REPORT ON THE PRELIMINARY STUDY

OF

THE BANGKOK-THONBURI SECOND BRIDGE PROJECT

SEPTEMBER 1968

OVERSEAS TECHNICAL COOPERATION AGENCY OF JAPAN

September 1968

Mr. Kanjana Hengsuvanich
Director General
Department of Public and Municipal Works.

Subkect: Report on the preliminary study of the Bangkok-Thonburi Second Bridge project.

Sir:

We have the pleasure to submit you the report on our preliminary study summerizing the results of our study in Bangkok from March 30th to April 30th, 1968.

In this report we have recommended the bridge site and the structural type of the Bangkok-Thonburi Second Bridge and the related structure.

We hereby present our sincere appreciation for the great favor of the officials of your Department during our stay in Bangkok.

With our best regards to you,

Respectfully yours,

Mitsuo Nishino
Leader of Surveying Team

Hiroyuki Wada

Tohru Ida

Yutaka Yamaguchi

ese Surveying Team of the
ok-Thonburi Second Bridge

CONTENTS

Charoon Kraing

Art. 1. Selection of site of the Thonburi 2nd Bridge reviewing from the city planning

The Sathorn Road is recommended as the site of the approach road on Bangkok side or the site of the Thonburi 2nd Bridge on the following reasons.

1-1) The following two are considered vital on the traffic problems in Bangkok City.

1) Congestion of traffic on the Memorial Bridge
2) The same in the center of Bangkok, specially in the western section next to Klong Krung Kasern Road.

1-2) To solve above questions,
Widening of the width of Memorial Bridge or construction of a new bridge near by the former one.
Improvement of street road nets and traffic control should be taken into account.

1-3) In compliance with the planning of the Bridge,
Construct a loop way in the Southern sector of Bangkok City to disperse the incoming traffic into the city center and to eliminate the traffic jam caused by-passing the center, out of the center section.
It will be one effective solution though somehow indirect to the question described in (a).

1-4) The Silom Road is nearer to the commercial center than the Sathorn and named the Krung Thon Bridge - Rajavithi Road - Raja Prarop Road - Raja Damri Road - Silom Road.
These roads constitute a loop way connecting each road and can be said fascinating.
Both sides of Silom Road are under development as commercial center and some parts have been already developed.
So the utilization of land along side the road as the main loop way is not recommendable. The Silom Road is equipped with four lanes and two parking lots and the congestion has been almost reached its limit and can not receive the traffic through the Thonburi Second Bridge.
If the Silom Road is used as approach it will be necessary to improve it to six lane road.

1-5) The Sathorn Road is situated farther to the commercial center than the Silom Road and can not form a continuous ring road. The utilization of the land along side the road, not highly populated commercial center and no much change is expected in future.
Could the Sathorn Canal be improved to culvert it is possible to construct an eight lane road easily and cheaply.

1-6) The Sathorn Canal planted on both dikes with fine looking trees, holding city beauty and function of natural drainage.
As suggested on the figure 1 it is possible to leave the fine scenery and the function of drainage.

Art. 2. Road intersection planning

2-1) Bangkok side.

On the Bangkok side, the crossing of the Charoen Krung Road should absolutely be elevated. Traffic over the Charoen Krung Road is so much congested that the traffic control is almost difficult. If the bridge will be movable one, influence of waiting cars against traffic on the Charoen Krung Road will be very big.

2-1-1) In case of elevated crossing the ramp from the Thonburi 2nd bridge to the Charoen Krung Road will be meaningless as the road is so congested that unless its width is widened.
There is no room taking up the additional traffic quantity to and from the Thonburi 2nd Bridge.

2-1-2) With elevated crossing, the width of road 33 m. - 35 m for the 4 lane road and 40 - 42 m. for the 6 lane road are necessary. (Fig. 2)
Taking 4 lane elevated crossing on the Silom Road, about 200 m. from the Charoen Road, the width of road should be widened. On the Sathorn Road there is no need of extension of width, even if it is 6 lane crossing.

2-2) Thonburi side.

The Charoen Nakorn Road having the right of way of 30 m. wide and still the traffic is not so congested, tells us that there is some room to absorb additional traffic.
The access road only to attach to the Charoen Nakorn Road or the surface intersection with the above will be sufficient for the time being.
The extension of the access road to Tak-Sin will be necessary in the near future, and taking this into account, the planning of the elevated intersection at the point having ramp is desirable.

FIG. 1 Sathorn Road.

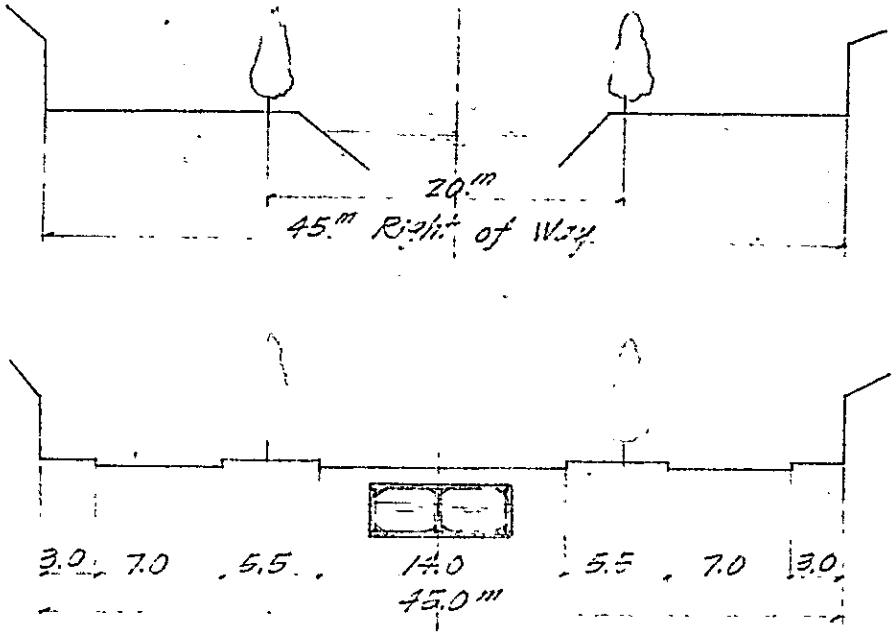
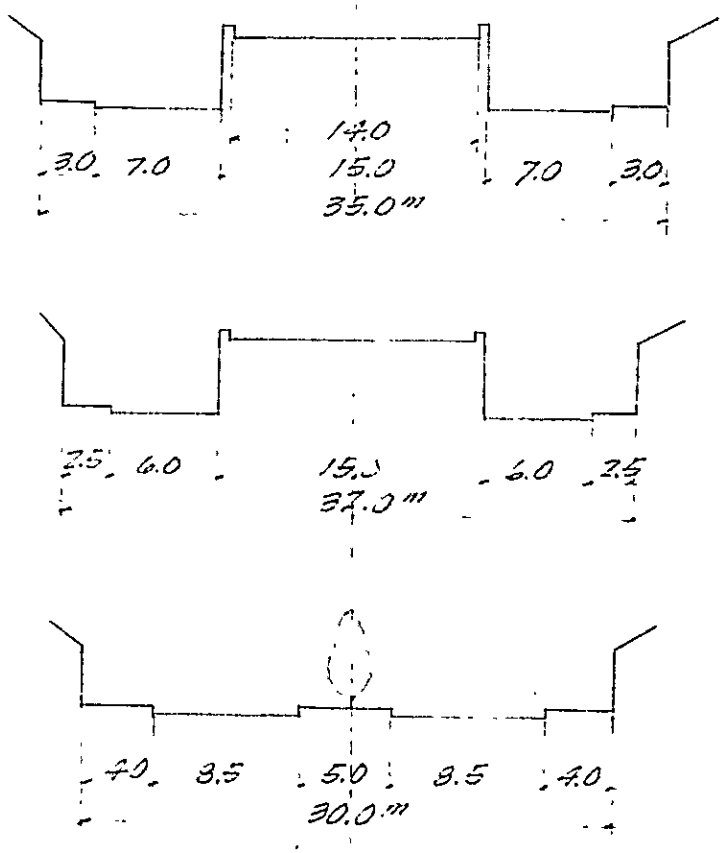


FIG. 2 4-Lanes Flyover.



Art. 3. Forecast of traffic between Bangkok and Thonburi

3-1) Method of Traffic Forecasting

In formulating proper traffic or road plan, it is first necessary to estimate the anticipated traffic volume in a proper manner to meet the amount of future traffic.

For this purpose, it is believed that performing an Origin and Destination survey is essential to the acquisition of basic date necessary for estimating the amount of future traffic, and without which it is next to impossible to make an accurate future traffic forecasting.

However, in the absence of necessary data, such as vehicular OD tables, economic statistics, and road plan, traffic forecasting in this report has been relied largely on our assumption. To make an accurate forecasting, it will be necessary either to conduct a series of proper traffic survey, or to make a traffic plan at an early date. Under the circumstances noted above, we are obliged to forecast the traffic with rather insufficient data.

An OD survey, which is performed to determine the movement of vehicular traffic, serves as an important basis for forecasting the anticipated volume of traffic. In this survey, all the movements of normal daily vehicular traffic have been checked taking into consideration such variables as the type of vehicles, origin, destination, travel time, the purpose of travel, and load.

However, since no vehicle traffic OD survey has ever been performed in Bangkok, we had no choice but to rely expressly on an only available bus passenger OD survey conducted in 1965 by the Ministry of Transportation, Thailand.

This survey is rather incomplete as person trip survey, because trip purpose is limited only to travellers' daily commutation and the persons surveyed were for the most part government office people, the data therefore were unreliable, and we had to consider the OD table as vehicle OD distribution.

In order to convert this bus passenger OD table to a vehicle OD table, we have multiplied the ratio of the volume of vehicular traffic crossing the Chao Phya River to the number of bus passenger crossing the Chao Phya River by the bus passenger OD table.

In other words, vehicle OD distribution is deemed to show substantially the same pattern as that in this OD table. In the said OD table, the volume of vehicular traffic crossing the Chao Phya River has been adjusted to correspond to actual traffic observations.

The future generating volume of each zone, which is necessary as part of data to calculate the future vehicle OD table, has thus been estimated by revising the present generating volume of each zone obtained from the OD table by the rate of population increase in each zone.

For an accurate and proper forecasting of the generating volume of traffic in each zone, it is essential that regression formulas are obtained by adjusting the present generating volume of each zone derived from the OD survey to economic factors of each zone, such as population, number of workers, product, and sales. Applied the future values of economic factors anticipated from the city planning to this equation, the future generating volume of each zone can be forecast.

While it may be necessary to know economic statistics of each zone and city planning, we have in this report relied upon population data only, the most fundamental of the economic statistics, because we were not able to obtain other useful information. The anticipated values have thus been found by a simple method.

With respect to the number of future vehicle registrations, we have figured out the total trips of anticipated vehicular traffic in Bangkok and Thonburi by the product of the trips of each vehicle and anticipated vehicle registrations reported by Dr. Gun Magamati, Deputy Director General, Department of Road Transport, Ministry of Communications, Thailand. From thepresent vehicle OD table and also from the present total vehicle registrations in the estimated area, we have now calculated the number of trips per vehicle.

In order to properly forecast the volume of future vehicle traffic, we must accurately estimate the anticipated vehicle registrations. In this case, however, it is desirable to predict the future vehicle registrations by each vehicle type for the reasons that both vehicle registrations and the trips of vehicles vary with each type.

The future traffic distribution has been predicted from the above anticipated traffic volume in each zone and the total trips using the Entropy method.

It will be necessary to estimate traffic assignment by assigning the anticipated traffic volume throughout the road network. But the road network in which traffic is to be assigned has been considered herein to be consisting of the existing roadways, proposed Bangkok-Thonburi bridges, acess

roads, for we know little or nothing of future road plan. It should be noted, however, that we have taken into consideration a probable increase in street width.

It will be appreciated that future road traffic cannot be forecast without considering a certain road network. In order to determine whether such a road plan is quite proper or not, it will be an idea to assign OD traffic to some road networks conceivable, so that a very reliable and accurate selection of a proper road network can be made.

Years predicated are 1975, when the proposed bridges are scheduled to be constructed, and 1990, when the current Bangkok city planning is expected to be completed.

Fig. 3-1-1 is the flow diagram showing the method of estimating the anticipated traffic between Bangkok and Thonburi.

The most of data necessary for forecasting the anticipated traffic in such a manner as above have been drawn from other data or on our assumptions. Various data for necessary traffic forecasting are herein given for your ready reference:

(1) Present vehicle OD table

(2) Presnet and future economic factors of each zone.

(3) Future vehicle registrations by type.

(4) Future road networks.

In order to make the results of the forecasting highly reliable and trustworthy, we feel it will be necessary to re-estimate anticipated traffic by performing a more extensive survey, or having a new city planning lied out.

