3.10 Foundation Treatment

Surface soil with boulders and a superficial loose rock zone of the bedrock should be removed for the foundation of the impervious core zone and the filter zones of the dam.

The bedrock is strong enough to support a 80 metre high rockfill dam, even for its weakest soft rock layer. Problem lies rather in the inter-stratal diversity of strength for alternating hard rocks and soft rocks. This may cause occurrence of harmful tension in the bedrock or in the embankment due to differential deformation of the foundation. This condition is examined by Finite Element Method utilizing the results of the in-situ rock mechanics tests. The differential deformation can be prevented by concrete replacement of the weak layers to a depth of two times thickness of the weak layer. Fig. 3.10.1 shows the above foundation treatment with concrete replacement.

Water seepage through the dam foundation and abutment can be cut off by ordinary cement grouting. From the result of the test grouting, the grout hole arrangement at 2 metre intervals on a couple of lanes is recommended. Necessary depth of the curtain grouting will be approximately 30 metres in the river bed and 30 metres to 60 metres in the abutments.

Blanket grouting shall also be carried out on the foundation of the impervious core and filter zones to ensure the watertightness near the surface of the above foundation. The blanket grouting is designed to be carried out by two lanes at 2 m hole interval (10 m in hole depth) and six lanes at 3 m hole interval (5 m in hole depth). Consolidation grouting will be carried out in the spillway portion. The consolidation grouting is designed to be done by two lanes at 2 m hole interval (5 m in hole depth).

No sign of lava tunnel has been found through two years field geological investigations, including observation of rock outcrops, core drilling with Lugeon test, test grouting, and test aditting. Judgement is negative for existence of a lava tunnel.

The low piezometric heads found in the borehole JD-12 and other holes nearby are judged to indicate existence of local privileged water passage, but not large opening as lava tunnel because of slow draw-down of the water level in the borehole and not outstandingly high Lugeon unit. A few small cavities of about 20 centimetres have been encountered at levels near the contemplated reservoir surface in the borehole JD-102, but not in other holes within 25 metres' distance, which seems to indicate limited distribution of the cavities. The highly pervious portions as indicated by the low groundwater level in JD-12 in the left abutment should be treated by rim curtain grouting stretching for about 400 metres from the wing of the spillway. This stretch of the grout curtain will cover all parts where the reservoir depth is more than 30 metres and can have more than 1/10 of hydraulic gradient. The rim grouting shall be made from a grouting tunnel driven at elevation 190 metres, one metre higher than the reservoir high water level, and to the depth of 60 metres through grout holes arranged at 3 metres intervals. By the split-spacing method, substantial quantity of the grout hole may be eliminated from the parts which do not require grouting, and be added where grouting is really necessary.

Followings are explanations for determination of extent (400m), depth and spacing of the rim grouting on the left flank :

The length (lateral extent) of the grout curtain has been determined so that the curtain may intercept seepages in a zone where the river bed of the Terre Rouge upstream of the dam site, which runs parallel with that grout curtain, is not higher than elevation 160 meters. As the full supply level of the reservoir being at elevation 189 meters, there can be seepage from a 30 meter deep reservoir through under a 300 meter wide plateau without any cut-off work outside the extent of the rim grout curtain. The seepage within the range of 100 meters outside the rim curtain is estimated at only 0.3 litres every second, little enough to be acceptable, assuming 1 exp.-4 cm/sec of permeability coefficient and 30 meters for the range of seepage in depth. The hydraulic gradient is estimated to be 1/10 (30m/300m). The length of the rim grout curtain is, therefore, sufficient.

The depth of the rim grout holes, 60 meters and 40 meters, has been determined to satisfy the conditions :

(1) to reach the level of the nearest river bed or deeper and ;

(2) To be deeper than the level of groundwater, actually observed and conceivable from the observations, including the part of groundwater table depression around the test hole J -12.

The grout hole spacing of 2 meters near the dam/spillway and 3 meters in the most part of the rim curtain has been determined empirically. The length of seepage paths through the plateau is larger (300m) than that under the dam body (approximately 60 m), and reverse is the hydraulic gradient. Requirement for the permeability in the rim can be not so strict as in the dam site. The purpose of the rim grouting is to block outstandingly large and continuous water leakage paths, if any. The grout hole arrangement at 3 meter intervals is deemed appropriate and sufficient.

In the scene of the construction work, the grouting will be performed by a split-spacing method, in which the holes will be initially drilled and grouted at larger intervals (e.g. 6 m) to examine by the grout-takes whether it is necessary to put other holes at the locations of 3 meter intervals. In this procedure, the grouting work quantity will be saved in zones appreciably watertight and may be added where it is necessary. In this context, the designed quantity will be sufficient with due spare.

The design of the foundation treatment with the curtain grouting, blanket grouting, consolidation grouting and river grouting is shown in Fig. 3.10.2.

3.11 Instrumentation

3.11.1 General

The instrumentation is installed in the dam body and foundation in order to monitor the behavior of the dam embankment and its foundation and to evaluate the pertinence of the design. The instrumentation aims at the following:

1) Control during construction period,
2) Operation and maintenance after completion,and
3) Collection of data for further design and study

3.11.2 Instrumentation for Construction Control

The main purpose of the construction control by the measuring apparatus during the construction periods is to check whether the construction of the dam is being carried out safely or not. It will be measured by comparing the design value with the actually measured one. For this purpose , the following measurements are designed to be equipped in the dam body and foundation.

1) Measurement of pore water pressure in dam body and foundation
2) Measurement of earth pressure in impervious core

3.11.3 Instrumentation for O/M after Completion

The main purpose for operation and maintenance (O/M) of the dam is to check the safety of it after impounding the reservoir. Moreover , the safety of the dam will also be monitored by checking the behavior of the dam embankment and its foundation.

For this purpose , the following measurements will be made in and on the main dam embankment and its foundation.

1) Measurement of vertical displacement in impervious core
2) Measurement of displacement of slope
3) Measurement of pore water pressure in impervious core
4) Measurement of earth pressure in impervious core
5) Measurement of pore water pressure in foundation
6) Measurement of seepage quantity through dam and its foundation

3.11.4 Selection of Measuring Apparatus

The various kinds of the measuring apparatus are selected to perform the above-mentioned measurement. The type and the required number of the apparatus are as follows.

Apparatus	Quantity	Abbreviation
1) Pore pressure meter (no.)		
- in foundation	30	PF
- in embankment	33	PP
- in abutments under grout tunnel	16	PN
2) Earth pressure meter (no.)	4	EP
3) Multi-layer settlement meter (set)	2	MV
4) Surface displacement survey point (pcs.)		
- reference point	10	SR
- survey point	22	SS
5) Leakage measuring facitity (set)	1	LE
6) Water level detector and in dicater with gaging staff (set)	1	WL
7) Recording and data processing system (lot)	1	-

(Note:A triangular weir is provided at entrance of the inspection tunnel to measure leakage water. No automatic water level recorder is provided at this location.)

Location of all measuring apparatus are shown in Fig.3.11.1 and Fig.3.11.2.

3.11.5 Measuring Apparatus

(1) Pore Pressure Meter

Pore pressure meters are installed to monitor the pore pressure in the dam embankment and foundation in order to analyze the stress status together with the earth pressure meters and the seepage status together with the leakage measuring facility.

The pore pressure meter is planned to be of strain gage type

The measuring system of the strain gage type pore pressure meter consists of transducer and such accessories as porous plug, connecting cable,etc.

The connecting cables are joined to relay terminal boxs set in the inspection gallery, around the right abutment of the spillway bridge, and in the side wall of grout tunnel, in order to transmit measureed pore pressure to the dam control house for recording and data processing.

(2) Earth Pressure Meter

Earth pressure meters are installed to monitor and to analyse the stress status in the dam embankment.

The earth pressure meter is planned to be strain gage type.

The measuring system of strain gage type earth pressure consists of transducer, connecting cable,etc.

The connecting cables are joined to relay terminal box set around the right abutment of the spillway bridge in order to transmit measured earth pressure to the dam control house for recording and processing.

(3) Multi-layer Settlement Meter

Multi-layer settlement meters are installed to monitor the internal vertical displacement of the dam embankment at 2 sections, namely at Sta.No 16(No.1) and Sta.No.10 (No.2).

The multi-layer settlement meter is of crossarm type , consisting of pipes, settlement plates and its detector, a tape measure,etc.

Settlement measured on the dam crest is input to the computer for processing not by on-line but by offline system.

(4) Surface Displacement Survey Points

Surface displacement survey points are installed to monitor the surface displacement of the dam embankment

The points consistof reference points (SR) and survey points (SS). SR are installed on the stable original ground. SS are installed on the slope and crest of the dam embankment. A pair of reference points are prepared for each alignment of survey points.

Number of points is as follows.

	SR	SS	total
on crest	2	6	8
on slope	8	16	24
total	10	22	32

The vertical displacement is measured by periodical levelling. The horizontal displacement in the traversing direction is measured by using a transit and a target device.

(5) Leakage Measuring Facility

Leakage measuring facility is installed to monitor and analyse the seepage status through the core embankment and dam foundation.

One(1) leakage measuring chamber is constructed at the toe of the main dam embankment in the spoilbank whose crest elevation is EL.125.00m and sloped down to the cofferdam. An inlet block is furnished in front of the measuring channel followed by tripple screens which have 1 m square in area with 75 mm (center to center) bar pitch. Around the end portion of the measuring chamber, a triangular weir is set with a notch angle of 90 degree , 750 mm high and 800 mm wide. Seepage water flows through the inlet block and screens and is measured at the weir and drained to the downstream side. To lead the leakage water into the measuring chamber, concrete wing walls are constructed on both sides of the chamber and jutted up to the both abutments.

Standing water in the sump pit of the inspection gallery is pumped up and drained through the inspection tunnel. At the entrance of the tunnel, a triangilar weir is provided to measure the water manually.

(6) Water Level Detector and Indicator

One(1)set of water level detection equipment with electric water level transmitter, housed in a water-proof enclosure is installed , being embedded in the inclined concrete slab for travelling winch, that will be temporarily furnished for closure of the diversion gate.

The water level detector will be of digital water level measurement sensor and consist of magnet float and other necessary accessories with the following requirements.

-measuring range : FWL.193.50 m to LWL.139.00 m

-accuracy : less than +/-1.0 cm

A staff gauge made of metel plate will be also installed running parallel with the detector and indicator on the inclined concrete step for the intake structure.

3.11.6 Recording and Data Processing System

As shown in the overall block diagram of instrumentation for measuring apparatus in Fig.3.11.2, data measured at each location will be transmitted to the computer for display and processing by the following system.

- Pore pressure (on-line)
- Earth pressure (on-line)
- Leakage water (on-line)
- Reservoir water level (on-line)
- Multi-layer settlement (off-line)
- Slope displacement (off-line)

The data except multi-layer settlement and slope displacement are transmitted to the computer through relay terminal boxes and data acquisition controller consisting of scanner, A.C.stabilizer,etc. or converter.

The data of multi-layer settlement and slope displacement are inputted to the computer manually.

Processed data are displayed on the monitor of the computer, outputted on printer and/or plotter according to the requirements.

TABLES

Table 3.5.1: TEST RESULTS OF EARTH MATERIAL

ITEM				EM1-1	EM1-2	EM2-1	EM2-2	EM3-1	EM3-2	EM4-1	EM4-2
Specific gravity		Gs		2.862	2.875	2.885	2.879	2.882	2.900	2.884	2.891
Gradation	Gravel		(%)	0	34	0	0	0	0	0	0
	Sand		(%)	5	13	4	4	1	2	5	7
	Silt		(%)	49	29	45	50	42	43	37	59
	Clay		(%)	46	24	51	46	57	55	58	34
Liquid limit		LL	(%)	70.2	63.7	68.0	62.8	75.6	69.0	72.2	68.0
Plastic limit		PL	(%)	45.7	46.3	45.8	40.7	59.7	48.2	48.2	46.6
Plasticity index		PI		24.5	17.4	22.2	22.1	15.9	20.8	24.0	21.4
Unified soil classification				MH	MH	MH	MH	MH	MH	MH	MH
Soluble salt			(part/million)		150	250			100	200	
Natural moisture content			(%)	42.8	45.0	41.6	37.0	41.8	36.0	38.2	37.0
Optimum moisture content		OMC	(%)		40.5	40.6			40.6	42.0	
Maxmum dry density		DDmax	(tf/m3)		1.297	1.306			1.31	1.278	
Coefficient of permeability		k	(cm/sec)								
	dry side				5.9E-06	7.6E-07			3.3E-06	4.8E-07	
	wet side				3.7E-08	7.6E-08			6.0E-07	1.0E-07	
Triaxial shear (effective stress)		CU condition									
Cohesion		c'	(kgf/cm2)		0.07	0.00			0.04	0.08	
Internal friction angle			(degrees)		34	33			33	33	

Table 3.5.2: SUMMARY OF TEST RESULTS OF EARTH MATERIAL

Item			Range	Average
Specific gravity	Gs		2.862 - 2.900	2.882
	Gravel	(%)	0 - 34	4
Gradation	Sand	(%)	1 - 13	5
	Silt	(%)	29 - 59	44
	Clay	(%)	24 - 58	47
Consistency	LL	(%)	62.8 - 75.6	68.7
	PL	(%)	40.7 - 59.7	47.7
	PI		15.9 - 24.5	21.0
Unified soil classification			MH	MH
Natural moisture content	wn	(%)	36.0 - 45.0	39.9
Soluble salt determination		(parts/million)	100 - 250	175

Table 3.5.3: PERMEABILITY OF EARTH MATERIAL

Sample		Dry density (tf/m^3)	Moisture content (%)	Coefficient of permeability (cm/sec)
EM1-2	(Dry side)	1.215	34.5	5.9×10^{-6}
	(Wet side)	1.215	44.1	3.7×10^{-8}
EM2-1	(Dry side)	1.241	36.0	7.6×10^{-7}
	(Wet side)	1.241	47.5	7.6×10^{-8}
EM3-2	(Dry side)	1.244	34.2	3.3×10^{-6}
	(Wet side)	1.244	46.5	6.0×10^{-7}
EM4-1	(Dry side)	1.214	37.9	4.8×10^{-7}
	(Wet side)	1.214	47.6	1.0×10^{-7}

Table 3.5.4: PROPERTIES OF FILTER MATERIAL

Item			A-1	A-2	A-3	A-4	A-5	A-6
Specific gravity	(Oven dry)		2.871	2.894	2.892	2.892	2.903	2.893
	(Saturated surface dry)		2.898	2.913	2.912	2.915	2.922	2.915
Water absorption	(%)		0.93	0.65	0.70	0.81	0.65	0.77
Gradation	Gravel	(%)	100	100	100	100	100	100
	Sand	(%)	0	0	0	0	0	0
	Silt	(%)	0	0	0	0	0	0
	Clay	(%)	0	0	0	0	0	0
Soundness		(%)	1.9	2.3	3.1	1.6	2.9	1.7
Abrasion		(%)	16.9	16.4	16.7	16.5	15.9	16.4

Table 3.5.5: PROPERTIES OF ROCK CORE MATERIAL

Item	R-1	R-2	R-3	R-4	R-5	R-6
Type of rock*	F	O	O	F	F	O
Hole	JQ-1	JQ-1	JQ-1	JQ-2	JQ-2	JQ-2
Depth (GL- m)	9.8	12.7	14.6	7.6	9.1	13.7
Unit weight (tf/m^3)	2.321	2.760	2.846	2.381	2.578	2.912
Natural moisture content (%)	7.4	1.2	1.0	4.8	5.6	0.7
Specific gravity	2.241	2.709	2.860	2.289	2.478	2.932
Water absorption (%)	10.3	1.8	1.8	10.6	6.8	2.4
Compressive strength (kgf/cm^2)	168	980	1408	216	517	855

* Type of rocks F : Flow Breccia
O : Old Lava (Felty)

Table 3.5.6: DESIGN VALUES OF EMBANKMENT MATERIALS

Item		Earth	Filter		Rock
			Fine	Coarse	
Specific gravity		2.88			
(Oven dry condition)			2.87	2.87	2.87
Natural moisture content	(%)	40.0			
Water absorption	(%)		2.0	2.0	2.0
Dry density	(tf/m^3)	1.23	1.90	2.00	2.10
Wet density	(tf/m^3)	1.72	1.94	2.04	2.14
Saturated density	(tf/m^3)	1.80			
Submerged density	(tf/m^3)	0.80	1.23	1.30	1.37
Coefficient of permeability	(cm/sec)	1×10^{-5}	1×10^{-3}	1×10^{-2}	1×10^{-1}
Strength parameter (effective stress analysis)					
Cohesion c'	(tf/m^2)	0.0	0.0	0.0	0.0
Internal friction angle ϕ'	(degree)	30.0	36.0	38.0	40.0

Table 3.6.1 RESULTS OF DAM STABILITY ANALYSIS
(Dam Scheme: Present Scheme (Dam Crest EL. 196.0 m),
Dam Section: Left Bank Dam Section)

MF-01: Case Name
SFN : Safety Factor in Normal Condition
SFE : Safety Factor in Seismic Condition

Case	Water Level	Seismic Coefficient	Upstream 1:2.3	Downstream 1:1.8
Reservoir Full	189.00	0.05	MO-01 SFN = 1.926 SFE = 1.568	MO-01 SFN = 1.533 SFE = 1.367
Rapid Drawdown (1)	155.50	0.05	MO-02 SFN = 1.979 SFE = 1.722	MO-02 SFN = 1.533 SFE = 1.367
Rapid Drawdown (2)	164.00	0.05	MO-03 SFN = 1.883 SFE = 1.594	MO-03 SFN = 1.533 SFE = 1.367
After Completion	—	0.025	MO-04 SFN = 1.979 SFE = 1.849	MO-04 SFN = 1.533 SFE = 1.446
Design Flood	193.50	—	MO-05 SFN = 1.979 SFE = —	MO-05 SFN = 1.533 SFE = —

Table 3.6.2 RESULTS OF DAM STABILITY ANALYSIS
(Dam Scheme: Expanded Scheme (Dam Crest EL. 215.0 m),
Dam Section: Left Bank Dam Section)

MF-01: Case Name
SFN : Safety Factor in Normal Condition
SFE : Safety Factor in Seismic Condition

Case	Water Level	Seismic Coefficient	Upstream 1:2.3	Upstream 1:2.5	Downstream 1:1.8
Reservoir Full	209.00	0.05	MF-01 SFN = 1.711 SFE = 1.387	MF-02 SFN = 1.881 SFE = 1.509	MF-01 SFN = 1.533 SFE = 1.366
Rapid Drawdown (1)	155.50	0.05	MF-03 SFN = 1.506 SFE = 1.294	MF-04 SFN = 1.620 SFE = 1.386	MF-03 SFN = 1.533 SFE = 1.366
Rapid Drawdown (2)	174.00	0.05	MF-05 SFN = 1.523 SFE = 1.289	MF-06 SFN = 1.620 SFE = 1.378	MF-05 SFN = 1.533 SFE = 1.366
After Completion	—	0.025	MF-07 SFN = 1.543 SFE = 1.435	MF-08 SFN = 1.597 SFE = 1.469	MF-07 SFN = 1.533 SFE = 1.446
Design Flood	212.50	—	MF-09 SFN = 1.831 SFE = —	MF-10 SFN = 1.982 SFE = —	MF-09 SFN = 1.533 SFE = —

Table 3.6.3 RESULTS OF DAM STABILITY ANALYSIS
(Dam Scheme: Expanded Scheme (Dam Crest EL. 215.0 m),
Dam Section: Right Bank Dam Section)

MF-01: Case Name
SFN : Safety Factor in Normal Condition
SFE : Safety Factor in Seismic Condition

Case	Water Level	Seismic Coefficient	Upstream 1:2.3	Downstream 1:1.8
Reservoir Full	209.00	0.05	—	MFR-01 SFN = 1.464 SFE = 1.276

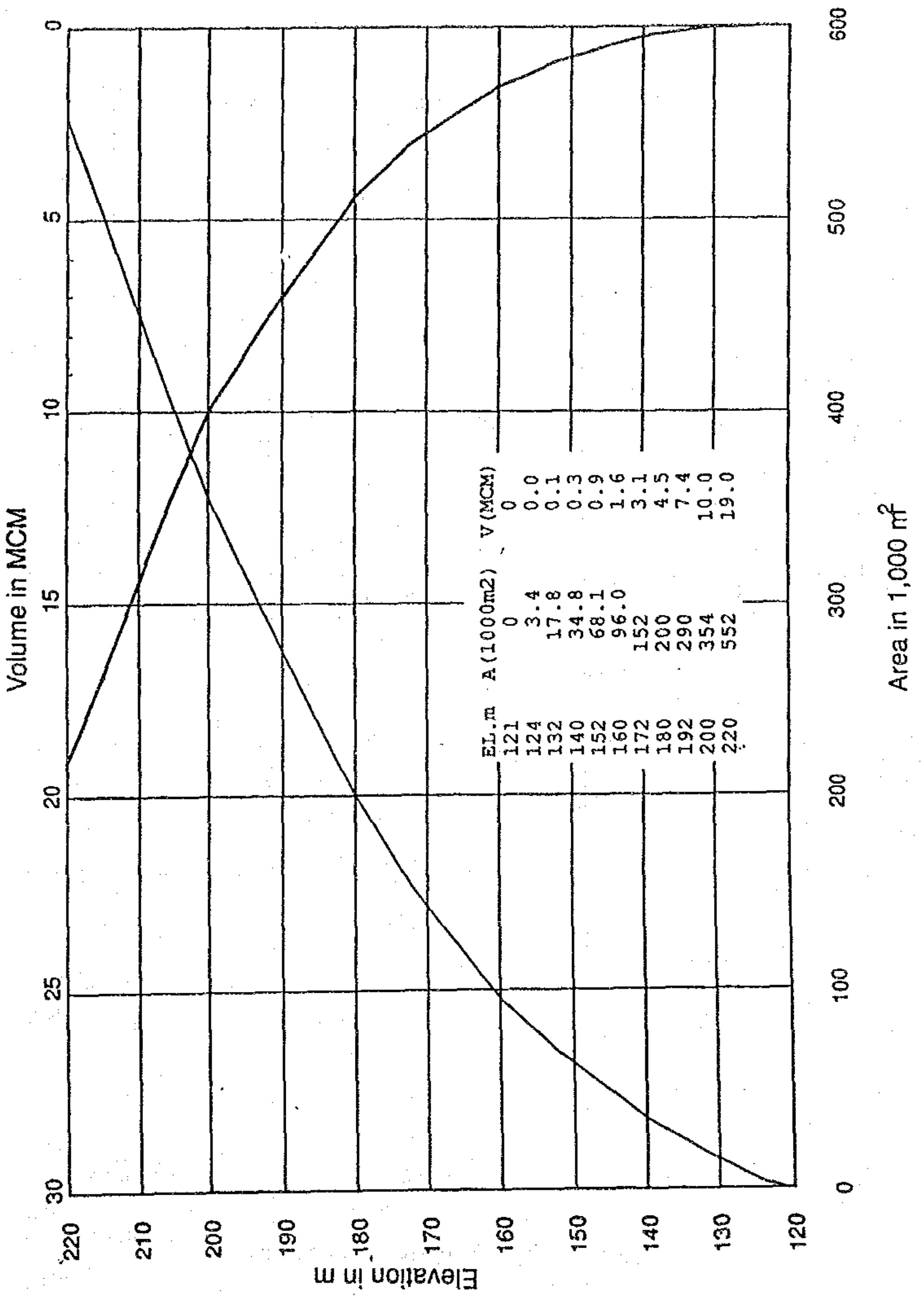
Table 3.6.4 RESULTS OF DAM STABILITY ANALYSIS
(Main Coffer Dam (Dam Crest EL. 155.5 m))

MF-01: Case Name
SFN : Safety Factor in Normal Condition
SFE : Safety Factor in Seismic Condition

Case	Water Level	Seismic Coefficient	Upstream 1:2.3	Downstream 1:1.8
Rapid Drawdown	138.00	0.05	C-01 SFN = 1.843 SFE = 1.546	C-01 SFN = 1.604 SFE = 1.426
After Completion	—	0.025	C-02 SFN = 1.998 SFE = 1.866	C-02 SFN = 1.604 SFE = 1.511
Design Flood	154.50	—	C-03 SFN = 1.997 SFE = —	C-03 SFN = 1.604 SFE = —

