MITHAWAN HILL TORRENT REGULATING FLOOD WATER HYDRAULIC MODEL STUDY

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Mithawan Hill Torrent like other 10 major Hill Torrents of the district drains Suleman Range hills which are steep and devoid of vegetation and so is a flashy stream. It debouches into plains at Darrah near Choti Bala about 42 miles south-west of D.G. Khan city. Flood basin irrigation is done from the flow of this hill torrent below darrah by putting cross earthen embankments in the bed of the nullah by the cultivators and diverting the flood water into fields enclosed in turn by embankments. In 1945 investigations for harnessing flood flows of Mithawan Hill Torrent in D.G. Khan District were carried-out. An earthen dam 8000 feet upstream of Choti Bala was proposed by Superintending Engineer, Project Circle but the scheme was not pursued further.

In 1957, a Hill Torrents Division was opened by the Irrigation Department for collecting the hydrological data and preparing flood control schemes for all the hill torrents but the division was closed in 1965 and the assignment was entrusted to Small Dam organization of A.D.C.

The discharges of Mithawan Hill Torrent recorded at Darrah for the period 1960 - 1964 are listed in table 1.1-1.1 which shows that annual run-off of this torrent is of the order of 40,000 acre feet.

The maximum flood recorded on 24.8.1958 had a peak of 77500 cusecs and has a duration of 18 hours, Fig. 1. One single flood on 24.8.1958 brought 42900 acre feet of discharge. The run off acertained at Darrah during rains in the Summer period of 1958 which is the wettest recorded year, is listed below :

Date 1958	Yield in acre feet
6/7	1,001
16/7	1,658
7/8	330
8/8	331
17/8	56
24/8	41,900
27/8	36
29/8	915
14/9	855
17/9	635

The table shows that only one rain during the year may necessitate storage.

The drainage from Suleiman Hill has increased substantially in recent years and so the maximum flood peak may exceed the ever recorded flood peak of 77580 cusecs. However for model study a hydrograph peaking at 77580 cusecs was used.

The current irrigation done on this hill torrent is 7899 acres during Kharif and 2447 acres during Rabi. Mr. G.E. Meade .A.O. Expert estimated that flood water of Mithawan carries 2% of sediment by volume which will mean that any detention or storage dam will be silted up rapidly as annual silt deposit will be of the order of 800 acre feet.

The total capacity of crossings of Hill Torrent in D.G. Khan Canal system is 9400 cusecs and thus the hill torrent has flood damage potential for the canal system. During 1967 the flood of this torrent breached right flood embankment of D.G. Khan Canal at R.D. 327 and damaged the tail at R.D. 3500 of Link No. III.

The idea of detention bunds or retarding dams instead of conventional dams was mooted by the F.A.O. expert who proposed that a high flood of duration less than a day may be spread out to continue for 5 days period by the detention bund to enable the cultivators to use flood water more effectively.

For regulating flood water of Mithawan Hill Torrent, Chief Engineer, Irrigation, Multan proposed in 1975 a detention bund 13650 feet long with maximum height of 35 feet, 2.7 miles D/S of the Darrah, Fig.2. The capacity curve of Reservoir is shown in Fig. 3. The top of bund is proposed at R.L. 655. The upstream slope, one vertical three horizontal was proposed to be armoured with stone. To reduce seepage, a central compacted clay core is also provided, Fig. 4.

It was proposed to provide overflow structure in the Detention Embankment as below :

R.D.	Structure	Size & Shape	Cill level	Discharge cfs
1800	Gated Regulator	10'x5' barrel	630	100
3500	Gated Regulator	10'x10' barrel	625	500
4300	Gated Silt Sluice	10'x10' barrel	625	500
6500	Gated Regulator	10'x10' barrel	620	500
9000	Gated Silt Sluice	10'x10' barrel	620	500
11100	Spillway	Width = 270'	640	
12650-13650	Breaching Section		632	

It was supposed that 5 No. irrigation and silt sluices which are scattered along the bund and are at low elevation will escape 75% of the total incoming silt in the reservoir whereas 25% of the silt will deposit in the reservoir. Thus the life of dam with siltation to crest level of spillway was estimated at 20 years and to full reservoir elevation of 650 at 55 years which may get reduced to 5 years and 14 years respectively if entire silt is entrained in the reservoir.

The objectives of the detention embankments are :

a. To save the cultivators from the labour of raising bunds in the bed of Nullah after every flood in the Nullah.

b. To attain proportional distribution of discharge in different proposed irrigation channels in accordance with established irrigation rights of the cultivators.

c. To store flood water for irrigation uses.

d. To lower the peak of floods downstream of the embankment and to protect D. G. Khan canal irrigation system.

As an alternative to flood detention embankment, a conventional weir with left-bank off-take regulator was also tried at Darrah to attain objectives (a) & (b) above.

Model :

In order to study the hydraulic and silt features of the proposed bund, about 4 mile-long reach of the hill torrent including Darrah and 1 mile downstream of the bund inclusive of entire reservoir area was represented on the model on 1:60 natural scale. The model and prototype ratios are given below :

Parameter	Dimension	Scale Ratio	Absolute Magnitude	
			prototype	Model
Length	Lr	1:60	1 ft	0.0166 ft
Area	Lr^2	1:3600	1000 sq.ft.	0.277 ft.
Velocity	$Lr^{\frac{1}{2}}$	1:7.74	1 ft/sec	0.129 ft/sec
Discharge	$Lr^{5/2}$	1:27885	100,000 cs	3.59 cs
Time	$Lr^{\frac{1}{2}}$	1:7.74	1 min	7.62 sec

The model was moulded in sand accurately in accordance with contours made available by Executive Engineer, Jampur Construction Division. All the features of the Dam, Spillway, Regulators and Silt Sluices were constructed to scale. For accurate measurement of the model discharge, a right angled V-Notch was used with discharge formula $Q = 2.5 H^{2.5}$.

Hydrograph peaking at 77500 cusecs was used on the model.

Model Tests :

Basic Test :

The basic test was proformed without proposed embankment. The model was moulded accurately after preliminary proof run test and was run with hydrograph peaking at 77500 cusecs after re-shaping the hydrograph to run specific discharge, Fig. 6. The current directions observed visually are given in Fig. 7.1 - 7.3 and recorded photographically for Q = 77500 cusecs are shown in Fig. 7.4. The water levels observed for the specific discharges are given in Table 2.

The results indicate that for all discharges the flow of the hill torrent after leaving Darrah gets bifurcated into two main currents, one taking a straight run but slightly left handed and the other right handed taking a sharp turn towards right at about 5000 and 6000 feet from Darrah - along the two natural depressions. The sheet flow on the flanks of the two main currents increases in depth and velocity with increase in flood stage of Nullah. The water levels observed at the Gauge positions shown in Fig. 2 are plotted in Fig.8

which shows that the water surface slope in the hill torrent is about 4.84 per thousand at all discharges.

Test with Detention Embankment :

The details of the retardation Dam tested on the model are given in page 3 & 4.

After remoulding the model and representing the proposed detention embankment of 1975 and the appurtenant structures, Figs.2, 4, 5.1, 5.2, the hydrograph peaking at 77500 cusecs was run by adjusting the discharge after every five minutes and observing water levels along the embankment at the same interval of time. Silt at the rate of 2% by volume was injected at the upstream end of model at all discharges. The velocities of the on-rushing currents impinging at the bund as well as the velocities of parallel flow along the bund were observed. To maximise the escapage of silt, the three regulators and the two sluices were kept open throughout the period of run of hydrograph as well as during the depletion of the pond (after the run of the hydrograph). Discharges of the three regulators, and two sluices and spillway were also recorded at different levels of the pool in the rising stage to determine their discharging capacities at every stage of the pond.

At low reservoir elevations, the two currents bifurcating at a point about 5000' - 6000' downstream of Darrah impinge on the embankment at S.S. 2 (R.D. 9000) and R2 (R.D. 3500) with a velocity of

3.0 ft to 4.5 ft per second and then split up to spread side-ways on both sides of the point of impingement along the bund, Fig. 9. The water level along the upstream face of the embankment were observed at intervals of 5 minutes on model, Fig. 10. The water levels attain uniform level at R.L. 640 after 40 minutes (after 5 hours on prototype) at a discharge of 45000 cusecs but vary (indicating parallel flow) in the period 10 minutes to 40 minutes (i.e. from discharge 10,000 to 40,000 cusecs). The maximum velocity of parallel flow along the bund was noted at R.D. 4000 - 6000 of the embankment due to the steep gradient of flow from R2 to R3 and S.S. 2 to R3. The parallel flow velocity diminishes as the potential gradient decreases by filling in of the low level pockets on the flanks of forward flow currents. The reach in between Regulator R2 to Silt Sluice 2 i.e. R.D. 4300 to 9000 is subjected to the parallel flow velocities beyond 3 feet per second and so this reach requires stone armouring. The water level becomes almost even from one end of the bund to the other at reservoir level 640. The flow velocity parallel to the bund at the most vulnerable point (R.D. 5000) with different rates of rise of discharge is plotted in Fig. 11 which shows the maximum velocity of 9 ft/sec if the rate of rise of discharge is 10,000 cusecs per hour, the same as observed in 1958 hydrograph. The size of stone to withstand velocity is 10 inches in dia or about 60 lb. in weight. The reservoir level with time is given in Fig. 12. The maximum reservoir level with all the regulators and spillway working rose to R.L. 652.4 against R.L. 650 computed. Head across the bund at Regulators/Sluices is plotted in Fig. 13. At maximum Reservoir Elevation it rises from 18.5' at R.D. 1800 (R1) to a maximum of 31' at R.D. 9000 (S.S. 2). The structures and the embankments will have to be designed to cater for maximum head across. The discharging capacities of regulators and silt sluices at different elevations of the reservoir are shown in Fig. 14.1 which shows that regulators will have to be provided with gates as the designed discharge of R2 and SS1 without gates is attained at Reservoir Elevation 631 whereas the designed discharge of R3 and SS2 is attained at Reservoir Elevation of 626.5. The discharging capacity of spillway at different Reservoir Elevation is plotted in Fig. 14.2. The discharging capacity of spillway at elevation 650 is 32000 cusecs against assumed discharge of 30400 cusecs. The total escaping discharge at R.L. 652.4 has been computed as 64000 cusecs as shown in Fig. 15. Thus the reduction in peak of flood of the order of 1958 is not substantial (only 18%).

Although the sluices and regulators were kept open at all Reservoir Elevations yet they were not drawing any silt except the wash-load because these draw water from the still pond. The bed load and suspended load carried by the flow gets deposited in the pond area at the tail end of back water curve, from where it cannot be flushed by sluices.

The water levels recorded at downstream of the spillway and sluices are plotted in Fig. 16. The bed level of stilling basins of structures should be designed in accordance with Fig. 17 (scour pattern d/s of regulators) keeping some provision against future retrogression.

Silt clearing capacity of the sluices :

In order to check minutely the silt clearing capacity of the sluices, a separate test was performed by filling the reservoir with fine silt upto a uniform level of 635.0 and then running the model for ten hydrographs peaking at 20,000 cusecs each of duration of 8 hours. All the five sluices were run without gates. It was noticed that the movement of silt was confined to a localised area in the vicinity of inlet of sluices, only when the depth of water in the reservoir is about 3-5 feet. The withdrawl of discharge by the silt sluices from low and high pond as recorded photographically are shown as below :

Fig.	18.1	Silt sluice SS1 drawing from low pond.
	18.2	Silt sluice SS1 drawing from high pond.
	18.3	Silt sluice SS2 drawing from low pond.
	18.4	Silt sluice SS2 drawing from high pond.

Conclusions :

1. The silt withdrawls are function of velocity at the bed of the channel to the inlet and as Reservoir Elevation rises, this velocity decreases and so silt entry into the sluices decreases and any sluicing by sluices is confined to localized area at the inlet of sluice. The sluices are not capable of sluicing any silt except the wash-load and so annual silt trapped in Reservoir will be 800 acre feet i.e. 2% of total average run-off of 40,000 acre feet. The capacity of

reservoir upto crest level of spillway (El 640) is 4000 acre feet and the reservoir will silt up to crest level of spillway in 5 years and will entail raising of embankments after regular intervals.

It may be pointed out that the Chichali Dam silted up in the first year of its operation.

2. The lowering of the peak of flood of the order of 1958 by the detention reservoir is of the order of 18% during the first year of operation of Dam which will reduce substantially during subsequent years, and so the damage potential of hill torrent is not lowered significantly.

3. So the objectives c & d page 9 cannot be met with even with detention embankment except for a limited period upto 5 years.

4. The on-rushing velocities of flow during the very initial stages of filling of reservoir do not exceed 4.5 f.p.s. whereas the maximum velocity of parallel flow along the face of embankment in the reach R.D. 4300 to R.D. 9000 can attain a value of 9 f.p.s. and so the average size stone armouring the upstream face of embankments should be of the order of 60 lbs.

5. The maximum head across the embankment varies from 18' at R.D. 1800 to 31' at R.D. 9000 and so the structures will have to be designed for this head across.

6. The structures as designed are not safe against tail erosion as tail water levels and scour R.Ls. were not assessed properly.

7. It is, therefore, concluded that the scheme of detention bund is not hydraulically feasible.

A distributor weir at Darrah site was therefore also studied as an alternative to the scheme.(Fig. 2)

Distributor as an alternate to detention embankment :

The results of detention embankment were discussed with Chief Engineer, Irrigation, Multan, Superintending Engineer, Derajet Circle and Executive Engineer, Jampur Construction Division at the model. The poor silt performance of five sluices was also demonstrated on the model. It was decided to try a distributor at Darrah as an alternate to detention embankment.

Main Features of the Distributor :

As envisaged, the distributor located 4000' downstream of Choti Bela will consist of an open weir 740 ft. long with crest at R.L. 676.0, a gated undersluice with a total span of 256 ft. with crest R.L. 669.0 and a gated regulator (clear water way = 60') on the left flank with crest at R.L. 672.0 to draw all the discharges of torrent upto 1200 cs for irrigation purposes. The design data of the distributor is given in Fig. 19 and Table 3.1 - 3.3. The undersluices had 9 bays of 24' and was further split up in two parts by a divide wall covering the off-take regulator. This divide wall was found to be essential to sluice the pocket effectively. The main canal was aligned on the left flank of nullah sufficiently away from the ingress of flows of Nullah, Fig. 20.

Test 1 :

In this test, only the rising stage of the hydrograph starting from a small discharge of 500 cusecs to the maximum discharge of 77500 cusecs was used to study the over-all working of the distributor, the discharging capacity of the canal regulator and the effect of flood waters on the safety of the canal. Each discharge was run for a sufficiently long time to record the steady water levels generated above the distributor, to measure the flow escaping through the canal regulator and to observe the flow currents downstream of the distributor in relation to the alignment of the canal.

It was noticed that as the discharge was slowly increased, the 75 ft. wide regulator with 60 ft. clear water way takes entire discharge upto 1200 cusecs beyond which the water starts crossing over the main weir at R.L. 676.0, Table 4.1-4.2. Then the regulator was widened to 127 ft. with 10 bays, each 10 ft. wide to double up its discharging capacity as desired by the Field Officers. The widened regulator takes 100% of incoming discharges upto 2300 cusecs at R.L. 676.0 and about 40% out of 10000 cusecs coming down the torrent, Table 5.1-5.2.

The main weir works ideally for all discharges especially when the undersluice is fully open at high flood discharges. The performance of the weir was also checked under conditions of 2-3 ft. retrogression and it worked quite satisfactorily. Some shoaling was, however, observed downstream of the under-sluices when the undersluice bays are opened to flush the silt deposited in the pocket as is evident from Fig. 21.1, 21.2, indicating that the undersluices as proposed will flush the pocket effectively.

The left current which was weaker without the distributor in position now becomes stronger due to radical change in flow section at the site of the distributor, Fig. 22, and consequently the parallel flow along the right bank of the canal increases. The spill discharge flows all along the canal alignment at all discharges above 10,000 cs and parallel flow velocity is as high as 6.3 f.p.s. at 30,000 cusecs and 9-10 ft/sec at 77000 cusecs. It was also seen during the test that some flow emerging from the under-sluice turns towards the left Fig.23.1, 23.2 after leaving downstream nose of left guide bank and travels along the canal with a maximum velocity of 8.5 ft. at a point about 2000 ft. downstream of the distributor and then in conjunction with the spill emanating from the left main current impinges against the canal at about 8000 ft. downstream of the distributor and flows all along the Mithawan canal upto its tail end, Fig. 24.

Test 2 : Downstream left guide bank lengthened, J-spur tied to the canal :

The downstream left guide bank was therefore lengthened to guide the flow from undersluices and 2500 ft. long 'J' spur to deflect the left main current to its original course and to save the canal from parallel flow along it, was provided. The flow conditions with this arrangement as observed visually are given in Fig. 25.1-25.3 and as recorded photographically for Q = 30,000 and 77500 cs are shown in Fig. 25.4-25.5, which indicate that the parallel velocity along the canal is brought down to the non-erosive magnitude all along the canal except its tail end where another spur of about 1000 ft. length is required to keep the spill flow away from the tail of the canal. The flow conditions in the presence of two spurs are shown in Fig. 26 which shows that the spill flow is at a safe distance from the canal.

Test 3 : Hydrograph run on the model.