The results of traffic forecasting are mentioned in this report. Another report "Traffic Forecast Between Bangkok and Thonburi" deals with the details of the data and methods used.

FIG. 3-2-1 ZONING

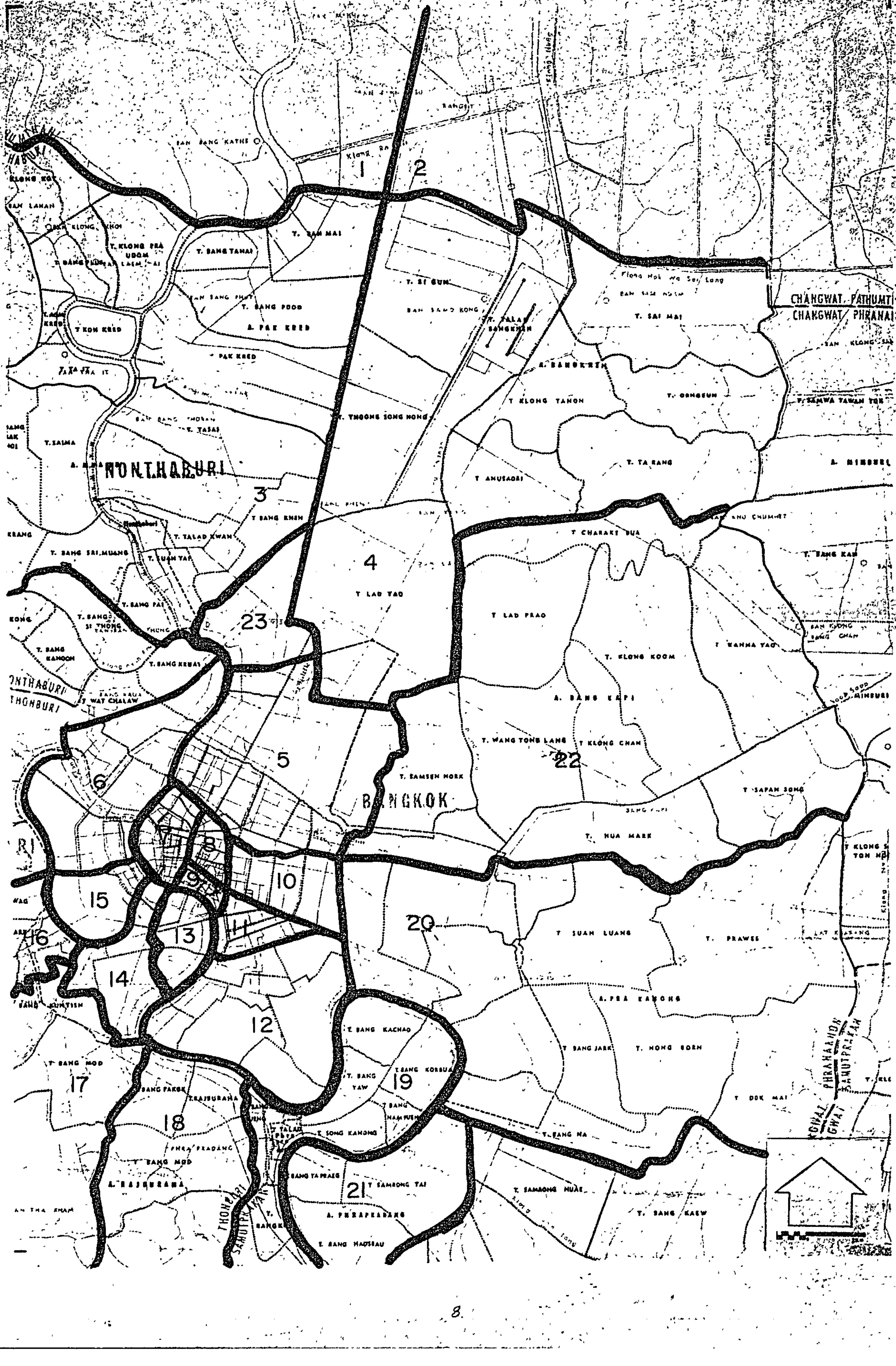
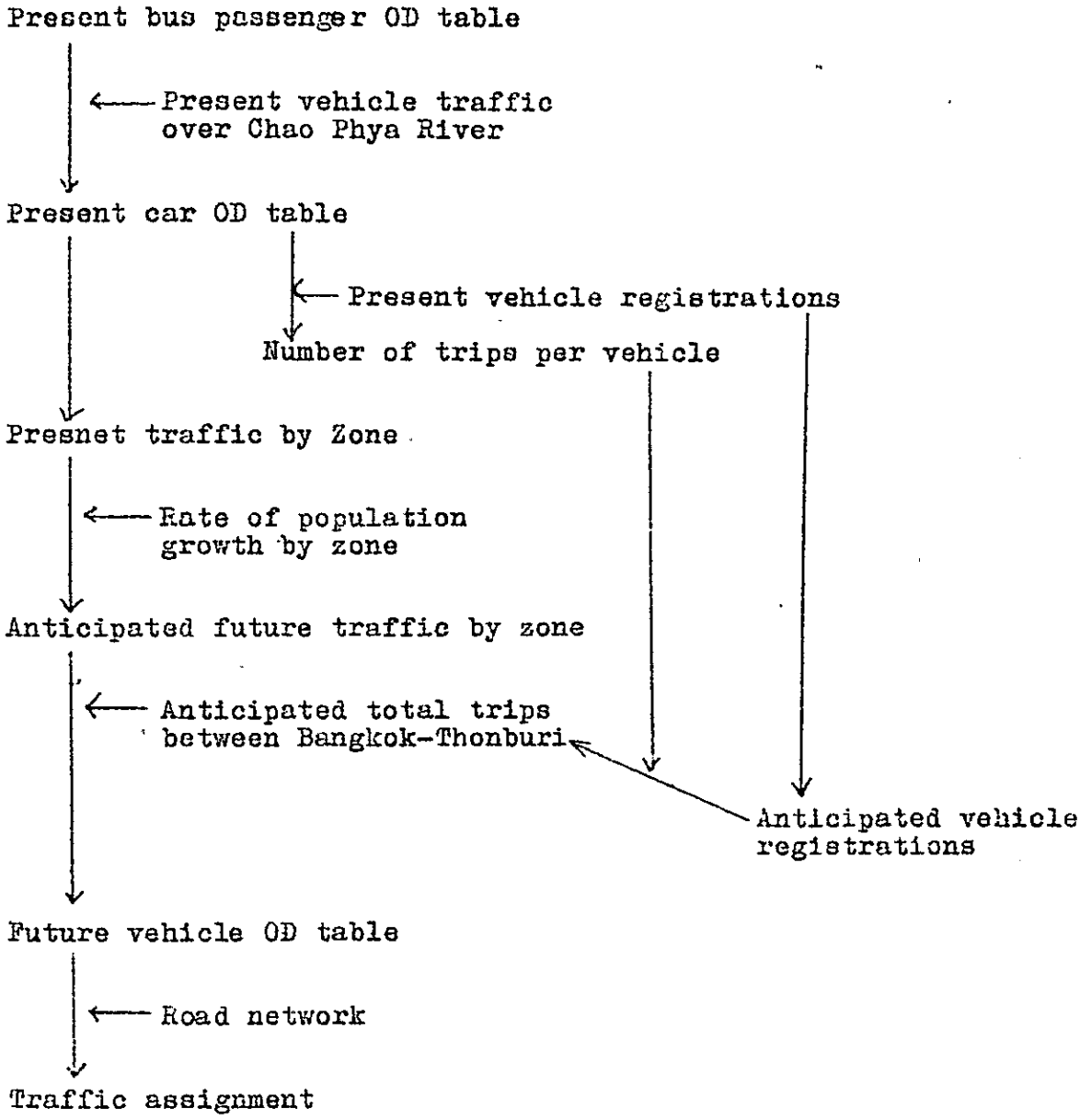


Fig. 3-1-1 Flow Diagram for Traffic Forecast Between Bangkok and Thonburi



3-2) Estimated Area and Zoning

Bangkok and Thonburi are two different cities, but they can be considered one and the same city, as they form the nucleus of the Metropolitan area. Therefore, the areas to be estimated herein are Bangkok and Thonburi.

Considering the purpose of traffic forecasting and the possibility of obtaining economic statistics, the zoning has been arranged in unit of Amphur. Amphur Dysit was divided into two areas - one that uses the Krung Thon Bridge and the other the Rama VI Bridge. These two zones have been designated as Zone No.5 and Zone No.23.

Refer to Table 3-2-1 and Fig. 3-2-1 for further information on zoning.

Table 3-2-1 Zoning

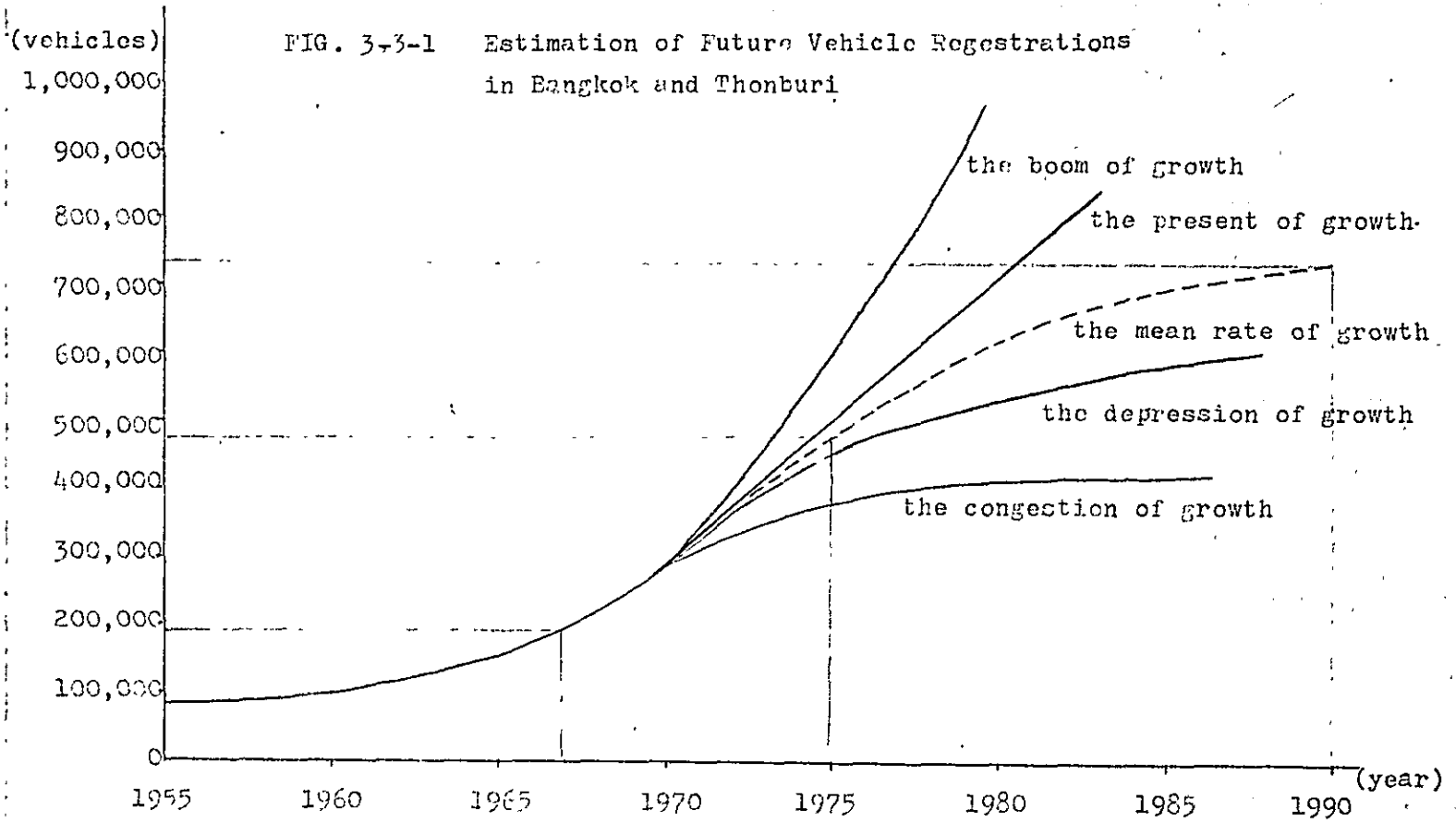
Zone No.	Zone Name	Zone No.	Zone Name
1	Bang Tanai	13	Klongsarn
2	Bang Mai	14	Thonburi
3	Pak Kred	15	Bangkok-Yai
4	Bang Khen	16	Pharsicharoen
5	Dusit	17	Bangkhunthien
6	Bangkok-Noi	18	Rajburane
7	Prana Korn	19	Prapradong
8	Ponprab	20	Prakanong
9	Sampantawong	21	Samrong Nua
10	Patumwan	22	Bang Kapi
11	Bangrak	23	Bang Sue
12	Yanawa		

3-3) Forecast of Future Total Trips

As a preliminary to estimating the OD tables, it is necessary to predict the total future trips of vehicles in both Bangkok and Thonburi.