FIGURES

Fig. 3. 2. 1



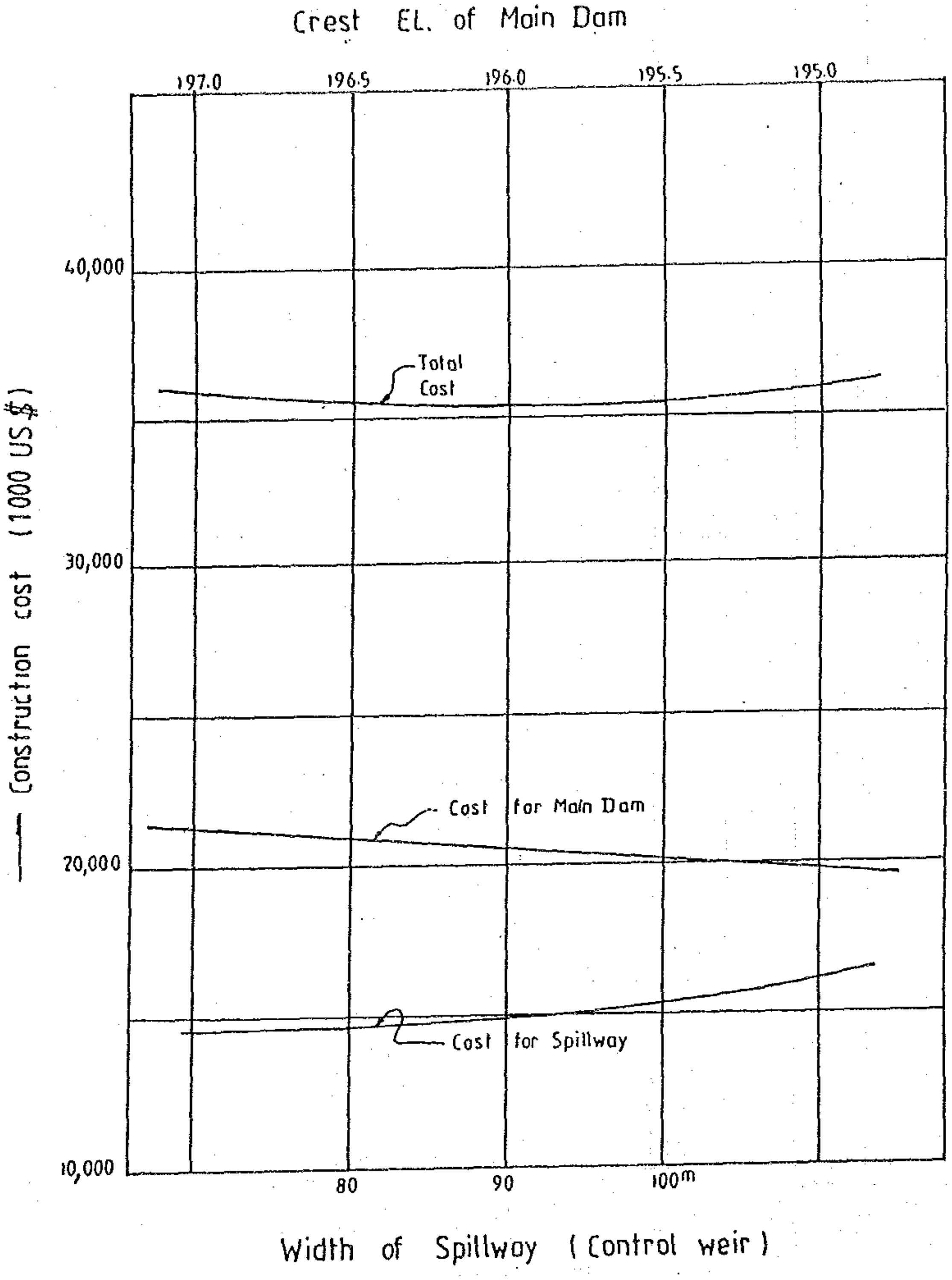
EL.m	A(1000m2)	V(MCM)
121	0	0
124	3.4	0.0
132	17.8	0.1
140	34.8	0.3
152	68.1	0.9
160	96.0	1.6
172	152	3.1
180	200	4.5
192	290	7.4
200	354	10.0
220	552	19.0

STAGE-STORAGE-AREA CURVE

GOVERNMENT OF MAURITIUS
PORT LOUIS WATER SUPPLY PROJECT

JAPAN INTERNATIONAL COOPERATION AGENCY

Fig. 3. 2. 2

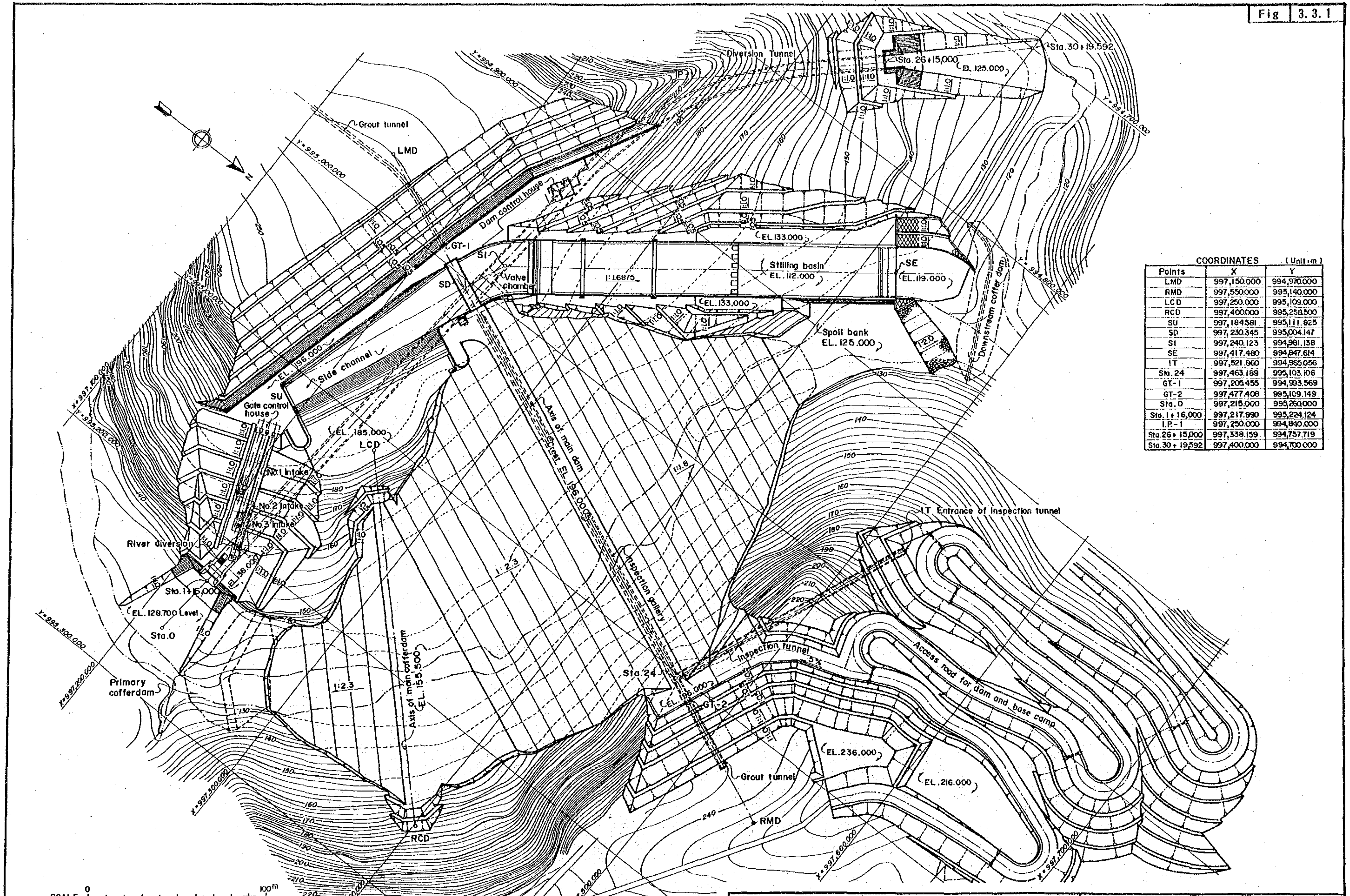


COST COMPARISON BETWEEN DAM HEIGHT AND SPILLWAY WEIR WIDTH

GOVERNMENT OF MAURITIUS
PORT LOUIS WATER SUPPLY PROJECT

JAPAN INTERNATIONAL COOPERATION AGENCY

Fig 3.3.1



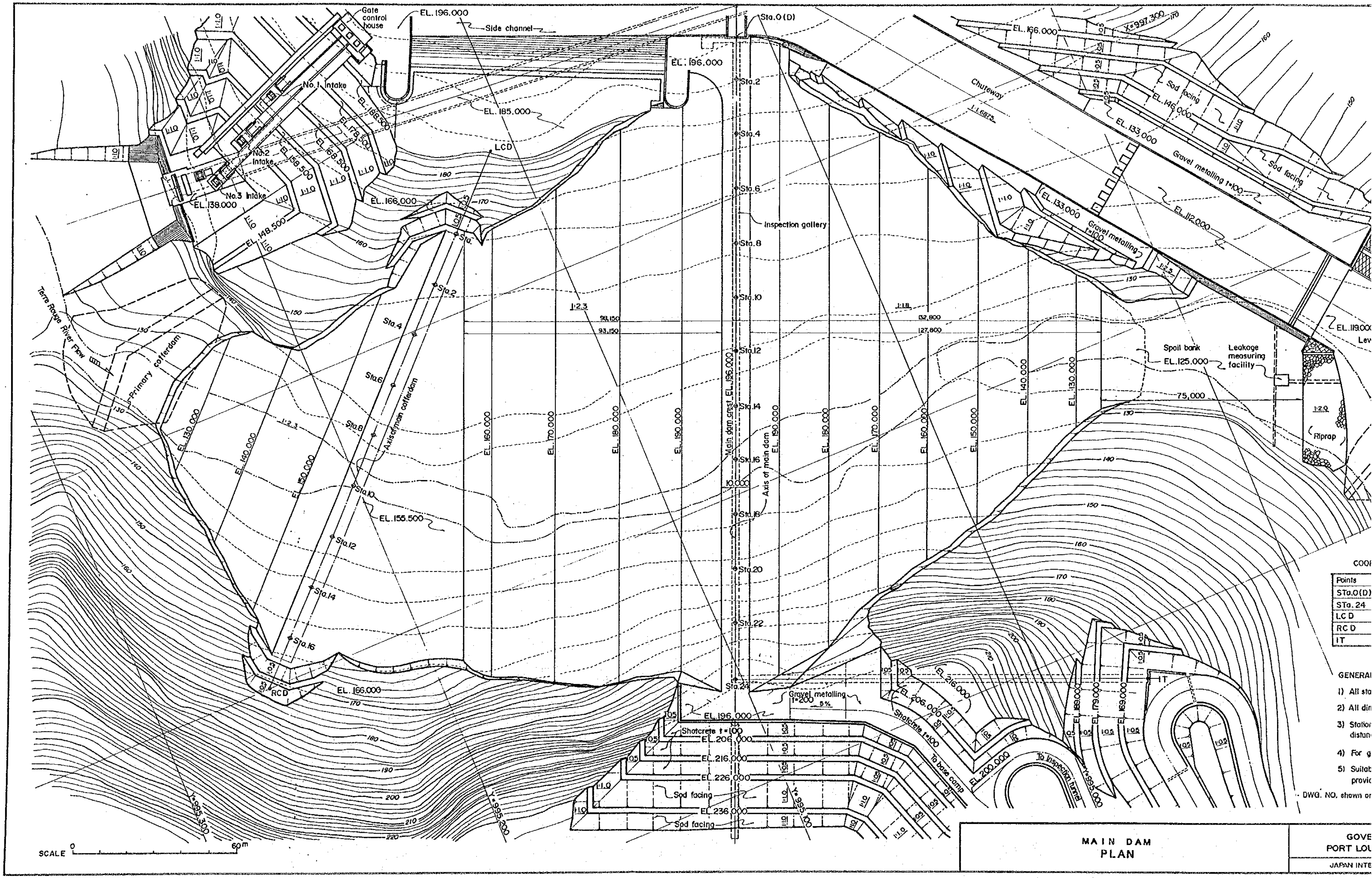
COORDINATES (Unit : m)

Points	X	Y
LMD	997,150.000	994,970.000
RMD	997,550.000	995,140.000
LCD	997,250.000	995,109.000
RCD	997,400.000	995,258.500
SU	997,184.581	995,111.825
SD	997,230.345	995,004.147
SI	997,240.123	994,981.138
SE	997,417.480	994,847.614
IT	997,521.860	994,965.056
Sta. 24	997,463.189	995,103.106
GT-1	997,205.455	994,993.569
GT-2	997,477.408	995,109.149
Sta. 0	997,215.000	995,260.000
Sta. 1+16,000	997,217.990	995,224.124
I.P.-1	997,250.000	994,840.000
Sta. 26+15,000	997,338.159	994,757.719
Sta. 30+19,592	997,400.000	994,700.000

MAIN DAM
GENERAL PLAN

GOVERNMENT OF MAURITIUS
PORT LOUIS WATER SUPPLY PROJECT

JAPAN INTERNATIONAL COOPERATION AGENCY



MAIN DAM
PLAN

GOVE
PORT LOU
JAPAN INTE

COOR

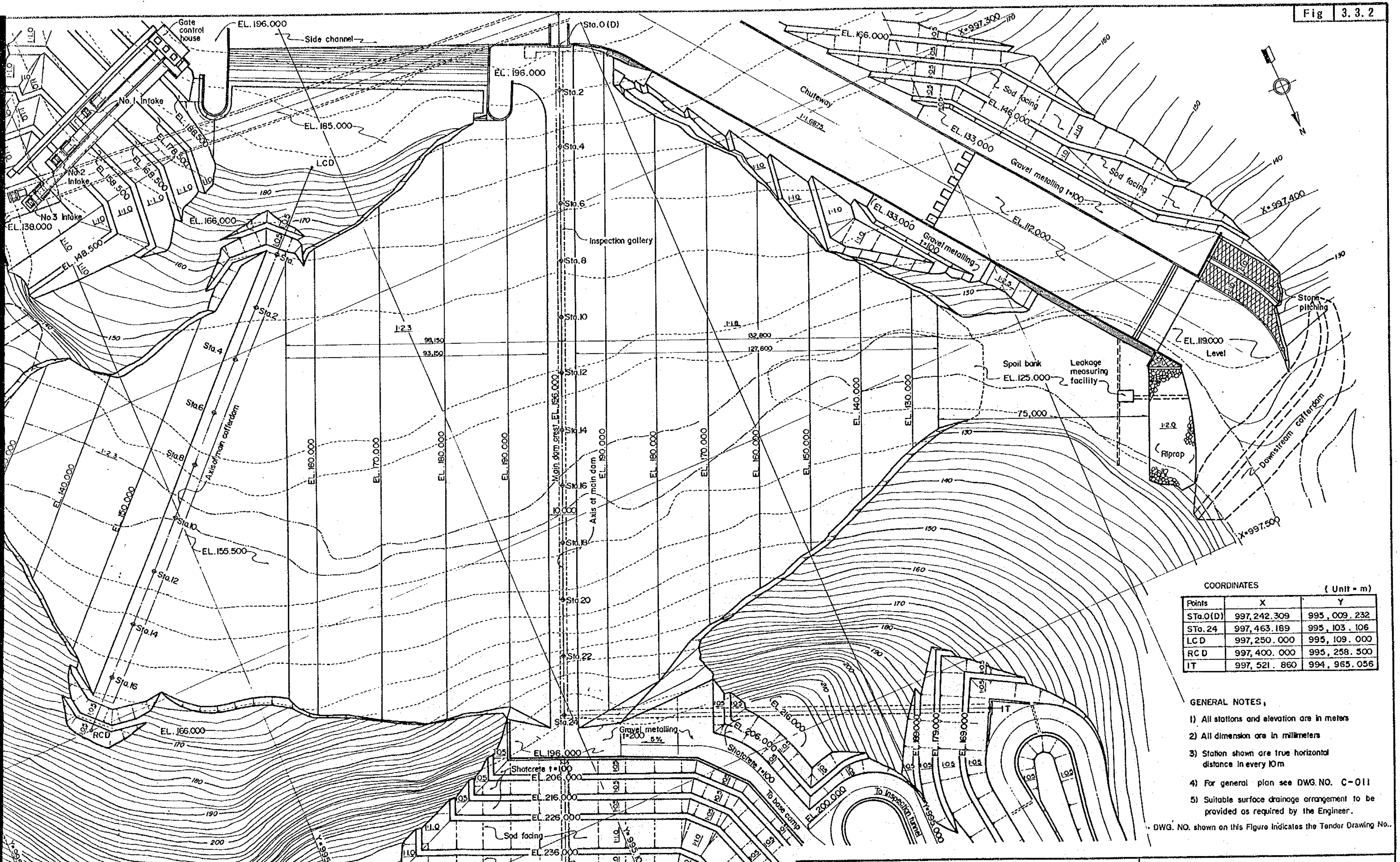
Points
STa.0(D)
STa. 24
LC D
RC D
IT

GENERA

1) All sta
2) All dir
3) Station distan
4) For g
5) Suitab provic

DWG. NO. shown or

Fig 3.3.2



COORDINATES (Unit = m)

Points	X	Y
STa.0(D)	997,242.309	995, 009. 232
STa.24	997,463.189	995, 103. 106
LCD	997,250.000	995, 109. 000
RCD	997,400.000	995, 258. 500
IT	997,521.860	994, 965. 056

GENERAL NOTES;

1) All stations and elevation are in meters
2) All dimension are in millimeters
3) Station shown are true horizontal distance in every 10m
4) For general plan see DWG.NO. C-011
5) Suitable surface drainage arrangement to be provided as required by the Engineer.

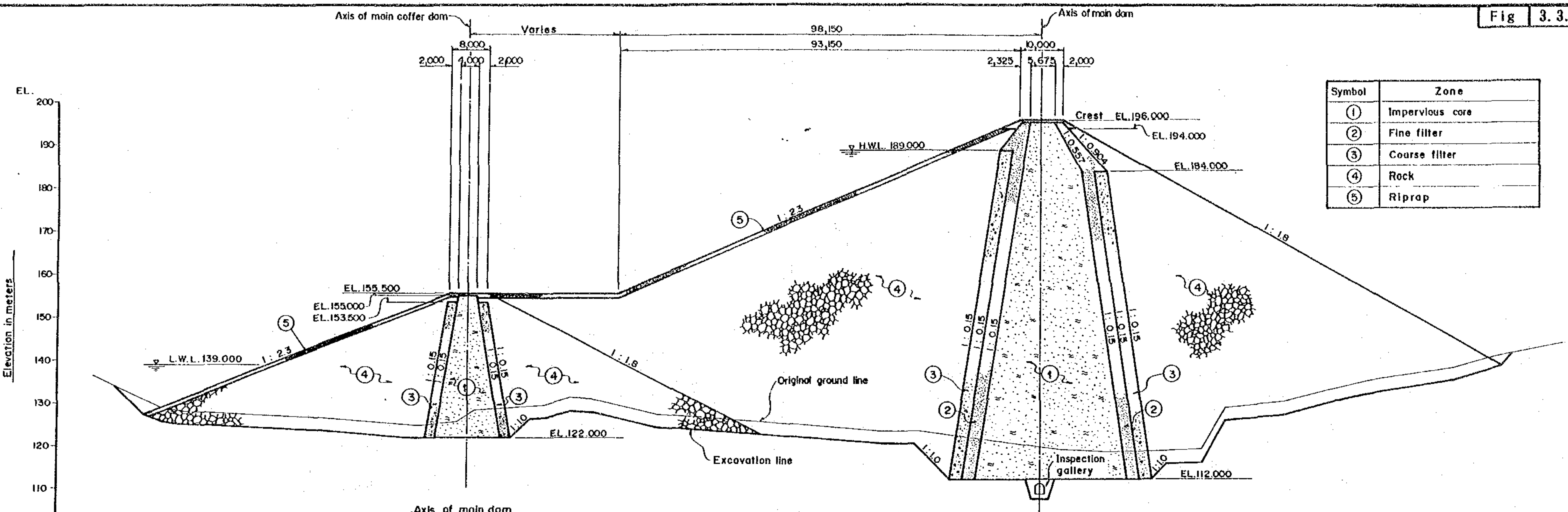
* DWG. NO. shown on this Figure indicates the Tender Drawing No..

MAIN DAM
PLAN

GOVERNMENT OF MAURITIUS
PORT LOUIS WATER SUPPLY PROJECT

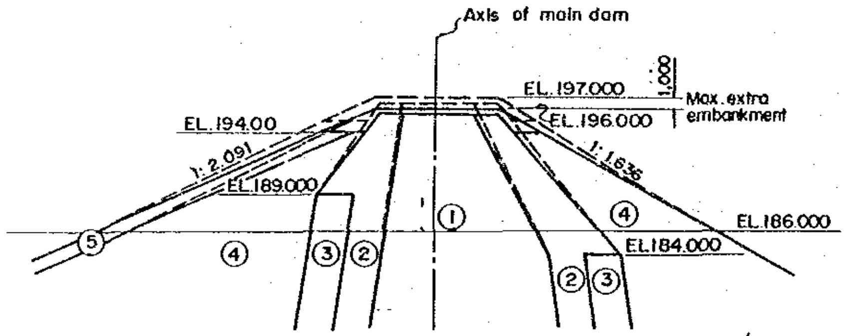
JAPAN INTERNATIONAL COOPERATION AGENCY

Fig 3.3.3

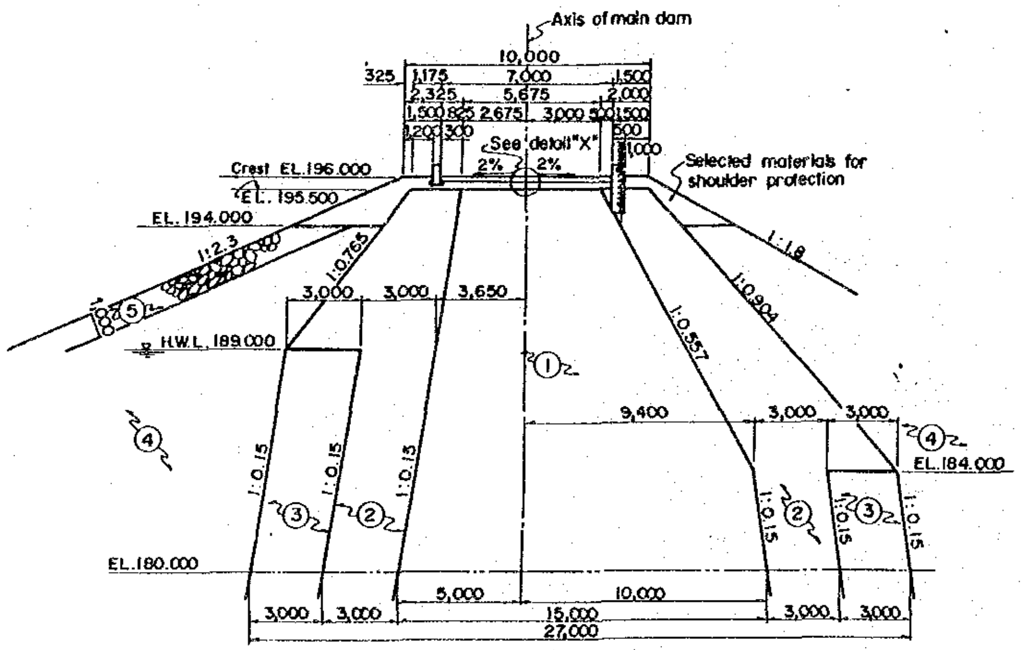


TYPICAL CROSS SECTION SCALE.A

Symbol	Zone
①	Impervious core
②	Fine filter
③	Course filter
④	Rock
⑤	Riprap

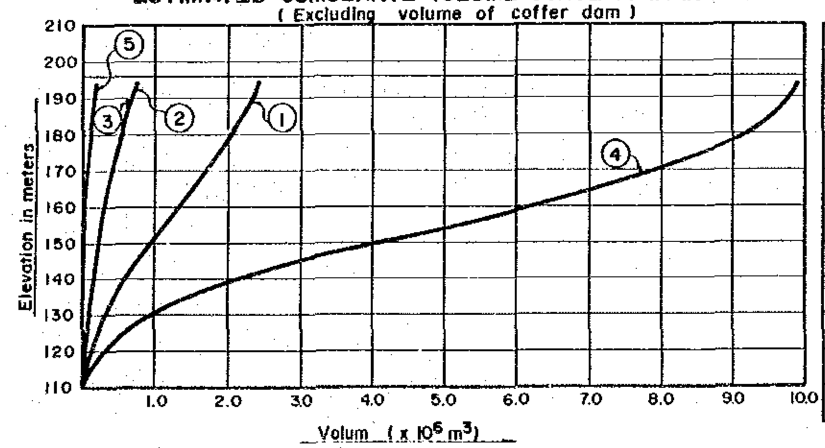


DETAIL OF EXTRA EMBANKMENT SCALE D



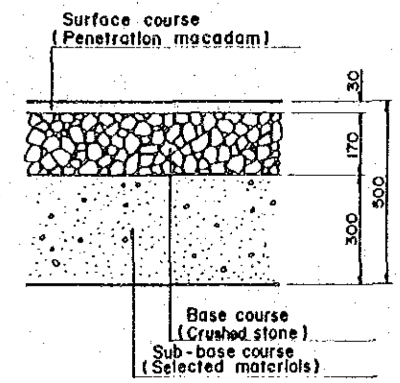
CREST DETAIL SCALE B

ESTIMATED CUMULATIVE VOLUME CURVE OF MAIN DAM
(Excluding volume of coffer dam)



ESTIMATED VOLUME OF MAIN DAM
(Excluding volume of coffer dam)

Elevation (m)	Zone ①	Zone ②	Zone ③	Zone ④	Zone ⑤	Total ($x10^3 m^3$)
196 ~ 190	9.9	4.8		7.7	2.1	24.5
190 ~ 180	29.2	9.4	8.7	62.0	4.8	114.1
180 ~ 170	34.1	12.4	12.4	126.9	4.3	190.1
170 ~ 160	38.1	11.7	11.7	174.4	3.7	239.6
160 ~ 150	36.3	9.8	9.8	212.3	6.4	274.6
150 ~ 140	35.7	8.4	8.4	187.0	-	239.5
140 ~ 130	30.3	6.4	6.4	118.9	-	162.0
130 ~ 120	19.3	4.1	4.1	78.2	-	105.7
120 ~ 110	10.0	1.8	1.7	17.8	-	31.3
Total($x10^3 m^3$)	242.9	68.8	63.2	985.2	21.3	1,381.4

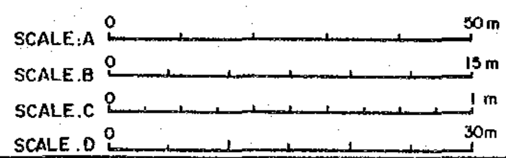


DETAIL "X" SCALE.C

NOTES ;

1) For general notes see DWG No. C－012
2) For typical cross section of main coffer dam see DWG No. C－001
3) Excavation levels indicated may change to suit actual site conditions

- DWG. NO. shown on this Figure indicates the Tender Drawing No..

