- Longitudinal survey and cross section survey for the lead canal for RMC (3,300 ft)
- Contour line (topo) survey in the reservoir around head regulator of RMC (5,700 ft)

2) Canals (RMC irrigation system)

- Longitudinal survey for Main Canal (139,500 ft), Ayadaw Extension Canal (121,355 ft), Budalin Extension Canal (59,800 ft), Dy and Minor canal (563,180 ft)
- Cross section survey for Main Canal, Ayadaw Extension Canal, Budalin Extension Canal, Dy and Minor canal
- Aforementioned surveys have been completed in below canals;

Right Main Canal (RMC) (RD 0 – RD 139+500)	**Ayadaw Extension Canal (AEC)**
RMC Dy-1	AEC DO-1, 2, 3
RMC Dy-1 Minor-1, 2	AEC Direct Minor-1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16, 17, 18, 19, 20
RMC Direct Minor-1	
RMC Dy-2	AEC Dy-1, 2, 3, 4, 5, 6, 7, 8, 9
RMC Dy-2 Minor-1, 2, 3, 4	**Budalin Extension Canal (BEC)**
RMC Dy-2A	BEC Dy-1, 2
RMC Dy-2A Minor-1, 2, 3, 4	BEC Direct Minor-1, 2, 3, 4
RMC, KBC, Dy-2	
RMC, KBC, Dy-2 Minor-1, 2, 3	

- Location and spot elevation survey for inlet & outlet of all Head regulator including DO & turn-out (for the canals mentioned in above table)

3) Structure observation survey for canal structures including bridges

- Detail structure survey (length, width, height, gate size, material, condition, etc.) and make sketch
- Plane survey at the structures which need large scale rehabilitation
- Section survey of structures

The structures of Right main canal, Ayadaw Extension Canal and Budalin Extension Canal have been completed.