We have estimated the total future vehicle registrations in Bangkok and Thonburi from the mean rate of growth shown by dashed line in Fig. 3-3-1, based on the estimation made by Dr. Gun Magamati.

FIG. 3-3-1 Estimation of Future Vehicle Regestrations in Bangkok and Thonburi



According to his estimation shown in Fig. 3-3-1, the anticipated vehicle registrations in 1975 and 1990 will be 493 (1,000 vehicles) and 731 (1,000 vehicles), respectively.

As will be described in Section 3-4, the trips of each vehicle are estimated to be 3.92 trips per vehicle. Assuming this figure remains unchanged in the future, the total trips of vehicles in Bangkok and Thonburi may be calculated as follows:

Year 1975

(1,000 veh.)		(trips/veh.)		(1,000 trips)
493	×	3.92	=1,933	

Year 1990

(1,000 veh.)		(trips/veh.)		(1,000 trips)
731	×	3.92	=2,866	

3-4) Forecast of Anticipated Traffic Distribution

The present OD table, which provides a basis for estimating the future traffic distribution, hasbeen prepared on the basis of the bus passenger OD survey conducted by the Department of Road Transport, Ministry of Communications, Thailand, in 1965.

Because the survey was conducted only on from-home-to-office trips, the trip generations of each zone in this OD survey are considered to be roughly proportionate to the population, but the rate of the trip generatic to the population in each zone as of 1965 in highly variable. We assume this is because the number of people in each zone are not sampled in proportion to the population in the same zone.
Thus, in zones such as Nos. 16, 17, and 22, where the rate of generating trips is too large in comparison with the population, the rate of generating trips of these zones have been revised to reflect the average rate of other zones.

With the above points in mind, the present bus passenger OD table has been prepared.

Table 3-4-1 has been obtained by comparing the rate of the volume of the bus passenger traffic crossing the Chao Phya River, which was derived on the assumption that these OD traffic volume flow through the minimum path, with the rate of the volume of vehicle traffic obtained by actual observations, made by the General Engineering Company in 1967.

Table 3-4-1 Comparison of Travellers versus vehicle Traffic Crossing the Chao Phya River

Traffic volume \ Bridge	Memorial	K.Thon	K.Thep	Rama VI	Total	Ratio
Vehicle	105,400	27,060	22,200	5,380	160,040	7.72
	0.658	0.169	0.139	0.034	1,000	
Bus Passenger	14,278	3,270	2,942	241	20,731	1.00
	0.688	0.158	0.142	0.012	1,000	

According to Table 3-4-1, the rate of the vehicular traffic passing through an existing bridge nearly equals that of bus passenger going through it with the exception of Rama IV Bridge. Thus it will be safe to regard the bus passenger OD distribution to be vehicle OD distribution. But to convert the bus passenger OD distribution to vehicular distribution, the figure must be multiplied by the rate of 7.72 times, for the volume of vehicular traffic crossing these bridges is 160,040 vehicles, while that of bus passenger run to 20,731 persons,
Therefore, as can be appreciated from the bus passenger OD table, the total trips of the present vehicles will become:

Total trips of bus passengers × 7.72

= 95,363 × 7.72

= 736,202 trips

On the other hand, since the number of vehicle registrations in 1967 is given in Fig. 3-3-1 as 188,000 vehicles, the average trips of each vehicle in 1967 can be expressed by

$$\frac{736,202 \text{ trips}}{188,000 \text{ veh.}} = 3.92 \text{ trips/veh.}$$

The above is no other than the basis which we have used to form the anticipated total trips of vehicles given in Section 3-3.

It is now necessary to find the generating volume of vehicle trips of each zone in both 1975 and 1990. Though the Entropy method permits the calculation of generating volume of traffic completely independent of the attracting volume of traffic, we can normally consider both of the above traffic volumes to be almost the same with each other.

We shall use hereinafter a simplified term "generating volume" as the sum of generating volume and attracting volume.

The generating volume of traffic of each zone both in 1975 and 1990 can be found as given in Table 3-4-2, if we multiply the generating trips of bus passengers as of 1965 by the ratio of the population in 1975 and 1990 to that in 1965, based on the assumption that an increase in the generating volume of each zone is in direct proportion to the population increase in the same zone.

In line with the prediction given in the Greater Bangkok Plan, we have used the figure of 6,300,000 people as the anticipated population in 1990 of the Metropolitan area. The rate of population increase in each zone was estimated by revising the actual population increase during years 1960 - 1965 with the maximum value of population density determined in due consideration of the present population density and land use.

Table 3-4-2 The Generating Volume of Traffic of each zone both in 1975 and 1990

Zone No.	Generating volume of Traffic in 1965	1975			1990		
		Multiple 1975/1965	Generating volume of traffic	Rate	Multiple 1990/1965	Generating volume of traffic	Rate
1	107	1,234	132	0.00055	2,865	307	0.00083
2	51	1,234	63	0.00026	2,865	146	0.00040
3	1,941	1,234	2,395	0.01000	2,865	5,561	0.01511
4	12,348	1,058	13,064	0.05453	1,381	17,053	0.04632
5	51,172	1,315	67,291	0.28089	2,390	122,301	0.33223
6	6,673	2,750	18,351	0.07660	3,660	24,423	0.06634
7	21,602	1,000	21,602	0.09017	1,000	21,602	0.05868
8	6,612	1,000	6,612	0.02760	1,000	6,612	0.01796
9	7,370	1,000	7,370	0.03076	1,000	7,370	0.02002
10	10,026	1,000	10,026	0.04185	1,000	10,026	0.02724
11	10,869	1,041	11,315	0.04723	1,672	18,173	0.04937
12	6,851	1,155	7,913	0.03303	1,534	10,509	0.02855
13	10,509	1,410	14,818	0.06185	1,625	17,077	0.04639
14	7,526	1,189	8,948	0.03735	1,440	10,837	0.02944
15	6,835	1,227	8,387	0.03501	1,790	12,235	0.03324
16	1,402	1,220	1,710	0.00714	1,840	2,580	0.00701
17	1,200	1,575	1,890	0.00789	4,660	5,592	0.01519
18	2,077	1,234	2,563	0.01070	2,865	5,951	0.01617
19	1,896	1,234	2,340	0.00977	2,865	5,432	0.01476
20	12,550	1,574	19,766	0.08251	3,370	42,294	0.11489
21	2,281	1,234	2,815	0.01175	2,865	6,535	0.01775
22	5,565	1,060	5,899	0.02462	1,385	7,708	0.02094
23	3,263	1,315	4,291	0.01791	2,390	7,799	0.02119
Total	190,726	-----	239,561	1.00000	-----	368,123	1.00000

Now the generating volume of traffic in each zone has been obtained. At this point, it should be noted that, since the generating volume of traffic, when the Entropy method is applied, could mean only relative largeness of each zone, we might as well multiply the rates of population increase during years 1965 and 1975 and also during 1965 and 1990 by bus passenger trip generations. In this case, however, it is necessary to find in advance the rate of generating volume of each zone to that of all zones, just as shown in the right-hand side column of Table 3-4-2.

By the Entropy method, in addition to the relative generating volume of each zone, it is necessary to provide the exponents (γ) that represents the effects of the time required on the traffic between zones. While it is somewhat small in value, we have used the value of 1.1 by fitting the gravity model to the bus passenger OD table. We have considered distance between zones in terms of time required for the traffic between zones.

As described, while OD distribution probability may be drawn from the above input data using a digital computer, OD tables can be obtained by multiplying this value by the total number of trips derived in Section 3-2.

Tables 3-4-3 through 3-4-4 show both the OD tables during years 1975 and 1990, which were given in trigonometric form.

Table 3-4-3 (No.1)

*** O/D Table BANGKOK-THONBURI 1975

	1	2	3	4	5	6	7	8	9	10
1	82	2	44	128	714	128	148	44	50	66
2		18	10	128	328	74	60	20	22	34
3			13054	1128	5243	1036	904	288	324	391
4				72871	32071	3383	5107	1664	1162	2104
5					245409	62963	109795	35269	21828	49211
6						42065	28258	4988	5516	6574
7							28511	15254	11752	10114
8								3171	3876	7036
9									5321	11330
10										8654
11										
12										
13										
14										
15										
16										
17										
18										
19										
20										
21										
22										
23										
Total										

Table 3-4-3 (No.2)

	11	12	13	14	15	16	17	18	19	20
1	66	42	78	44	42	8	14	10	10	148
2	42	24	38	22	24	4	6	6	4	58
3	387	208	388	223	200	44	64	46	36	644
4	2449	1284	2416	1384	1290	206	416	288	212	3881
5	31988	14264	36998	31758	19811	2804	7966	2429	2407	49599
6	7536	3846	20228	10156	22388	1830	2830	932	645	19862
7	13330	6245	27250	16034	16364	1651	2897	1216	773	13427
8	5531	1834	7002	3406	3108	528	652	386	261	5902
9	16758	4264	11498	6042	4216	692	712	638	370	4682
10	17750	5160	6382	3528	4004	542	846	549	430	13263
11	19759	11174	8510	4878	4036	583	1472	851	675	10666
12		30489	3654	2916	1864	284	830	767	420	5110
13			29124	24144	14124	1744	2982	1502	823	6616
14				10082	7354	922	3406	1343	550	3686
15					13378	1548	1240	518	319	3500
16						6467	152	106	67	574
17						--	598	662	222	1272
18								13722	336	884
19									13833	1124
20										81773
21										
22										
23										
Total										

Table 3-4-3 (No.3)

	21	22	23	Total
1	10	128	42	2130
2	6	50	10	1018
3	40	405	484	38645
4	264	3475	622	210804
5	3217	27721	46743	1085945
6	1800	5312	1736	296151
7	716	6012	4286	348615
8	250	2196	866	106703
9	310	1554	698	118936
10	586	3408	1160	161796
11	488	2926	982	182597
12	256	1508	750	127702
13	438	2806	1264	239133
14	238	1562	642	144402
15	234	1436	574	135350
16	40	232	98	27594
17	70	436	158	30501
18	60	257	127	41357
19	48	258	95	37751
20	3609	5540	1382	318985
21	16132	361	114	45419
22		13111	1390	95195
23			2513	69249
Total				1932989

Table 3-4-4 (No.1)

*** O/D Table BANGKOK-THONBURI 1990

	1	2	3	4	5	6	7	8	9	10
1	254	6	120	246	1782	244	214	64	74	94
2		58	28	250	836	144	88	30	34	50
3			31269	1913	11511	1747	1159	370	428	490
4				87498	49856	4038	4636	1508	1088	1868
5					493909	97310	129041	41378	26469	56562
6						49924	25504	4494	5136	5804
7							19568	10452	8322	6789
8								2169	2740	4714
9									3888	7846
10										5680
11										
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22										
23										
Total										

Table 3-4-4 (No.2)

	11	12	13	14	15	16	17	18	19	20
1	156	82	138	80	92	16	54	26	24	394
2	100	46	70	40	52	8	28	14	12	186
3	797	357	603	350	383	84	232	110	88	1518
4	3570	1564	2654	1540	1748	278	1070	493	357	6480
5	60353	22486	52621	45727	34760	4894	26487	5368	5253	107218
6	10920	4656	22092	11228	30164	2452	7228	1581	1081	32971
7	14687	5750	22633	13482	16768	1682	5626	1569	985	16949
8	6084	1686	5806	2860	3180	538	1262	498	332	7437
9	13090	4050	9852	5242	4456	728	1428	849	487	6098
10	19126	4664	5184	2902	4012	540	1606	693	536	16373
11	34048	16514	11346	6586	6638	956	4588	1762	1379	21616
12		37648	4070	3288	2562	386	2162	1327	718	8652
13			29272	24566	17514	2150	7006	2345	1269	10108
14				10386	9230	1152	8102	2123	859	5700
15					20769	2356	3593	997	607	6595
16						9785	438	203	127	1077
17							3287	2414	802	4542
18								33272	804	2097
19									32729	2634
20										189866
21										
22										
23										
Total										

Table 3-4-4 (No.3)

	21	22	23	Total
1	28	236	98	4776
2	14	94	24	2270
3	94	664	994	86578
4	445	4037	904	265539
5	7003	41685	87959	1904377
6	3009	6134	2508	380293
7	910	5280	4709	336371
8	317	1924	948	102960
9	406	1408	790	114757
10	729	2926	1246	156114
11	995	4126	1732	282977
12	438	1778	1104	163636
13	673	2982	1682	265908
14	370	1680	864	168743
15	445	1882	942	190514
16	74	302	160	40171
17	254	1084	492	87072
18	144	424	262	92647
19	112	421	194	84539
20	8440	8948	2792	658557
21	38002	587	234	101725
22		14731	1956	120020
23				121438
Total				2865991

3-5) Estimation of Traffic Assignment

This section deals with the problem of just how the OD traffic distribution predicted in Section 3-4 will flow and great the anticipated volume of traffic might be in each section of road network.