The complete hydrograph of the Hill Torrent for the year 1958 (Fig. 6 - Table 6.1-6.2) was run on the model. The levels generated above the distributor in this case were observed and the discharge finding its way into the canal regulator was measured for different levels in the pocket for rising stages as well as for falling stages. The four right bays of undersluices were opened when the level above the distributor reached R.L. 681.7 and the level in the pocket was 681.3. The water levels fell to R.L. 681.5 at the main weir and to R.L. 681.1 in the pocket. The undersluice was fully opened when the upstream level again rose to R.L. 681.7 and 681.3 at main weir and pocket respectively. The maximum level attained at the weir at 77500 cusecs was 682.0 against the corresponding level in the pocket at 680.3.

The bed contours at the end of the hydrograph are shown in Fig. 27 which indicates that :

a. The pocket can be kept clean by proper regulation of bays of undersluices.

b. The bed load of torrent can be effectively stopped from entering the canal.

c. The upstream nose of divide wall separating the weir and the undersluice is subjected to heavy action and should be properly designed to cater for scour R.L. 638.

d. There is no indication of scour downstream of weir and undersluices.

Conclusions :

1. The measurement of discharge passing through canal regulator shown in Fig. 28 indicates that the 6-bay regulator can take 100% of incoming discharge upto 1250 cusecs without overtopping the spill weir at R.L. 676 whereas 10-bay regulator can similarly draw whole of the incoming discharge upto 2450 cusecs. It can also be seen that the 10 bay regulator can safely pass 4000 cusecs at 10,000 cusecs incoming discharge and about 9000 cusecs at a peak discharge of 77500 cusecs. The discharging capacity of the regulator can be further increased if the upstream noses of the piers are curved to streamline the flow entering the canal.

2. The feeder canal downstream of distributor can only be protected against parallel flow by :-

a. Extending the downstream left guide bank of the distributor to attain a length of 370' downstream of left abutment.

b. Constructing a 'J' spur at R.D. 4.30 and mole-head spur at R.D. 13.8 of the canal.

3. For proper flushing of pocket, a subsidiary divide wall in continuation of pier No. 5 upto a total length of 190' is a must.

4. The Feeder canal and its off-take regulators will have to be properly designed.

5. With a distributor weir at Darrah site only objective a & b detailed in page 4 can be attained and it has no bearings on objective c & d.

- - -

Discharge Recorded at Darrah of Mithawan Hill Torrent — Tab. 1.1

Year	*Date*	*Hours of flow*	*Peak discharge in cusecs*	*Total discharge in Acre ft.*
	19.3.60	6	17736	3720
	6.7.60	8	2018	349
	8.7.60	10	15266	2243
	9.7.60	11	44776	9681
	11.7.60	18	37650	20675
			Total :	36668
1961	16.7.61	10	34270	6873
	20.7.61	7	5481	678
	23.7.61	7	1255	231
	24.7.61	7	726	167
	26.7.61	10	22657	5682
	27.7.61	7	4443	549
	18.8.61	4	233	39
	21.8.61	6	684	135
	27.8.61	7	2018	345
	2.9.61	8	44892	9004
	4.9.	9	44892	9909
	8.9.61	7	21800	3267
			Total :	36879

Discharge Recorded at Darrah of Mithawan Hill Torrent

Tab. 1.2

Year	*Date*	*Hours of flow*	*Peak discharge in cusecs*	*Total discharge in Acre ft.*
1962	21.6.62	4	1682	203
	30.6.62	7	20290	2941
	1.7.62	3	2024	325
	2.7.62	7	7320	1231
	12.7.62	11	7938	1307
	17.7.62	7	36314	4536
	18.7.62	8	59162	3439
	19.7.62	2	3476	344
	20.7.62	9	8523	1990
	11.8.62	8	37153	5074
	30.8.62	8	25084	3735
	31.8.62	6	37902	5586
	7.9.62	8	17223	3123
	11.9.62	6	7320	1141
	12.9.62	13	59163	9861
			Total :	44896

Discharge Recorded at Darrah of Mithawan Hill Torrent

Tab. 1.3

Year	*Date*	*Hours of flow*	*Peak discharge in cusecs*	*Total discharge in Acre ft.*
1963	29.4.63	8	17003	3203
	12.5.63	8	18219	3115
	22.6.63	8	20290	3318
	30.6.63	7	20290	3108
	2.7.63	5	3476	541
	11.7.63	8	20290	3658
	21.7.63	7	5921	934
	12.8.63	8	34200	5396
	18.8.63	8	21789	3726
	20.8.63	11	17003	3005
			Total :	30004

Discharge Recorded at Darrah of Mithawan Hill Torrent

Tab. 1.4

Year	*Date*	*Hours of flow*	*Peak discharge in cusecs*	*Total discharge in Acre ft.*
1964	14.5.64	7	3756	661
	11.7.64	3	3367	315
	12.7.64	17	19122	13350
	13.7.64	1	19122	678
	15.7.64	5	1688	562
	16.7.64	5	1688	362
	17.7.64	1	180	-
	18.7.64	4	3175	608
	19.7.64	3	613	125
	25.7.64	7	2143	438
	26.7.64	4	3367	222
	27.7.64	3	1023	4669
	6.8.64	7	2809	8400
	11.8.64	7	1382	222
	12.8.64	10	19122	4969
	16.8.64	8	21586	7966
			Total :	43547

Tab. 2

Water Levels in the Channel
Without Embankment

Gauge / Discharge in cs	G1	G2	G3	G4	G5	G6	G7
6000	677.1	671.0	657.0	644.0	616.0	601.9	590.0
10000	679.0	671.5	657.5	644.9	616.5	602.0	591.5
20000	681.5	673.0	658.5	645.5	617.0	602.5	594.4
40000	683.7	674.5	659.4	646.0	617.7	603.6	597.6
60000	685.5	675.0	660.0	646.6	618.1	604.7	598.5
77500	686.8	675.3	660.5	647.0	618.3	605.5	599.0

Data of Proposed Distributor on Mithawan Hill Torrent at 4000 ft below Choti Bala

Tab. 3.1

1. Main Weir :

Total span	=	744 ft
q	=	150 cs
H_L	=	6 ft
D/S Floor Level	=	662.0
Crest R.L.	=	676.0
U/S glacis	=	1 : 1
D/S glacis	=	1 : 3
Crest width	=	3 ft
Length of floor	=	63 ft

Data of Proposed Distributor on Mithawan Hill Torrent at 4000 ft below Choti Bala Tab. 3.2

2. Undersluice :

Total span	=	256 ft (24' x 9 + 5' x 8)
Crest R.L.	=	669.0
Crest width	=	3 ft
U/S glacis	=	1 : 1
D/S glacis	=	1 : 3
D/S Floor R.L.	=	660.0
q	=	300 cs
H_L	=	6 ft
Length of floor	=	100 ft

Data of Proposed Distributor on Mithawan Hill Torrent, at 4000 ft below Choti Bala

Tab. 3.3

3. Regulator :

Total span	=	127 ft (10' x 10 + 3' x 9)
Crest R.L.	=	672.0
Crest width	=	3 ft
U/S glacis	=	vertical
D/S glacis	=	1 : 3
D/S Floor R.L.	=	665.0
q	=	25 cs
Length of Floor	=	26 ft.

Tab. 4.1

Working of Mithawan Weir & Regulator

4000 ft below Choti Bala

Discharge at Darrah in cs	Water levels around weir			Discharge in Regulator 75' wide	Water levels at spur		Remarks
	2000' U/S	at weir	D/S weir	in the pocket		U/S	D/S	
500	674.5	673.0	-	672.9	200 cs	Dry	Dry	Undersluice closed
1000	675.9	674.5	-	674.2	570 cs	Dry	Dry	Undersluice closed
1500	677.7	676.5	668.0	676.0	1250 cs	Dry	Dry	Undersluice closed
2000	678.0	677.0	668.0	676.5	1650 cs	Dry	Dry	Undersluice closed
3000	678.5	677.5	668.8	677.0	1850 cs	Dry	Dry	Undersluice closed
5000	679.0	678.0	669.5	677.4	1960 cs	Dry	Dry	Undersluice closed

Tab. 4.2

Working of Mithawan Weir & Regulator

4000 ft below Choti Bala

Discharge at Jarrah in cs	Water levels around weir				Discharge in Regulator 75' wide	Water levels at spur		Remarks
	2000' U/S	at weir	D/S weir	in the pocket		U/S	D/S	
10000	680.0	678.6	671.5	678.2	2510 cs	662.0	656.2	Undersluice closed
30000	681.9	680.0	674.0	679.2	3150 cs	664.3	656.5	Right 4 bays of undersluice open.
50000	683.8	681.5	675.3	680.7	4210 cs	666.0	656.7	Right 4 bays of undersluice open.
60000	684.0	681.3	676.0	679.8	3200 cs	666.7	656.8	Undersluice fully op
77500	687.0	683.0	677.0	681.0	1770 cs	667.7	657.2	Undersluice fully op

Note : The spur 4000' below the weir should be designed for maximum head across of 11.0'.

Working of Mithawan Weir & Regulator

4000 ft below Choti Bala

Tab. 5.1

Discharge at Darrah in cs	Water levels around weir: 2000' U/S	at weir	D/S weir	in the pocket	Discharge in Regulator 127' wide	Water levels at spur: U/S	D/S	Remarks
500	674.6	673.3	-	673.0	250 cs	Dry	Dry	Undersluice closed
1000	676.0	673.8	-	673.7	620 cs	Dry	Dry	Undersluice closed
1500	677.0	674.8	-	674.6	1350 cs	Dry	Dry	Undersluice closed
2000	678.0	675.8	667.0	675.6	1850 cs	Dry	Dry	Undersluice closed
3000	678.5	676.2	667.5	676.0	2342 cs	Dry	Dry	Undersluice closed
5000	679.0	676.3	663.2	676.7	2732	Dry	Dry	Undersluice closed

Tab. 5.2

Working of Mithawan Weir & Regulator

4000 ft below Choti Bala

Discharge at Darrah in cs	Water levels around weir 2000' U/S	at weir	D/S weir	in the pocket	Discharge in Regulator 127' wide	Water levels at spur U/S	D/S	Remarks
10000	680.0	677.8	669.5	677.7	3736 cs	659.5	654.5	Undersluice closed
30000	681.6	679.0	672.0	678.5	5019 cs	663.0	656.0	Right 4 bays of undersluice open.
50000	683.8	681.0	674.0	680.5	6134 cs	664.2	656.0	Right 4 bays of undersluice open.
60000	684.0	680.3	674.8	679.4	5019 cs	665.0	656.0	Undersluice fully op
77500	686.8	682.4	676.2	680.7	6134 cs	667.0	656.2	Undersluice fully op

Complete Hydrograph of Mithawan Hill Torrent for the year 1958

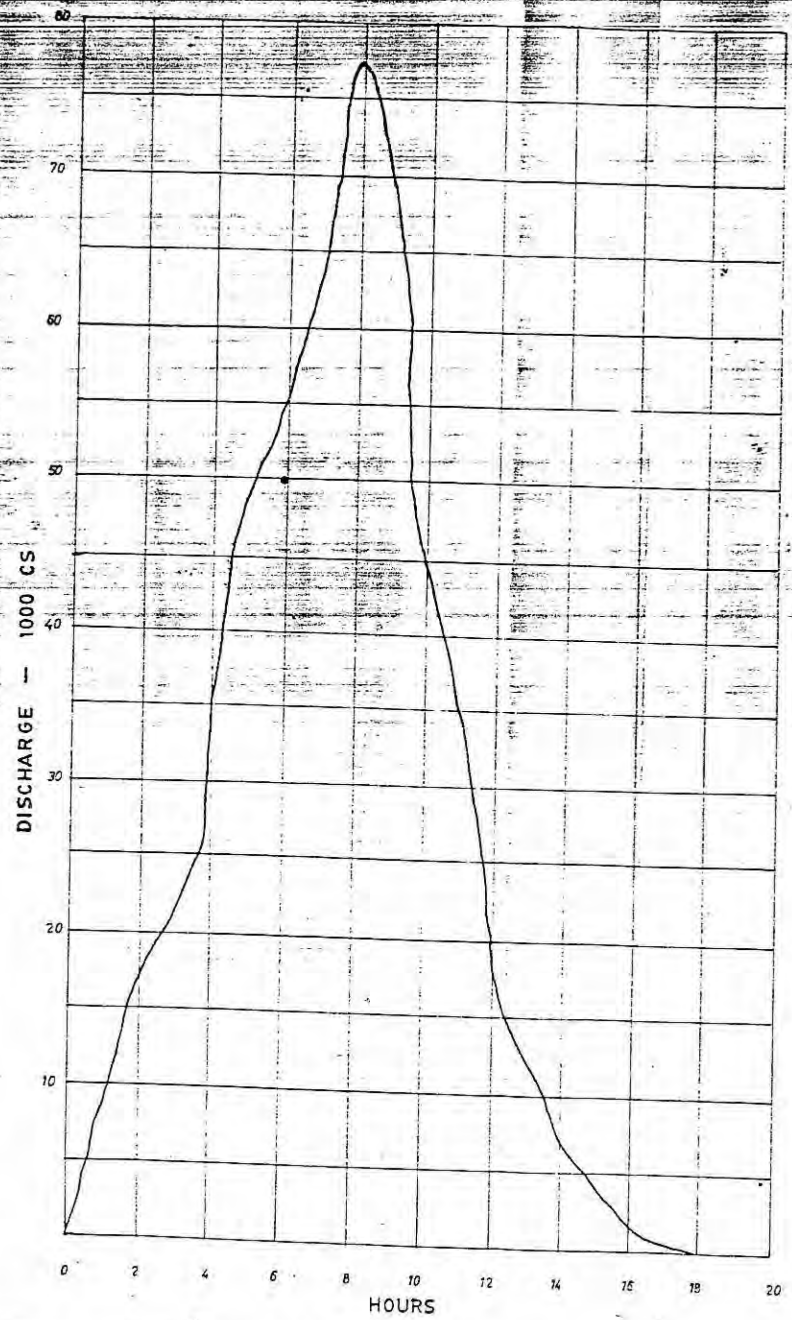
Tab. 6.1

Model time in minutes	*Discharge*
0	0
5	4800
10	10000
15	16000
20	21600
25	26800
30	32000
35	37600
40	45000
45	52000
50	59000
55	62200
60	74500
62	77500
65	71000

Complete Hydrograph of Mithawan Hill Torrent for the year 1958 — Tab. 6.2

Model time in minutes	*Discharge*
70	60000
75	50000
80	39500
85	30000
90	22000
95	16000
100	12000
105	9000
110	6500
115	4500
120	2800
125	1500
130	800
135	300
140	0