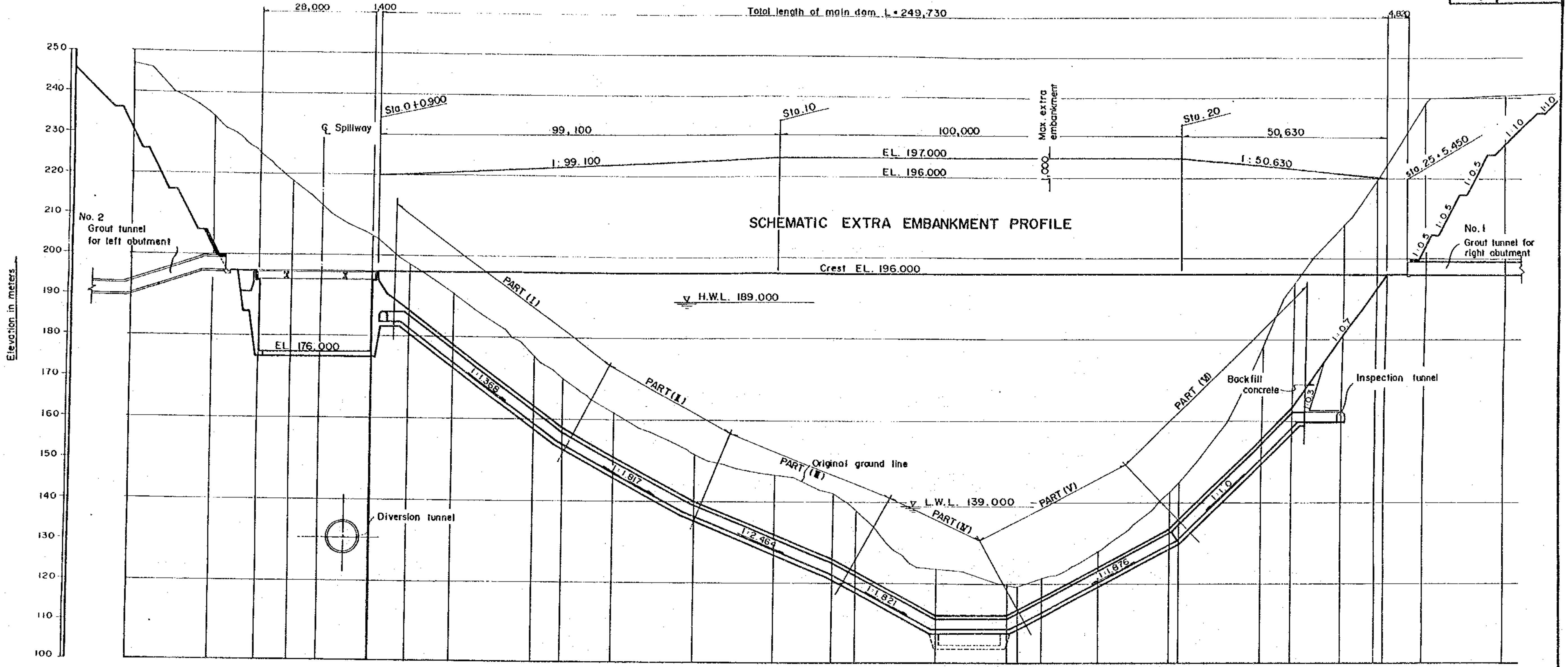


MAIN DAM
TYPICAL SECTION & DETAILS

GOVERNMENT OF MAURITIUS
PORT LOUIS WATER SUPPLY PROJECT

JAPAN INTERNATIONAL COOPERATION AGENCY

Fig 3.3.4



Station Nos.	Distance (m)	Accumulative Distance (m)	Ground Height (m)	Formation Height (m)	Cut depth (m)
sta - 6	-20.000	-60.000	247.000		
sta. -4	-20.000	-40.000	234.000		
2-8.500	-8.500	-28.500	225.500	175.000	50.500
sta. -2	-7.500	-20.000	216.000	Level	43.000
1-2.500	-12.500	-13.000	212.500	175.000	37.500
0-0.500	-0.500	-0.500	204.700	175.000	29.700
sta. 0	0.000	0.000	204.500	175.000	29.500
0+9.000	9.000	9.000	195.500	186.000	9.500
sta. 2	11.000	20.000	190.300	177.958	12.342
sta. 4	20.000	40.000	175.400	163.337	12.063
4+7.300	7.300	47.300	170.000	158.000	12.000
sta. 6	12.700	60.000	161.500	151.009	10.441
sta. 8	20.000	80.000	151.000	140.000	11.500
sta. 10	20.000	100.000	146.800	131.884	14.916
11+4.500	14.500	114.500	142.000	126.000	16.000
sta. 12	5.500	120.000	138.000	122.980	15.020
sta. 14	20.000	140.000	123.500	112.000	11.500
15+7.366	17.366	157.366	119.600	112.000	7.600
sta. 16	2.634	160.000	119.000	113.404	5.596
16+5.800	5.800	165.800	121.000	116.500	4.500
sta. 18	14.200	180.000	128.000	124.067	3.933
19+7.700	17.700	197.700	142.500	133.500	9.000
sta. 20	2.300	200.000	145.000	135.800	9.200
sta. 22	20.000	220.000	178.500	155.800	22.700
22+8.300	8.300	228.300	193.700	164.100	29.600
sta. 24	11.700	240.000	208.000	180.814	27.186
24+8.400	8.400	248.400	219.000	192.814	26.186
25+0.630	2.230	250.630	223.100	196.000	27.100
sta. 26	9.370	260.000	238.500	206.000	32.500
sta. 28	20.000	280.000	240.500	236.000	4.500

Level (formation height between 175.000 at 2-8.500 and 175.000 at 1-2.500; between 112.000 at sta. 14 and 112.000 at 15+7.366)

PROFILE

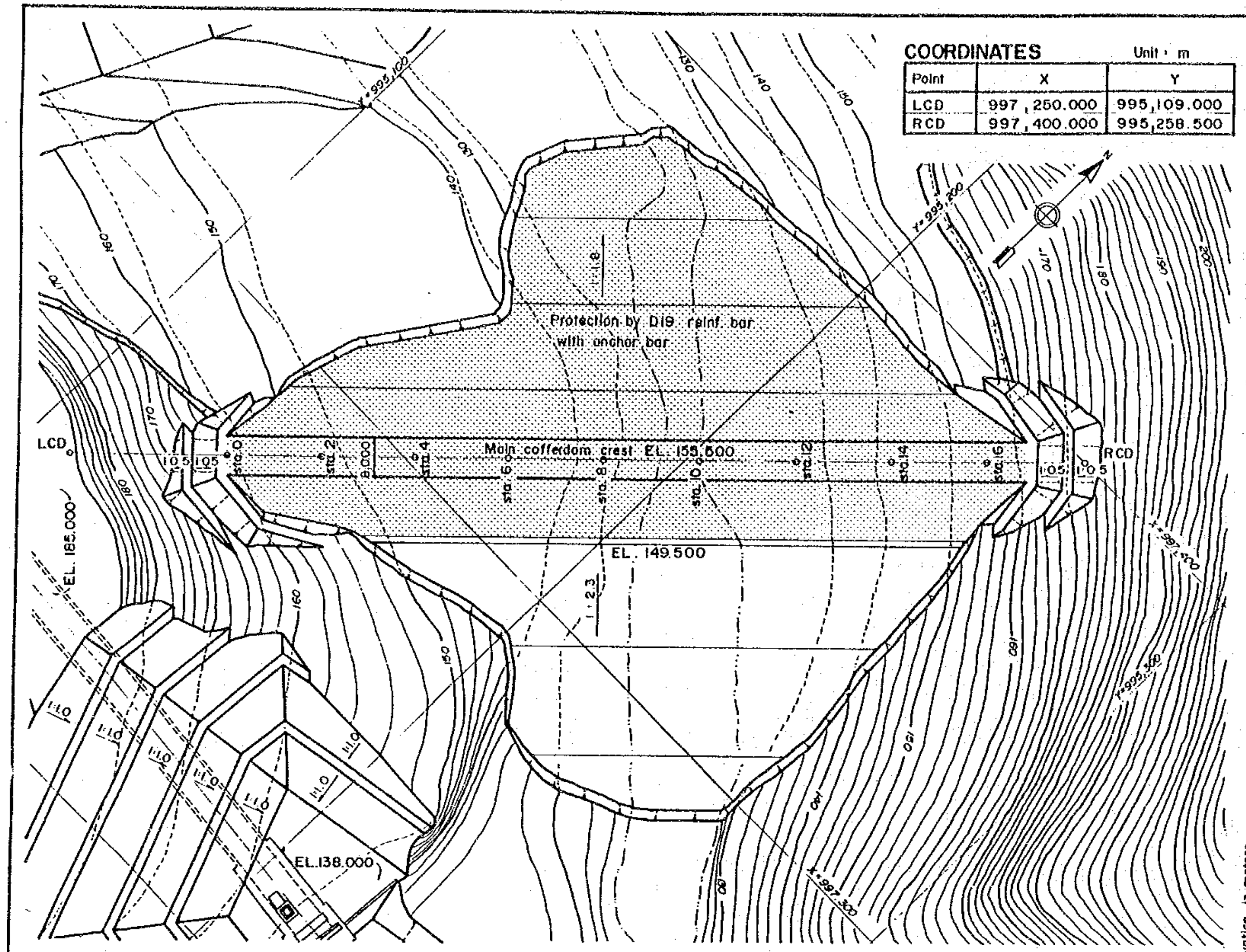
SCALE 0 ——— 50m

Note;
1) Excavation levels indicated may change to suit actual geological conditions.

MAIN DAM
PROFILE

GOVERNMENT OF MAURITIUS
PORT LOUIS WATER SUPPLY PROJECT
JAPAN INTERNATIONAL COOPERATION AGENCY

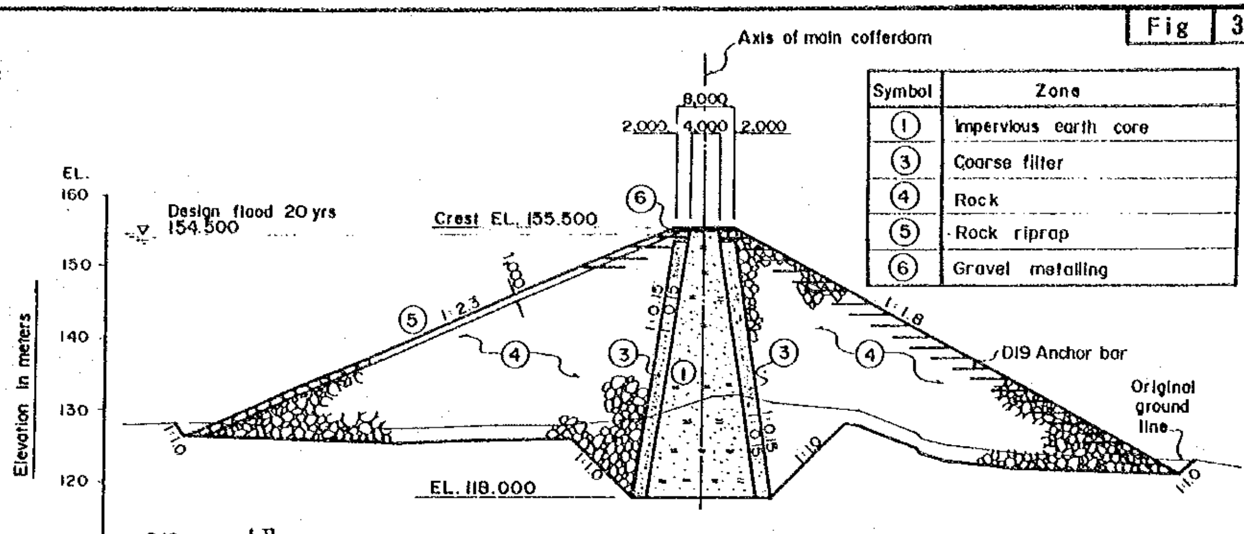
Fig 3.3.5



PLAN SCALE A

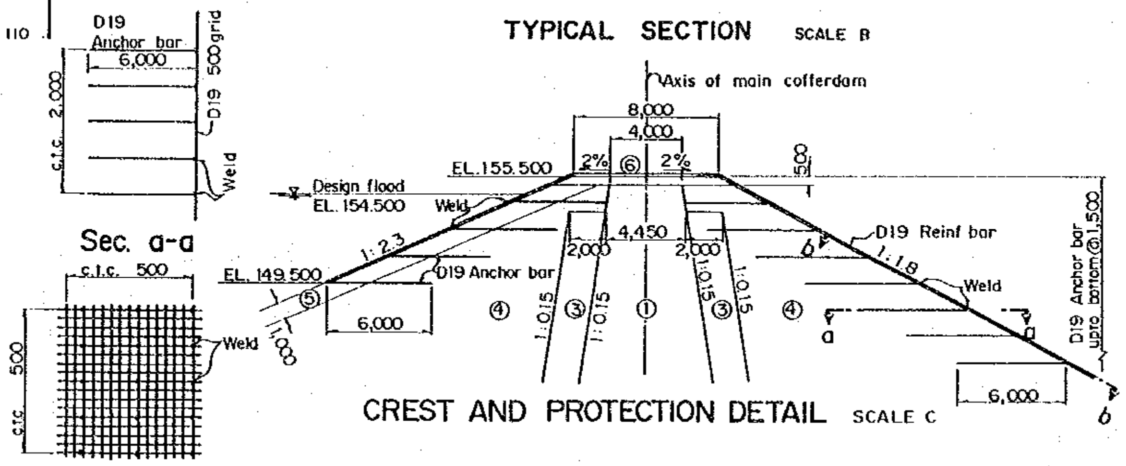
COORDINATES Unit : m

Point	X	Y
LCD	997,250.000	995,109.000
RCD	997,400.000	995,258.500

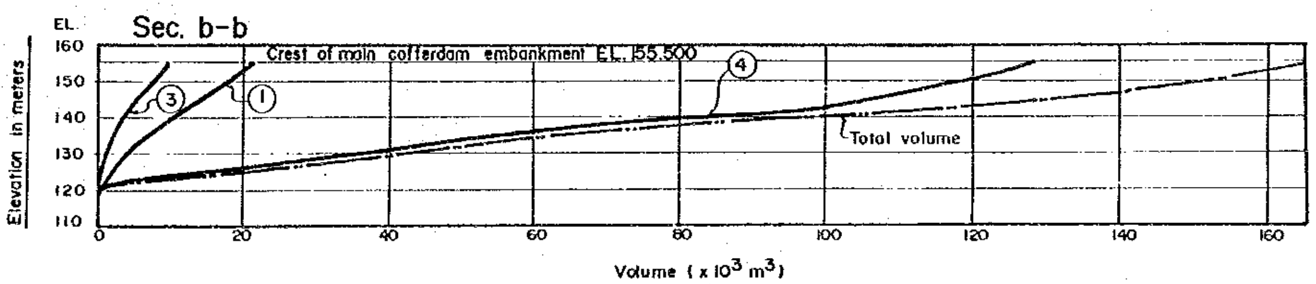


TYPICAL SECTION SCALE B

Symbol	Zone
①	Impervious earth core
③	Coarse filter
④	Rock
⑤	Rock riprap
⑥	Gravel metalling



CREST AND PROTECTION DETAIL SCALE C

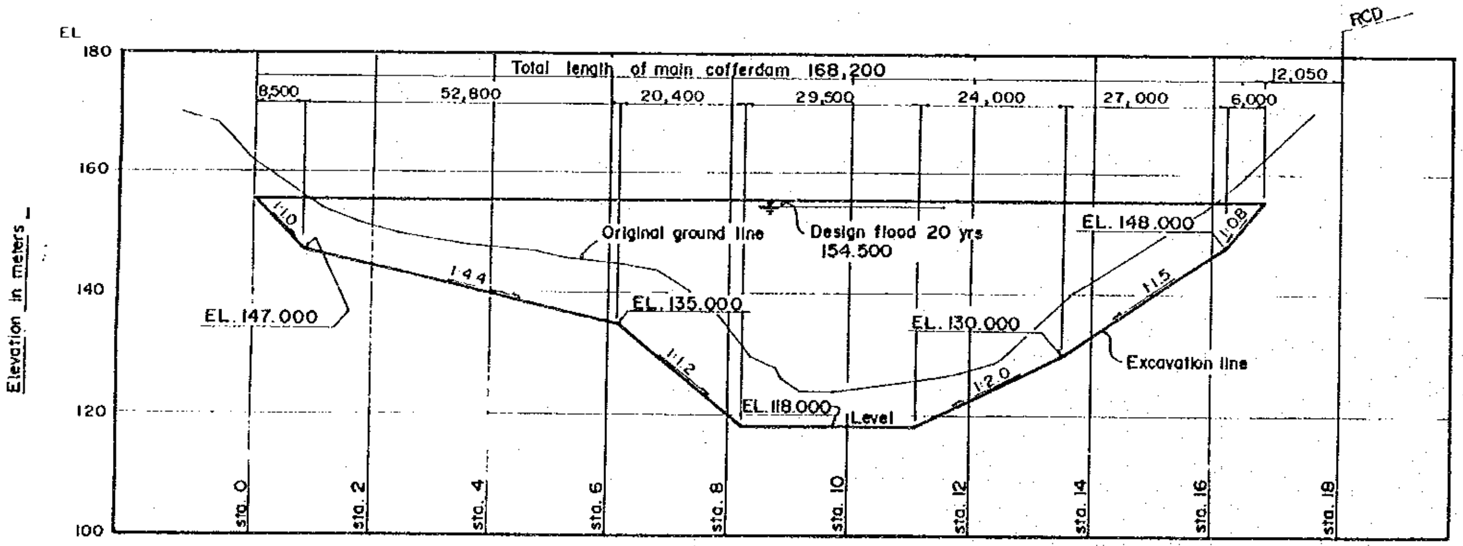


ESTIMATED CUMULATED VOLUME CURVE

(x10³m³)

Elevation (m)	Zone ①	Zone ③	Zone ④	Zone ⑤	Zone ⑥	Total
155.50 ~ 150.00	3.4	1.9	7.5	2.1	0.76	15.66
150.00 ~ 140.00	7.5	4.1	39.2	2.5	-	53.30
140.00 ~ 130.00	6.4	2.4	45.7	1.7	-	56.20
130.00 ~ 120.00	4.2	1.3	35.4	0.5	-	41.40
120.00 ~ 110.00	-	-	0.5	-	-	0.50
Total	21.5	9.7	128.3	6.8	0.76	167.06

ESTIMATED VOLUME



PROFILE SCALE A

SCALE A 0 — 60 m
SCALE B 0 — 50 m
SCALE C 0 — 20 m

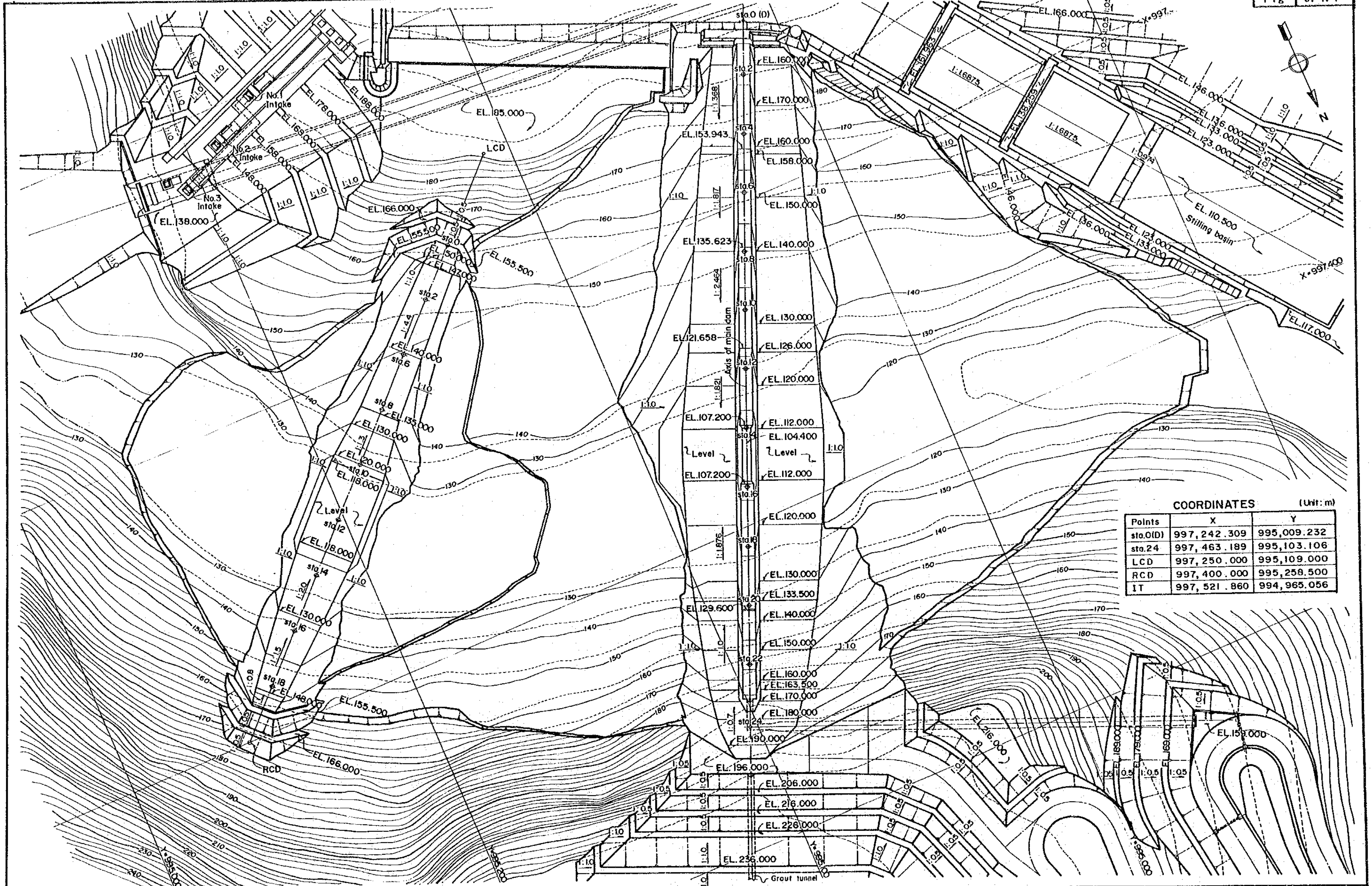
NOTES :

1) Excavation lines may be changed according to the actual geological conditions.
2) All dimension are in millimeters while elevation are in meters
3) Stations shown are true horizontal distance in 20 m
4) For location details, see DWG. No. C-011 - DWG. NO. shown on this Figure indicates the Tender Drawing No..

MAIN COFFERDAM
MAIN COFFERDAM, PLAN, PROFILE & TYPICAL SECTION

GOVERNMENT OF MAURITIUS
PORT LOUIS WATER SUPPLY PROJECT
JAPAN INTERNATIONAL COOPERATION AGENCY

Fig 3.4.1



COORDINATES (Unit: m)

Points	X	Y
sta.0(D)	997,242.309	995,009.232
sta.24	997,463.189	995,103.106
LCD	997,250.000	995,109.000
RCD	997,400.000	995,258.500
IT	997,521.860	994,965.056

NOTES;

1) For general notes see DWG No.C-012.
2) For cross section see DWG No.C-016 to DWG.C-025.
3) Excavation levels indicated may change to suit actual site conditions.