While a number of methods have hitherto been introduced to permit the estimation of traffic assignment in various ways, the traffic has been assumed to flow via the route which offers the shortest travelling time. That is to say, we have divided traffic assignment into several times for convenience's sake and the OD traffic shown in the OD table is flowed through the shortest route in any desired volume. We have utilized a method whereby the shortest route is determined by changing the running speed, therefore the running time, according to the volume of each road section's traffic that might increase each time traffic is flowed therethrough. Then the volume of traffic is added to the shortest route thus determined, until the whole OD traffic volume is assigned.

Needless to say, in this method of traffic assignment, the presence and absence of certain roads will give delicate effects on the volume of traffic of other roads. For this reason, it is necessary to consider all the projected routes; otherwise, the traffic volume in one section of road cannot be estimated accurately.

The above remark particularly applies to routes that are in competition with others.

In order to find the volume of traffic passing over the proposed Bangkok-Thonburi Bridge No.1 in Ta Chang-Wangner, we have included in the road network the proposed Bangkok-Thonburi Bridge No.2 linking the Sathorn or Silon Road. This road network is shown in Fig. 3-5-1.

In computing the traffic assignment with a digital computer, OD traffic volume is divided into 1/4, or a total of four times of traffic assignment have already been completed.

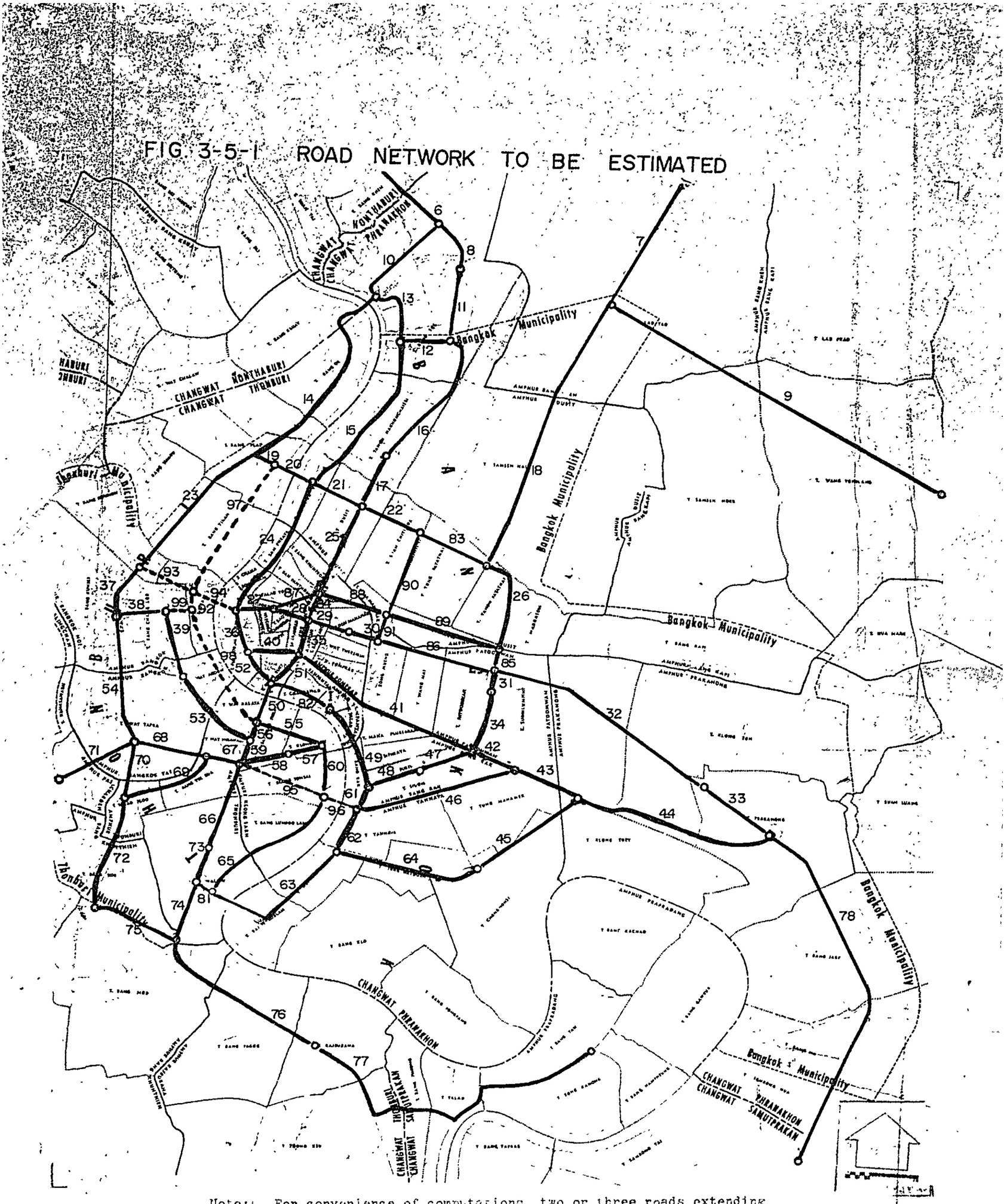
While traffic between Bangkok and Thonburi in 1990 will be too large to be handled by the combined traffic-carrying capacity of this road network, traffic assignment has nevertheless been carried out to ascertain as to how large the traffic volume of the proposed bridge will be when a certain period of time goes by following the completion of the bridge.

Of the results of assignment computations, part of traffic between Bangkok and Thonburi area are indicated in Table 3-5-1 alongside the 1967 figure for purposes of comparison. All the results are also given in Fig. 3-5-2 through 3-5-3.

Table 3-5-1 Traffic between Bangkok and Thonburi

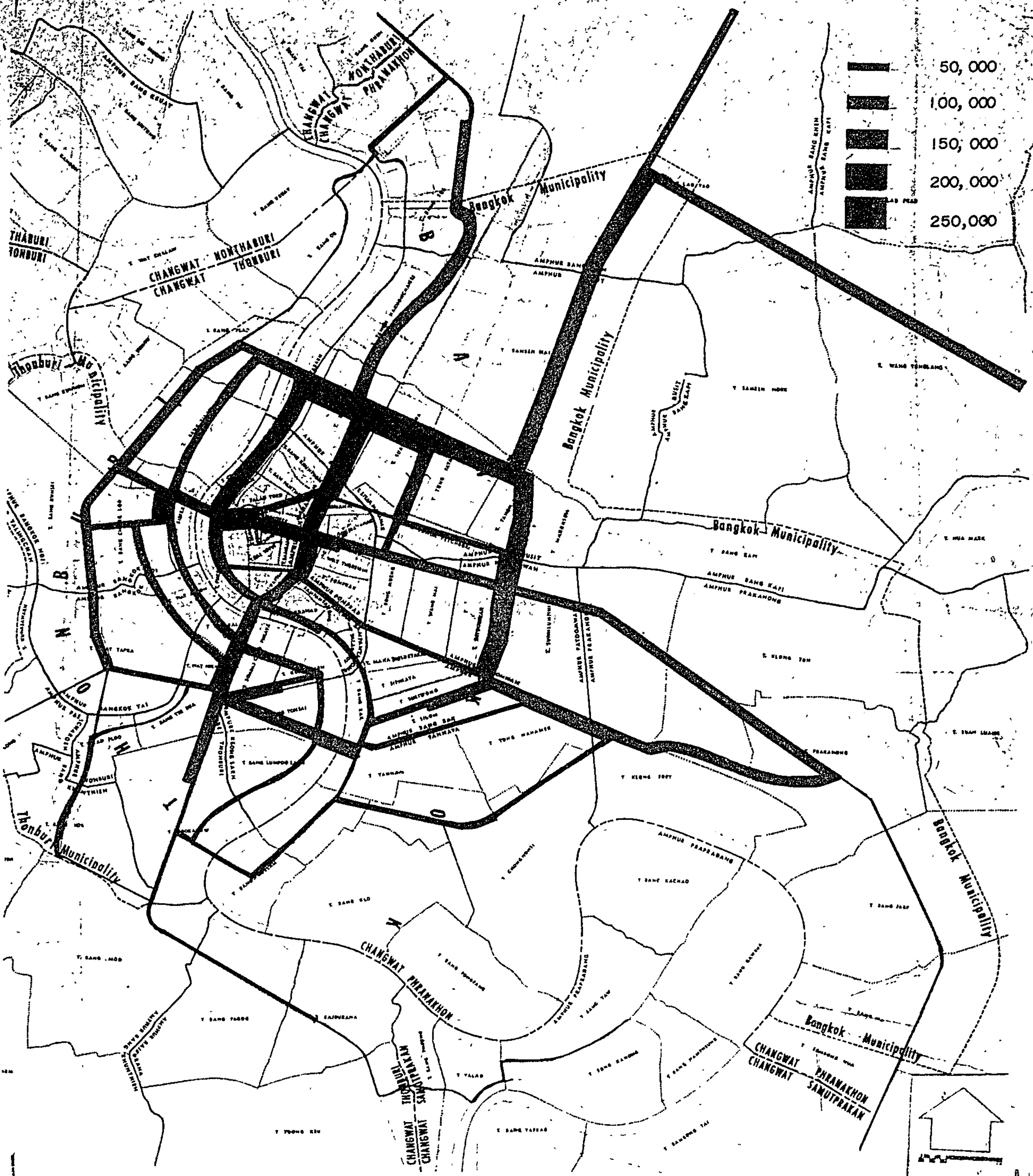
Link No.	Bridge	1967	1975	1990
14	Rama VI	5,380	24,565	35,757
20	K. Thon	27,060	73,356	104,151
50	Memorial	105,400	112,455	114,527
63	K. Thep	22,200	61,538	79,855
94	No.1	———	91,384	134,854
96	No.2	———	83,857	132,929
Total	———	160,040	447,155	602,073

FIG 3-5-1 ROAD NETWORK TO BE ESTIMATED



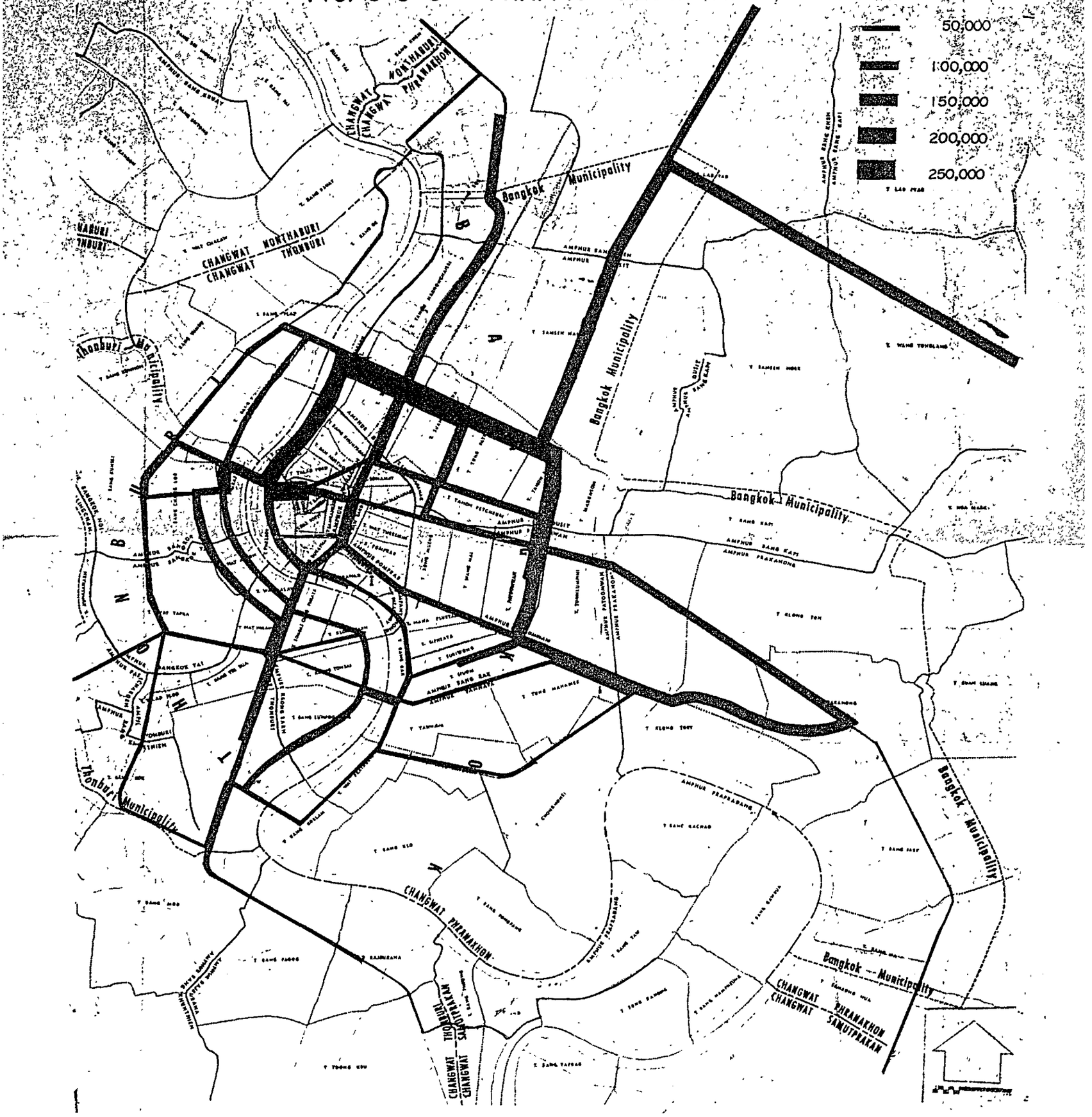
Note: For convenience of computations, two or three roads extending in the same direction are shown as one roadway. Since a main emphasis is placed on the forecasting of traffic volume on the bridge and its access roads, there may be slight inaccuracy the traffic volume of other roads.