FIG.1



IRR-747

MITHAWAN HILL TORRENT

1958 HYDROGRAPH

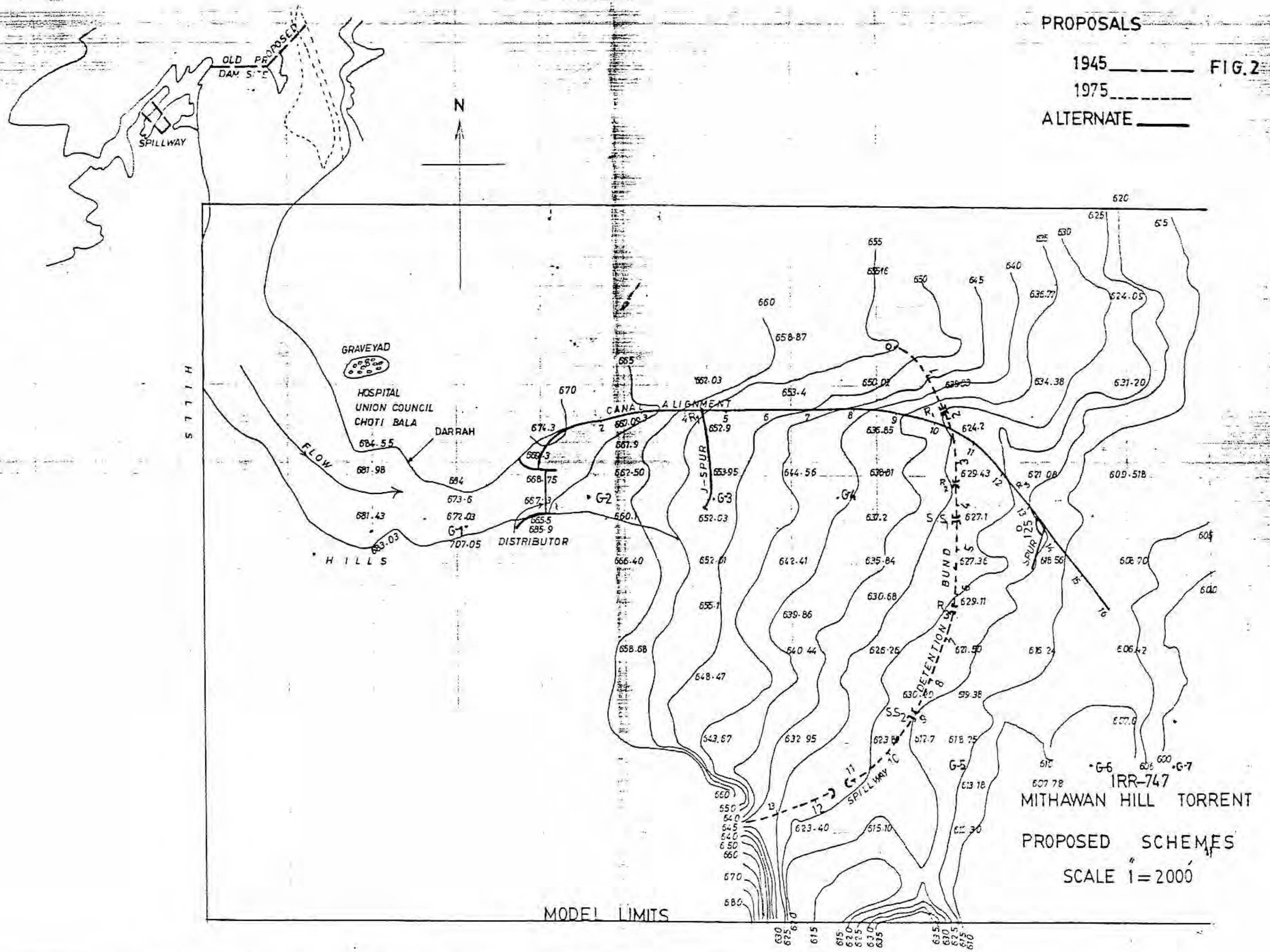
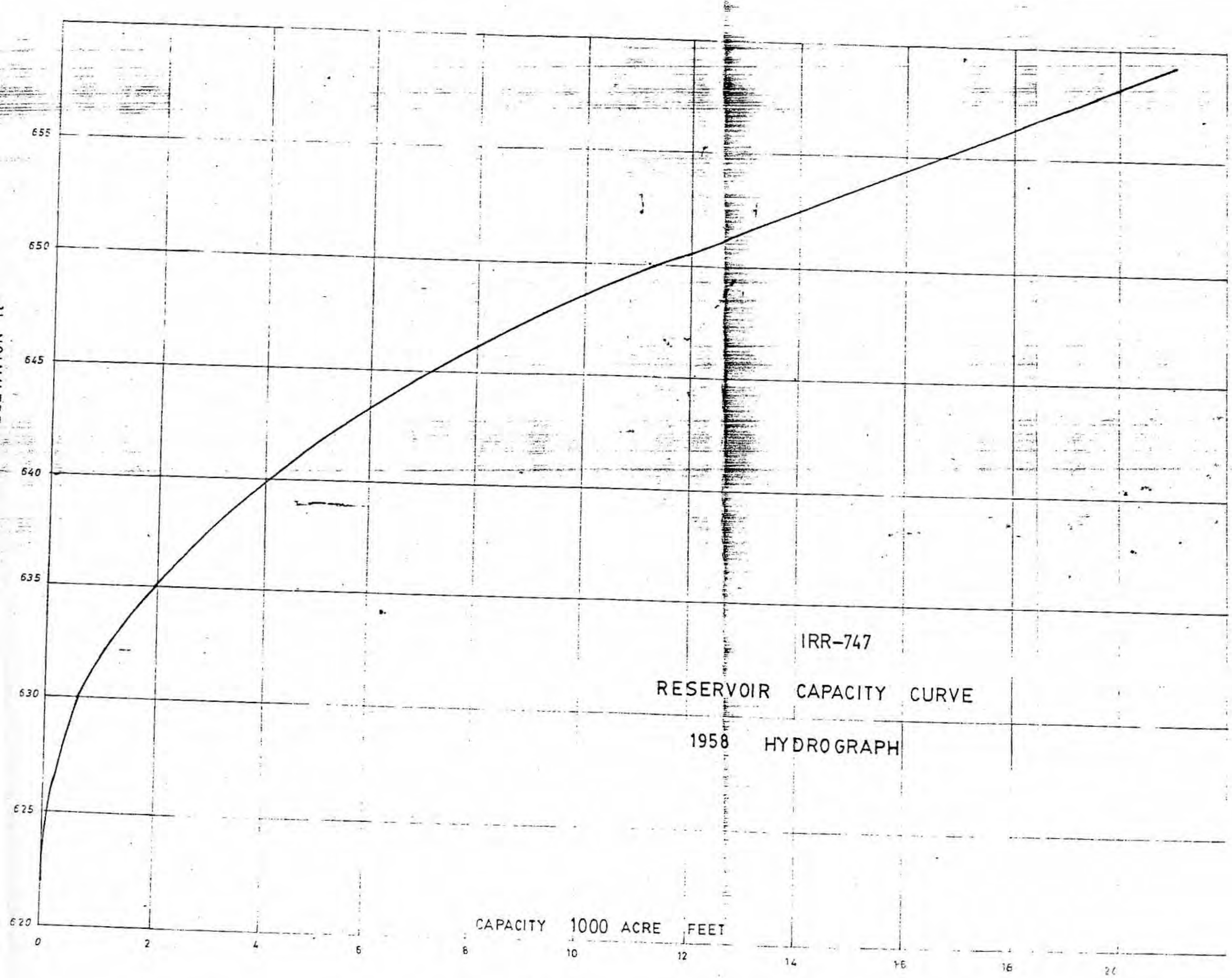


FIG. 2

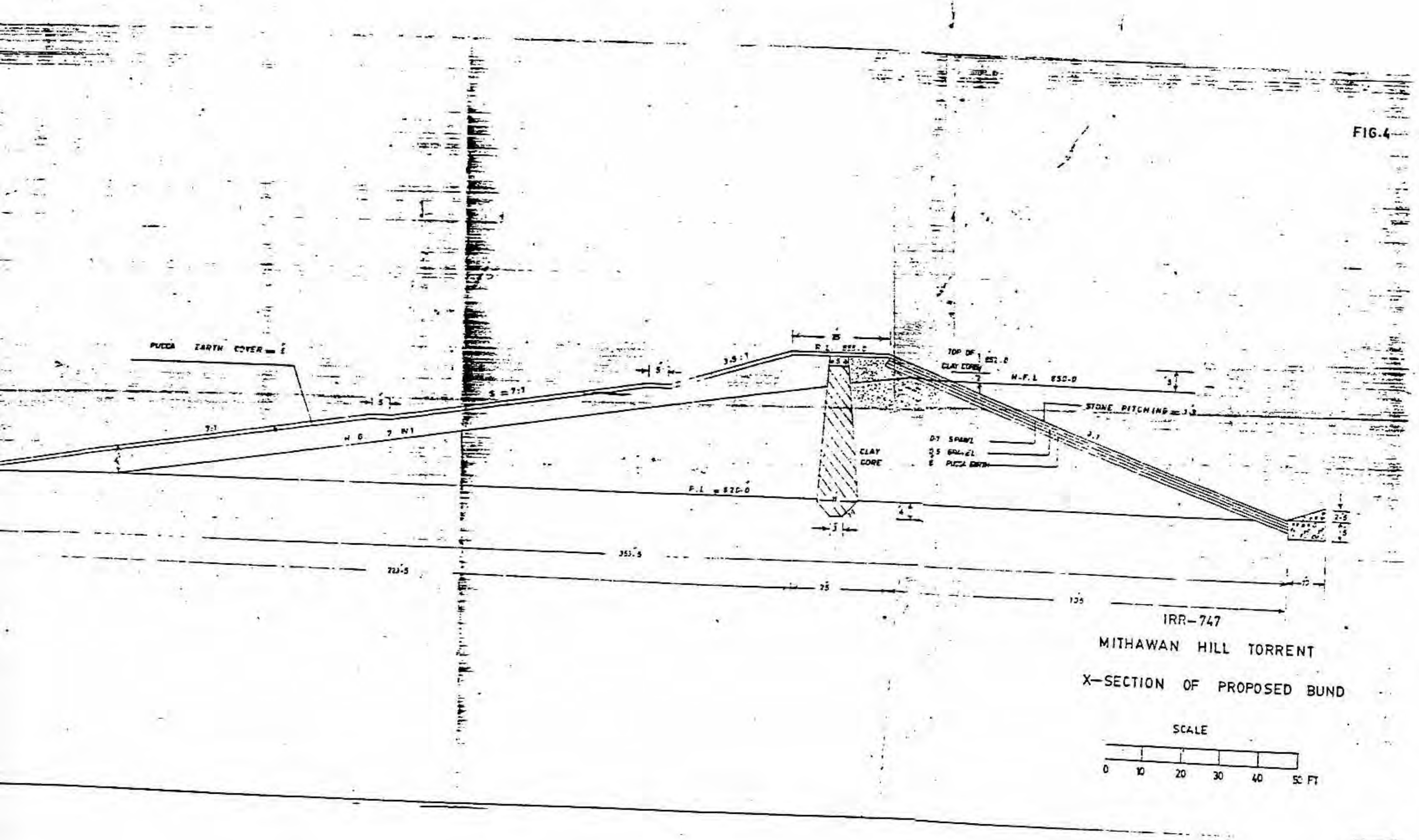
IRR-747
MITHAWAN HILL TORRENT
PROPOSED SCHEMES
SCALE 1" = 2000'



ELEVATION ft
655
650
645
640
635
630
625
620
0
2
4
6
8
10
12
14
16
18
20
CAPACITY 1000 ACRE FEET
IRR-747
RESERVOIR CAPACITY CURVE
1958 HYDROGRAPH