- DWG. NO. shown on this Figure indicates the Tender Drawing No..

SCALE 0 — 60m

MAIN DAM
EXCAVATION PLAN

GOVERNMENT OF MAURITIUS
PORT LOUIS WATER SUPPLY PROJECT

JAPAN INTERNATIONAL COOPERATION AGENCY

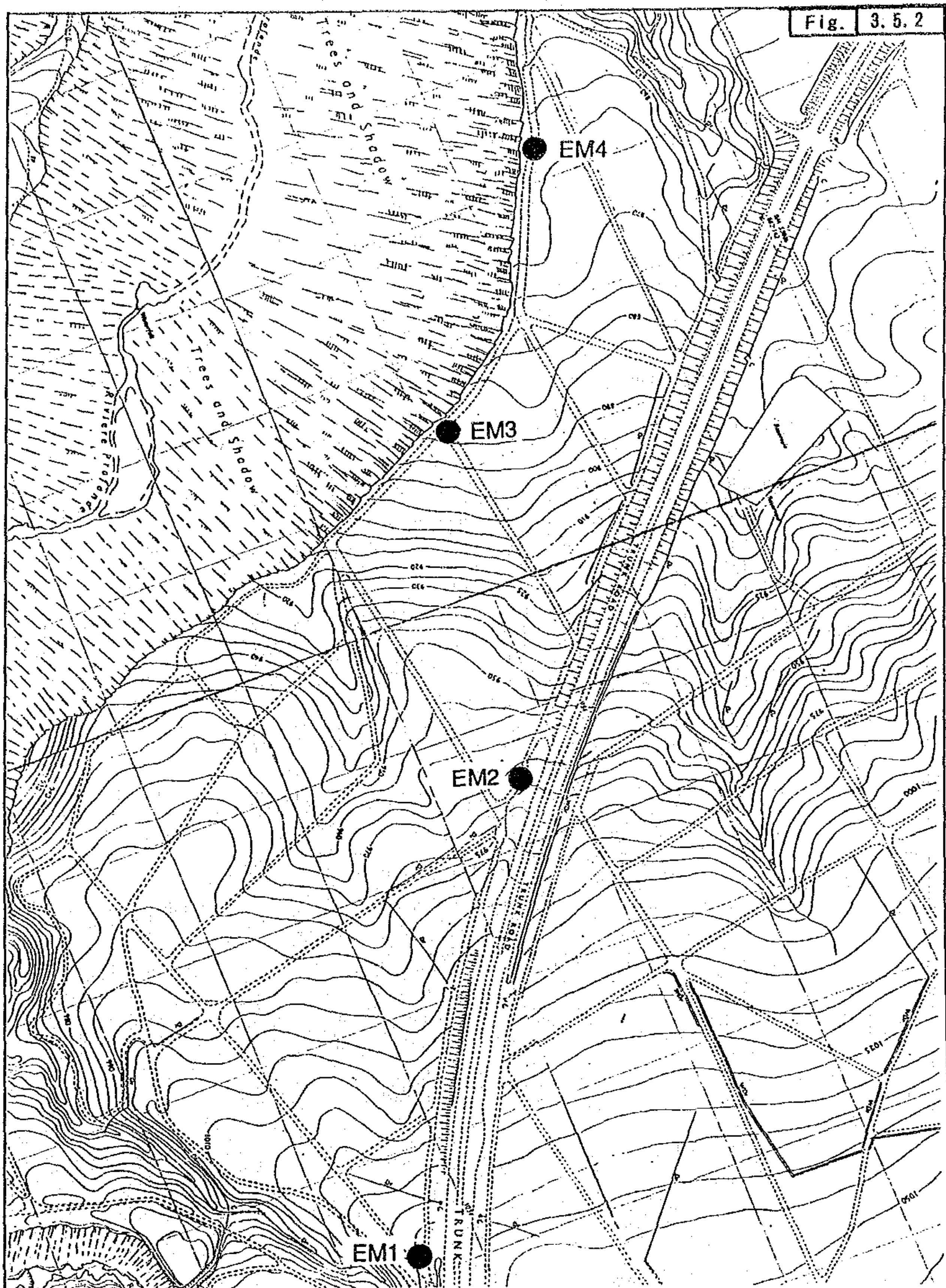
Fig 3.5.1

GENERAL
GENERAL LAYOUT

GOVERNMENT OF MAURITIUS
PORT LOUIS WATER SUPPLY PROJECT

JAPAN INTERNATIONAL COOPERATION AGENCY

Fig. 3.5.2

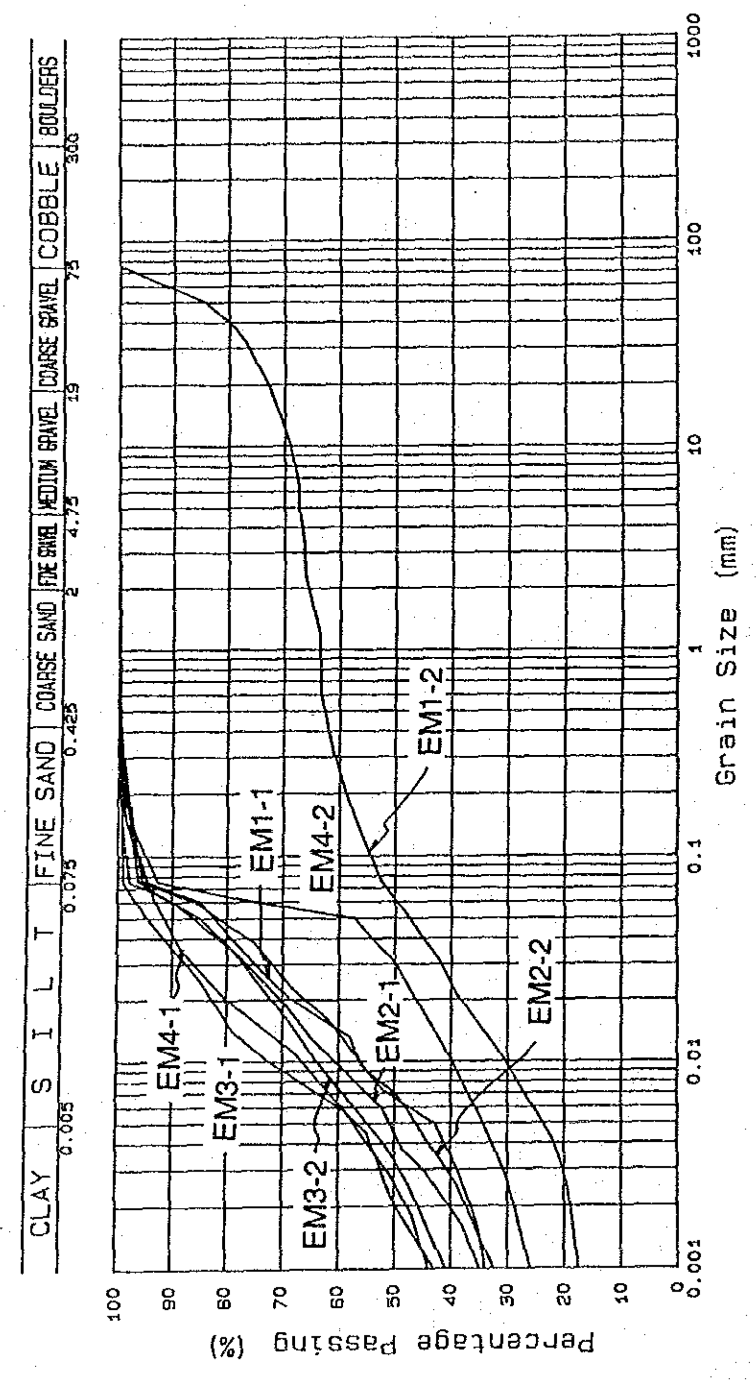


SAMPLING LOCATIONS IN BORROW AREA

GOVERNMENT OF MAURITIUS
PORT LOUIS WATER SUPPLY PROJECT

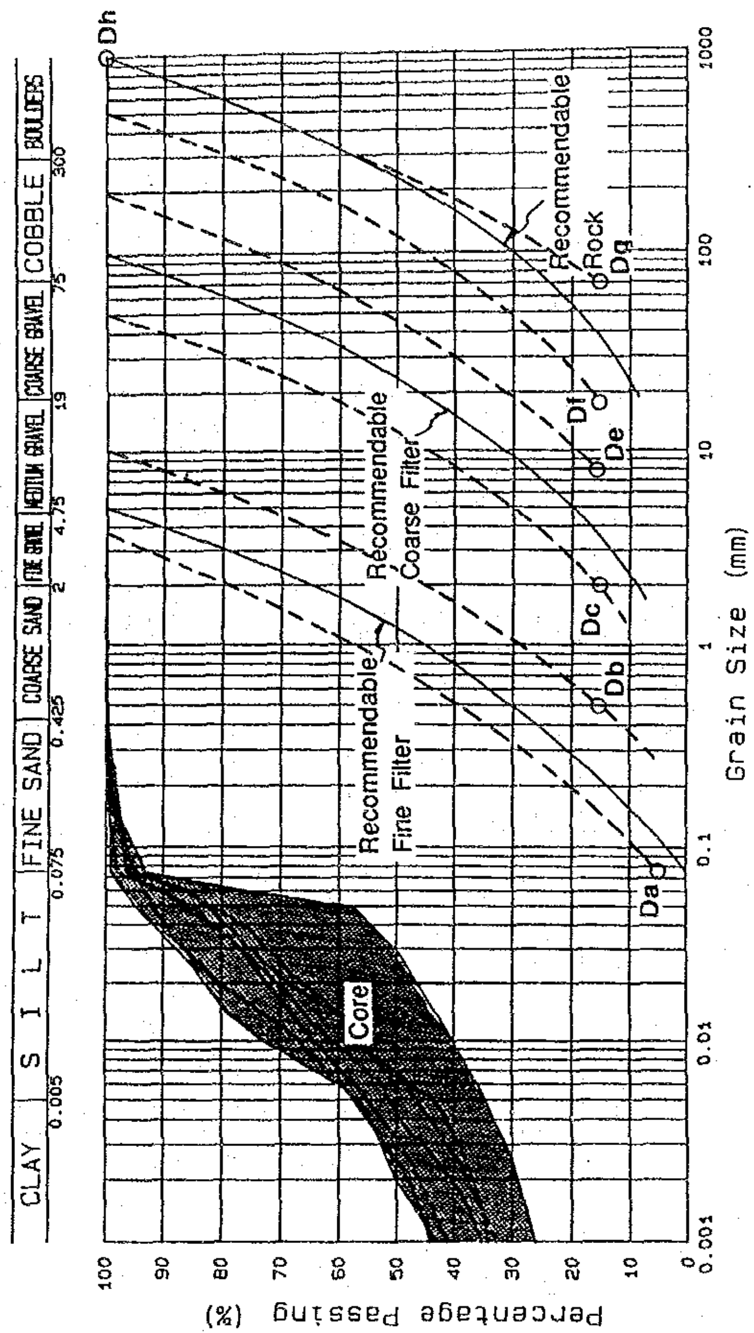
JAPAN INTERNATIONAL COOPERATION AGENCY

Fig. 3.5.3



GRADING CURVES OF EARTH MATERIALS	GOVERNMENT OF MAURITIUS PORT LOUIS WATER SUPPLY PROJECT
	JAPAN INTERNATIONAL COOPERATION AGENCY

Fig. 3.5.4

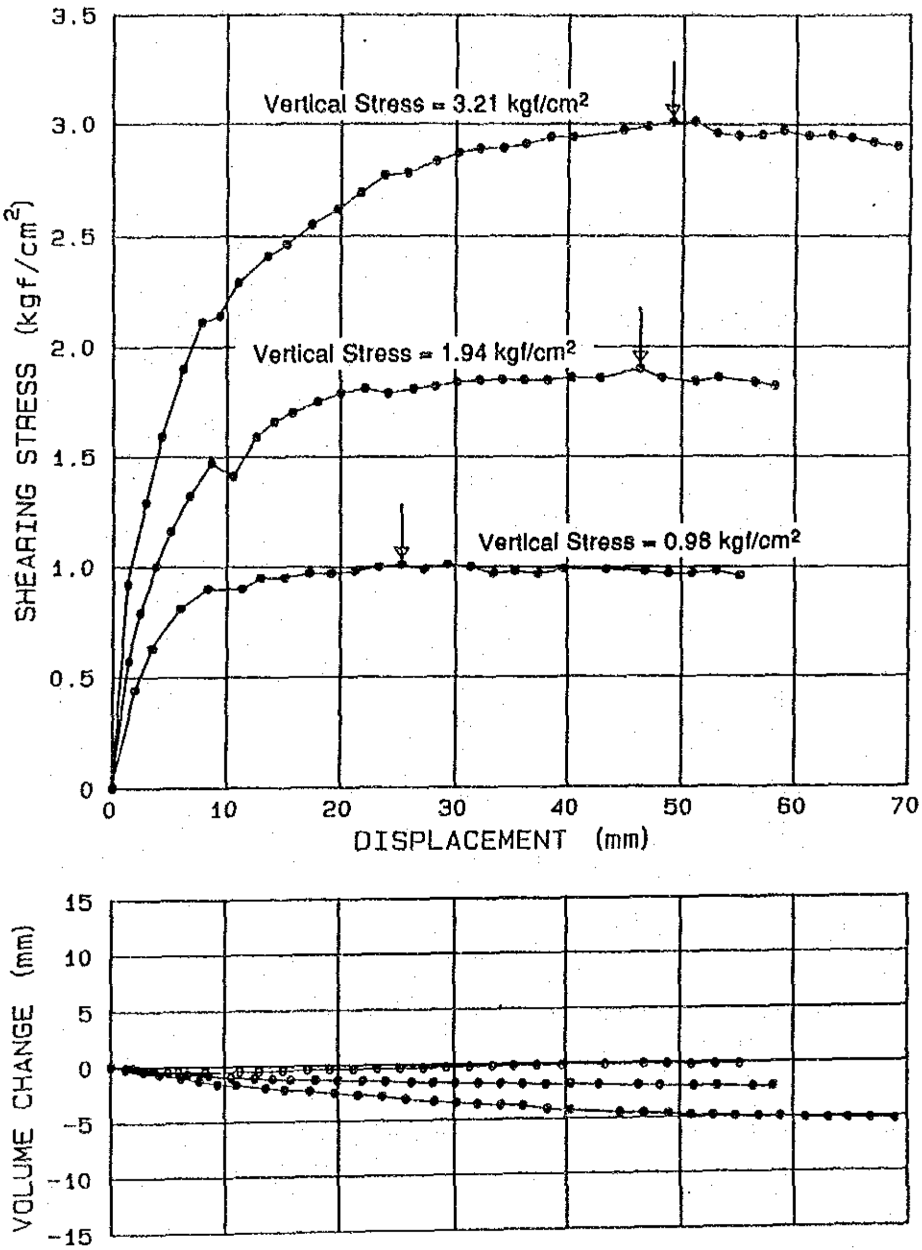


GRADING CURVES OF RECOMMENDABLE FILTER AND ROCK MATERIALS

GOVERNMENT OF MAURITIUS
PORT LOUIS WATER SUPPLY PROJECT

JAPAN INTERNATIONAL COOPERATION AGENCY

Fig. 3.5.5

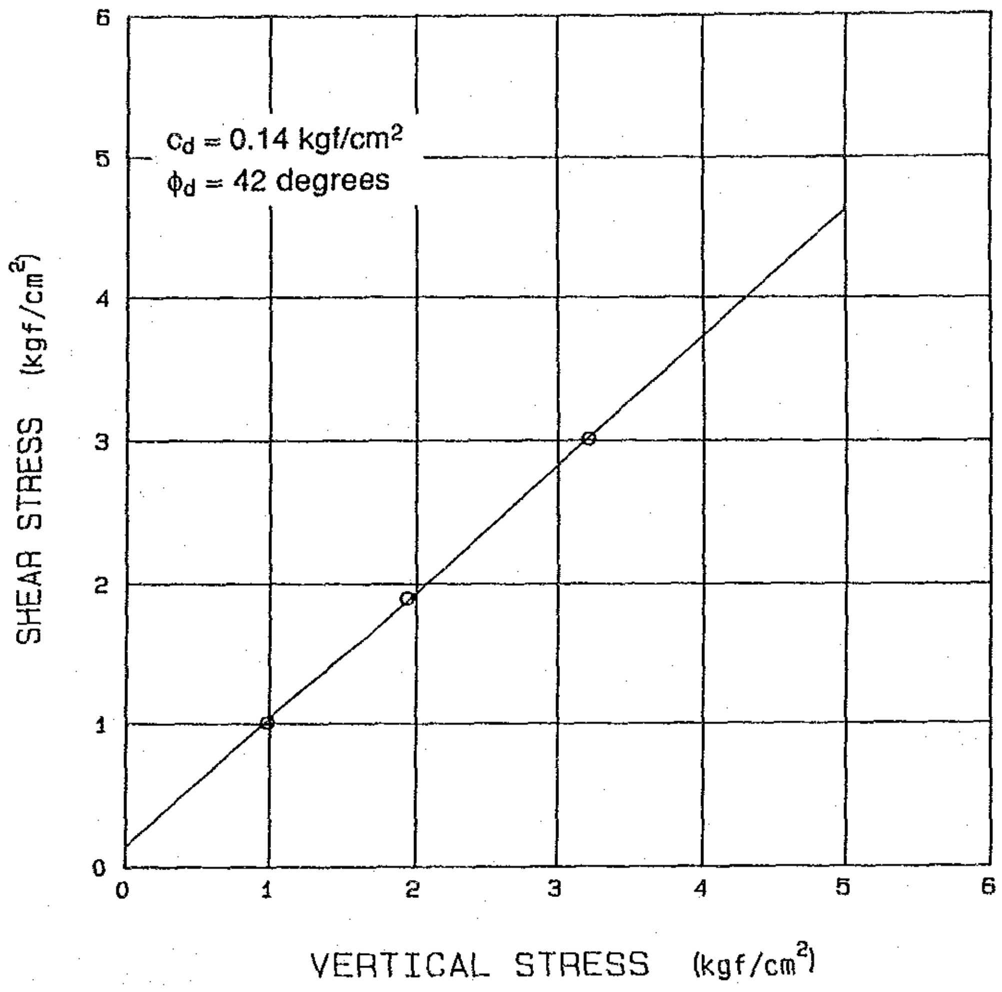


RELATION BETWEEN DISPLACEMENT, AND SHEARING STRESS AND VOLUME CHANGE

GOVERNMENT OF MAURITIUS
PORT LOUIS WATER SUPPLY PROJECT

JAPAN INTERNATIONAL COOPERATION AGENCY

Fig. 3.5.6

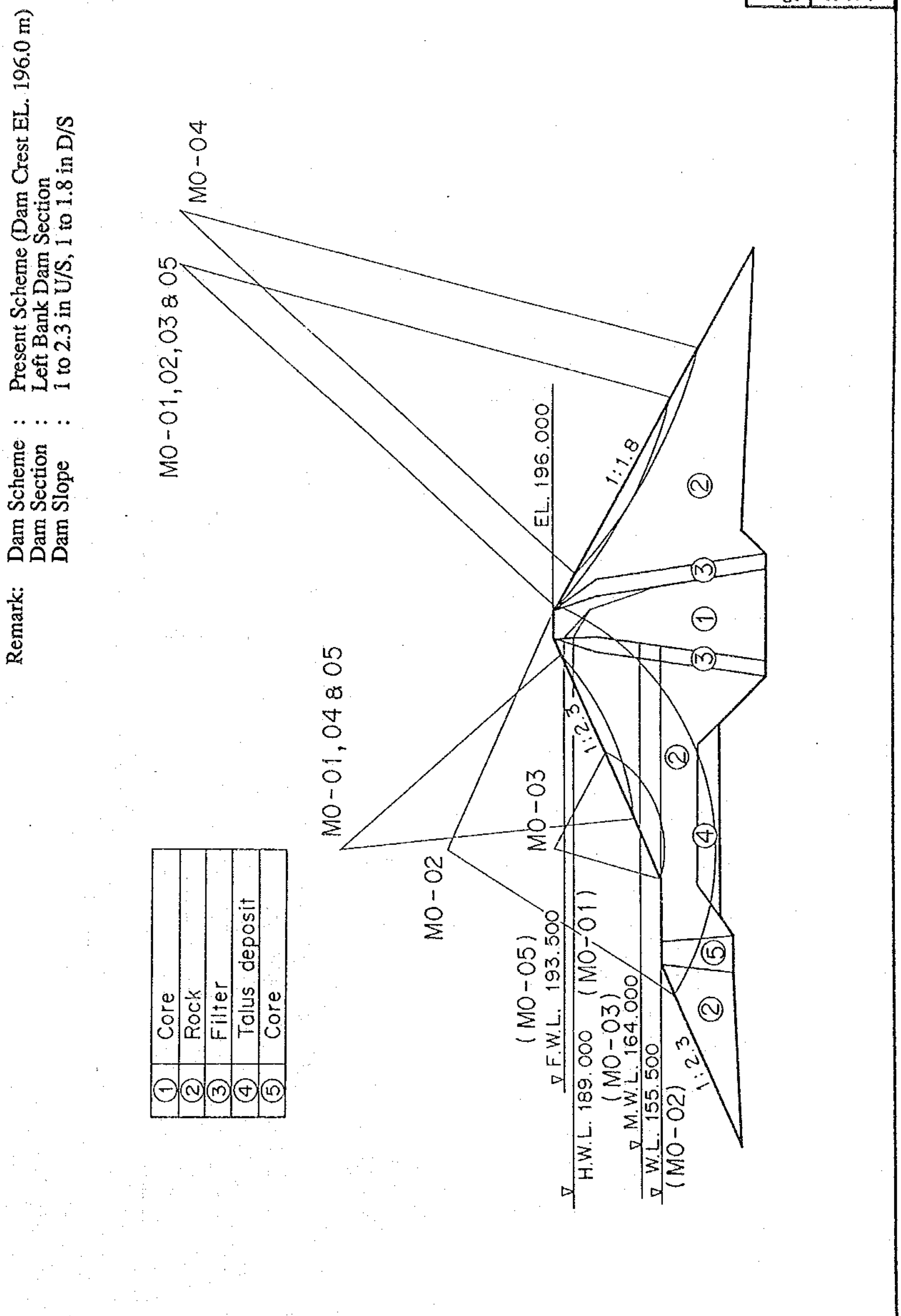


RELATION BETWEEN VERTICAL STRESS AND SHEAR STRESS

GOVERNMENT OF MAURITIUS
PORT LOUIS WATER SUPPLY PROJECT

JAPAN INTERNATIONAL COOPERATION AGENCY

Fig. 3.6.1



SLIDING CIRCLE WHICH PROVIDES MIN. SAFETY FACTOR

GOVERNMENT OF MAURITIUS
PORT LOUIS WATER SUPPLY PROJECT

JAPAN INTERNATIONAL COOPERATION AGENCY

Remark: Dam Scheme : Expanded Scheme (Dam Crest EL. 215.0 m)
Dam Section : Left Bank Dam Section
Dam Slope : 1 to 2.3 in U/S, 1 to 1.8 in D/S