FIG. 3-5-2 TRAFFIC FLOW AT 1975



Note: For convenience of computations, two or three roads extending in the same direction are shown as one roadway. Since a main emphasis is placed on the forecasting of traffic volume on the bridge and its access roads, there may be slight inaccuracy the traffic volume of other roads.

FIG. 3-5-3 TRAFFIC FLOW AT 1990



Note: For convenience of computations, two or three roads extending in the same direction are shown as one roadway. Since a main emphasis is placed in the forecasting of traffic volume on the bridge and its access roads, there may be slight inaccuracy the traffic volume of other roads.

Art. 4. Structure to Cross Chao Phya River

There are river bottom tunnel and bridge to cross the river. We prefer bridge to tunnel on the following reasons.

4-1) River bottom tunnel

Merit 1 Traffic is free from the navigation of ships

Demerit 1 Construction cost is exceptionally high
2 Maintenance cost including illumination, ventilation and drainage is very high.
3 A long approach is necessary (total length of tunnel will come up to 1,800 m.) and connection with the Charoen Nakorn Road is impossible.
4 Traffic capacity is restricted by ventilation

4-2) Bridge

Merit 1 Construction cost is lower than that of tunnel

Demerit 1 In case of fixed bridge, along approach is required. (Total length of bridge and approach approx. 1,700 m.)
Connection with the Charoen Nakorn Road becomes impossible and the construction cost becomes higher.
Traffic is influenced by the navigation of ships, in case of movable bridge.

Art. 5. Fixed versus movable bridge

The necessary clearance below the bridge for navigation will be 40 m taking the height of mast of ship as 30 m, and adding tidal range, waving and some allowance the height of road surface above the M.S.L. will be about 42 m.

These were settled after consultation with those officials in charge of the Civil Engineering Department and us.

Under these conditions, it will not be impossible to construct a fixed bridge from the engineering stand point, but it is considered not appropriate from the under mentioned reasons.

5-1) Taking the gradient of the approach road as 5% one side of approach is about 735 m. long and the length through both approaches will be 1,470 m. and adding 220 m., width of the Chao Phya River the total length reaches 1,690 m., so that it makes a very large scale bridge. In this case, the super structure does not always require large amount of construction cost by selecting a proper type of bridge, but it is easily understood that the cost of sub structure will increase considerably as the structure is very high. As the approach is long, the cost of land will become an important item.
Rough estimate with the clearance of 30 m. below the bridge, the construction cost will be almost the same for the fixed and the movable bridge.

5-2) Next comes the problem of appearance of the bridge. Everybody will easily understand that such a large scale bridge of height over 40 m. will spoil the fine panorama view of Bangkok City.
However the bridge itself holds its fine appearance the high structure skyrockets in the air will spoil the fine view of the City as a whole.
We are afraid wheather the super structure match with those famous and fine cathedrals and temples in the historical area of Bangkok.
From the two vital reasons we can not recommend the fixed type bridge. We now turn to the movable bridge. We know well that the movable bridge is preferable, but we can not miss one vital drawback of it. The bridge of this type built for the purpose of alleviating the traffic congestion might result adversely in the future.

Art. 6. Selection of the type of bridge and the estimate of construction cost

The width of the Chao Phya River at the construction site of bridge one from Thonburi side to the Silom Road of Bangkok side and other from the Thonburi side to the Sathorn Road of Bangkok side, is 220 m., same for both.

The bridge crossing the main stream, the movable one is preferable as described in paragraph 1.

6-1) Main span

As to the movable bridge, the Bascule, Lift and Swing type come to the fore.
The Lift bridge, where the clearance below the bridge is 40 m., the height of 50 m. is necessary for the tower, and not recommendable from a higher cost and no good appearance.

For Swing bridge, construction of a massive pier in the river center is needed, and from this pier extending to both ways, necessiate navigation channels of 60 m. wide. The construction cost of a movable bridge becomes higher and this type of bridge is not recommendable. The Bascule type will be the superior. In this case, the motors, machines and equipment to drive the movable girder will be installed on the pier.

Consequently, the pier becomes larger and massive but this type is considered most fitted to the conditions of the site.
To save the weight of moving parts, the use of steel plate or steel grid for the floor part is advisable. For the main girder, the up to date slender box type was planned, the truss type is low in cost but is out of mode.
The larger girder was taken into consideration for the side span. This type is one of the stiffened arch and costs cheaper in construction of bridge exceeding 80 m. in length and it gives a good appearance. The five span bridge adding one pier each in the side space is considered, but as the soil condition of the site is not satisfactory we consider the three span type to be favorable.

6-2) Approach bridge

Now compare the cases of the approach bridge connection to the Silom Road and to the Sathorn Road.
From present conditions of the Charoen Krung Road, the Sathorn Road should intersect the former astride, as it is impossible to take them on the surface.

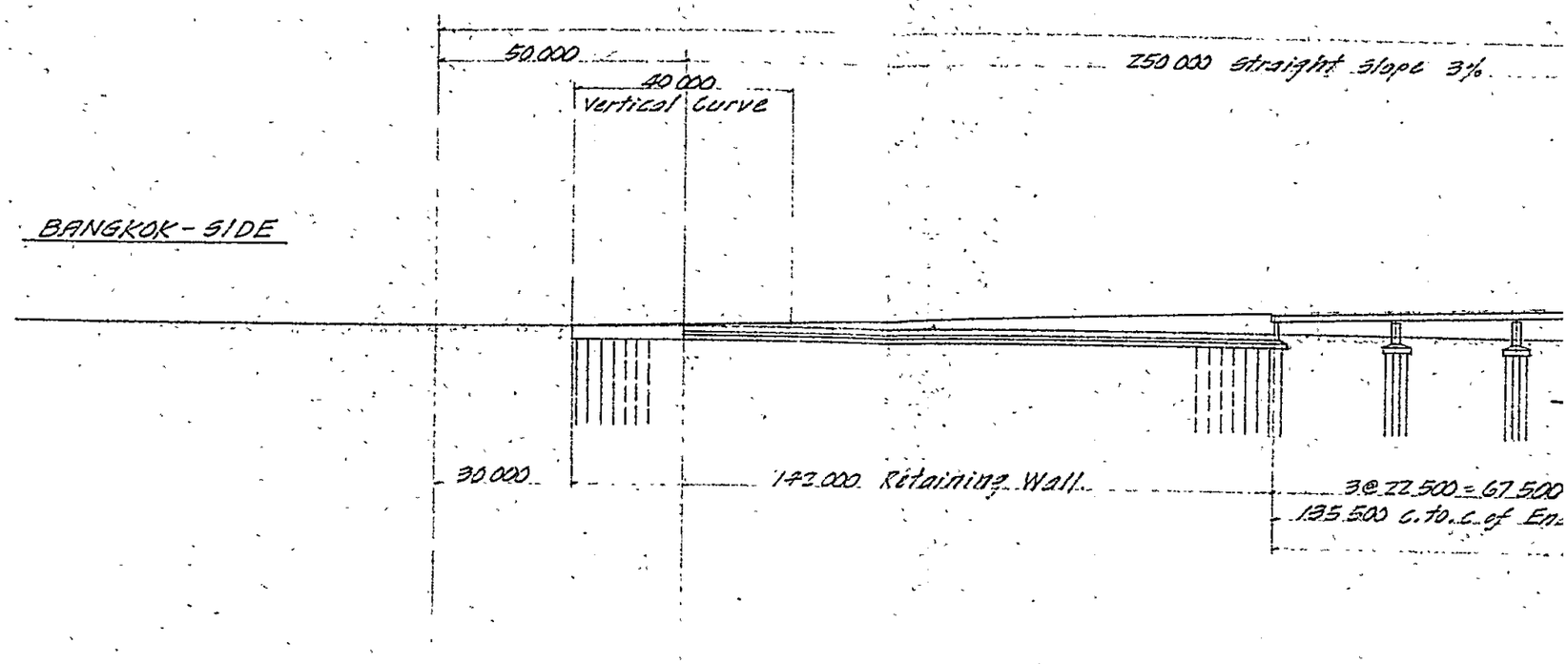
On the contrary, the approach bridge should intersect the Silom Road on the surface. This has been already described in paragraph 1. After the above work had been planned, the elevated bridge at the approach was planned.
As the conditions at the Thonburi side are the same the main road astrides the Charoen Nakorn Road and the ramp is connected to it.
The sub structure of the approach road is not so high and the construction cost will be low.

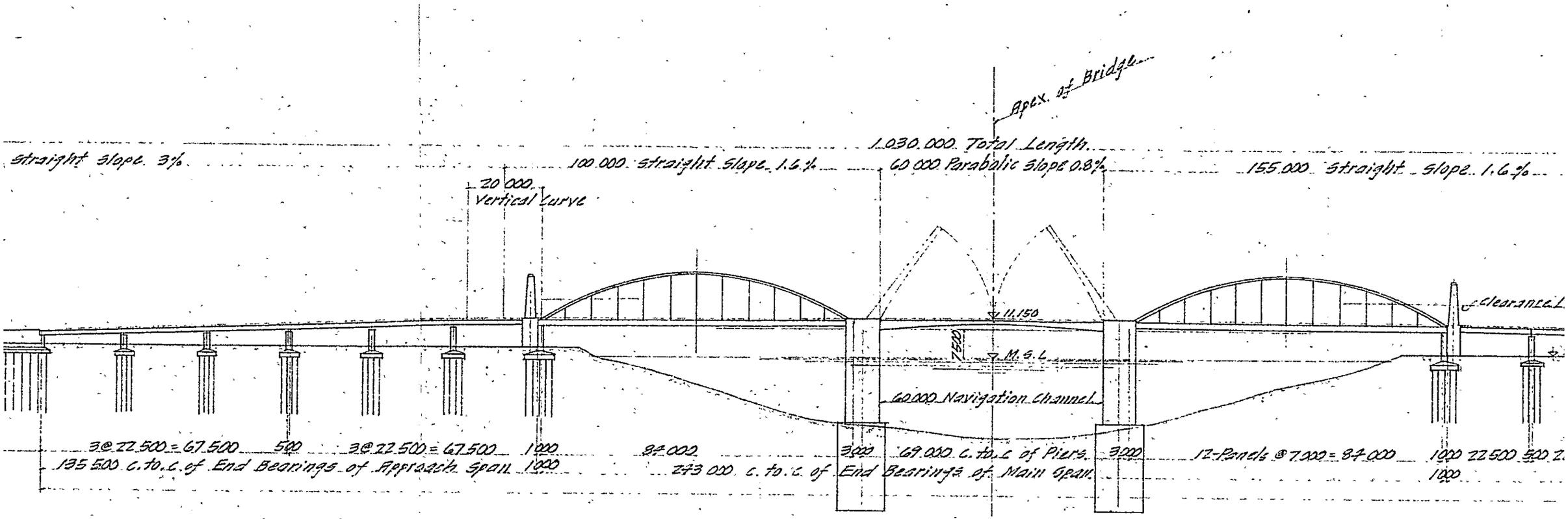
It is not favorable to adopt a large span. According to our rough estimate, the span of 20 m - 25 m long will be the most economical for either concrete, pre-stressed concrete or steel bridge.

Taking this in account, in almost all cases we planned combination of simple girder, two span continuous girder and three span continuous girder with a span of 22.5 m. The portion astride the Charoen Nakorn Road, the width of the road forced us to choose the span of 35 m. For the approach bridge, there is not so much difference in construction cost between the pre-stressed concrete and the steel bridge.

From a policy to utilize the local material as much as possible the adoption of pre-stressed concrete is recommendable. For the foundation, we have no question about the use of pre-cast concrete pile. We have made up a skelton plan of main span and approach bridge. As for the main span, to connect the Silom Road and to connect the Sathorn Road the same type and the same span distribution were taken.