FIG. 3

FIG.4



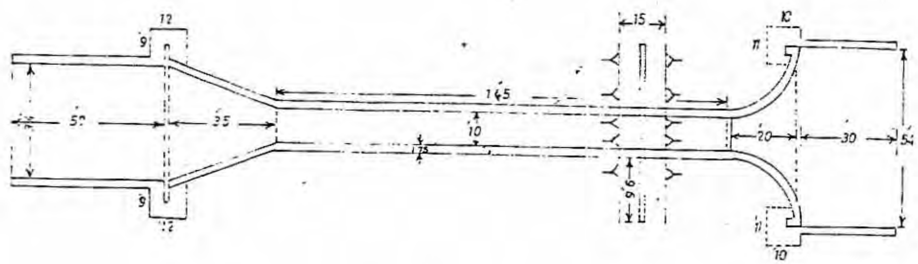
IRR-747

MITHAWAN HILL TORRENT

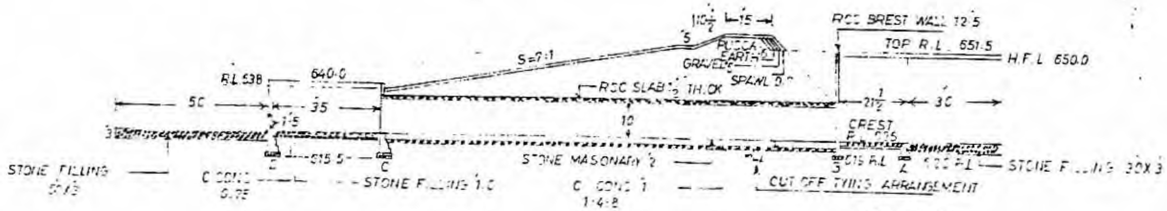
X-SECTION OF PROPOSED BUND

FIG 5.1

PLAN



CROSS SECTION



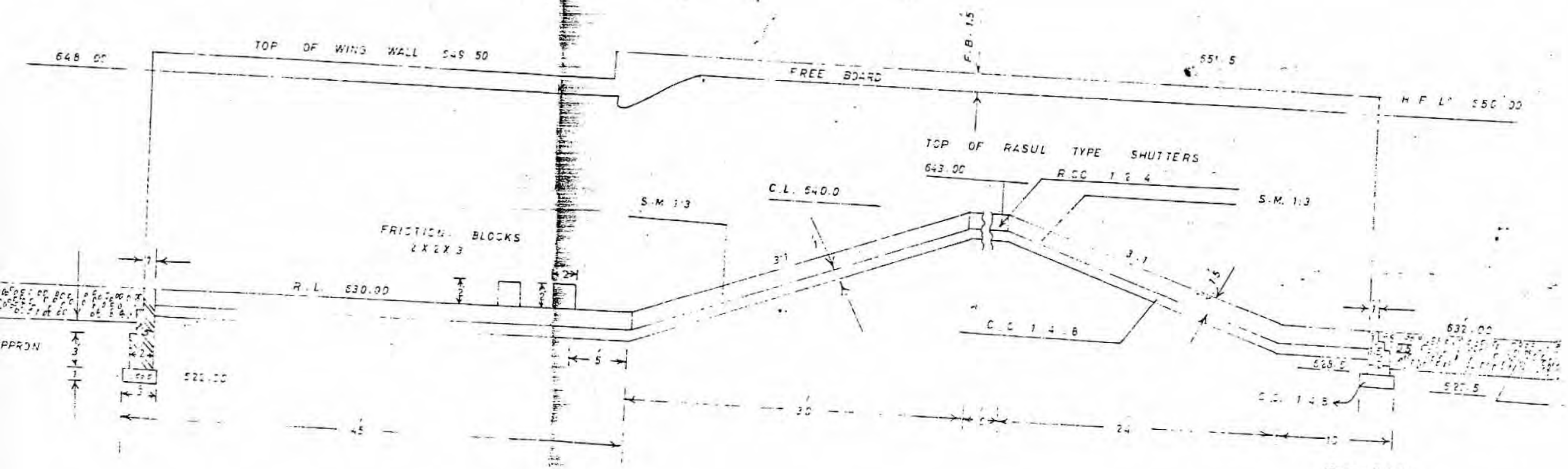
IRR-747

MITHAWAN HILL TORRENT

REGULATOR / SILT SLUICE

SCALE

0 15 30 45 60 FT



F

IRR—747

MITHAWAN . HILL TORRENT

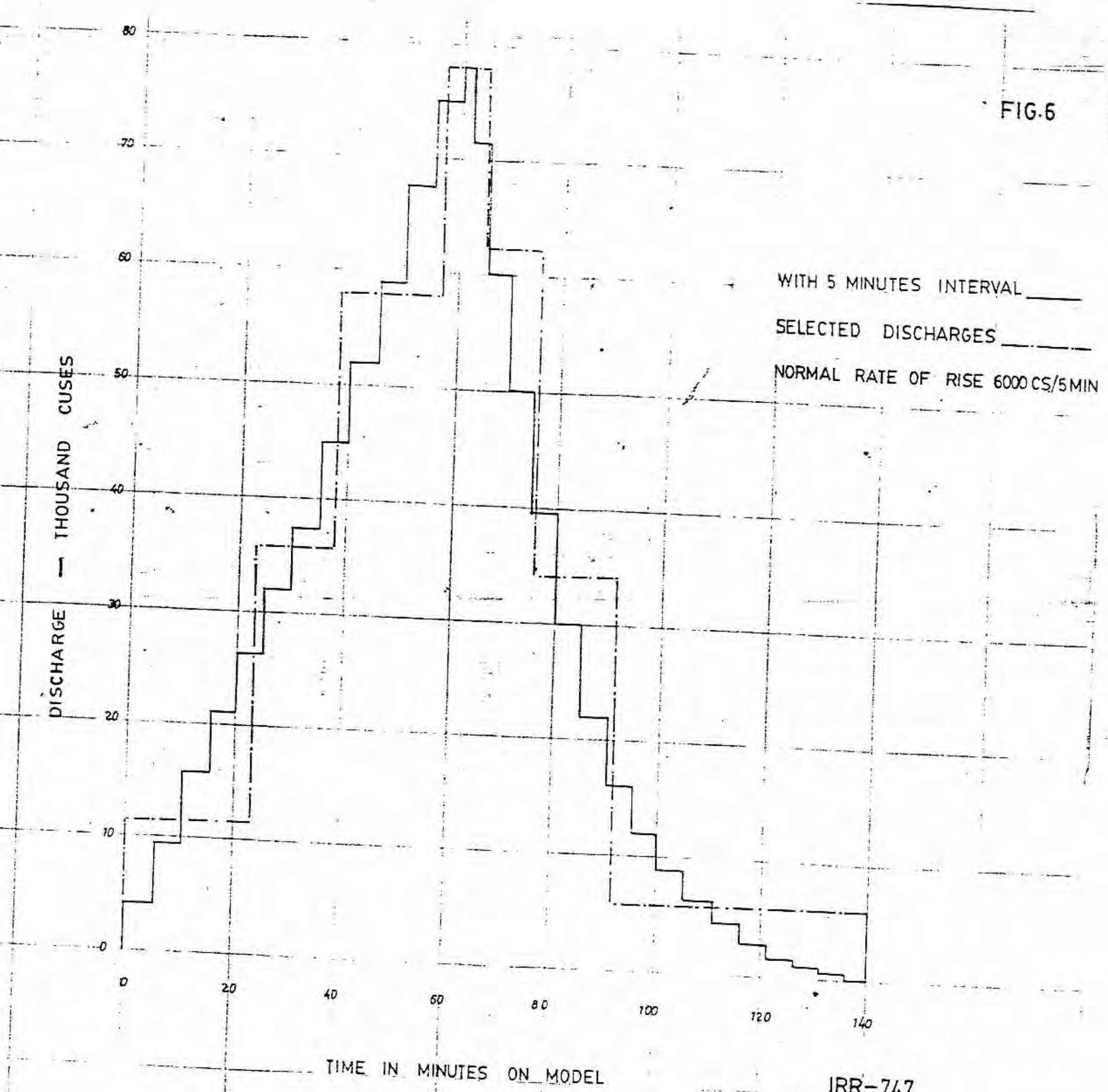
X—SECTION OF STONE MASON

SPILLWAY

SCALE

0 50 100 200

FIG.6

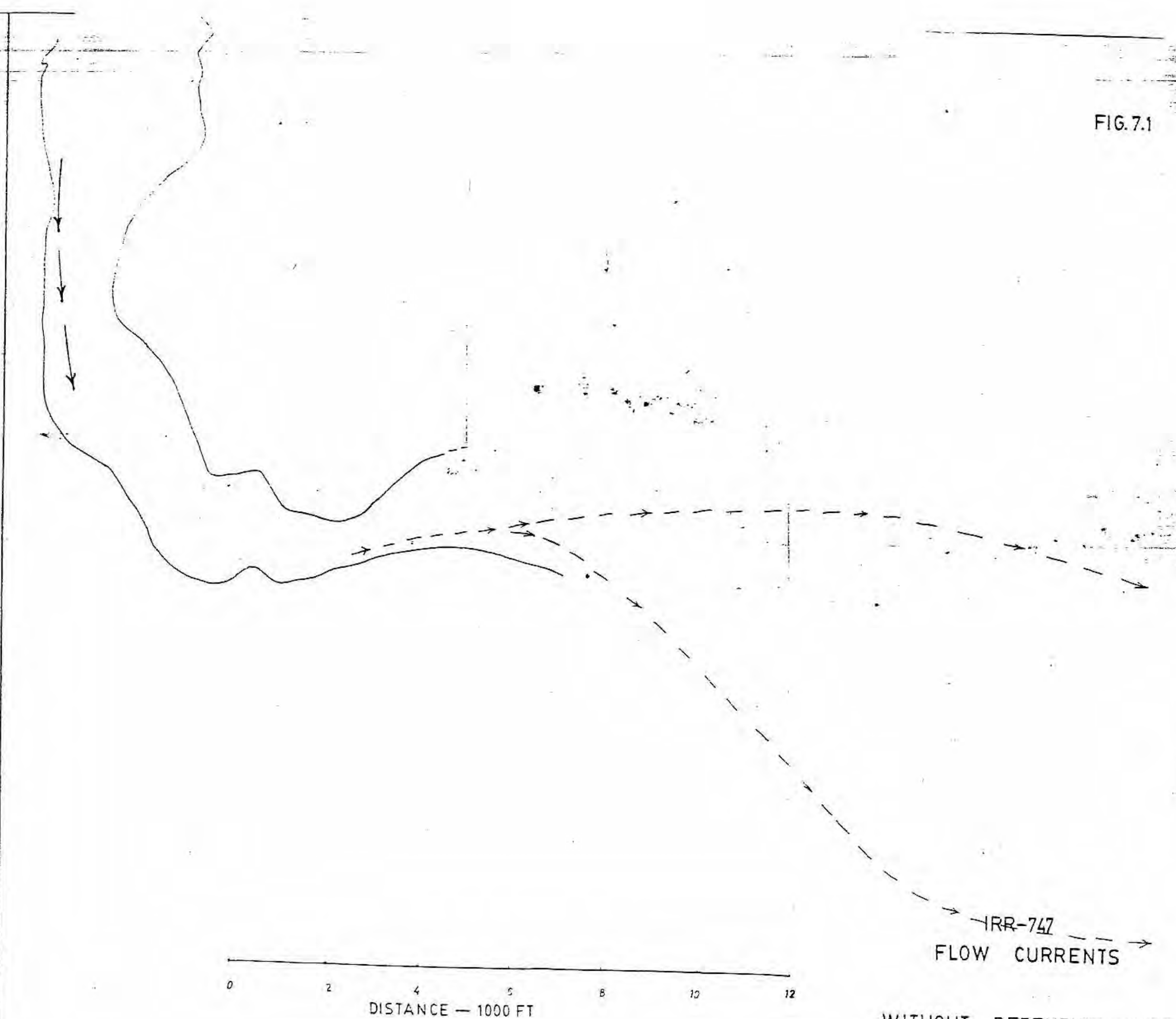


IRR-747

MITHAWAN HILL TORRENT

1958 HYDROGRAPH

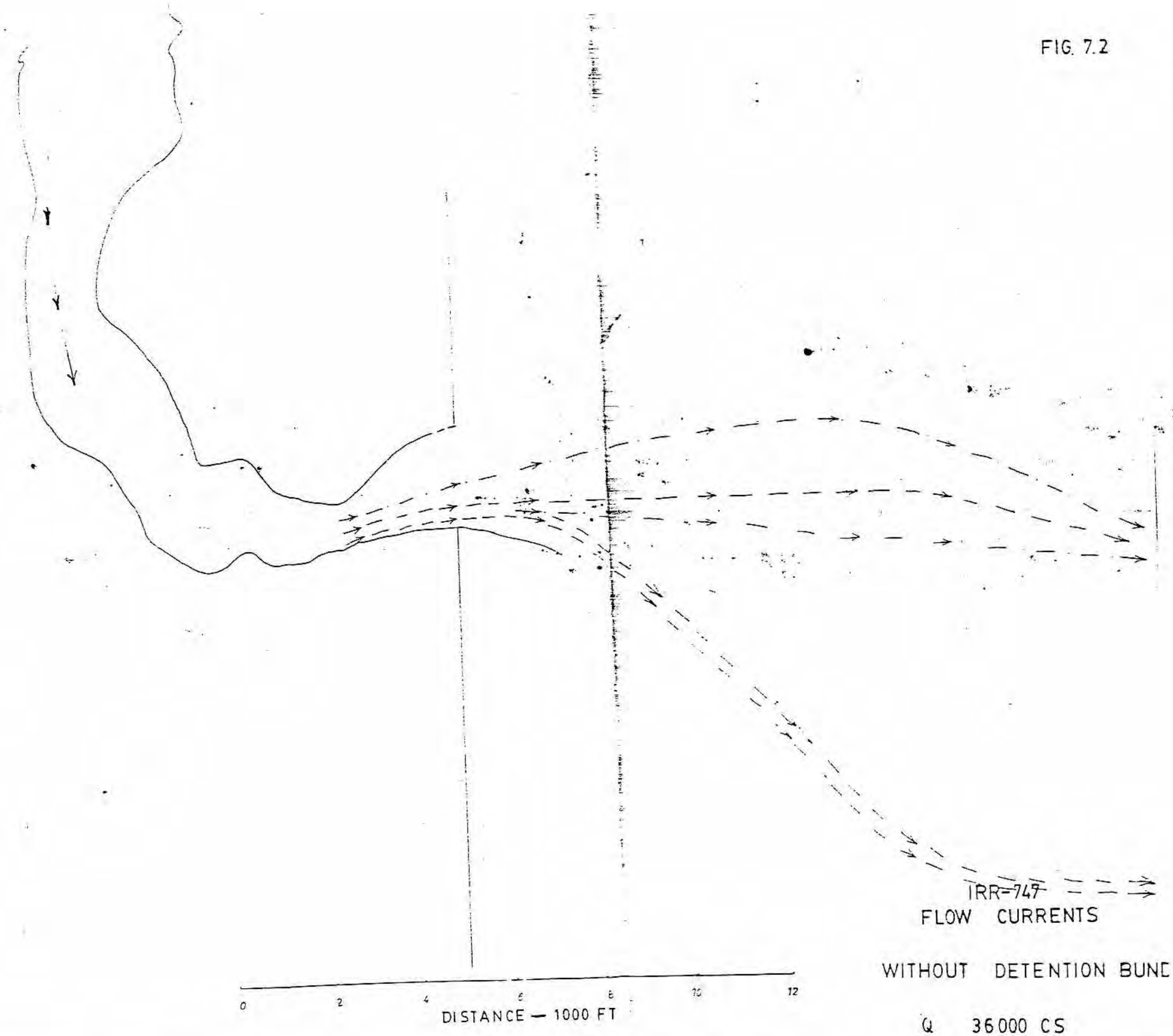
FIG. 7.1



WITHOUT DETENTION BUND

Q 12000 CS

FIG. 7.2

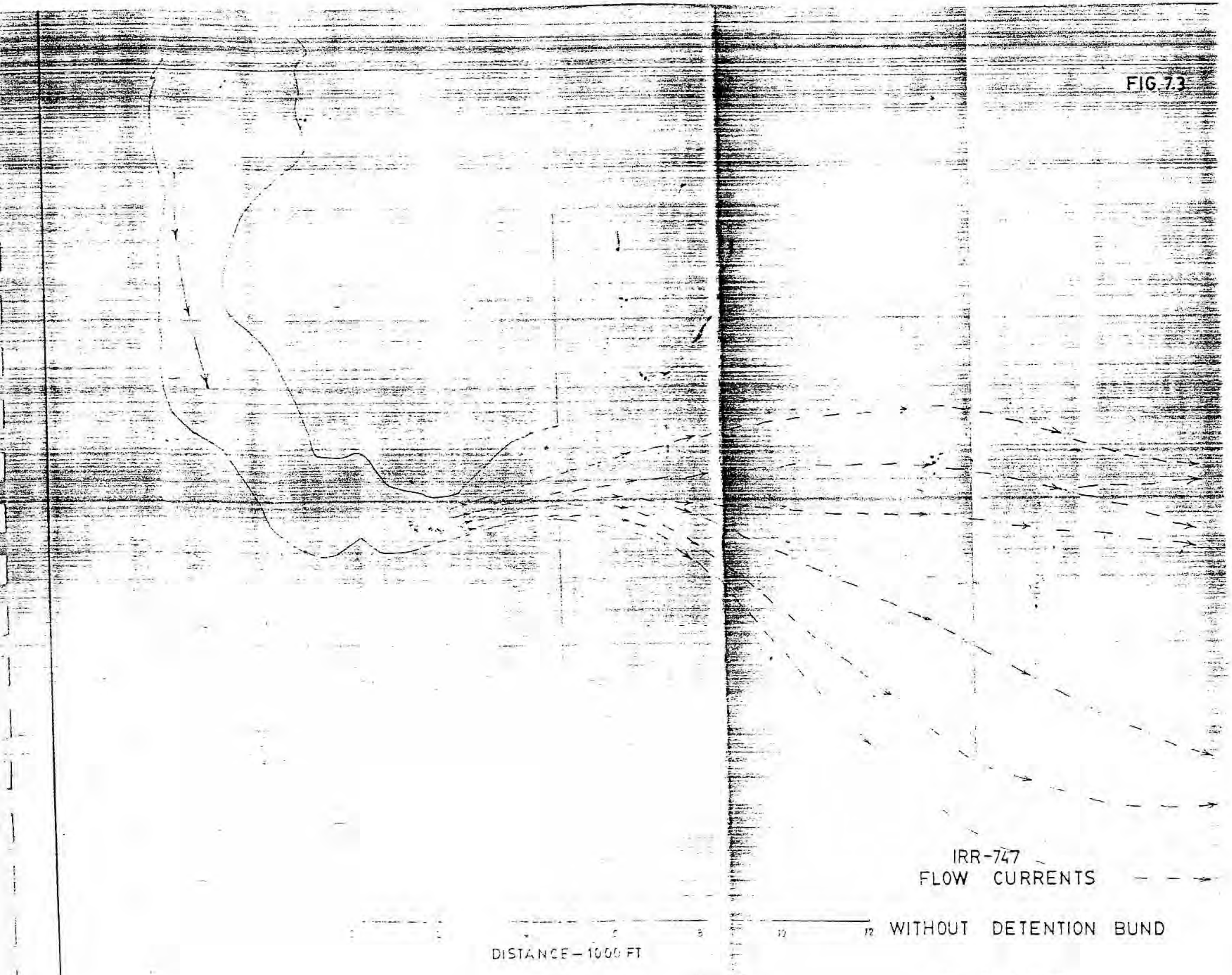


IRR-747
FLOW CURRENTS

WITHOUT DETENTION BUNC

Q 36000 CS

FIG. 7.3



IRR-747
FLOW CURRENTS
WITHOUT DETENTION BUND
Q 77,500 CS

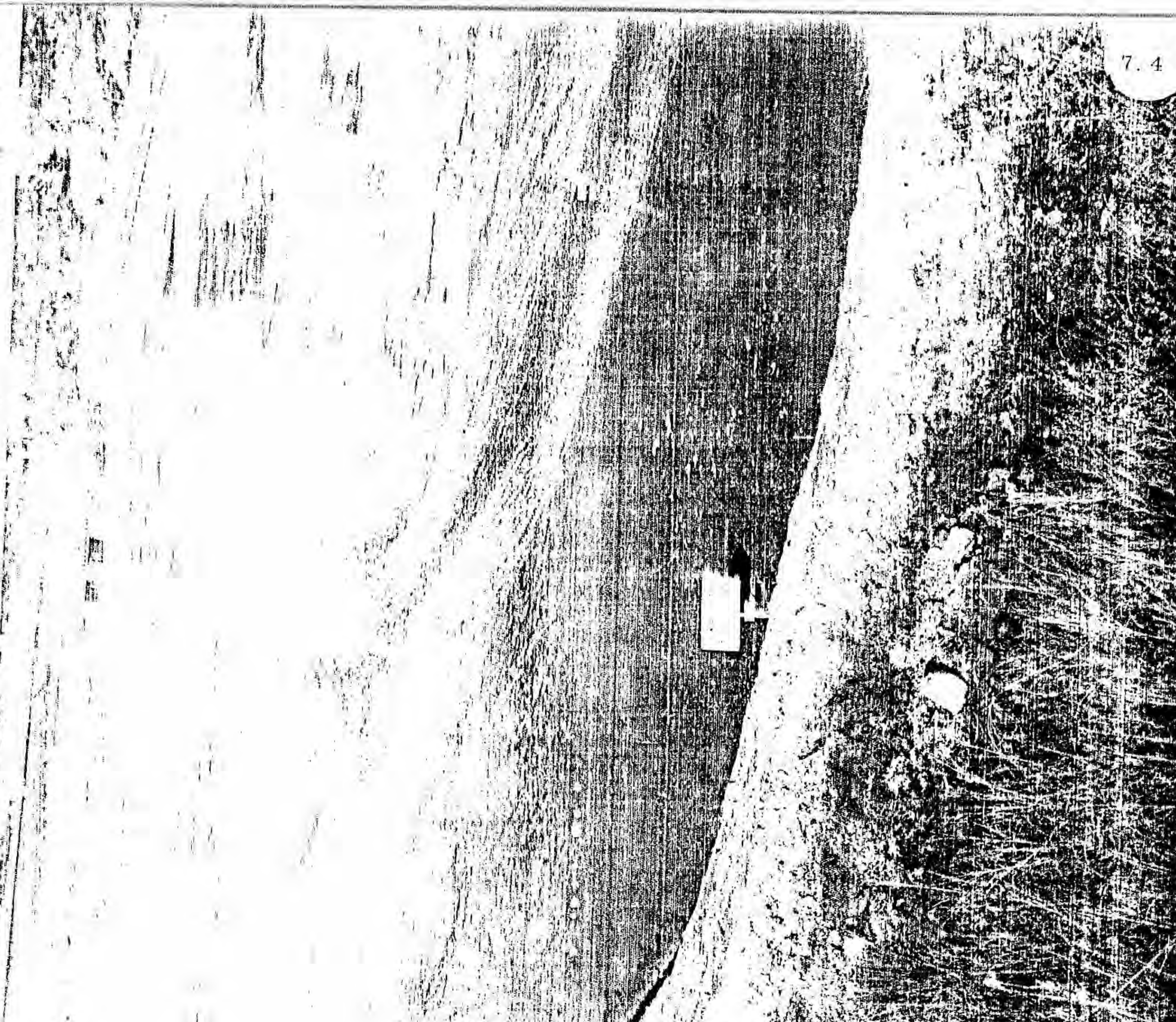
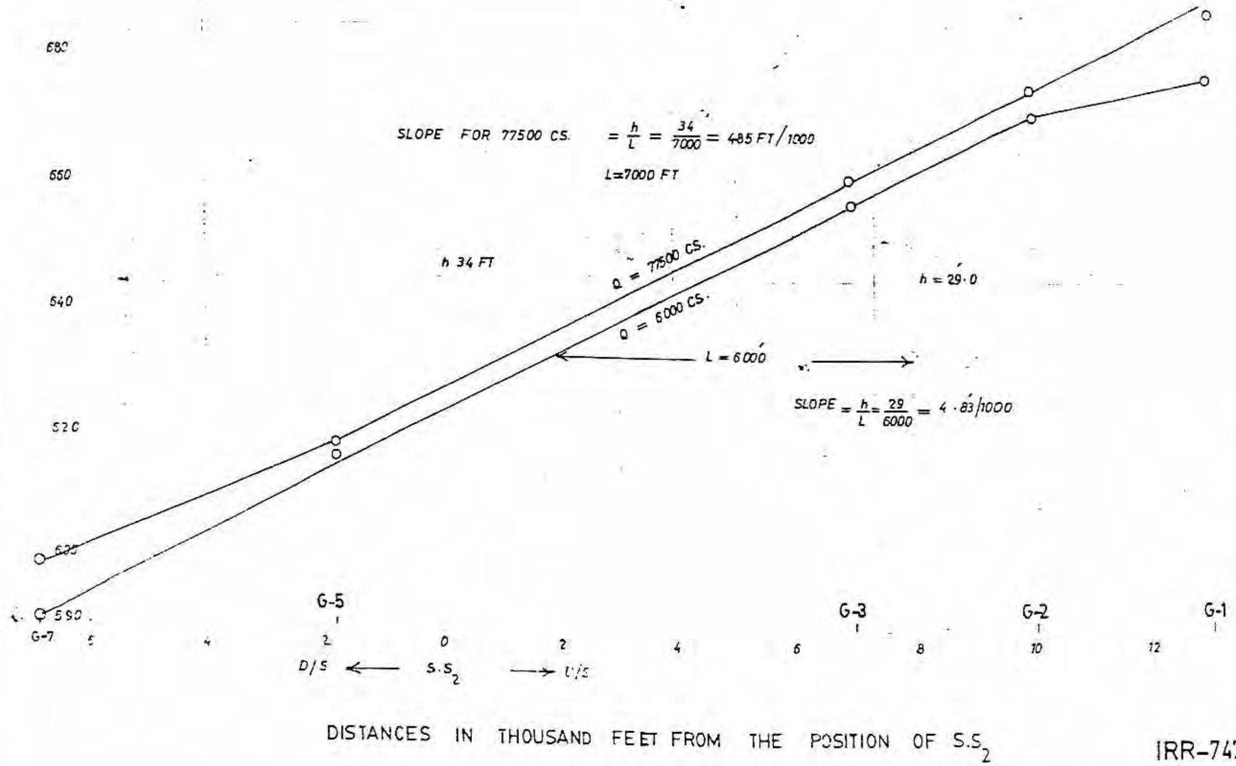