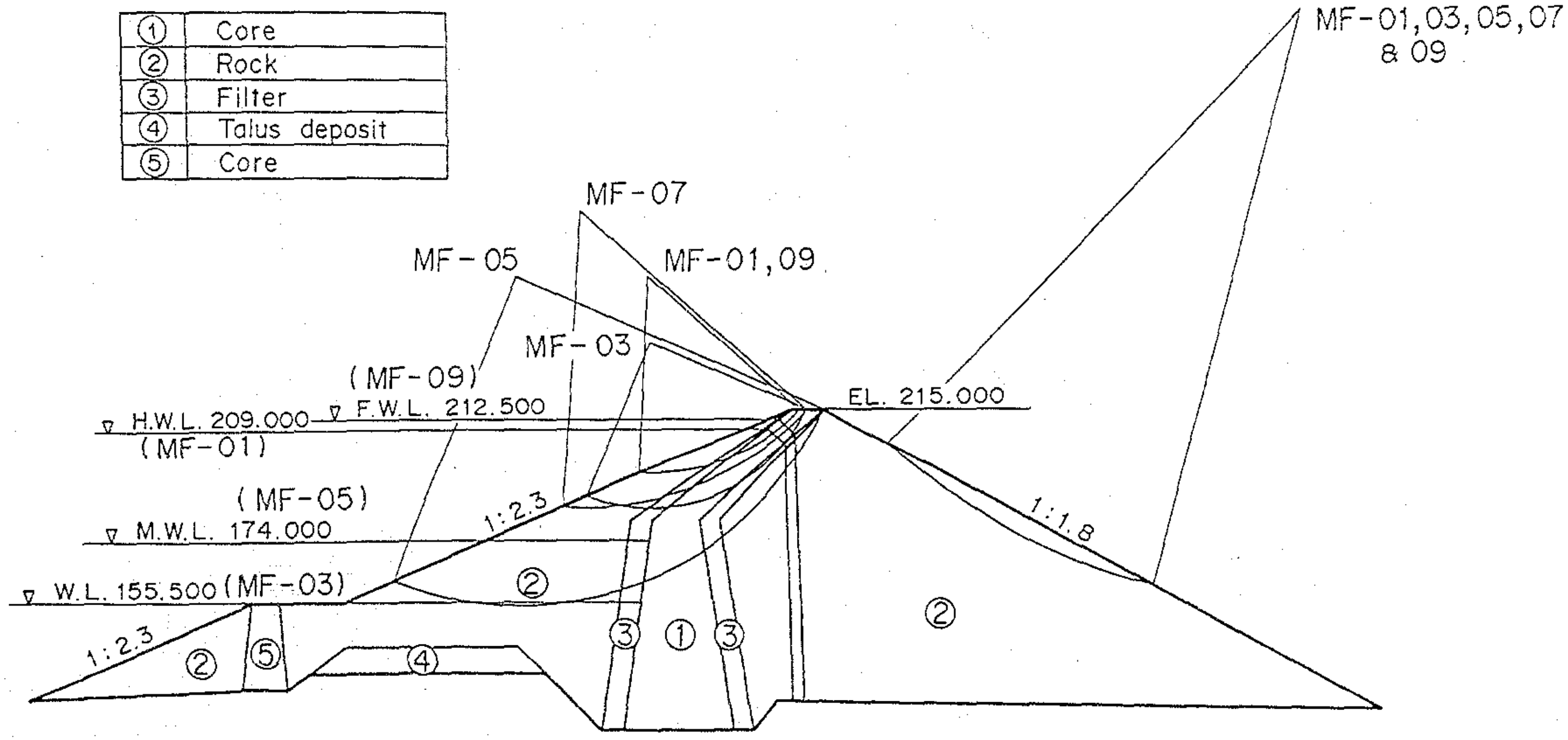


Fig. 3.6.2

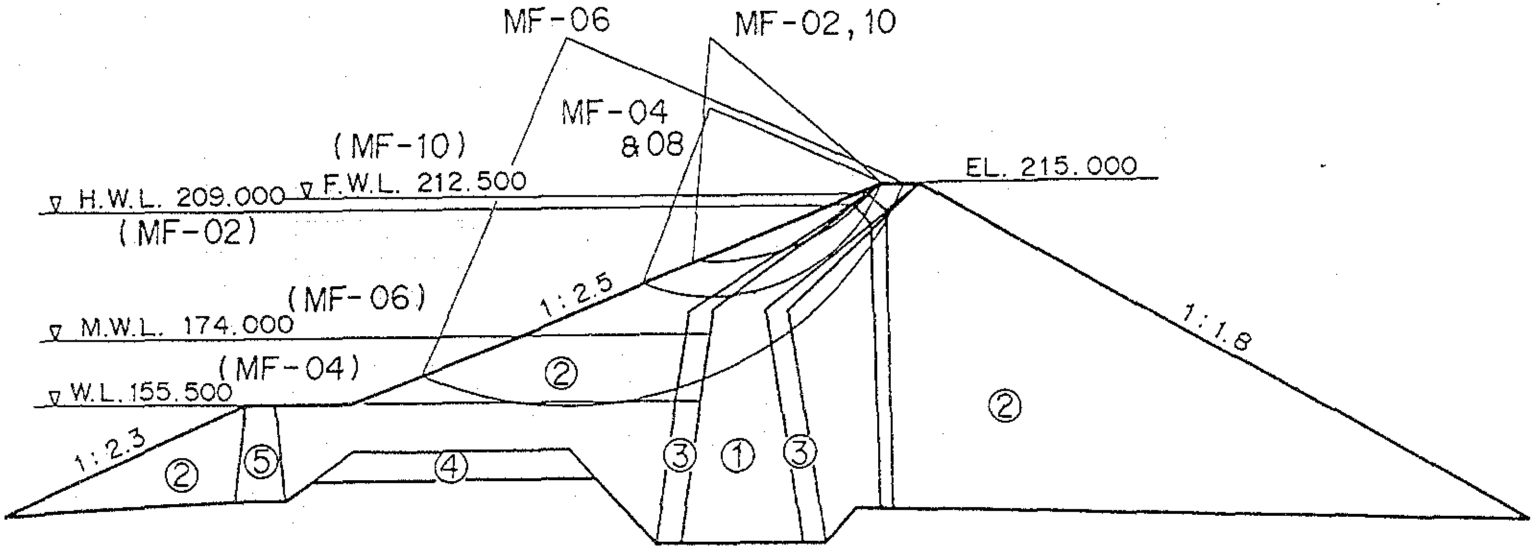
SLIDING CIRCLE WHICH PROVIDES MIN. SAFETY FACTOR

GOVERNMENT OF MAURITIUS
PORT LOUIS WATER SUPPLY PROJECT
JAPAN INTERNATIONAL COOPERATION AGENCY

Fig. 3.6.3

Remark: Dam Scheme : Expanded Scheme (Dam Crest EL. 215.0 m)
Dam Section : Left Bank Dam Section
Dam Slope : 1 to 2.5 in U/S, 1 to 1.8 in D/S

①	Core
②	Rock
③	Filter
④	Talus deposit
⑤	Core



SLIDING CIRCLE WHICH PROVIDES MIN. SAFETY FACTOR

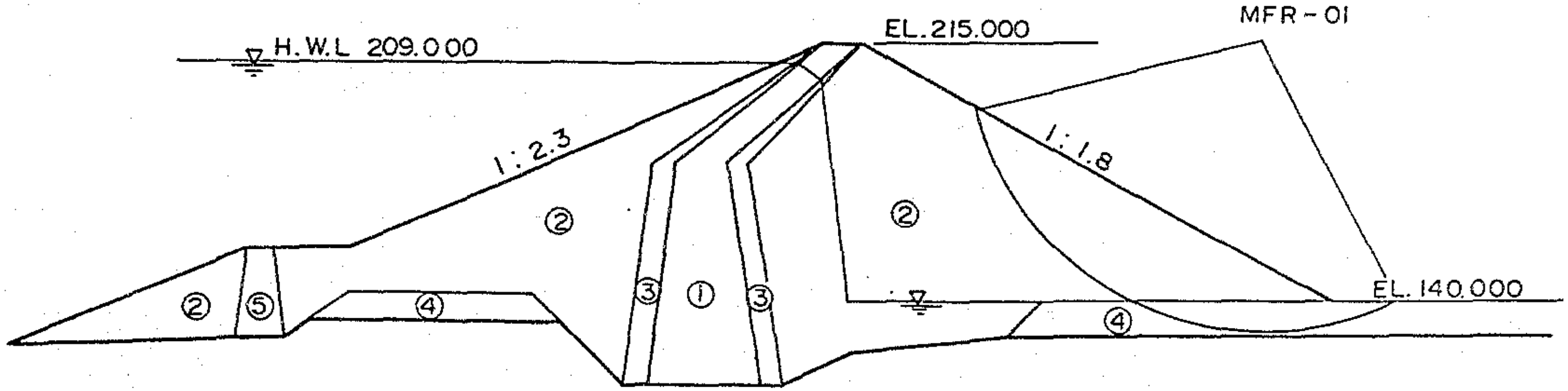
GOVERNMENT OF MAURITIUS
PORT LOUIS WATER SUPPLY PROJECT

JAPAN INTERNATIONAL COOPERATION AGENCY

Fig. 3.6.4

Remark: Dam Scheme : Expanded Scheme (Dam Crest EL. 215.0 m)
Dam Section : Right Bank Dam Section
Dam Slope : 1 to 2.3 in U/S, 1 to 1.8 in D/S

①	Core
②	Rock
③	Filter
④	Talus deposit
⑤	Core

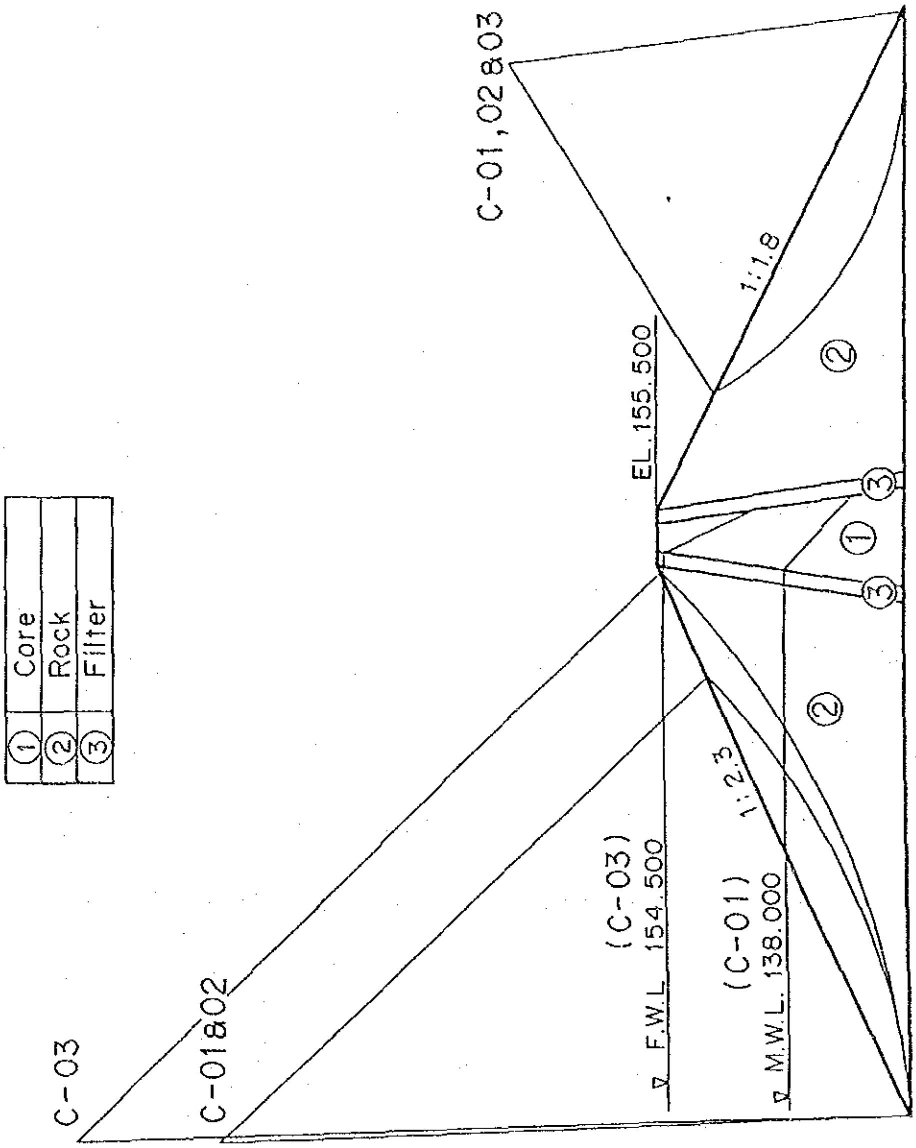


SLIDING CIRCLE WHICH PROVIDES MIN. SAFETY FACTOR

GOVERNMENT OF MAURITIUS
PORT LOUIS WATER SUPPLY PROJECT

JAPAN INTERNATIONAL COOPERATION AGENCY

Fig. 3.6.5

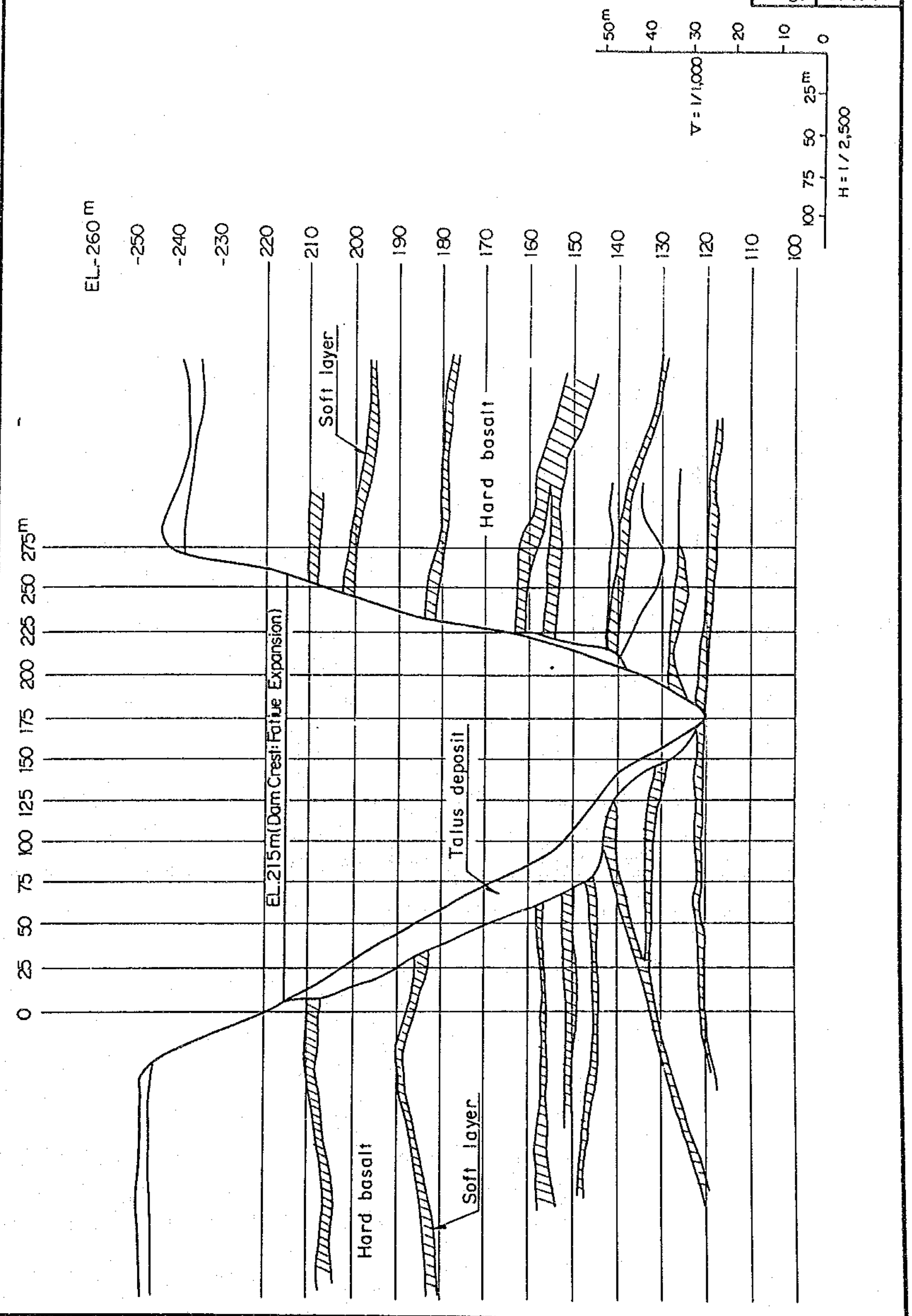


SLIDING CIRCLE WHICH PROVIDES MIN. SAFETY FACTOR (Main Cofferdam)

GOVERNMENT OF MAURITIUS
PORT LOUIS WATER SUPPLY PROJECT

JAPAN INTERNATIONAL COOPERATION AGENCY

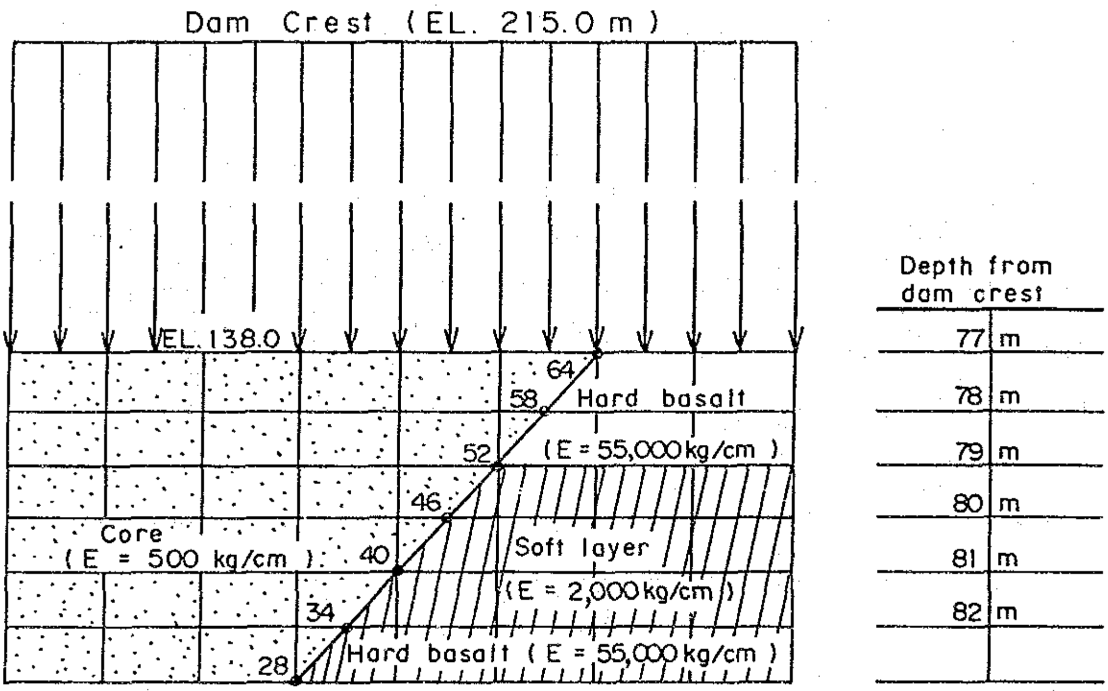
Fig. 3.7.1



GEOLOGICAL SECTION AT DAM SITE

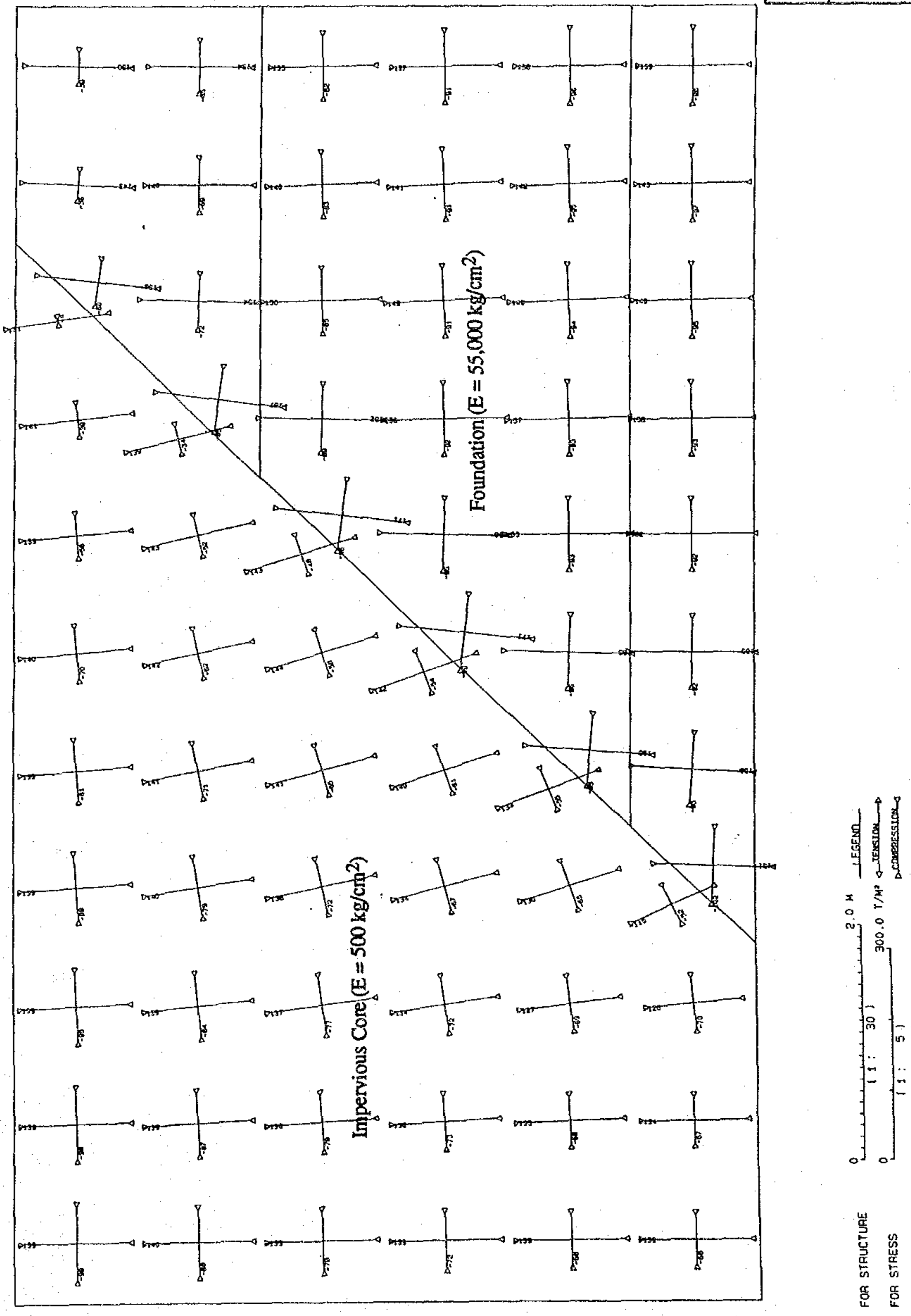
GOVERNMENT OF MAURITIUS
PORT LOUIS WATER SUPPLY PROJECT

JAPAN INTERNATIONAL COOPERATION AGENCY



MODEL FOR ANALYSIS

Fig. 3.7.3

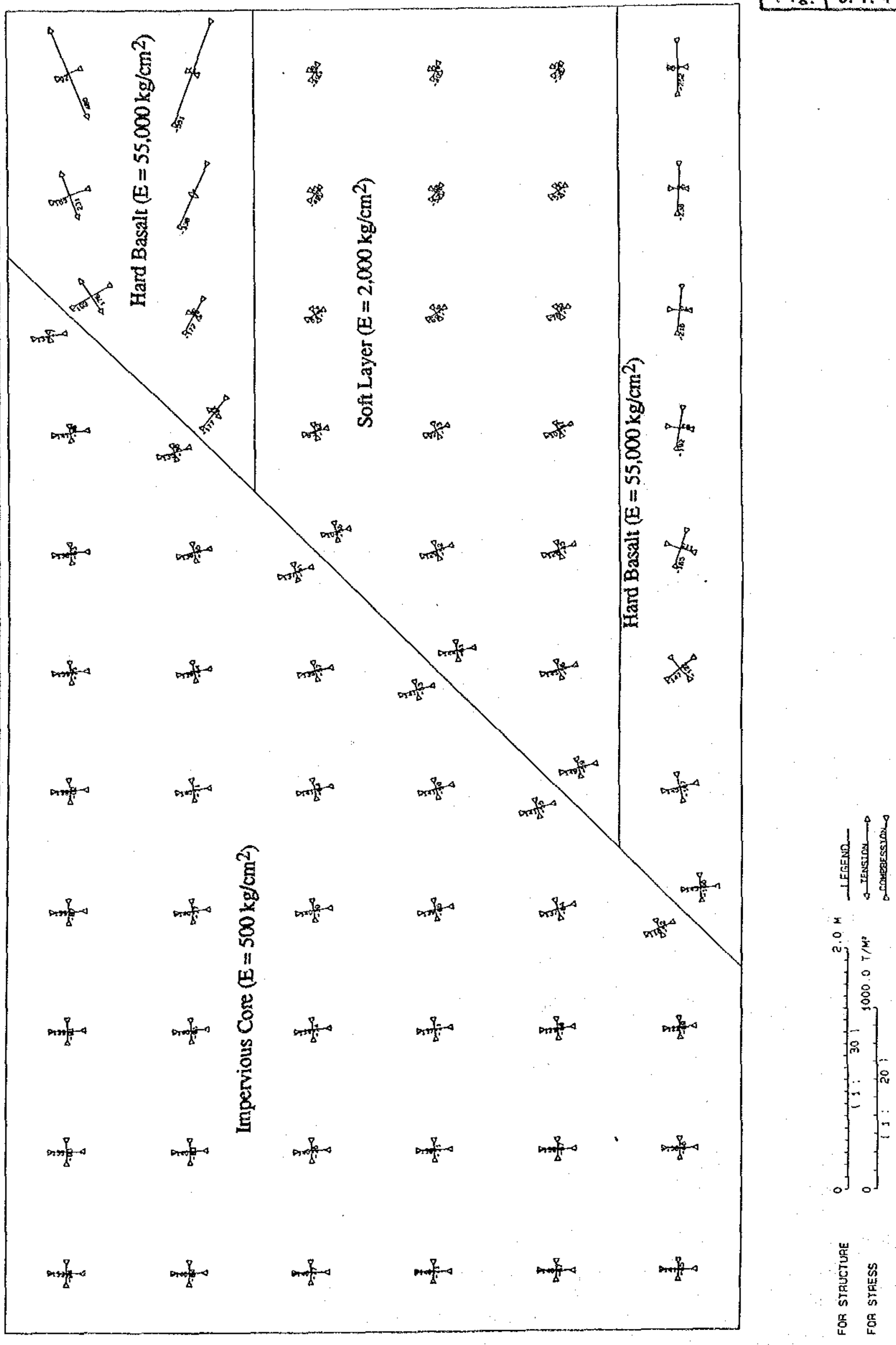


STRESS ANALYSIS RESULT (CASE (i))