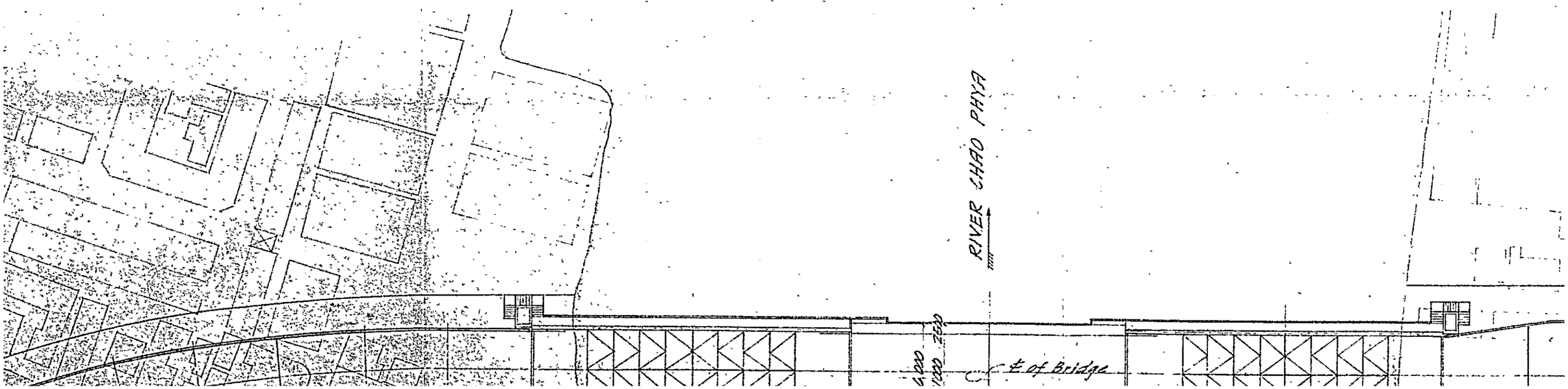
The latter bridge is 46 m. longer than the former one in total length.
Dare to say, the approach part of the latter will be constructed in the existing canal, the cost of sub structure will be somewhat higher. The comparison of the rough estimate of construction cost is tabulated as follows:
Such estimate had been complied before accurate survey and exploration of soil were carried out and some error in them will be unavoidable.

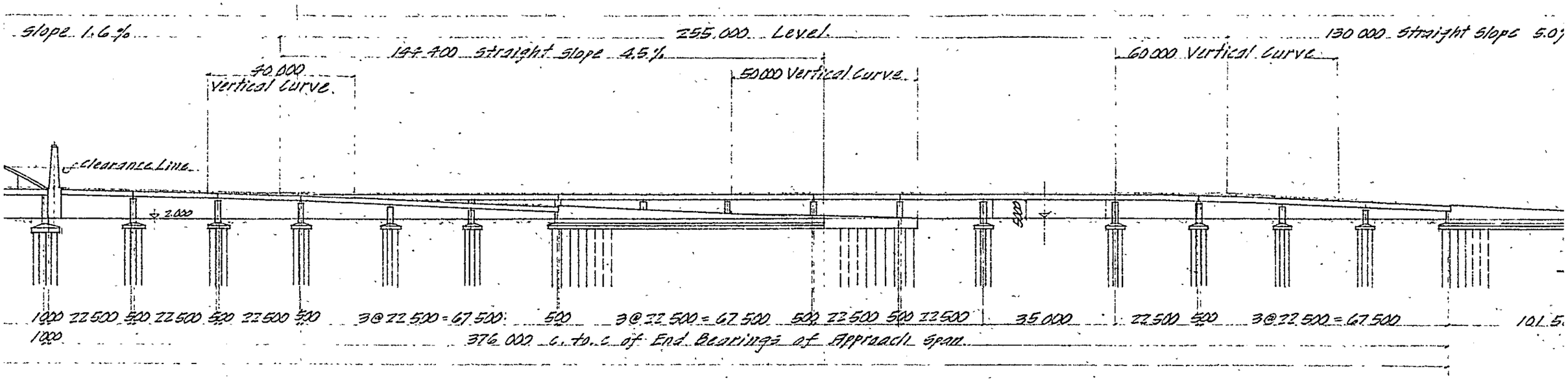

50.000
40.000
Vertical Curve
250.000 Straight Slope 3%
BANGKOK-SIDE
30.000
142.000 Retaining Wall
3@22.500=67.500
135.500 c.to.c of En