FIG. 8

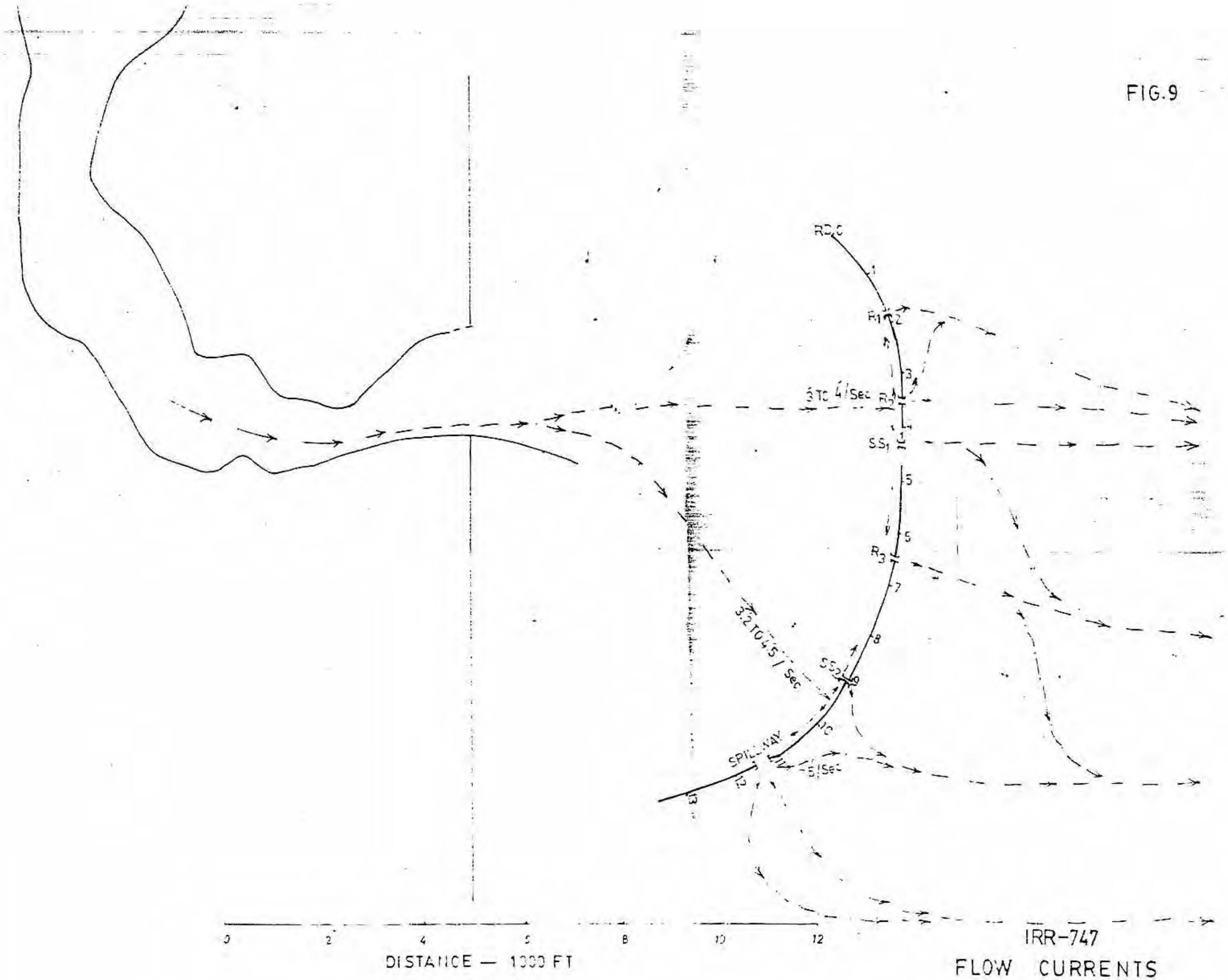


IRR-747

MITHAWAN HILL TORRENT

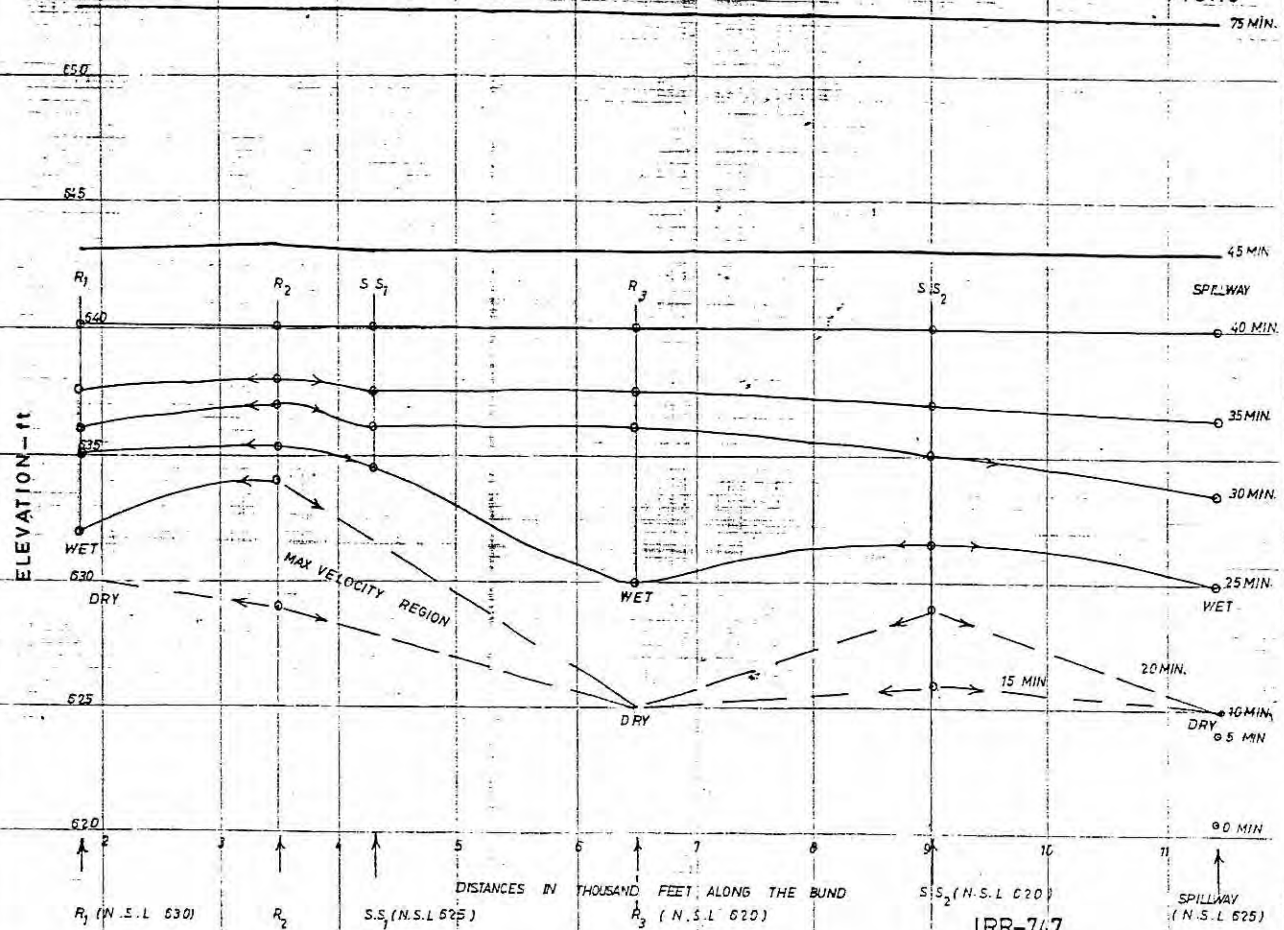
WATER SURFACE SLOPE

FIG.9



IRR-747
FLOW CURRENTS
WITH DETENTION BUND
Q 20000 CS.

FIG.10



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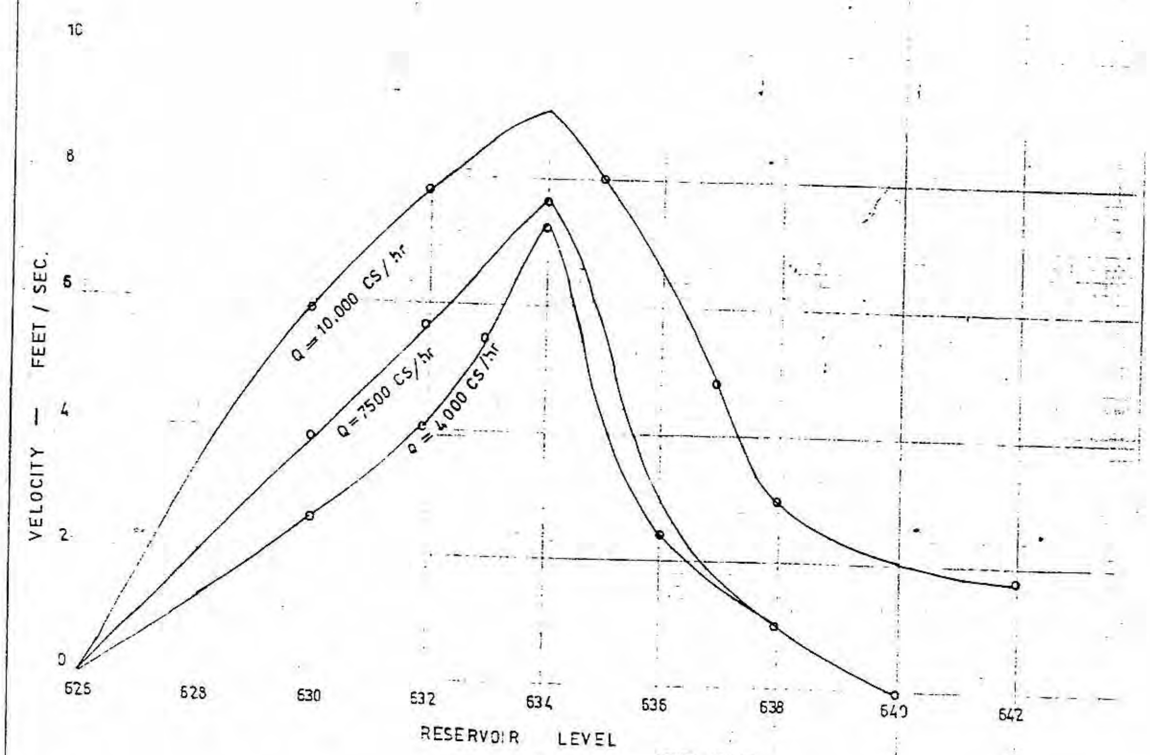
RESERVOIR BUILD UP WITH TIME

FLOW TO LOW LEVEL REGIONS→

FIG.11



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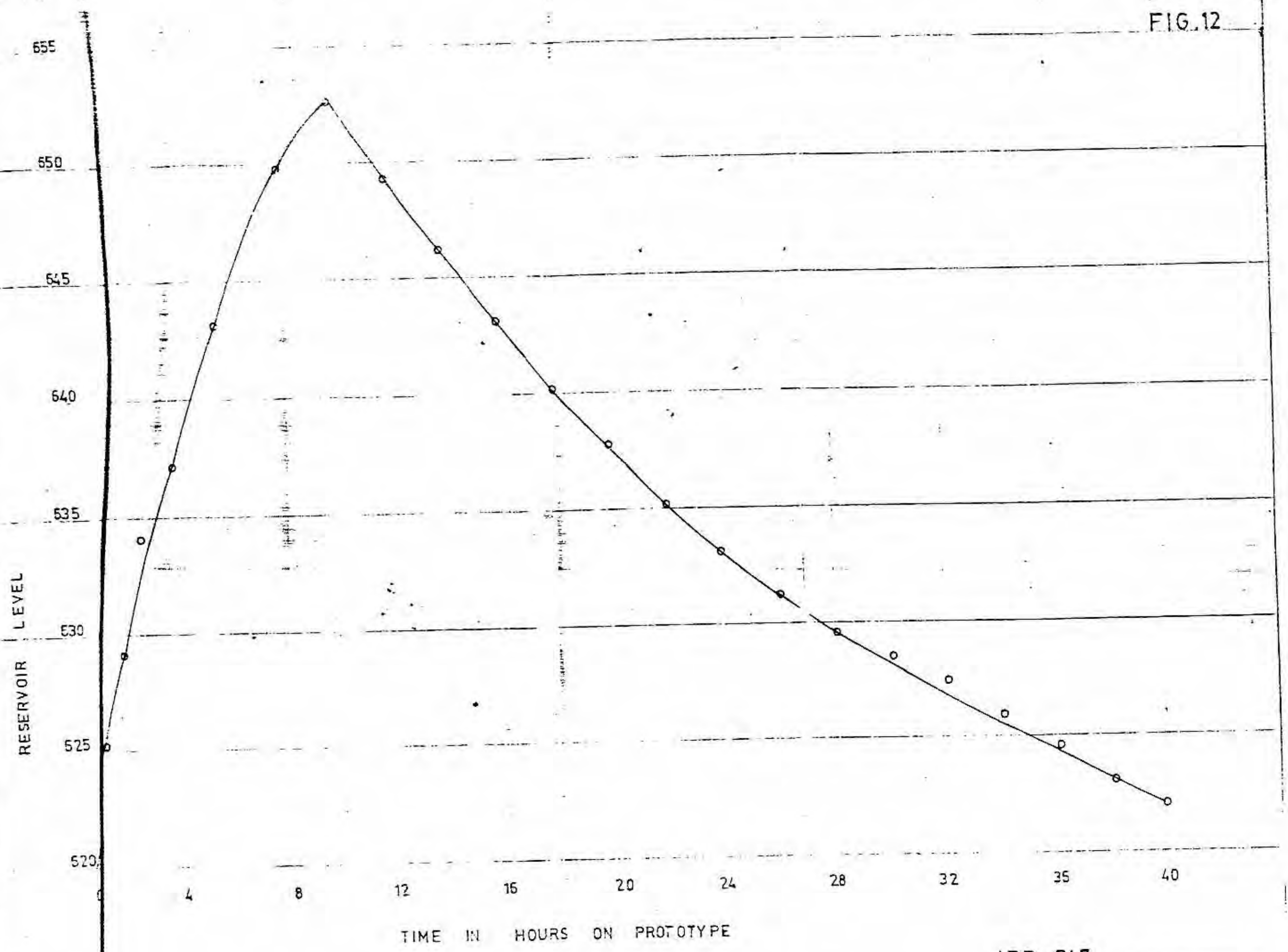
VELOCITY CURVES