GOVERNMENT OF MAURITIUS
PORT LOUIS WATER SUPPLY PROJECT

JAPAN INTERNATIONAL COOPERATION AGENCY

Fig. 3.7.4

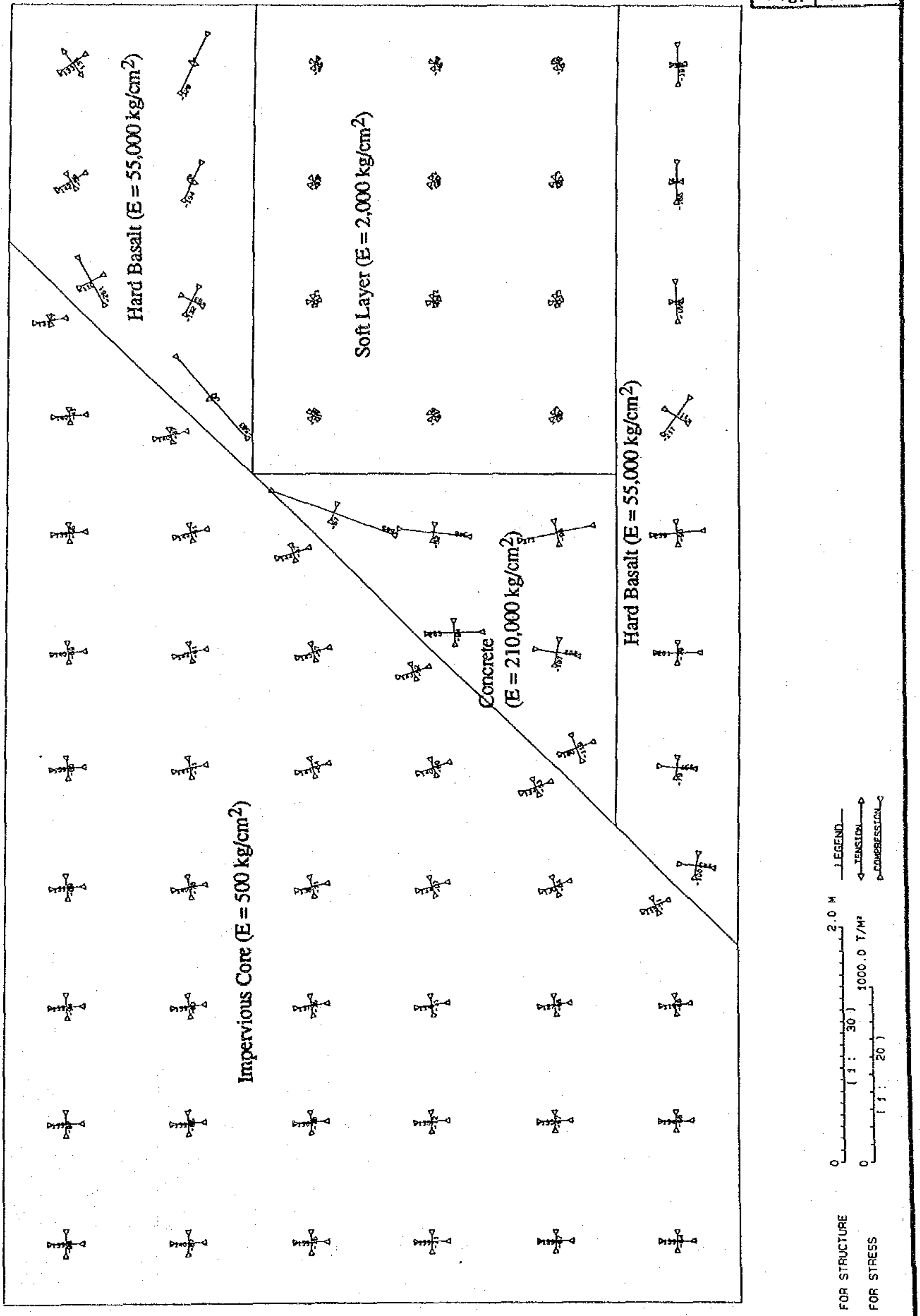


STRESS ANALYSIS RESULT (CASE (ii))

GOVERNMENT OF MAURITIUS
PORT LOUIS WATER SUPPLY PROJECT

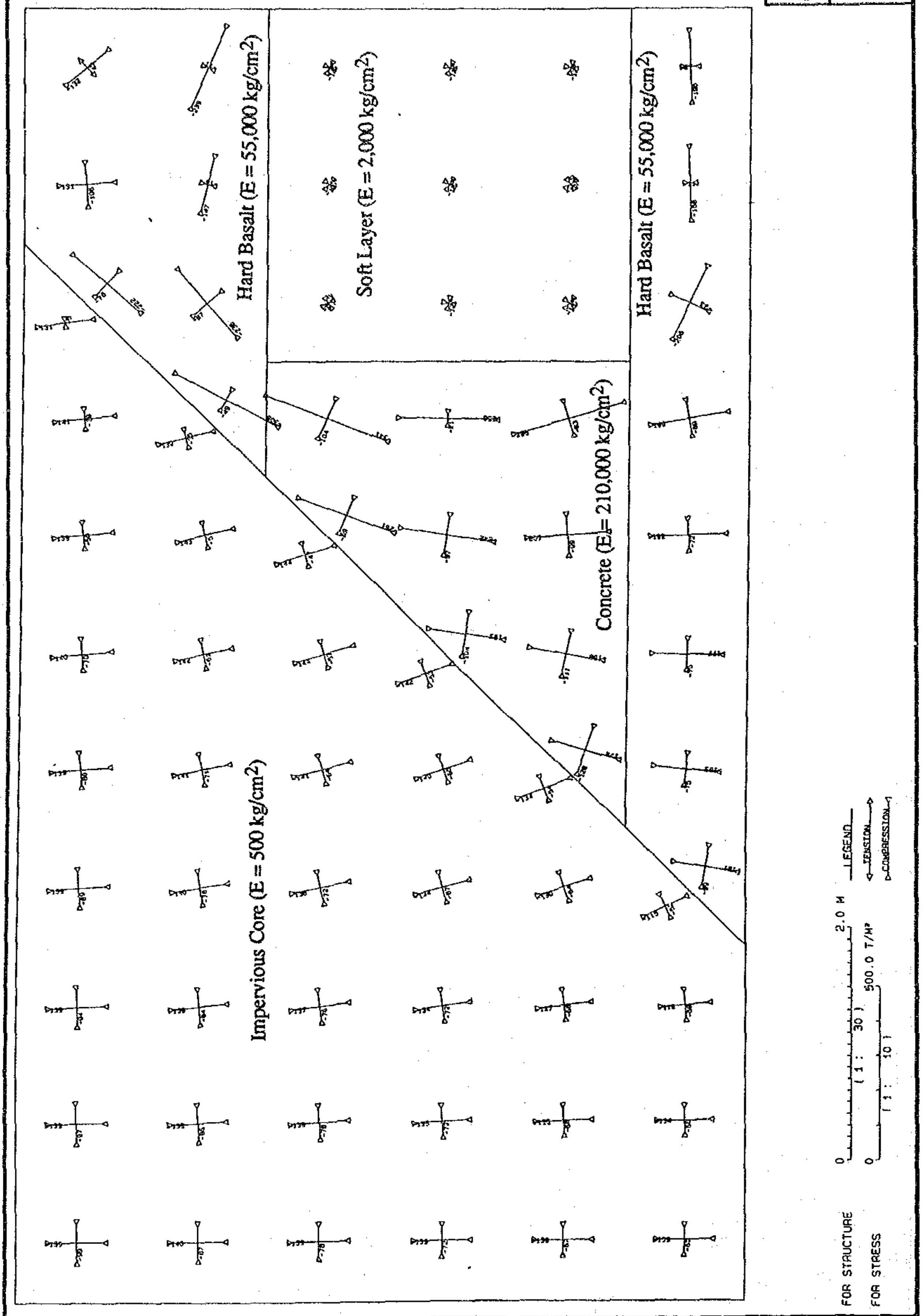
JAPAN INTERNATIONAL COOPERATION AGENCY

Fig. 3.7.5



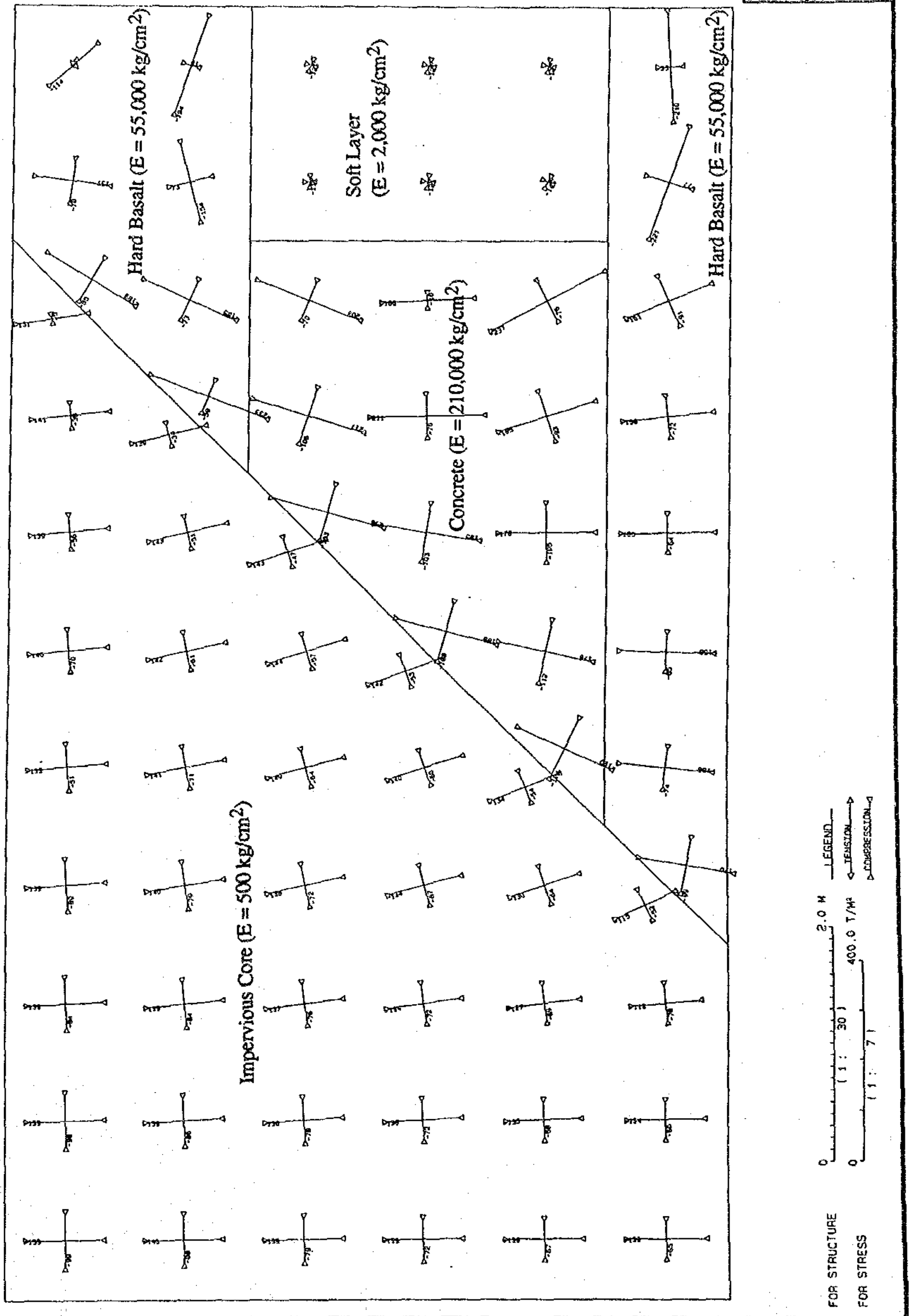
STRESS ANALYSIS RESULT (CASE (A))	GOVERNMENT OF MAURITIUS PORT LOUIS WATER SUPPLY PROJECT
	JAPAN INTERNATIONAL COOPERATION AGENCY

Fig. 3.7.6



STRESS ANALYSIS RESULT (CASE (B))	GOVERNMENT OF MAURITIUS PORT LOUIS WATER SUPPLY PROJECT JAPAN INTERNATIONAL COOPERATION AGENCY

Fig. 3.7.7

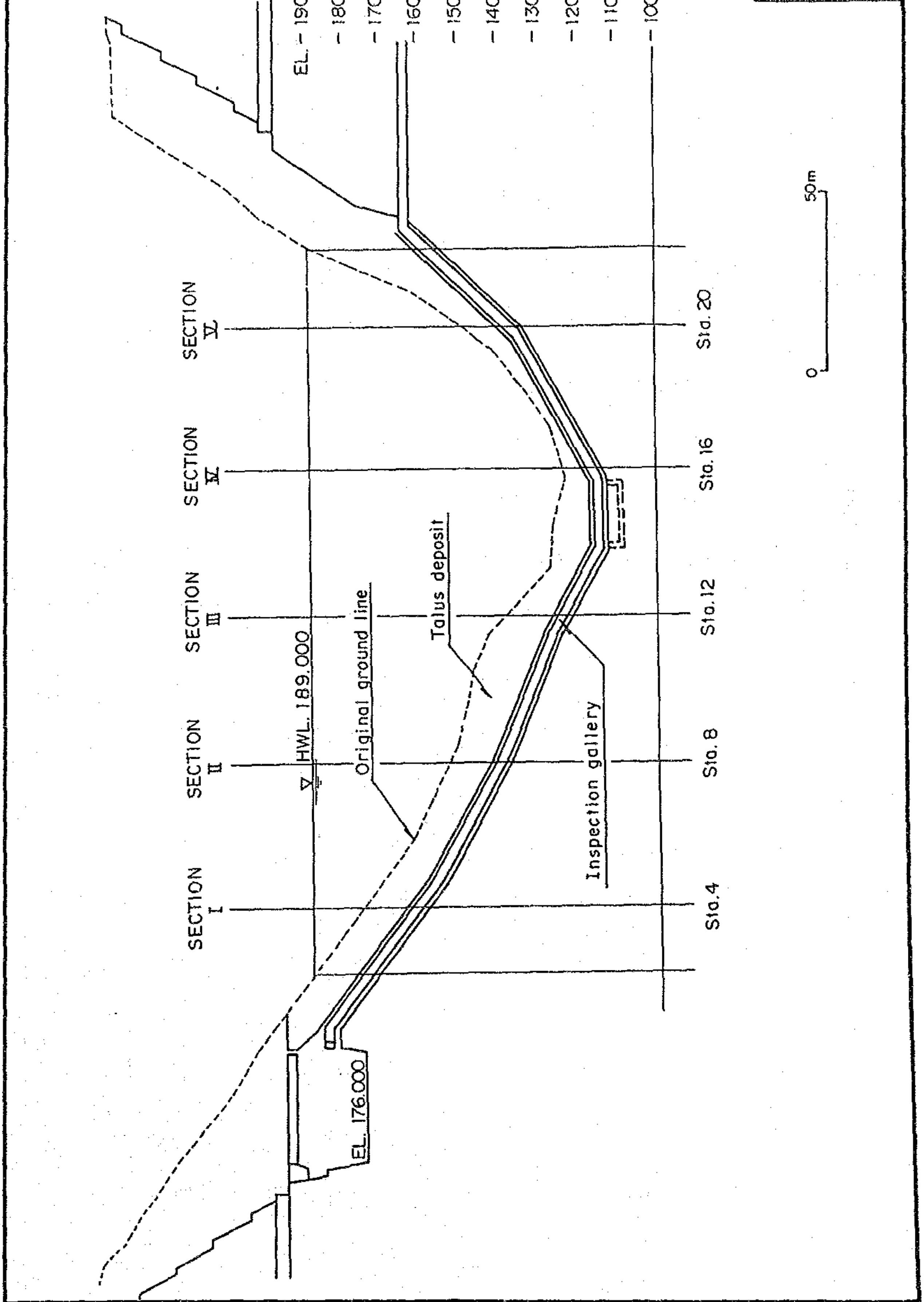


STRESS ANALYSIS RESULT (CASE (C))

GOVERNMENT OF MAURITIUS
PORT LOUIS WATER SUPPLY PROJECT

JAPAN INTERNATIONAL COOPERATION AGENCY

Fig. 3.8.1

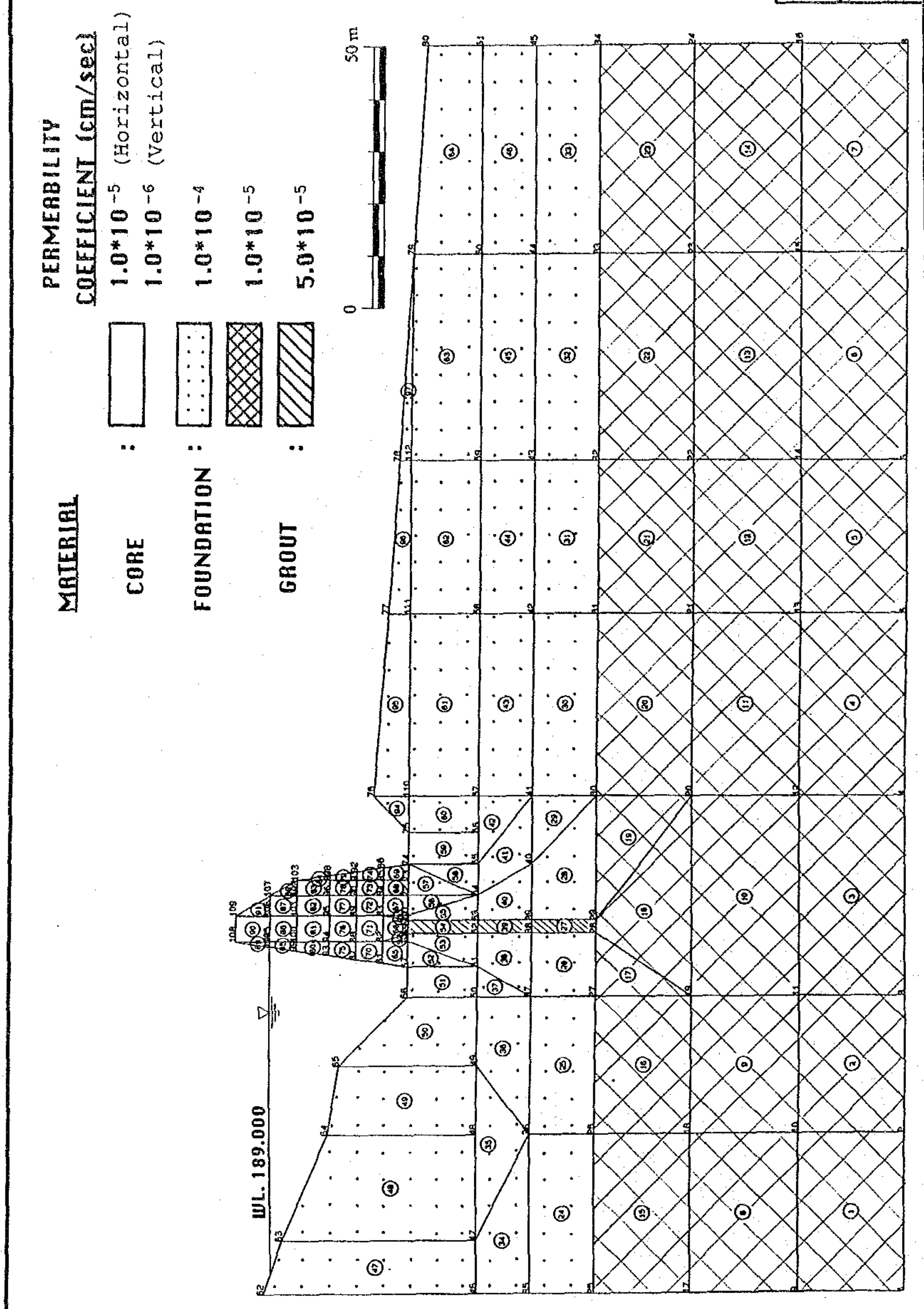


DAM SECTIONS FOR WHICH SEEPAGE ANALYSIS WAS CARRIED OUT

GOVERNMENT OF MAURITIUS
PORT LOUIS WATER SUPPLY PROJECT

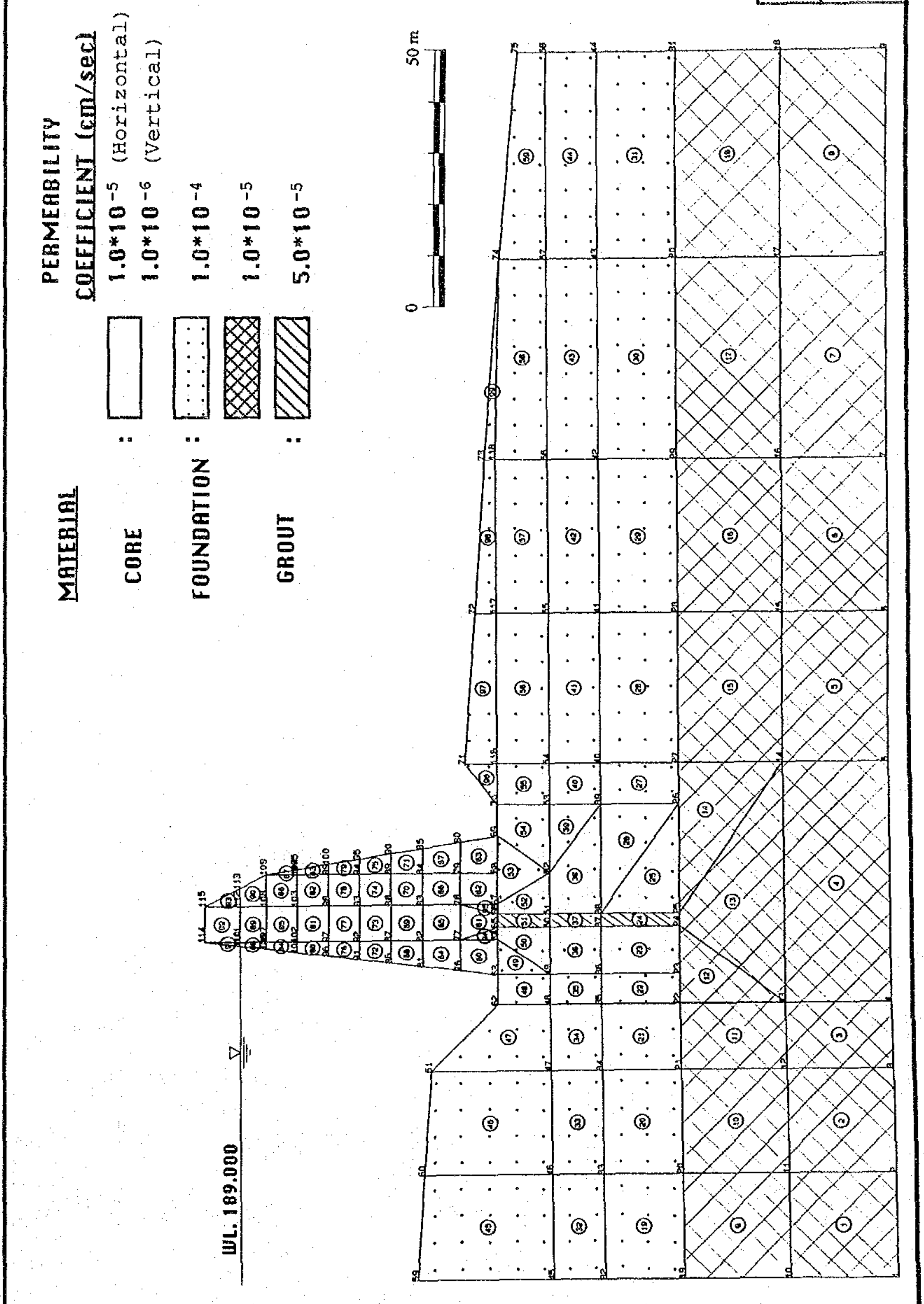
JAPAN INTERNATIONAL COOPERATION AGENCY

Fig. 3.8.2



MODEL FOR F.E.M. SEEPAGE ANALYSIS (SECTION NO. I)	GOVERNMENT OF MAURITIUS PORT LOUIS WATER SUPPLY PROJECT
	JAPAN INTERNATIONAL COOPERATION AGENCY