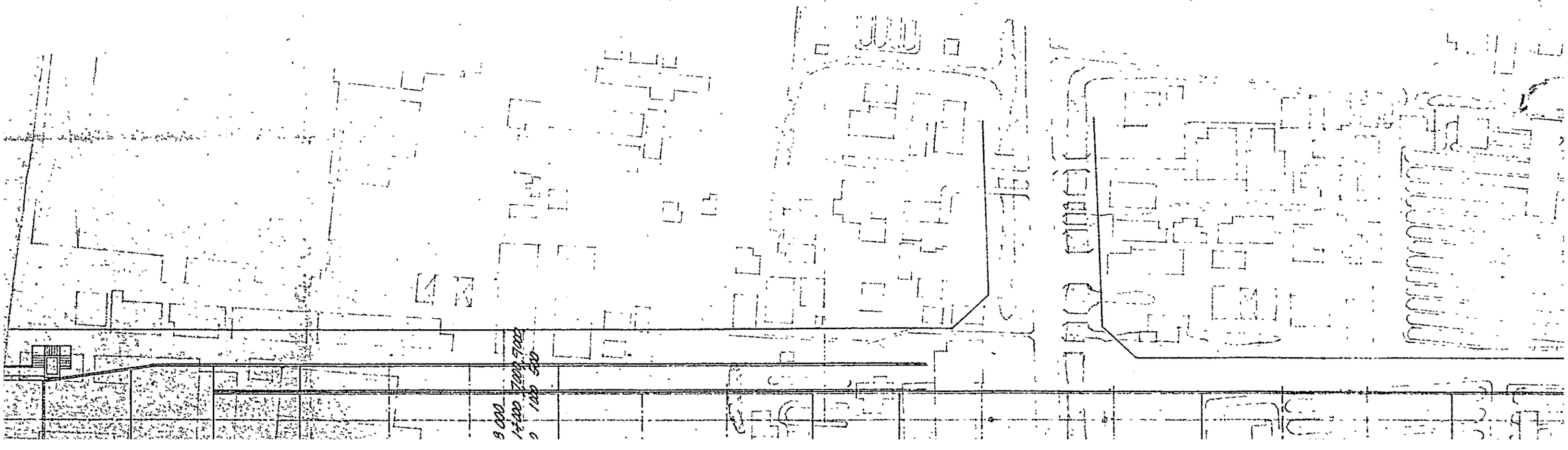


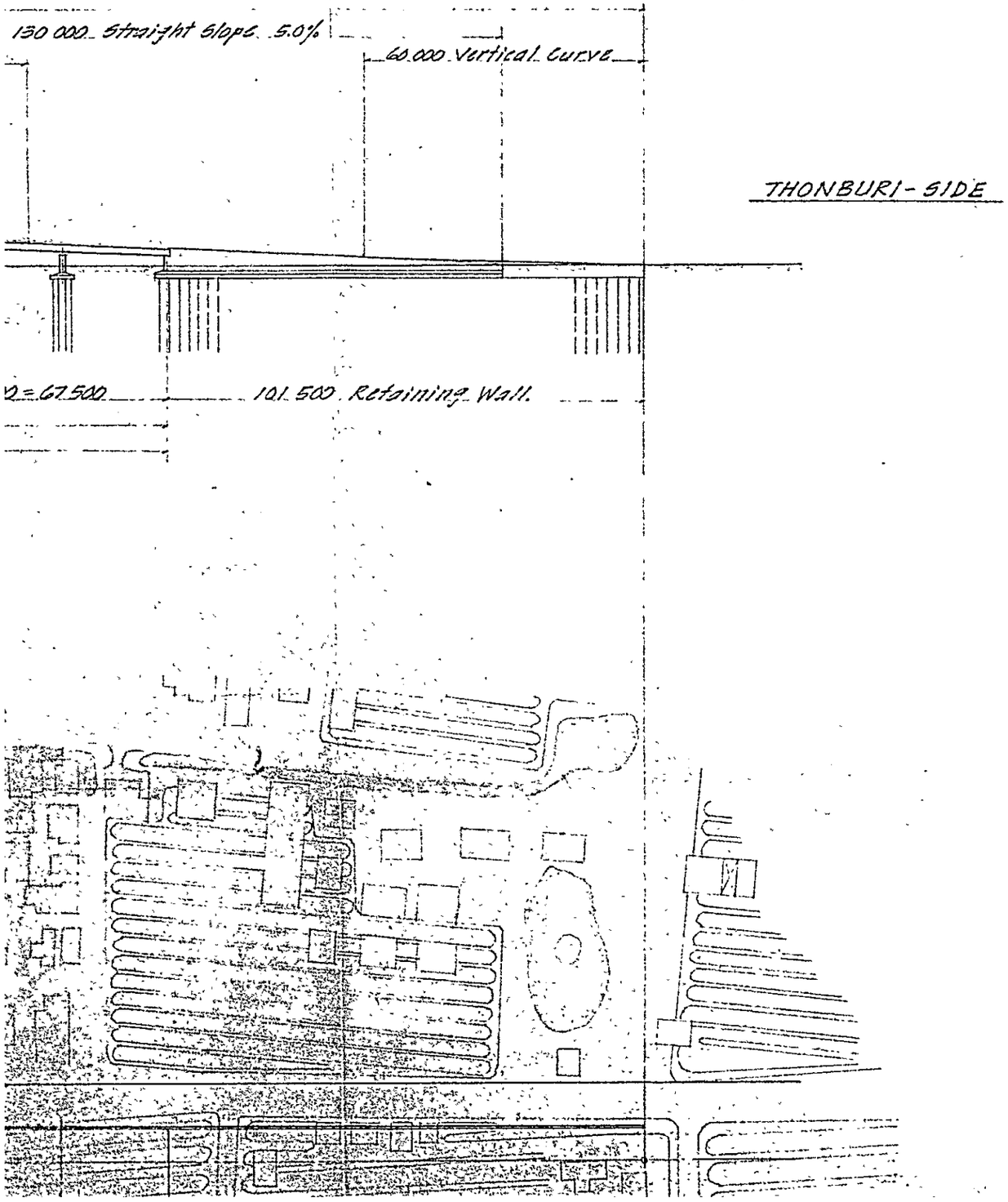
GENERAL ELEVATION

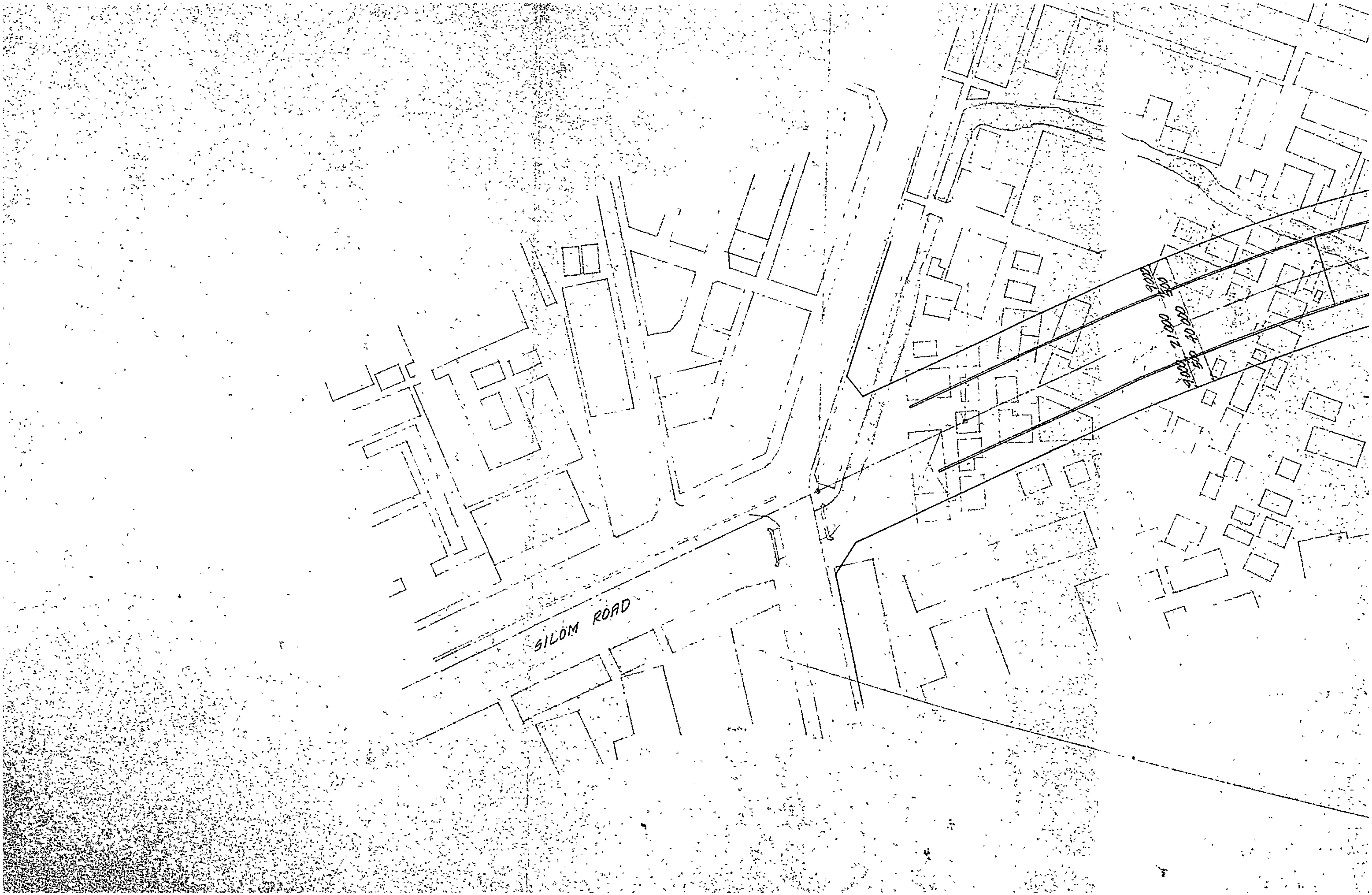
Scale 1:1000



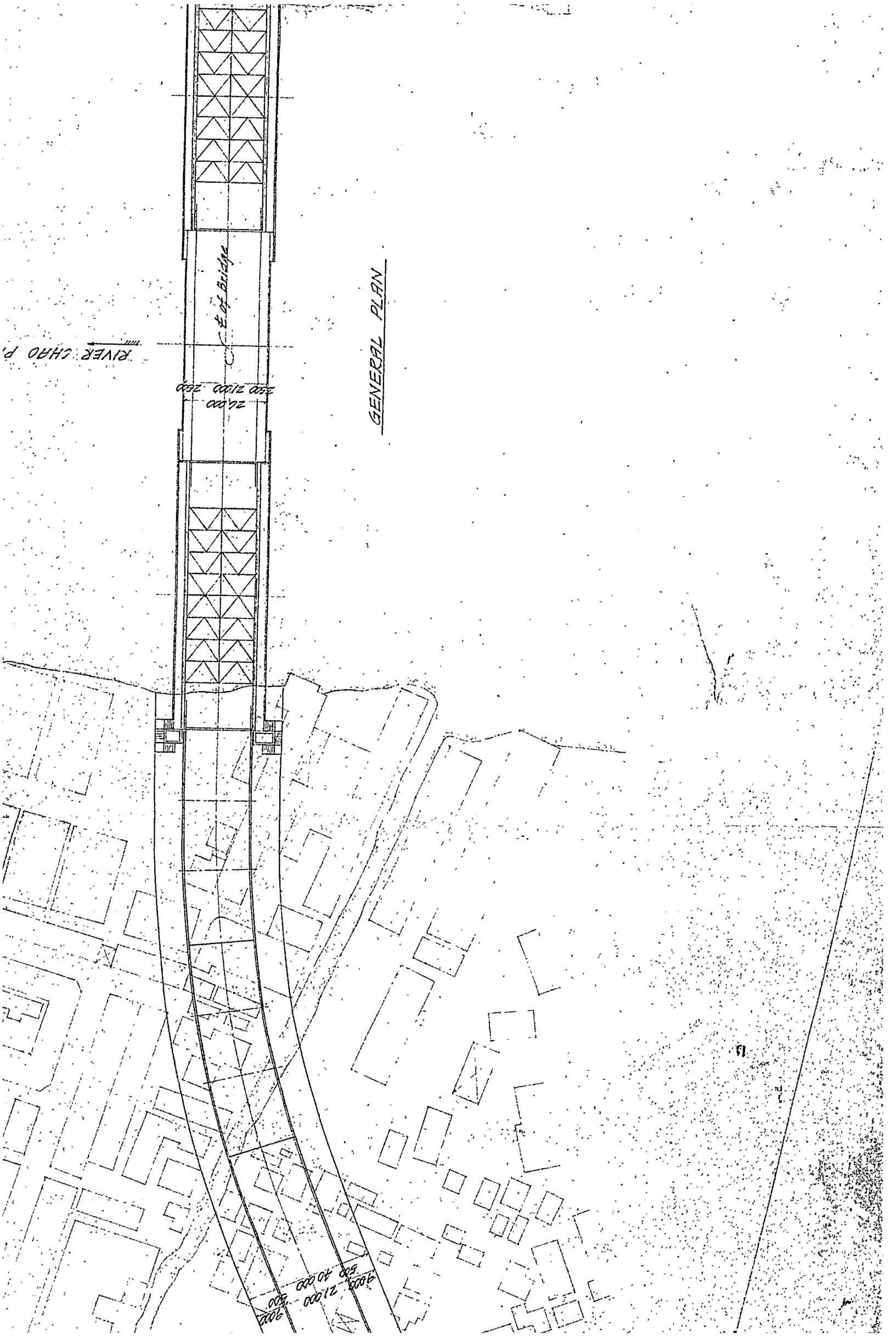

Slope 1.6%
255.000 Level
130 000 Straight Slope 5.0%
194 400 Straight Slope 4.5%
40 000 Vertical Curve
50 000 Vertical Curve
60 000 Vertical Curve
Clearance Line
± 2.000
1000 22 500 500 22 500 500 22 500 500 3@22 500 = 67 500 500 3@22 500 = 67 500 500 22 500 500 22 500 35 000 22 500 500 3@22 500 = 67 500
1000
376 000 c. to c. of End Bearings of Approach Span

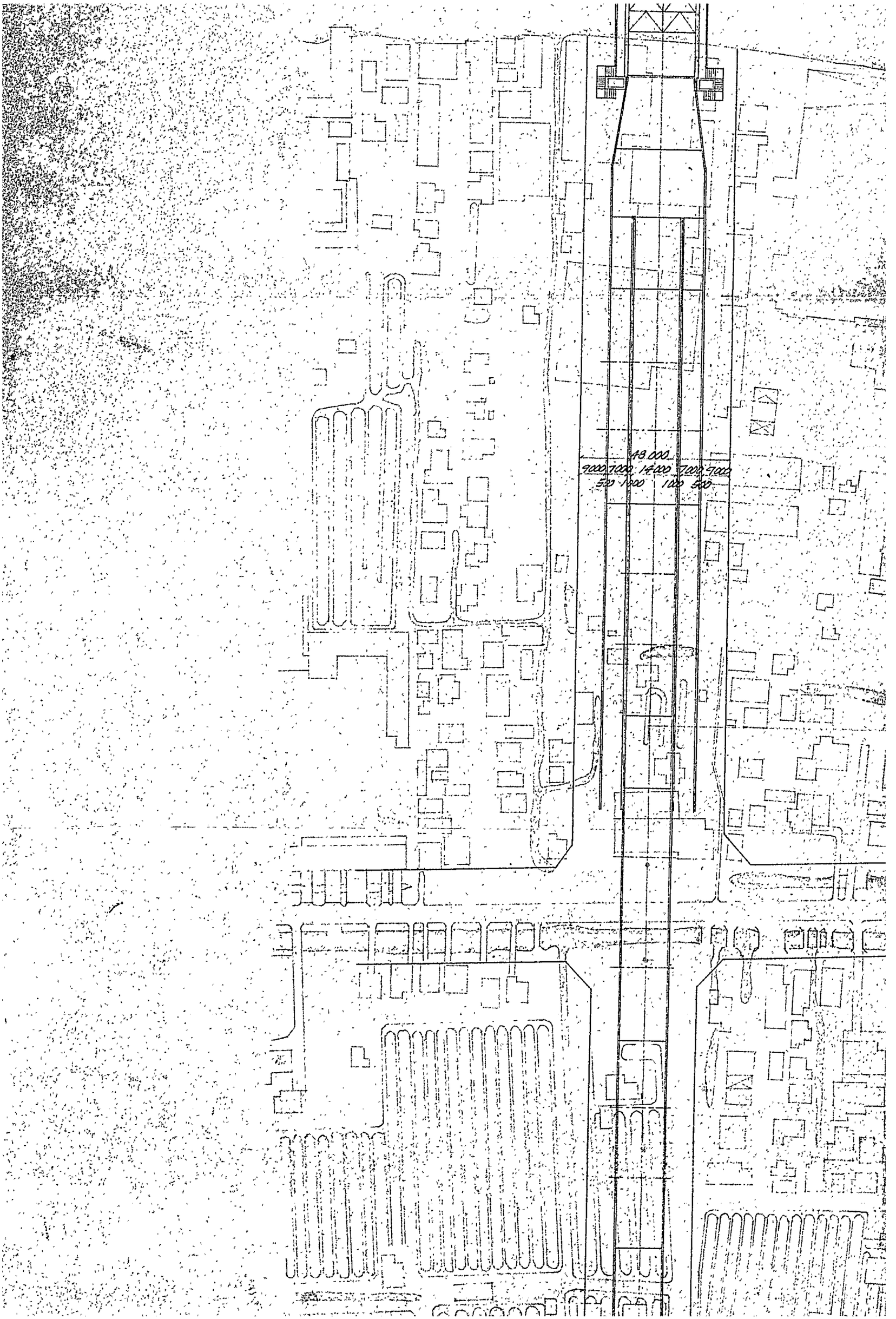


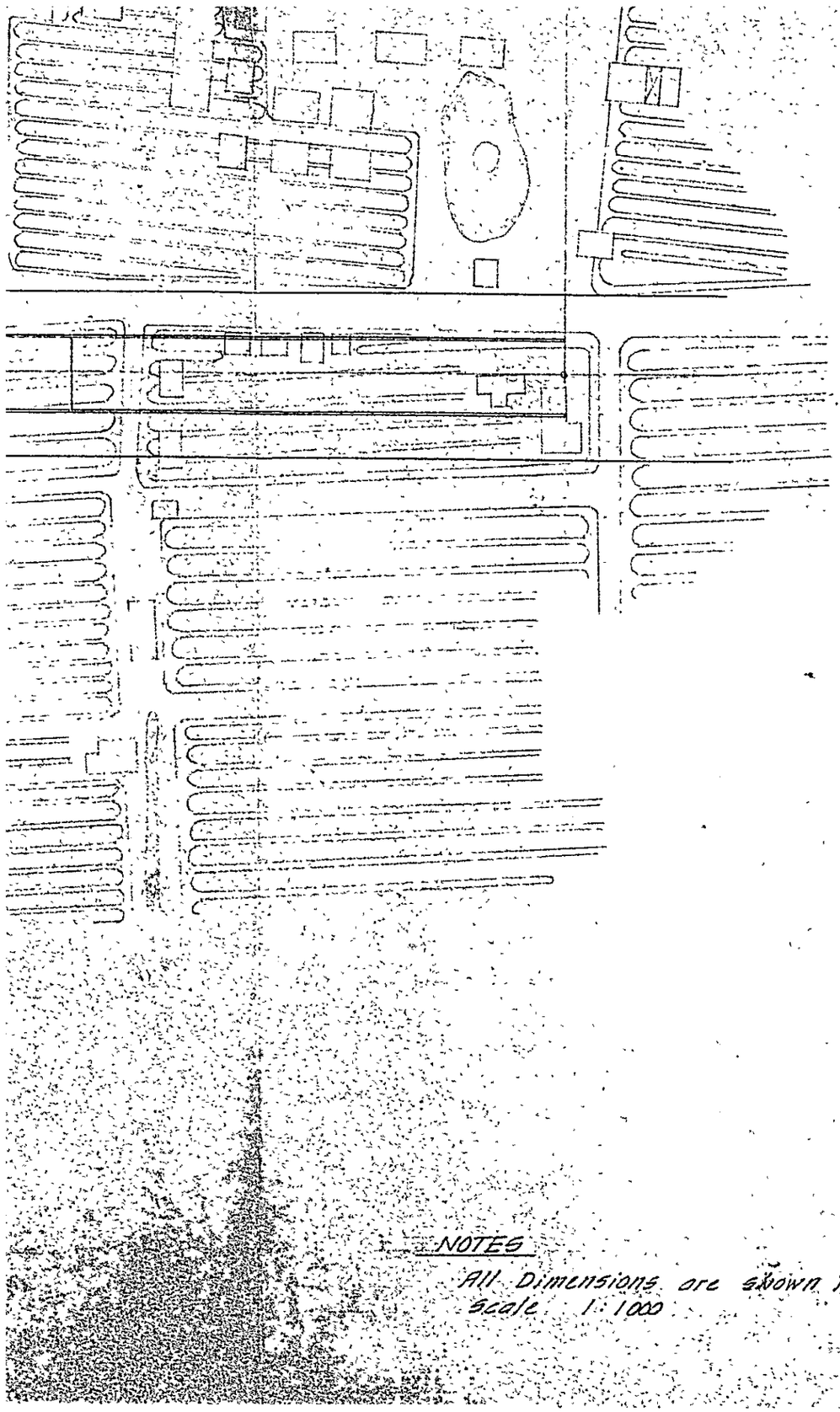

130 000 Straight Slope 5.0%
60.000 Vertical Curve
THONBURI - SIDE
2 = 67.500
101.500 Retaining Wall