AT R.D. 5000 OF PROPOSED BUND

FOR DIFFERENT RATES OF RISE OF DISCHARGE

FIG.12

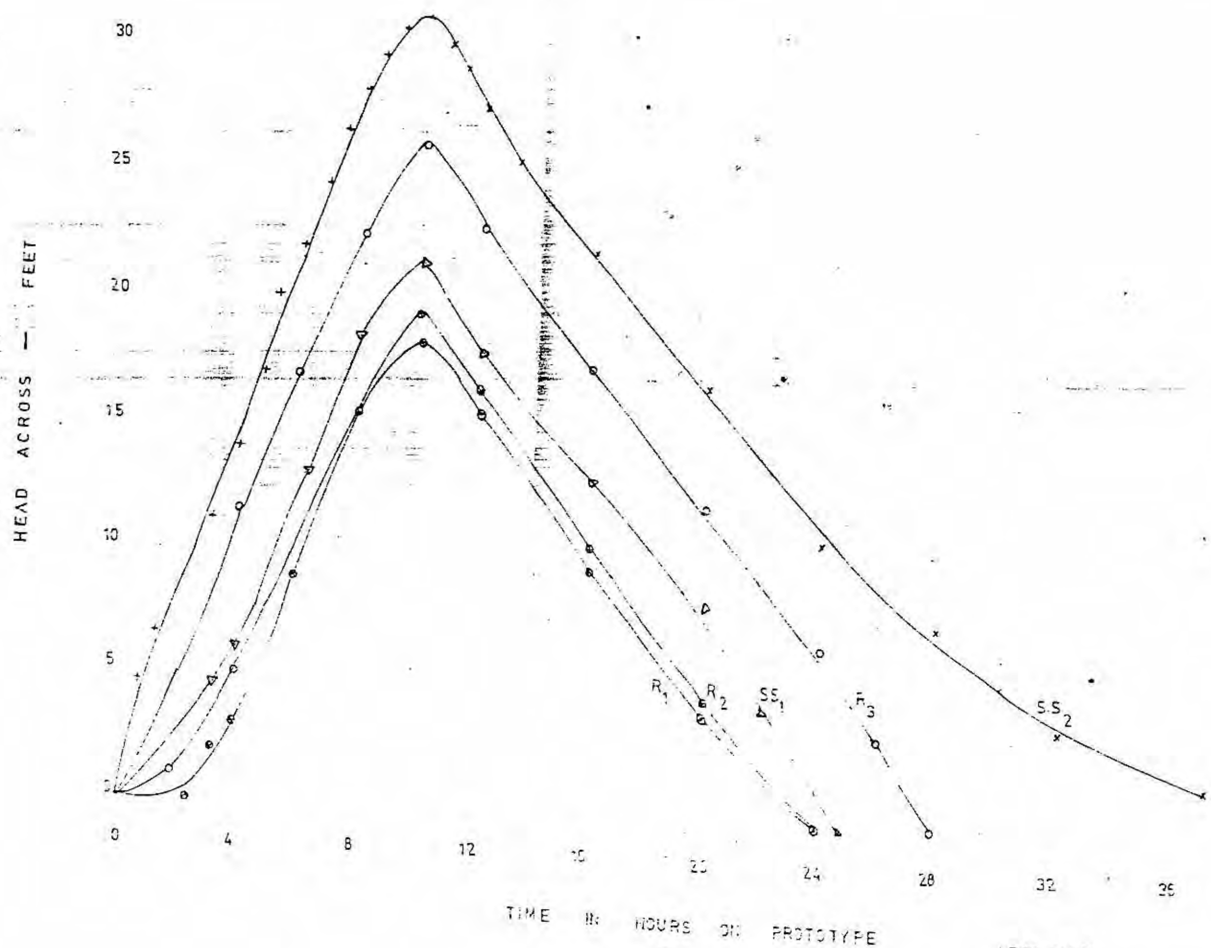


IRR-747

RESERVOIR LEVEL WITH TIME

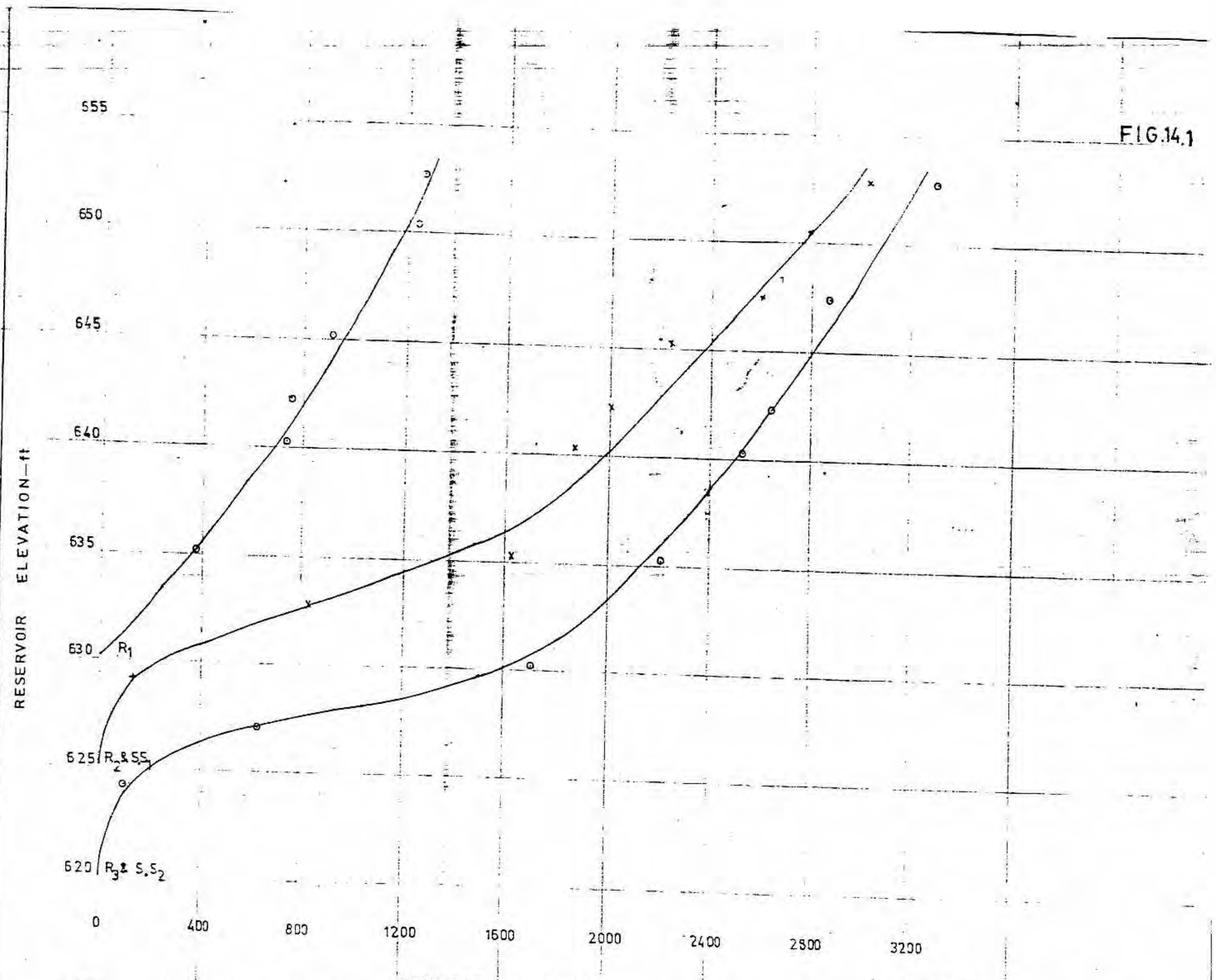
1958 HYDROGRAPH

FIG.13



IRR-747
HEAD ACROSS THE BUND
AT REGULATORS
1958 HYDROGRAPH

FIG.14.1



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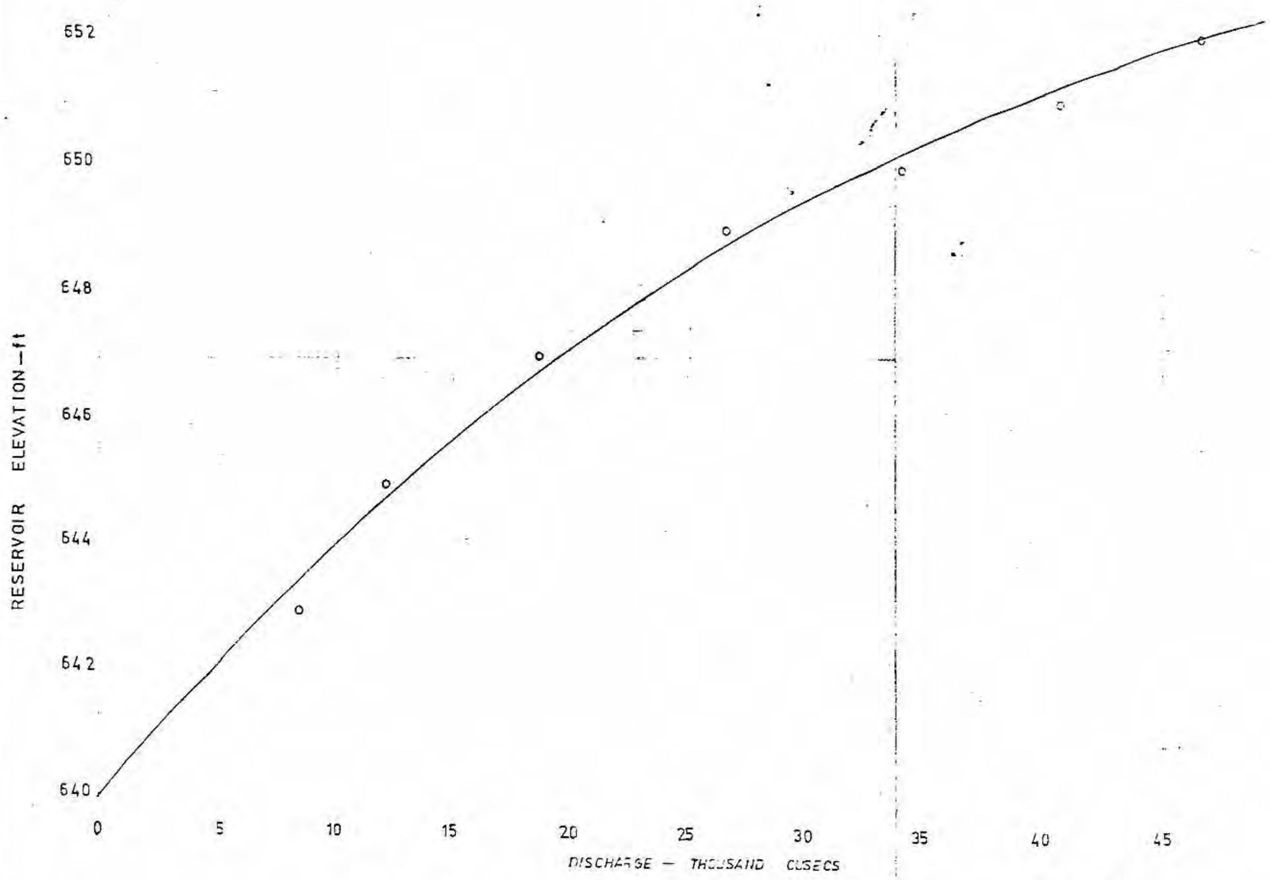
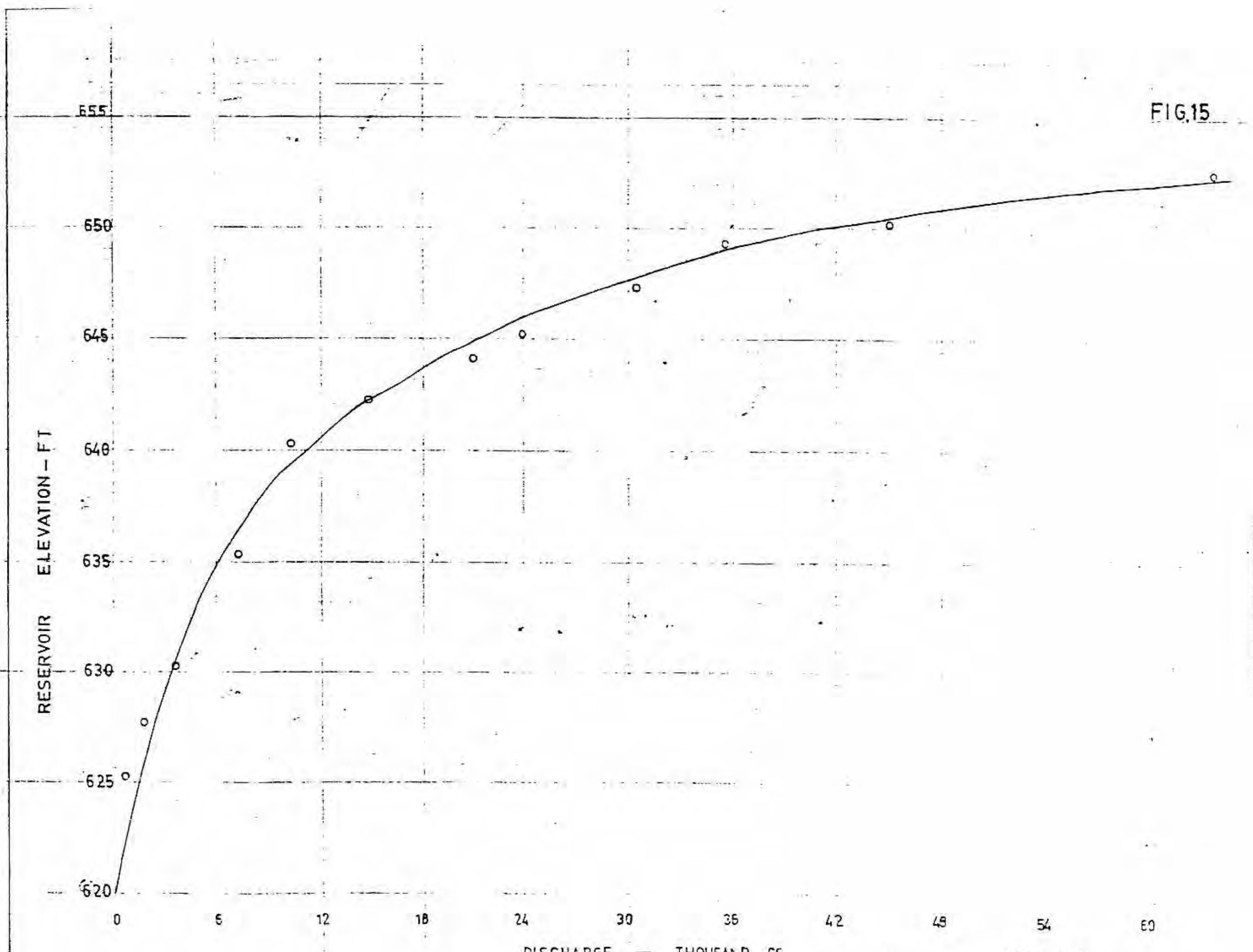
DISCHARGE OF REGULATORS
WITH RESERVOIR LEVEL

FIG.14.2



IRR-747
K SPILLWAY DISCHARGE
WITH RESERVOIR LEVEL

FIG.15



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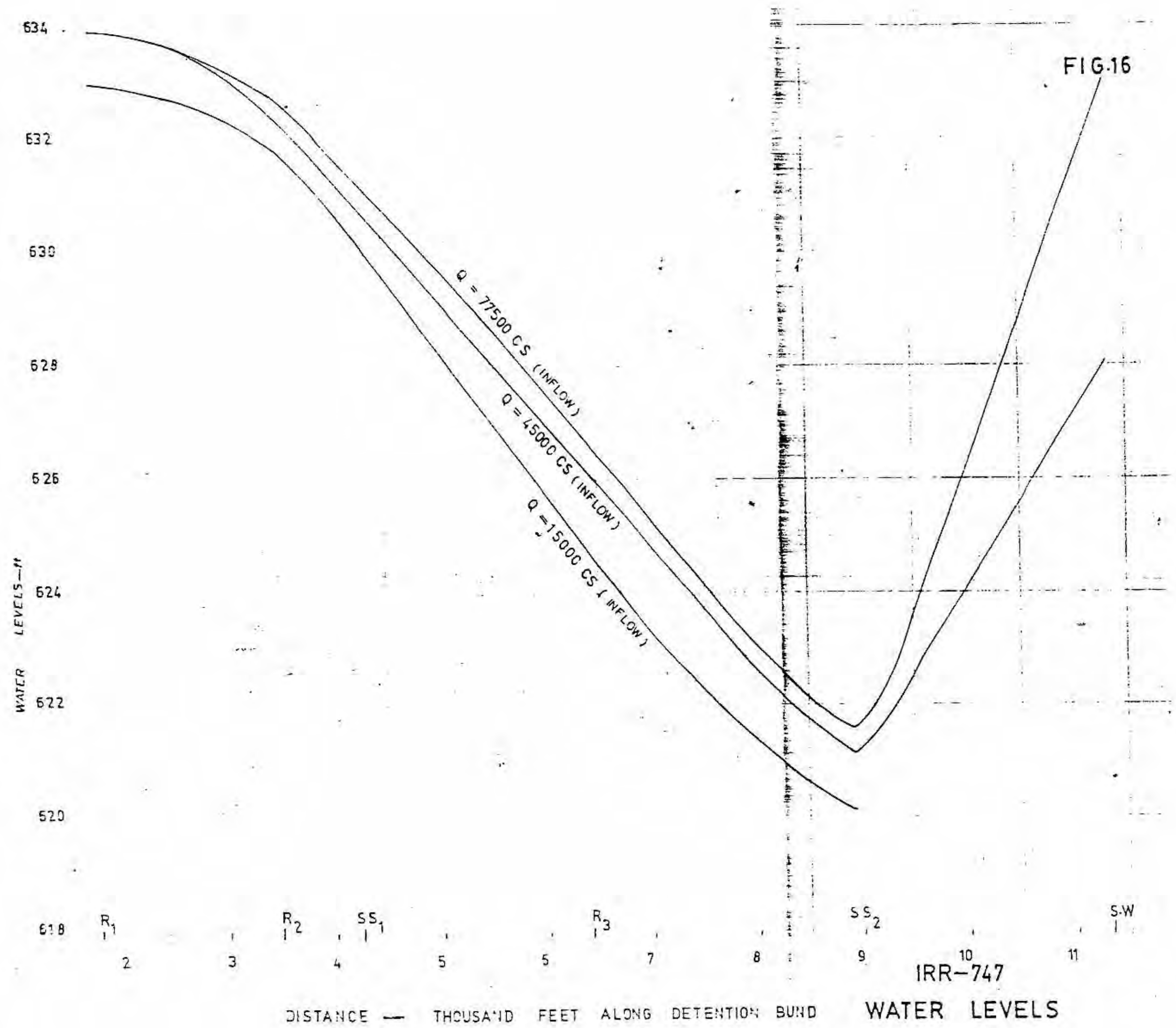
DISCHARGE ESCAPING THROUGH