Fig. 3.8.3

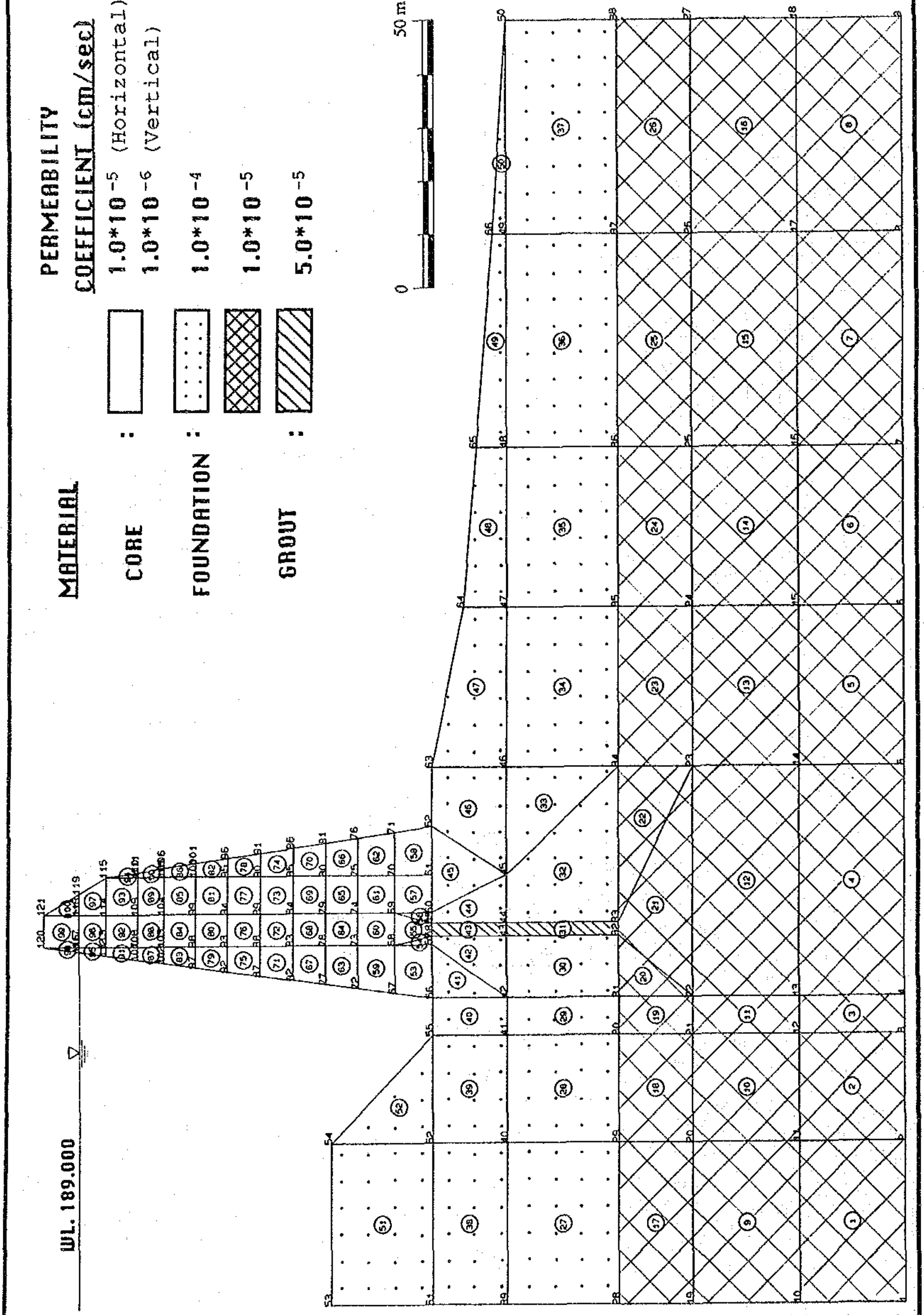


MODEL FOR F.E.M. SEEPAGE ANALYSIS
(SECTION NO. II)

GOVERNMENT OF MAURITIUS
PORT LOUIS WATER SUPPLY PROJECT

JAPAN INTERNATIONAL COOPERATION AGENCY

Fig. 3.8.4

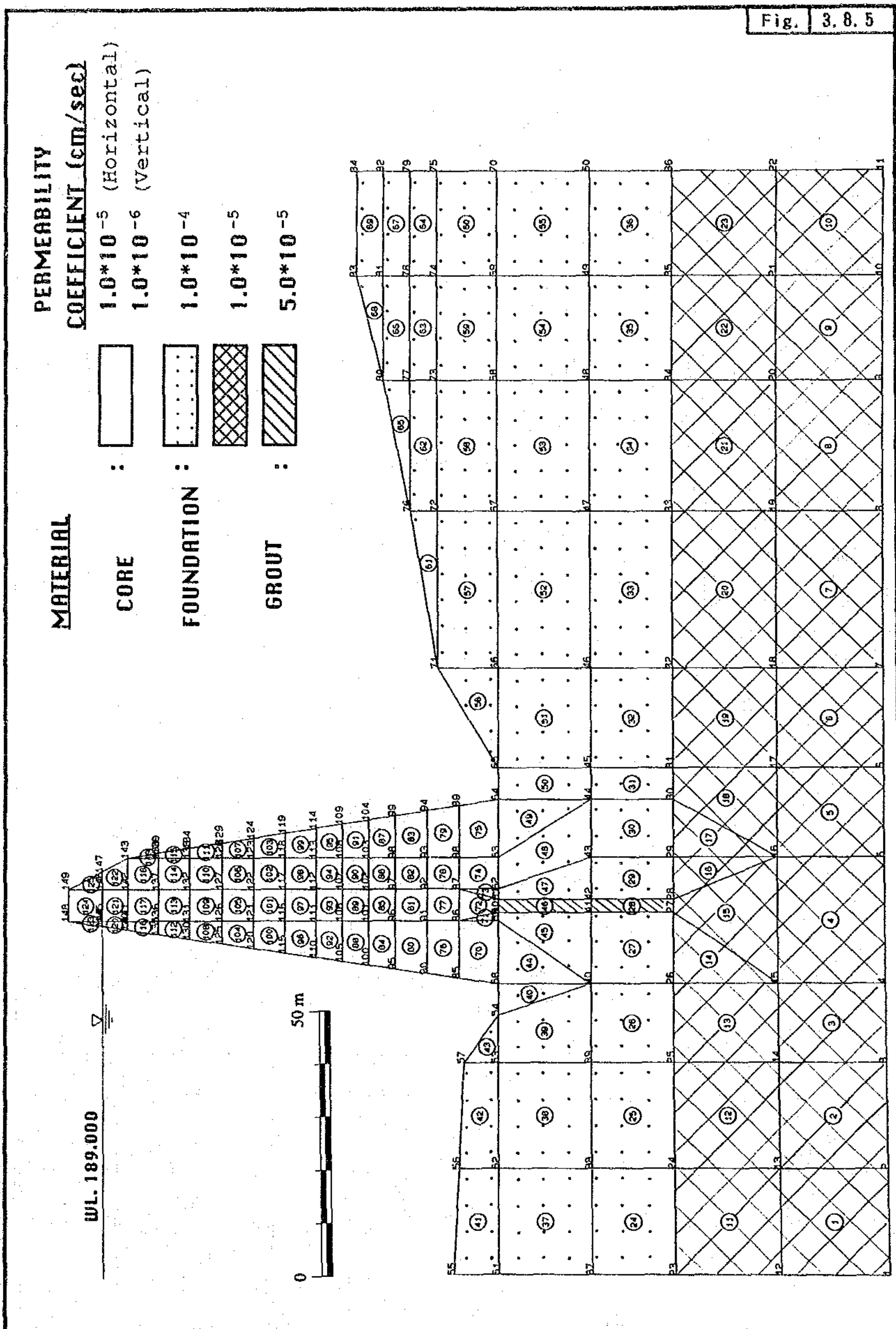


MODEL FOR F.E.M. SEEPAGE ANALYSIS
(SECTION NO. III)

GOVERNMENT OF MAURITIUS
PORT LOUIS WATER SUPPLY PROJECT

JAPAN INTERNATIONAL COOPERATION AGENCY

Fig. 3.8.5

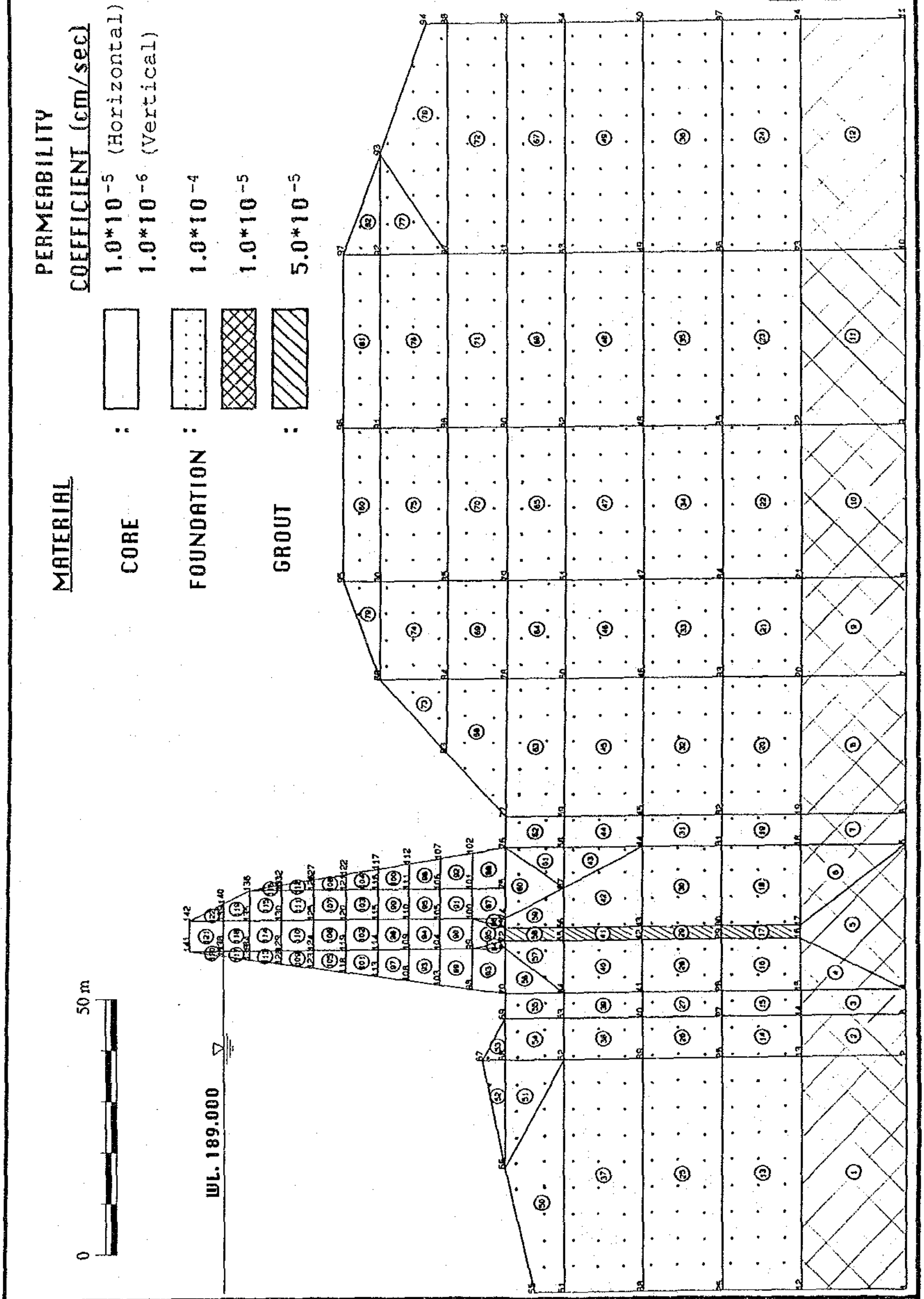


MODEL FOR F.E.M. SEEPAGE ANALYSIS
(SECTION NO. IV)

GOVERNMENT OF MAURITIUS
PORT LOUIS WATER SUPPLY PROJECT

JAPAN INTERNATIONAL COOPERATION AGENCY

Fig. 3.8.6

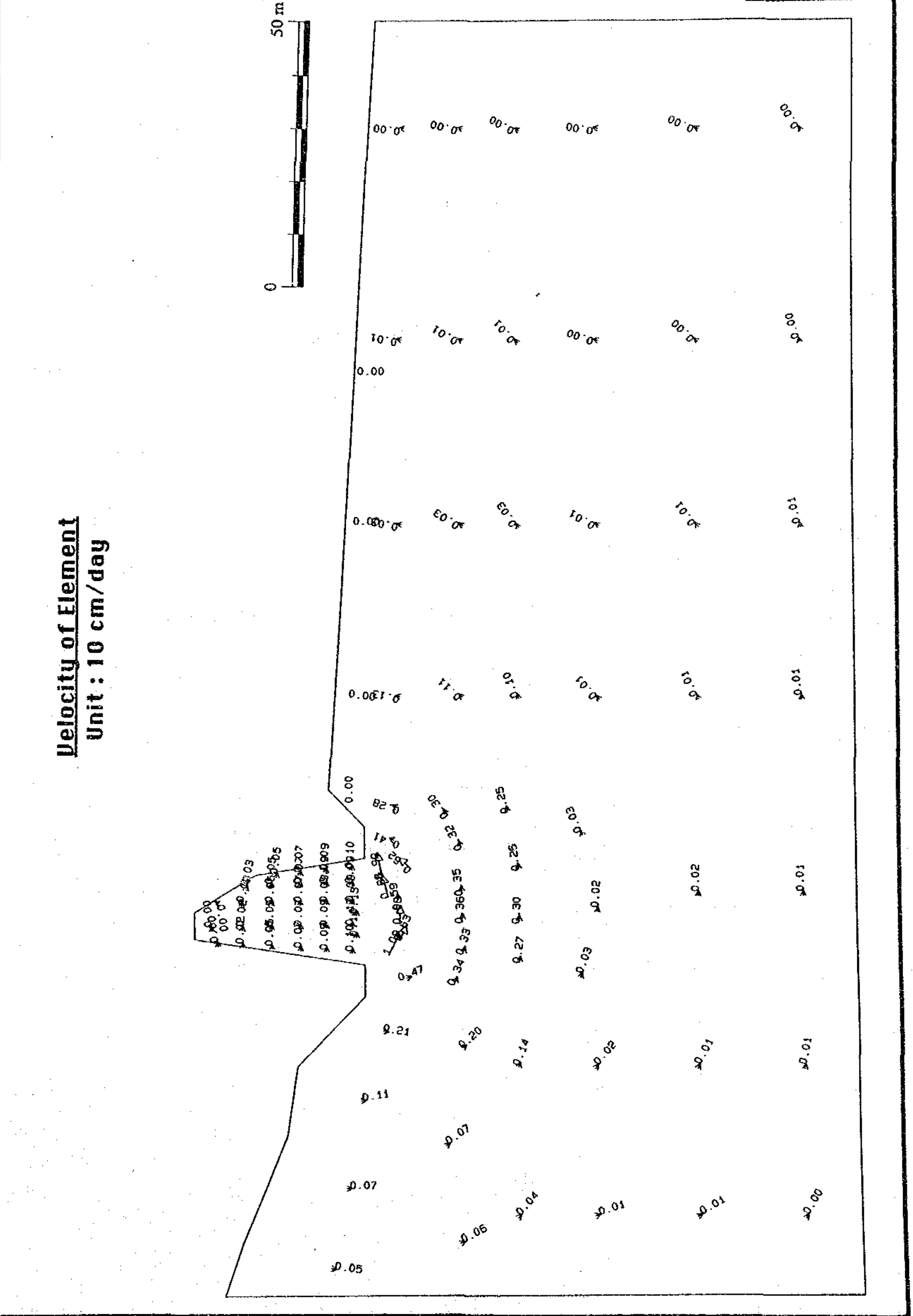


MODEL FOR F.E.M. SEEPAGE ANALYSIS
(SECTION NO. V)

GOVERNMENT OF MAURITIUS
PORT LOUIS WATER SUPPLY PROJECT

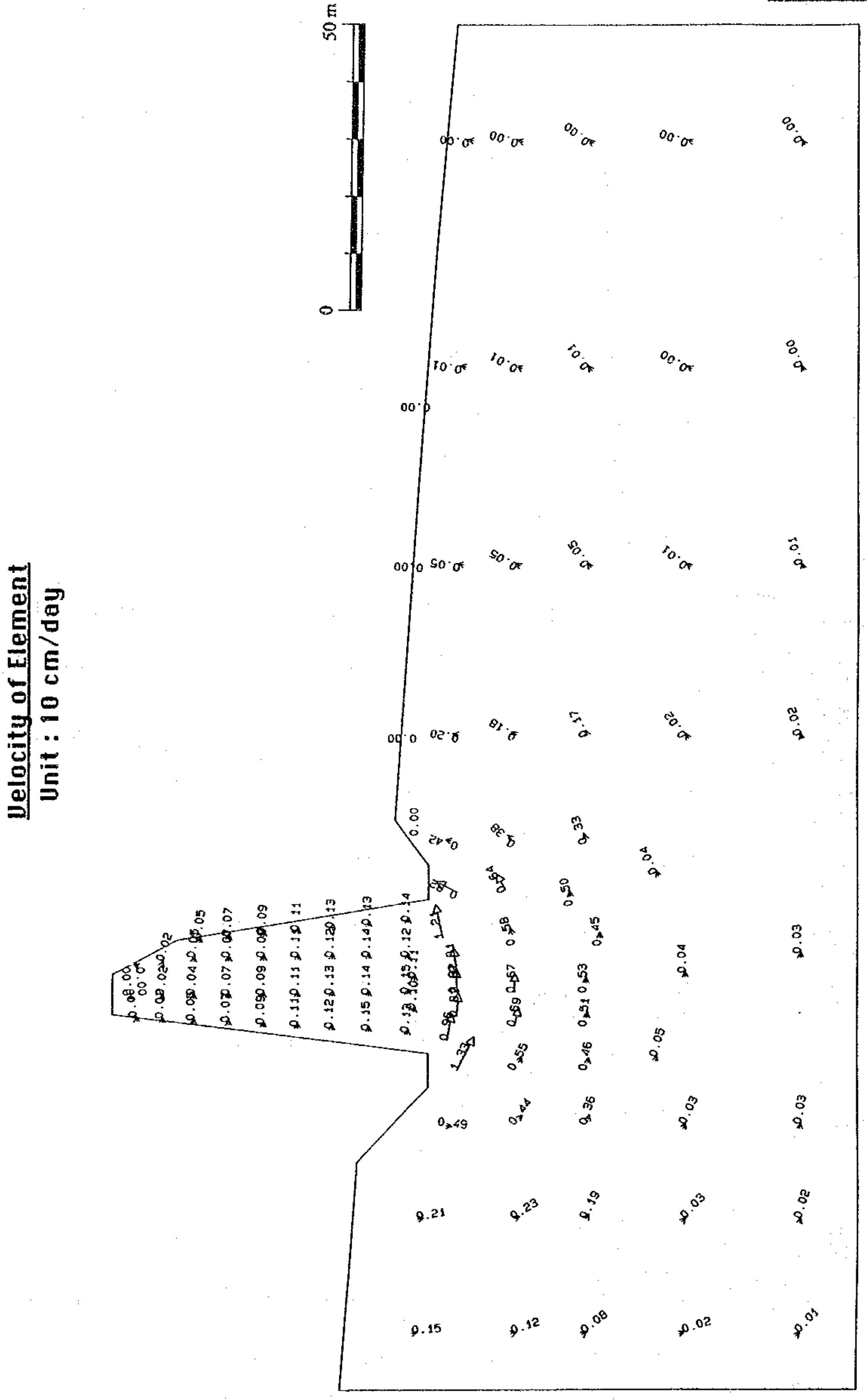
JAPAN INTERNATIONAL COOPERATION AGENCY

Fig. 3. 8. 7



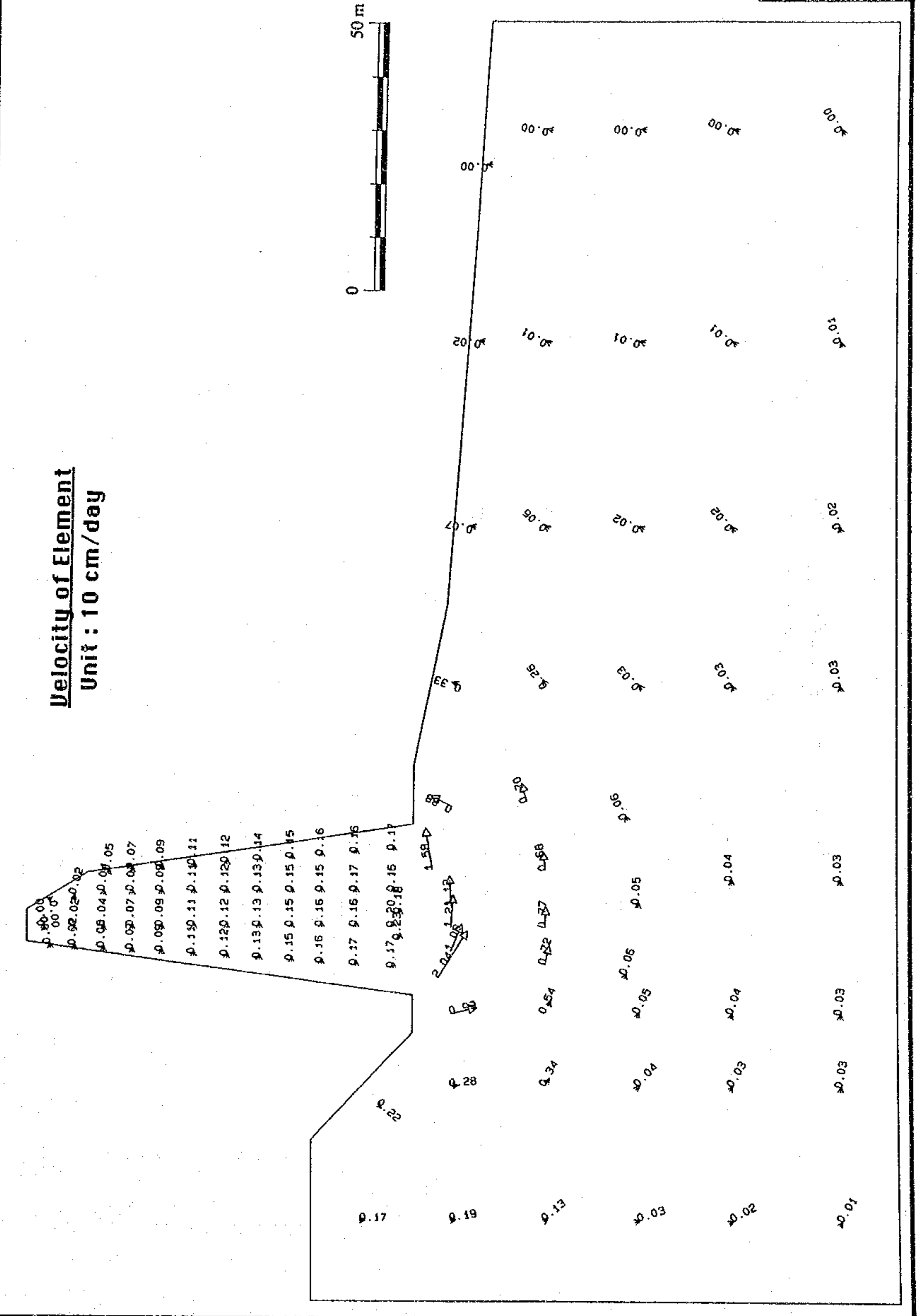
SEEPAGE FLOW DISTRIBUTION (SECTION NO. I)	GOVERNMENT OF MAURITIUS PORT LOUIS WATER SUPPLY PROJECT JAPAN INTERNATIONAL COOPERATION AGENCY