REGULATORS AND SPILLWAY

AT DIFFERENT STAGES



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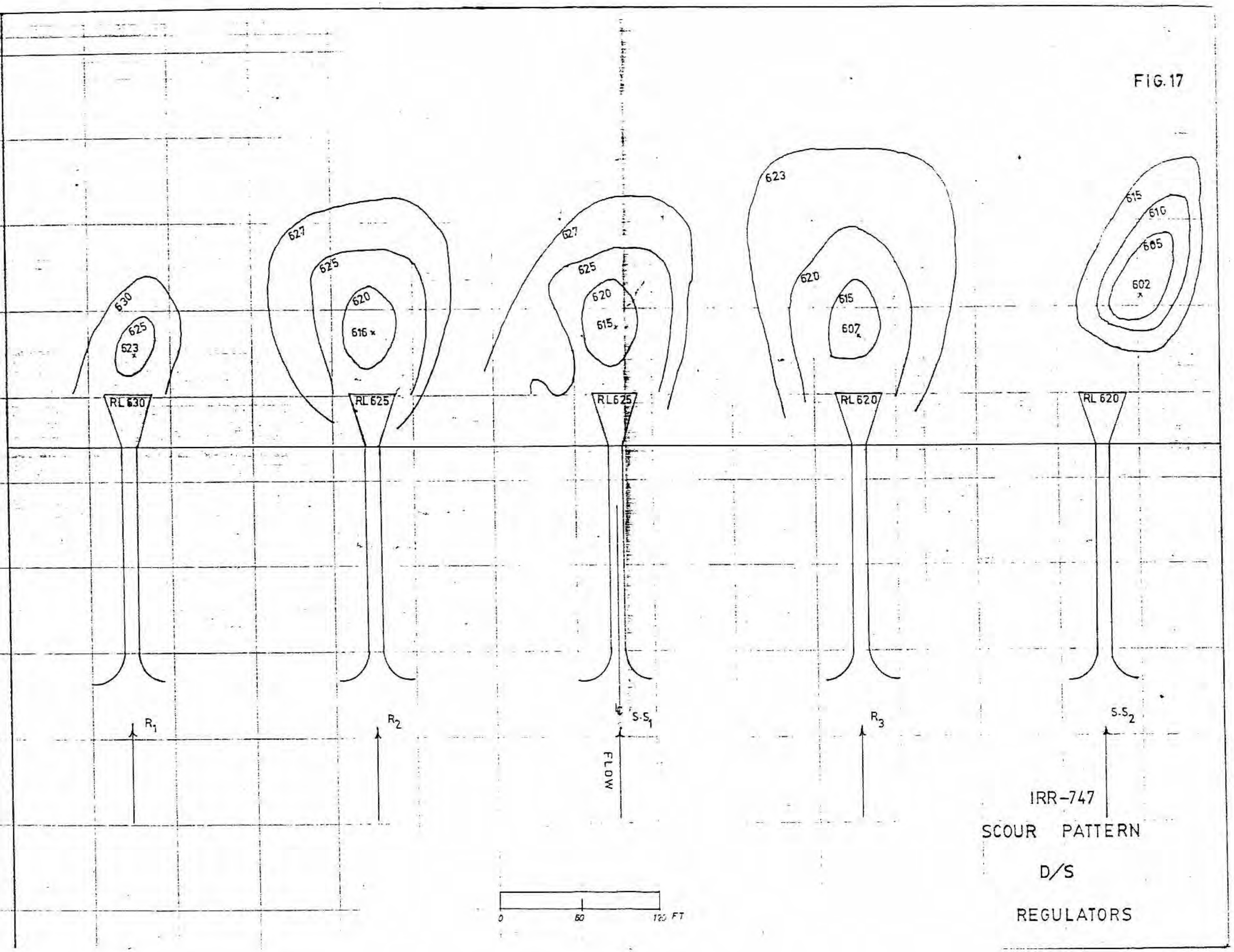
WATER LEVELS

D/S

REGULATORS & SPILLWAY

FIG. 17



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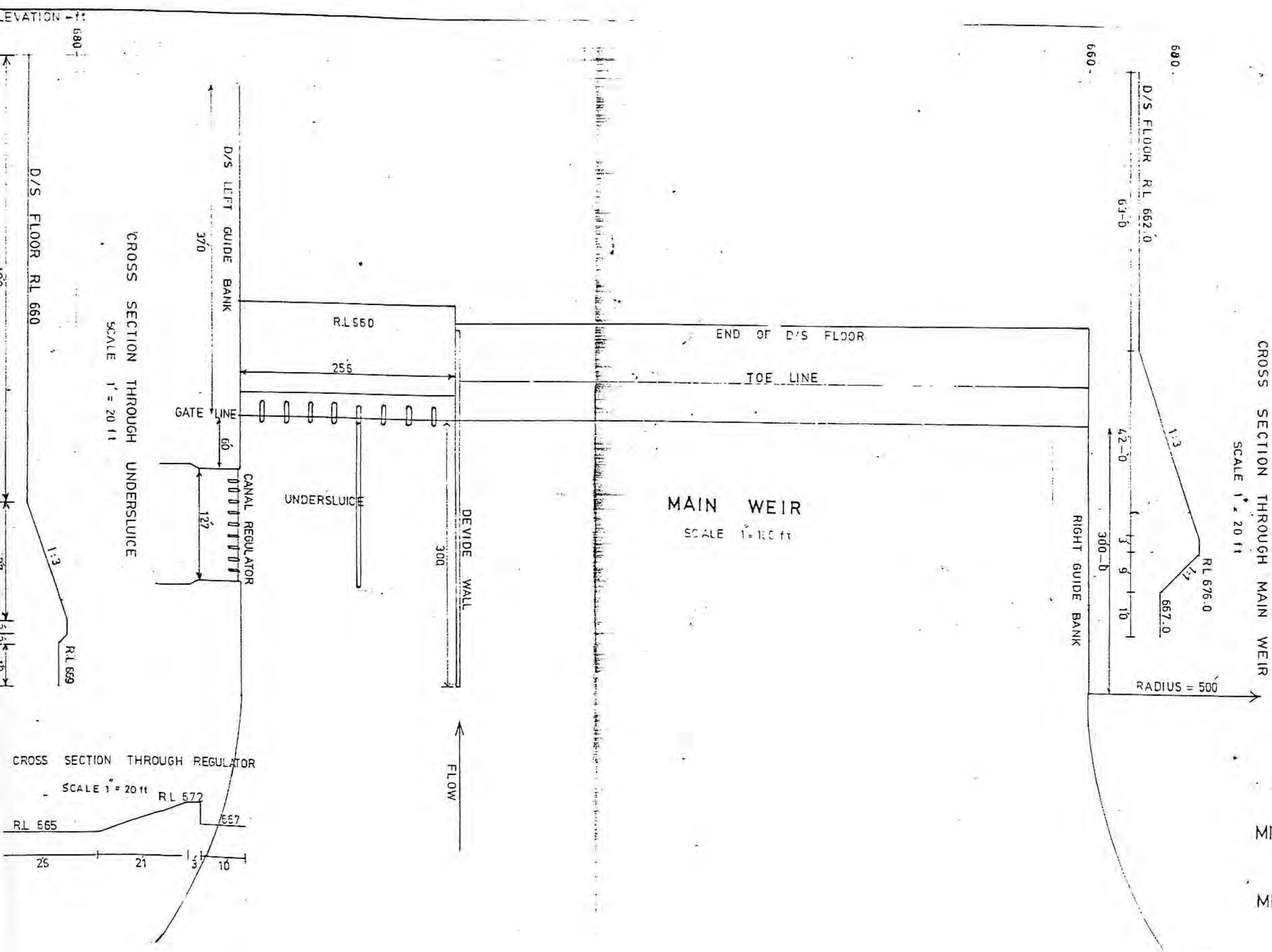
SCOUR PATTERN
D/S
REGULATORS



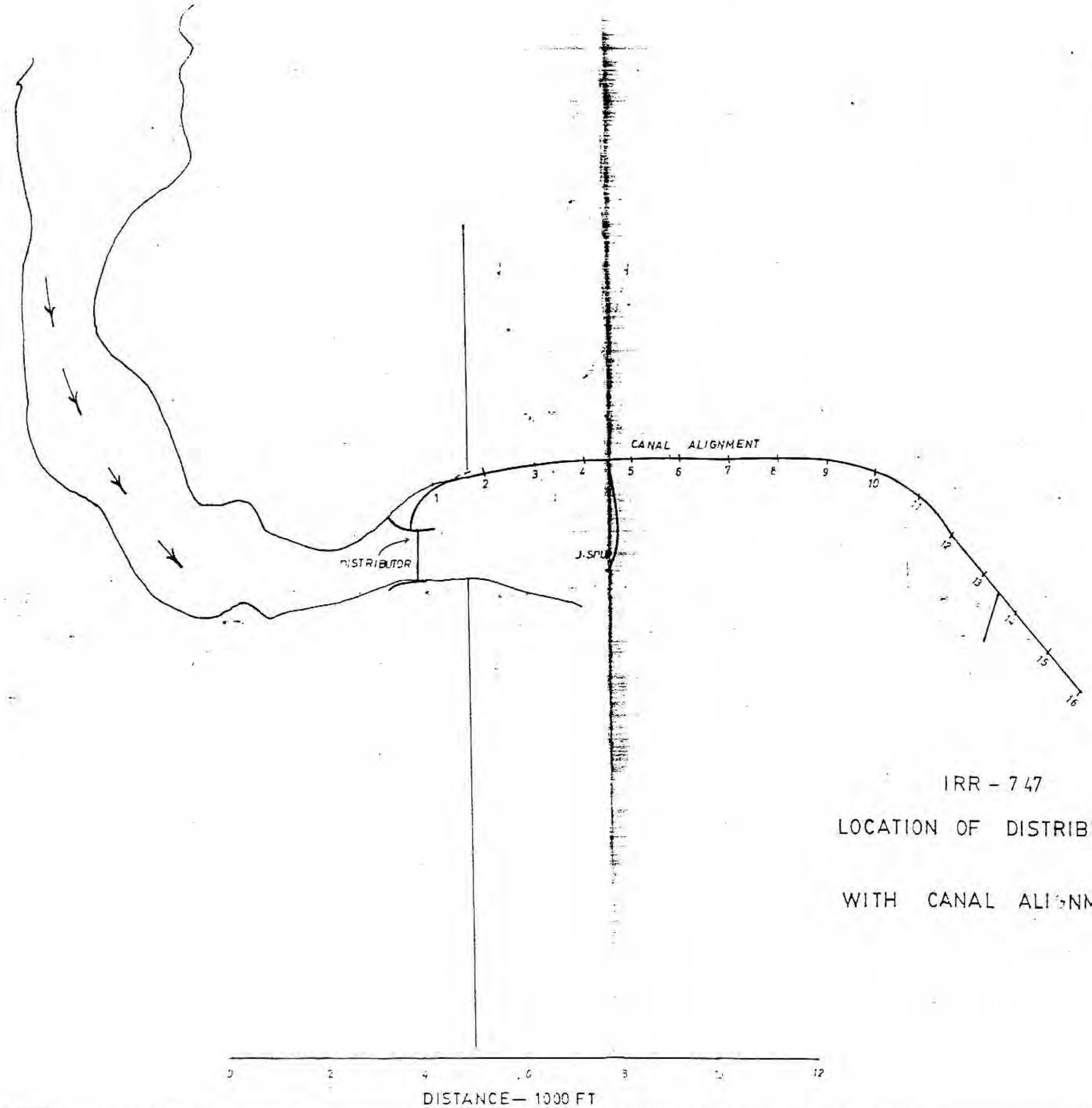
IRR - 7-

MITHAWAN HILL

MITHAWAN DIST

SCALE 1" =

FIG. 20

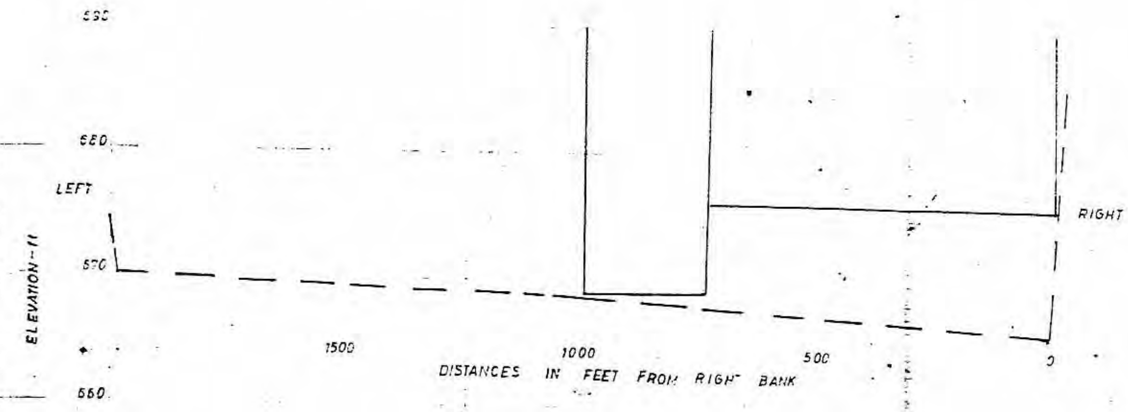


IRR - 747

LOCATION OF DISTRIBUTOR

WITH CANAL ALIGNMENT

FIG.22



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PROPOSED SITE FOR DISTRIBUTOR

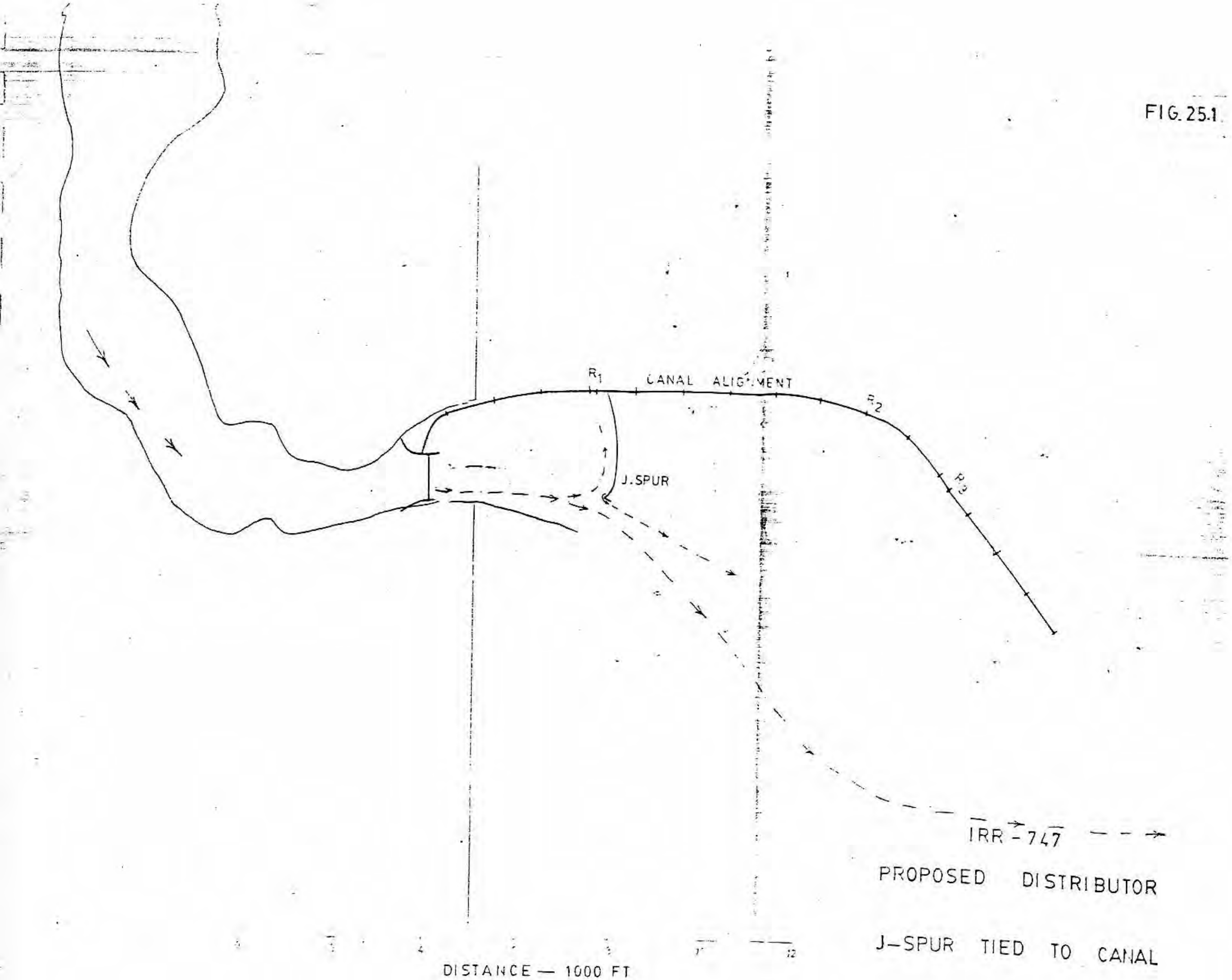
4000 FT BELOW CHOTI BALA

FLOW SECTION

ORIGINAL ---------

WITH DISTRIBUTOR ———

FIG. 25.1



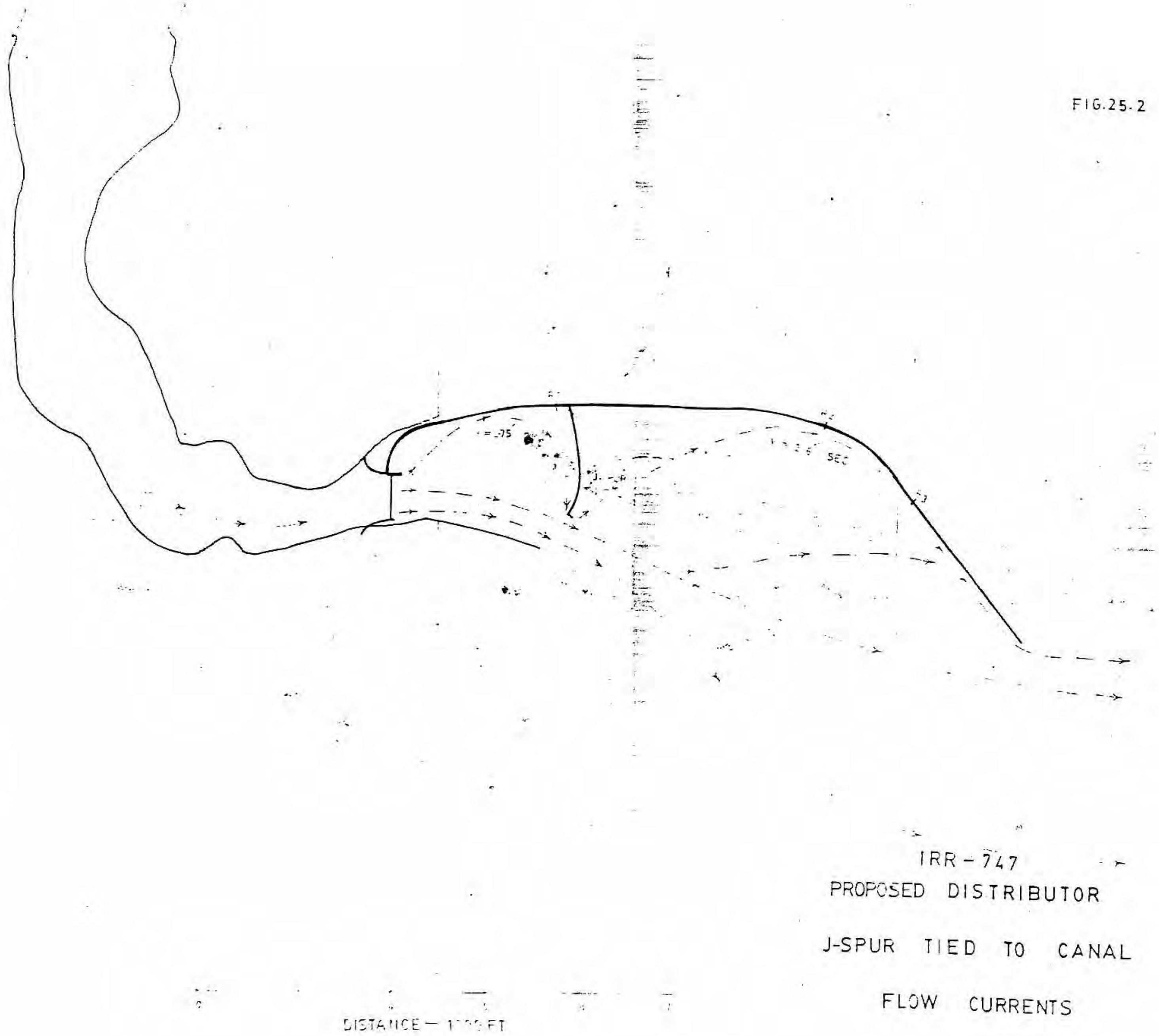
PROPOSED DISTRIBUTOR

J–SPUR TIED TO CANAL

FLOW CURRENTS

Q 10,000 CS.

FIG.25.2



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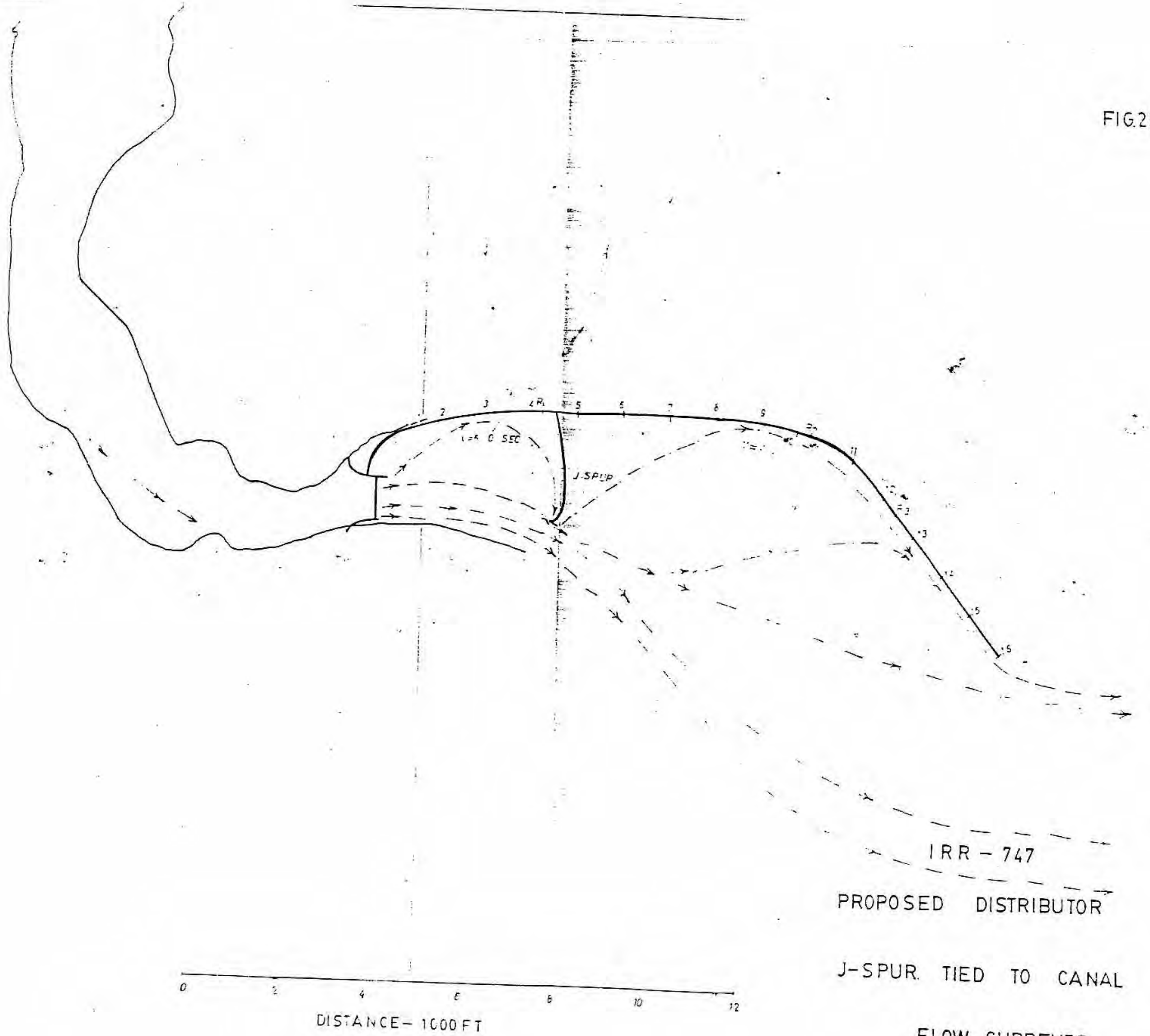
PROPOSED DISTRIBUTOR

J-SPUR TIED TO CANAL

FLOW CURRENTS

Q 30,000 CS.

FIG.25.3



IRR – 747

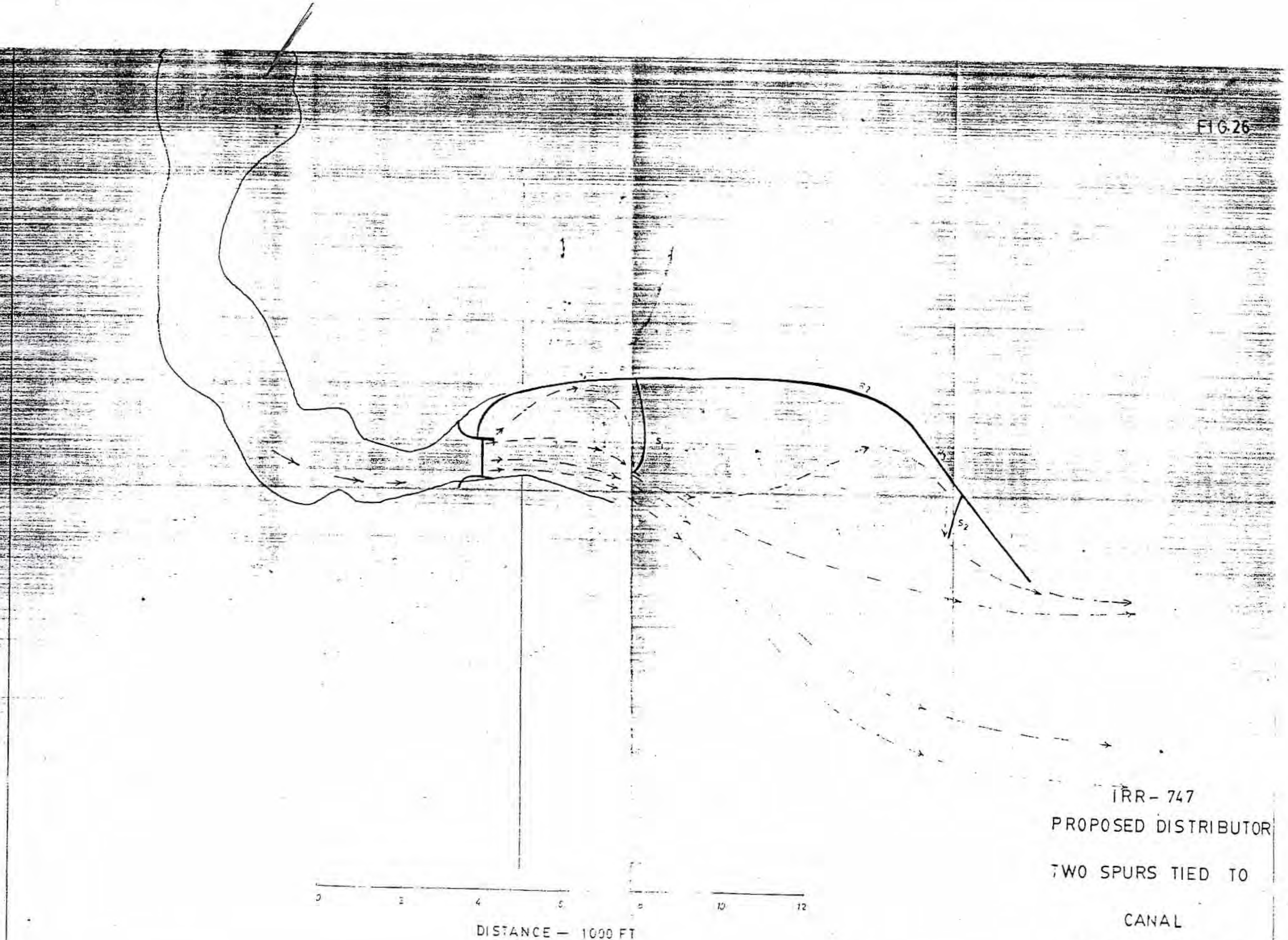
PROPOSED DISTRIBUTOR

J-SPUR. TIED TO CANAL

FLOW CURRENTS

Q 77,500 CS.

FIG. 26



IRR - 747

PROPOSED DISTRIBUTOR

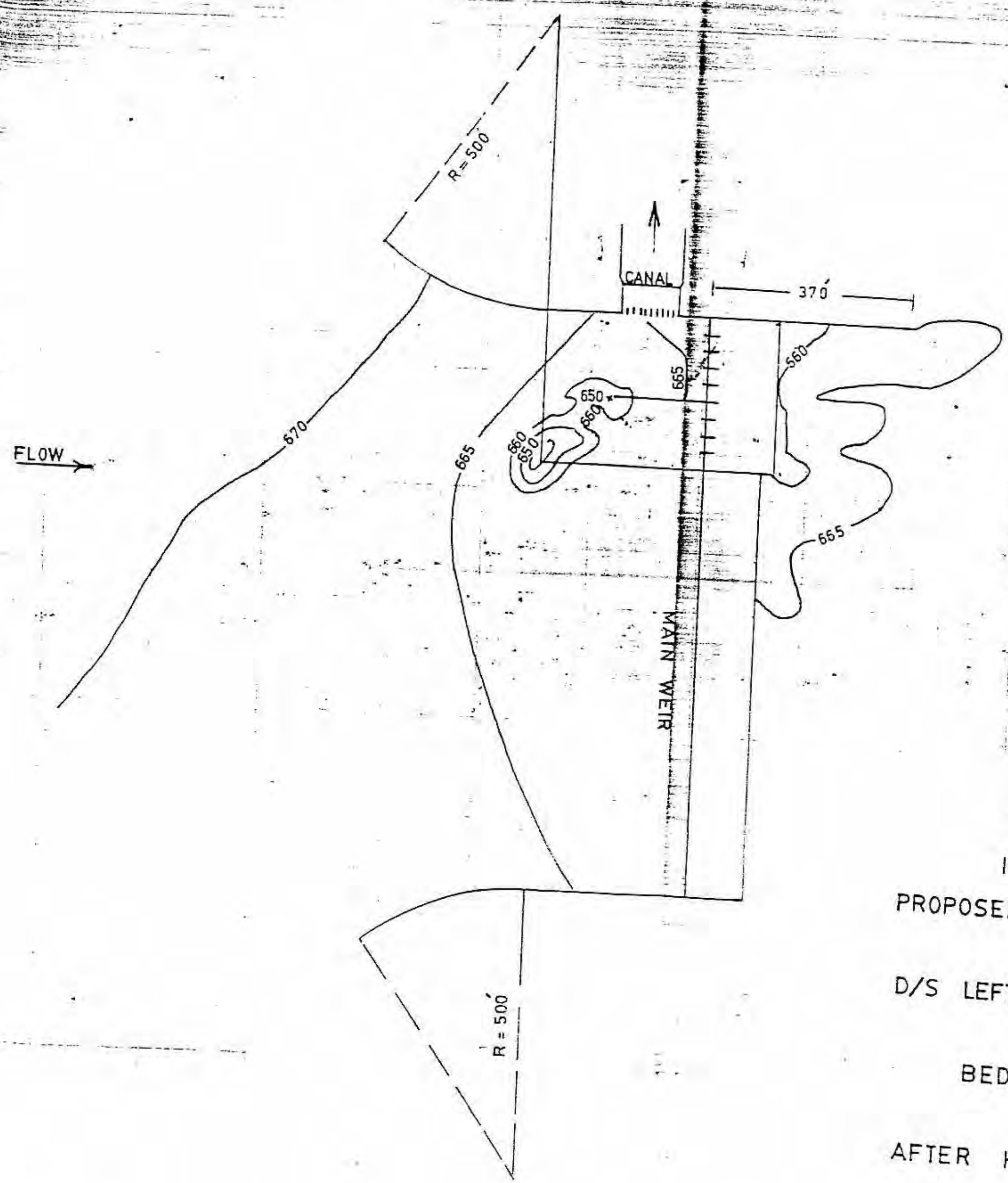
TWO SPURS TIED TO

CANAL

FLOW CURRENTS

Q 77,500 C.S.

FIG.27



IRR - 747
PROPOSED DISTRIBUTOR

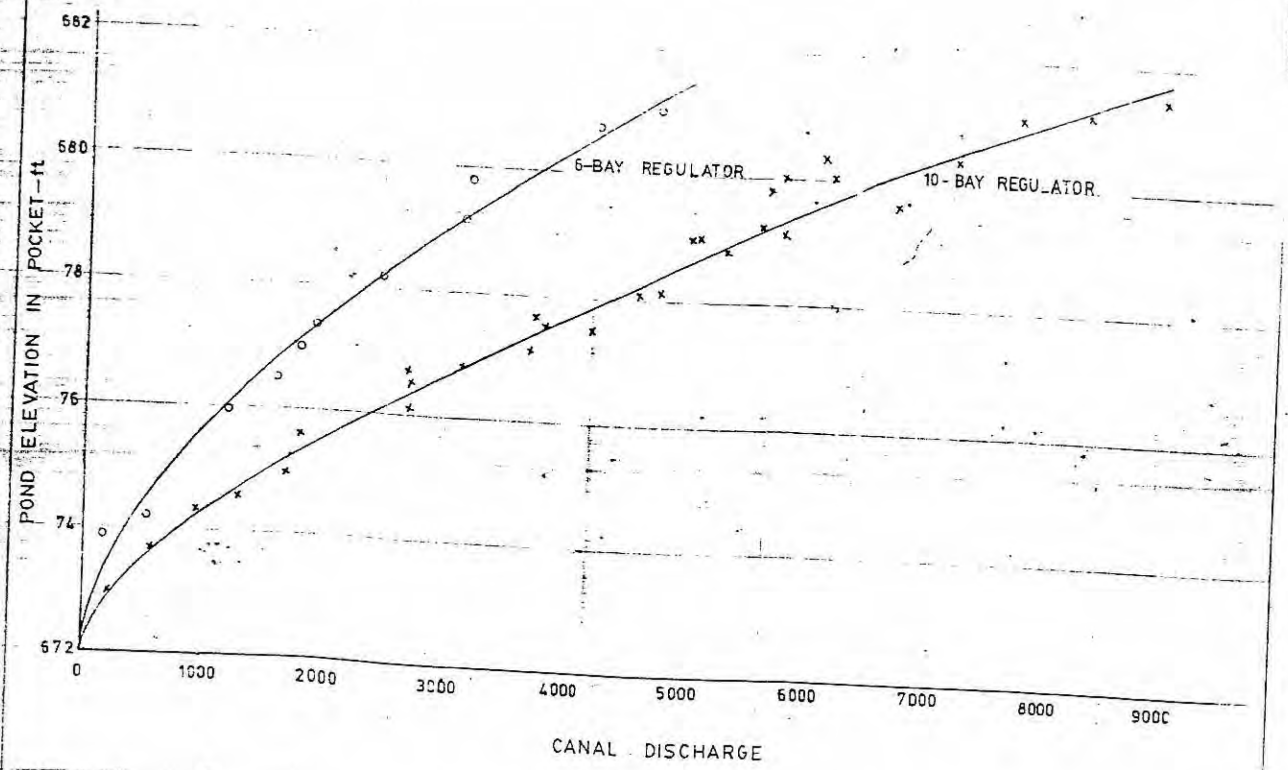
D/S LEFT ABUTMENT EXTENDED

BED CONFIGURATION

AFTER HYDROGRAPH RUN

SCALE 1″ = 2000′

FIG.28.



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MITHAWAN HILL TORRENT

CANAL INTAKES