Fig. 3.8.8



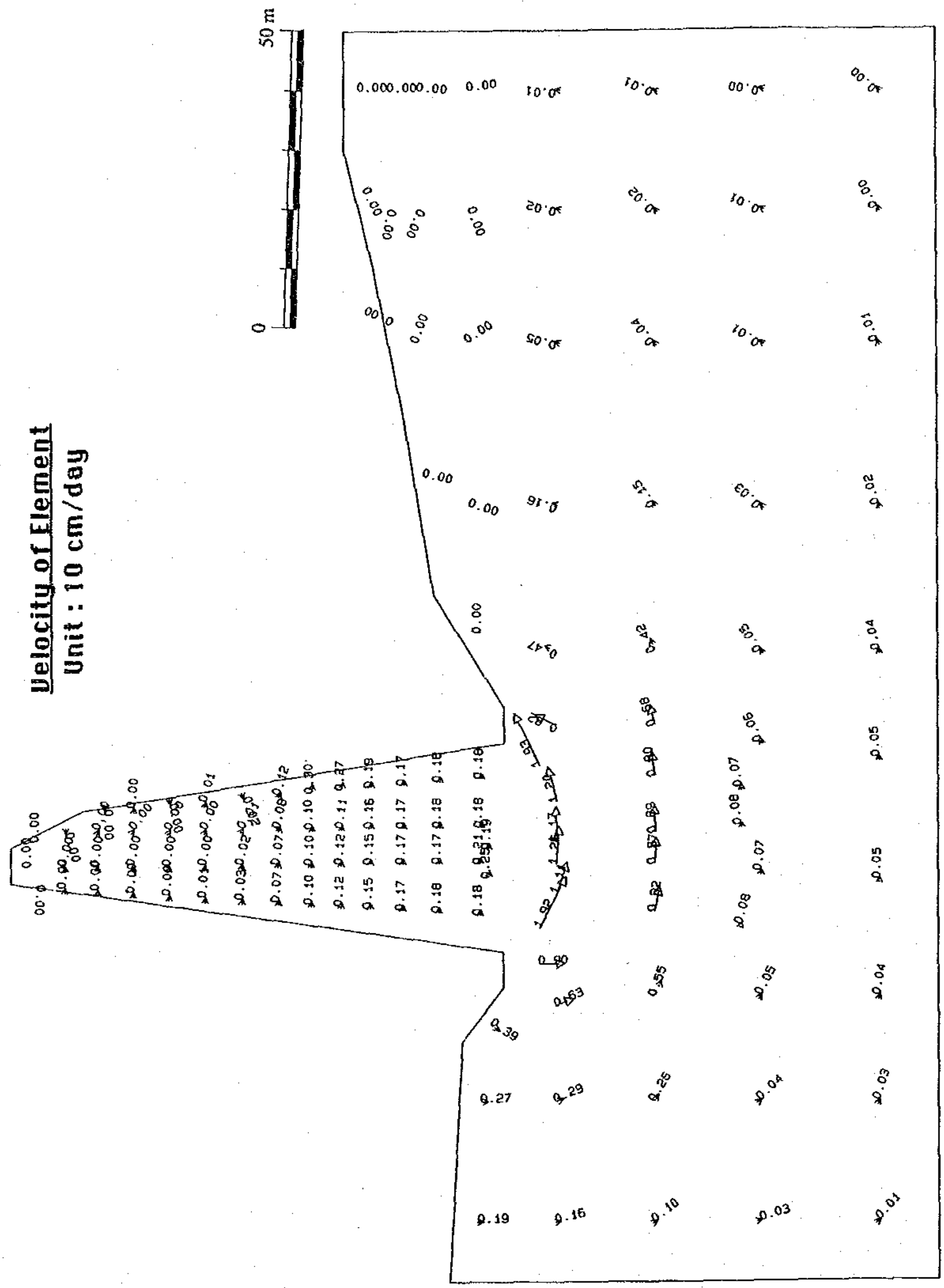
SEEPAGE FLOW DISTRIBUTION (SECTION NO. II)	GOVERNMENT OF MAURITIUS PORT LOUIS WATER SUPPLY PROJECT
	JAPAN INTERNATIONAL COOPERATION AGENCY

Fig. 3.8.9



SEEPAGE FLOW DISTRIBUTION (SECTION NO. III)	GOVERNMENT OF MAURITIUS PORT LOUIS WATER SUPPLY PROJECT JAPAN INTERNATIONAL COOPERATION AGENCY

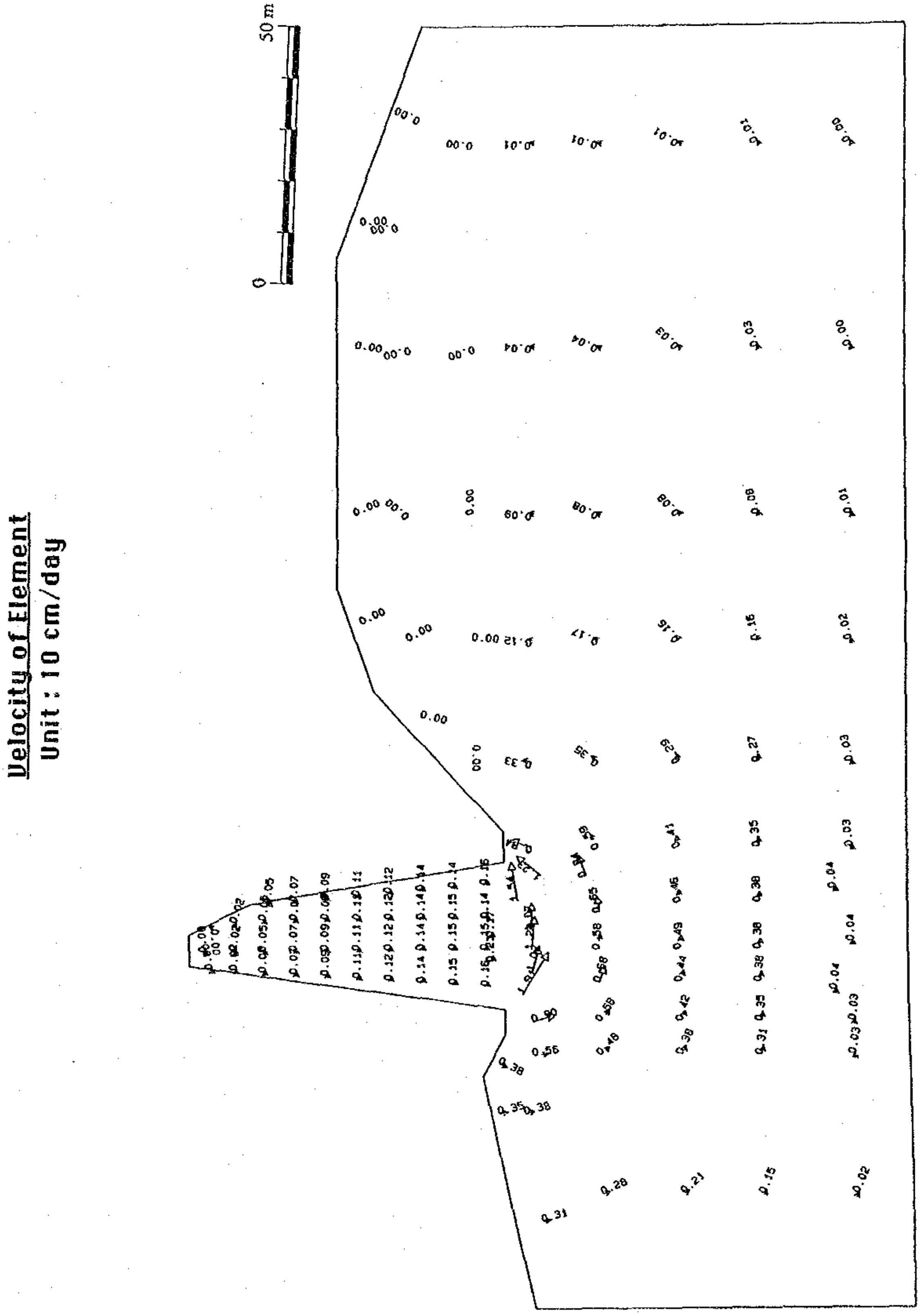
Fig. 3. 8. 10



SEEPAGE FLOW DISTRIBUTION
(SECTION NO. IV)

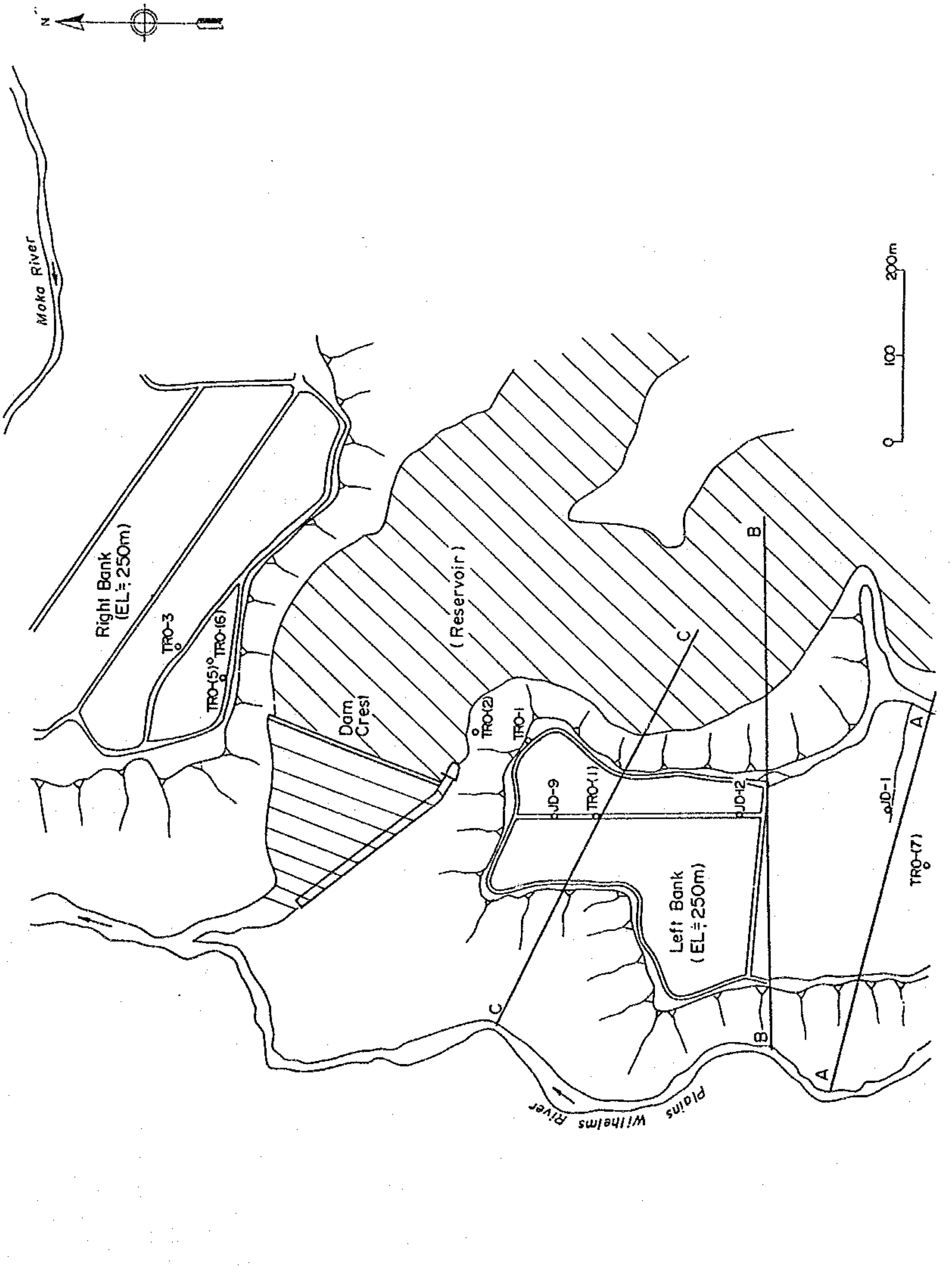
GOVERNMENT OF MAURITIUS
PORT LOUIS WATER SUPPLY PROJECT
JAPAN INTERNATIONAL COOPERATION AGENCY

Fig. 3.8.11



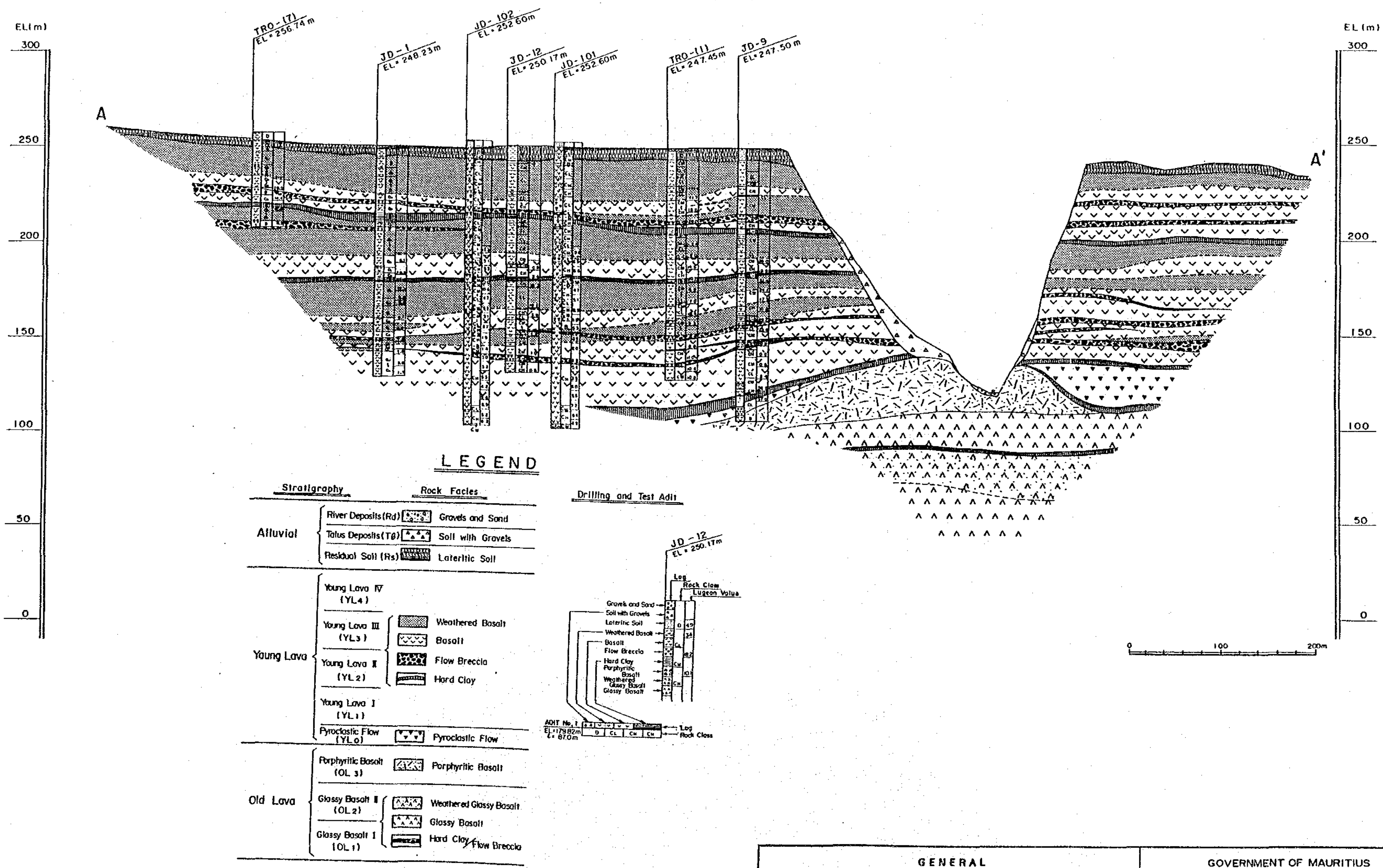
SEEPAGE FLOW DISTRIBUTION (SECTION NO. V)	GOVERNMENT OF MAURITIUS PORT LOUIS WATER SUPPLY PROJECT JAPAN INTERNATIONAL COOPERATION AGENCY

Fig. 3.9.1



DAM SITE GENERAL MAP	GOVERNMENT OF MAURITIUS PORT LOUIS WATER SUPPLY PROJECT
	JAPAN INTERNATIONAL COOPERATION AGENCY

Fig 3. 9. 2



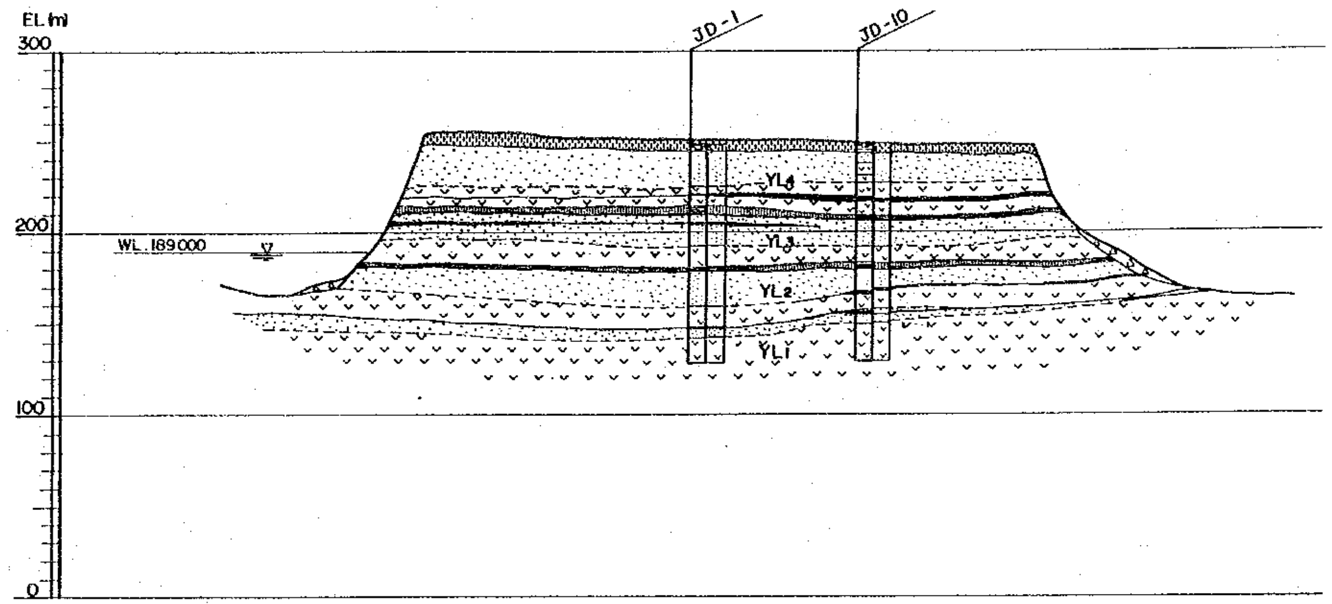
GENERAL
GEOLOGICAL PROFILE ALONG
THE DAM AXIS

GOVERNMENT OF MAURITIUS
PORT LOUIS WATER SUPPLY PROJECT

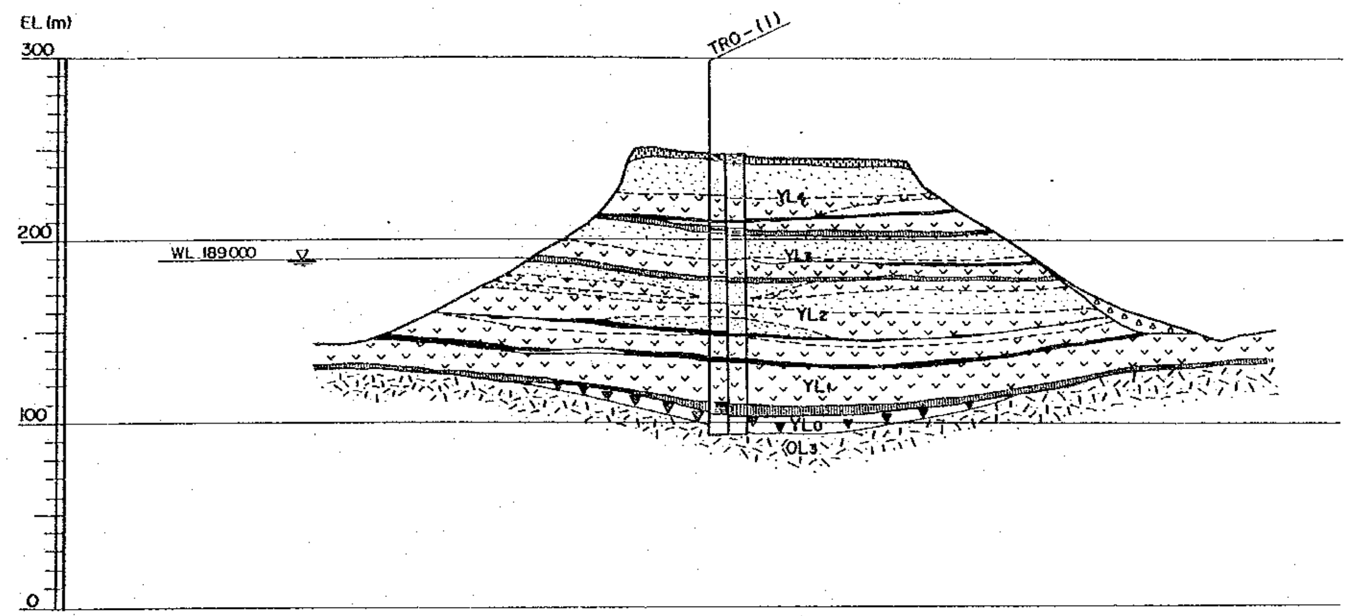
JAPAN INTERNATIONAL COOPERATION AGENCY

Fig.	3. 9. 3

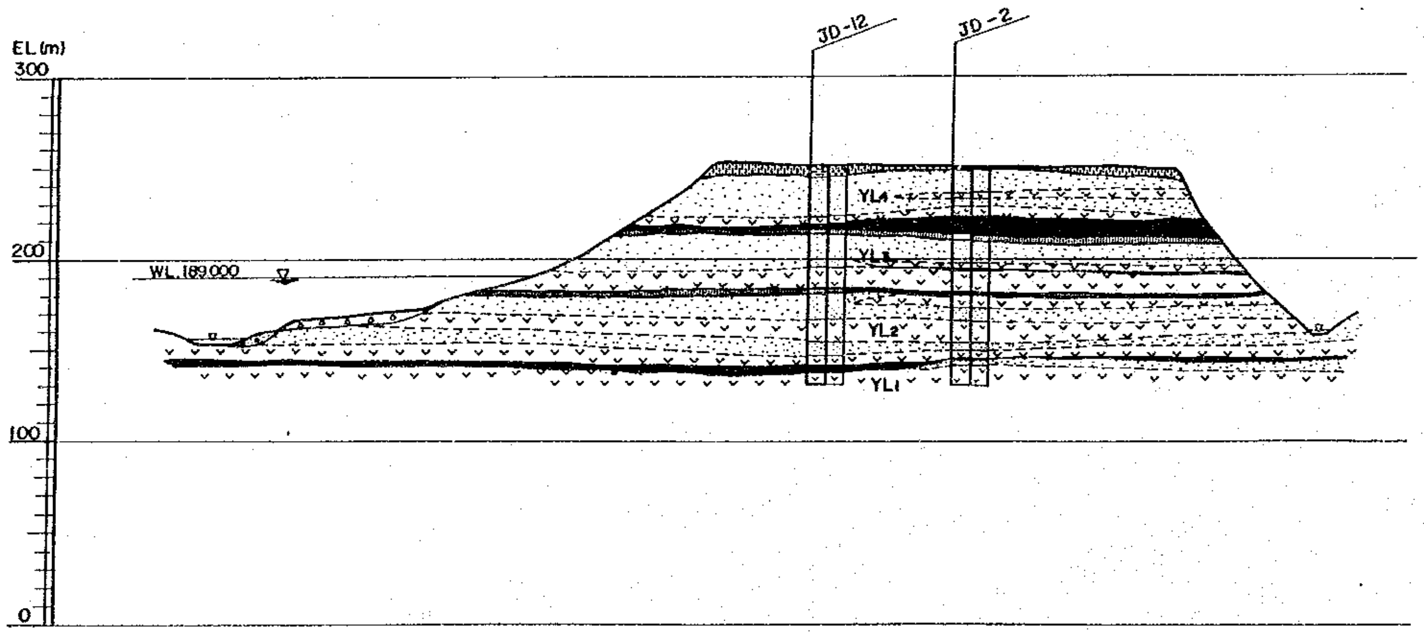
SECTION A－A



SECTION C－C



SECTION B－B



LEGEND

Alluvial	River Deposits	Gravels and Sand
	Talus Deposits	Soil with Gravels
	Residual Soil	Lateritic Soil
Young Lava	Young Lava Ⅳ (YL4)	
	Young Lava Ⅲ (YL3)	Weathered Basalt Basalt
	Young Lava Ⅱ (YL2)	Flow Breccia Hard Clay
	Young Lava Ⅰ (YL1)	
	Pyroclastic Flow (YL0)	Pyroclastic Flow
Old Lava	Porphyritic Basalt (OL3)	Porphyritic Basalt

TYPICAL GEOLOGICAL SECTIONS IN LEFT BANK	GOVERNMENT OF MAURITIUS PORT LOUIS WATER SUPPLY PROJECT JAPAN INTERNATIONAL COOPERATION AGENCY