SILOM ROAD
21.000
40.000

GENERAL PLAN




49.000
9000 7000 14000 7000 7000
500 1000 100 500



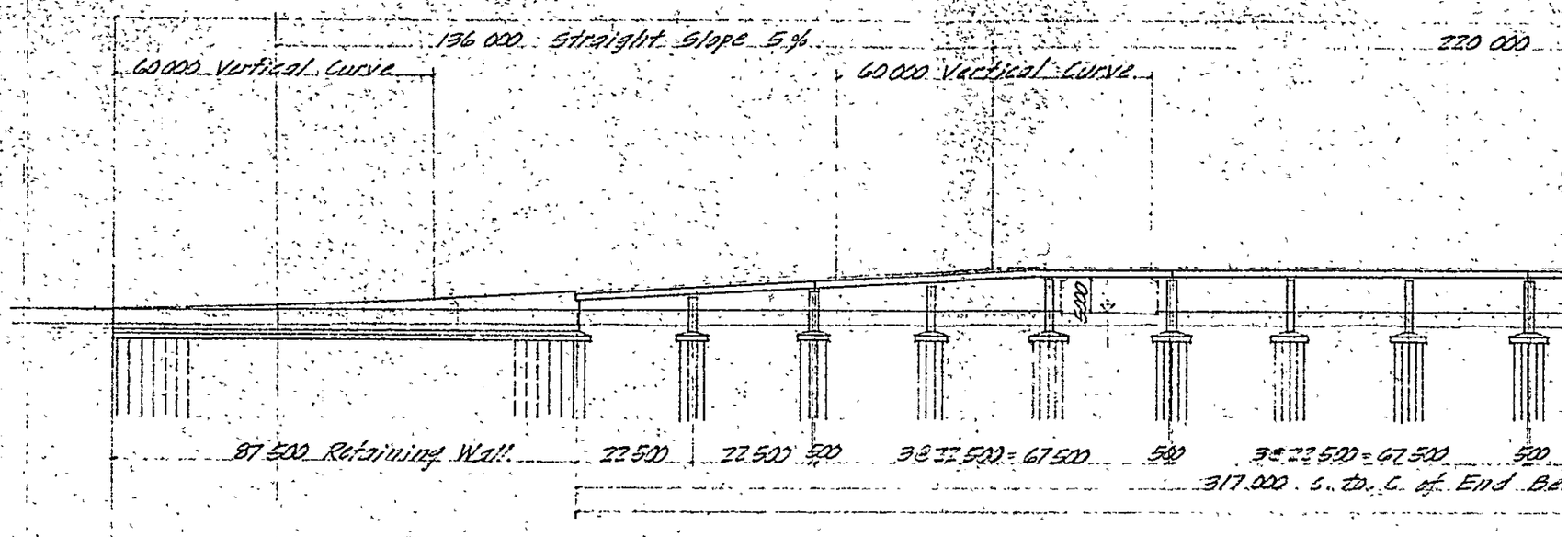
NOTES

All Dimensions are shown in mm.
Scale 1:1000

GENERAL VIEW
OF
BANGKOK-THONBURI BRIDGE

FIG. 1 SILOM ROAD

BANGKOK - SIDE

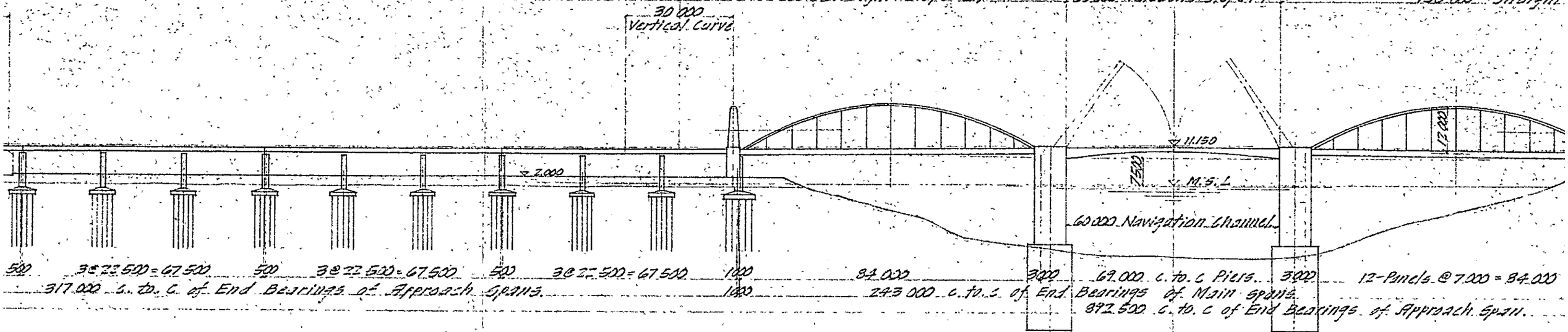


Apex of Bridge

1.076.000 Total Length

220 000 Level | 110 000 Straight Slope 2% | 60.000 Parabolic Slope 1½ | 150 000 Straight

30 000 Vertical Curve



500 | 3@22 500 = 67 500 | 500 | 3@22 500 = 67 500 | 500 | 3@22 500 = 67 500 | 1000 | 84 000 | 3000 | 69 000 c. to. c Piers | 3000 | 12-Piers @ 7.000 = 84 000

317 000 c. to. c of End Bearings of Approach Spans. | 1000 | 243 000 c. to. c of End Bearings of Main Spans.

892 500 c. to. c of End Bearings of Approach Span.

GENERAL ELEVATION

Scale 1:1000

RIVER CHAD PHYA

150.000 Straight Slope 2 %

200.000 Straight Slope 0.5 %

120.000 Straight Slope 5 %

150.000 Straight Slope 5 %

30.000 Vertical Curve

50.000 Vertical Curve

60.000 Vertical Curve

60.000

17.200

℄ Clearance Line

7.000

7 Panels @ 7.000 = 84.000

1000 22.500 500 22.500 500 22.500 500 22.500 22.500 3 @ 22.500 = 67.500 500 3 @ 22.500 = 67.500 500 22.500 35.000 22.500 500 22.500 22.500 96.000 Remain.

1000

Approach Span

330.500 c. to c. of End Bearings of Approach Spans

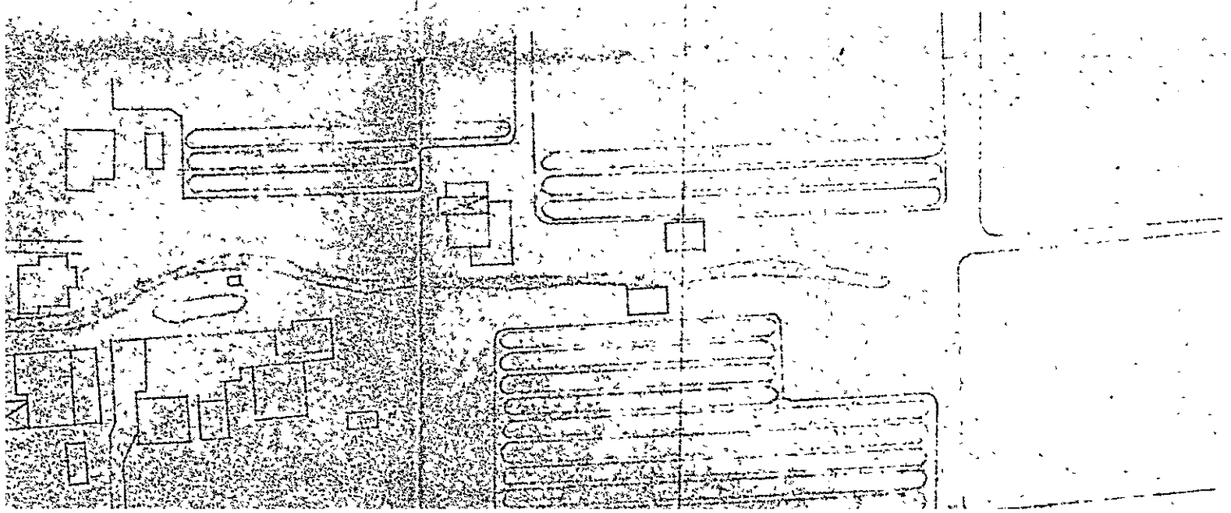
1000

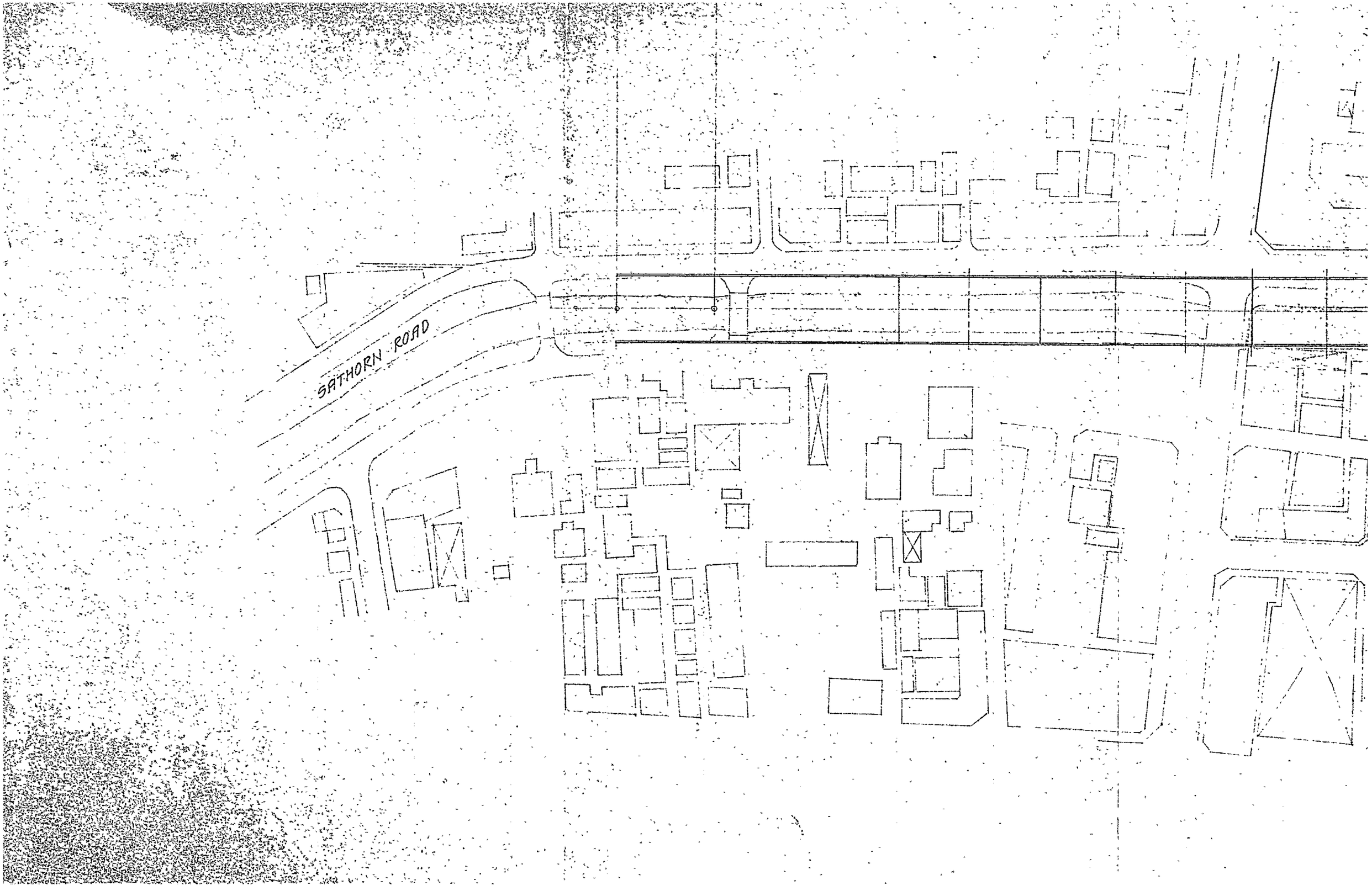
000 Straight Slope 5%

60.000 Vertical Curve

THONBURI - SIDE

00 22500 96.000 Retaining Wall




SATHORN ROAD

GENERAL PLAN

RIVER CHAO PHYA

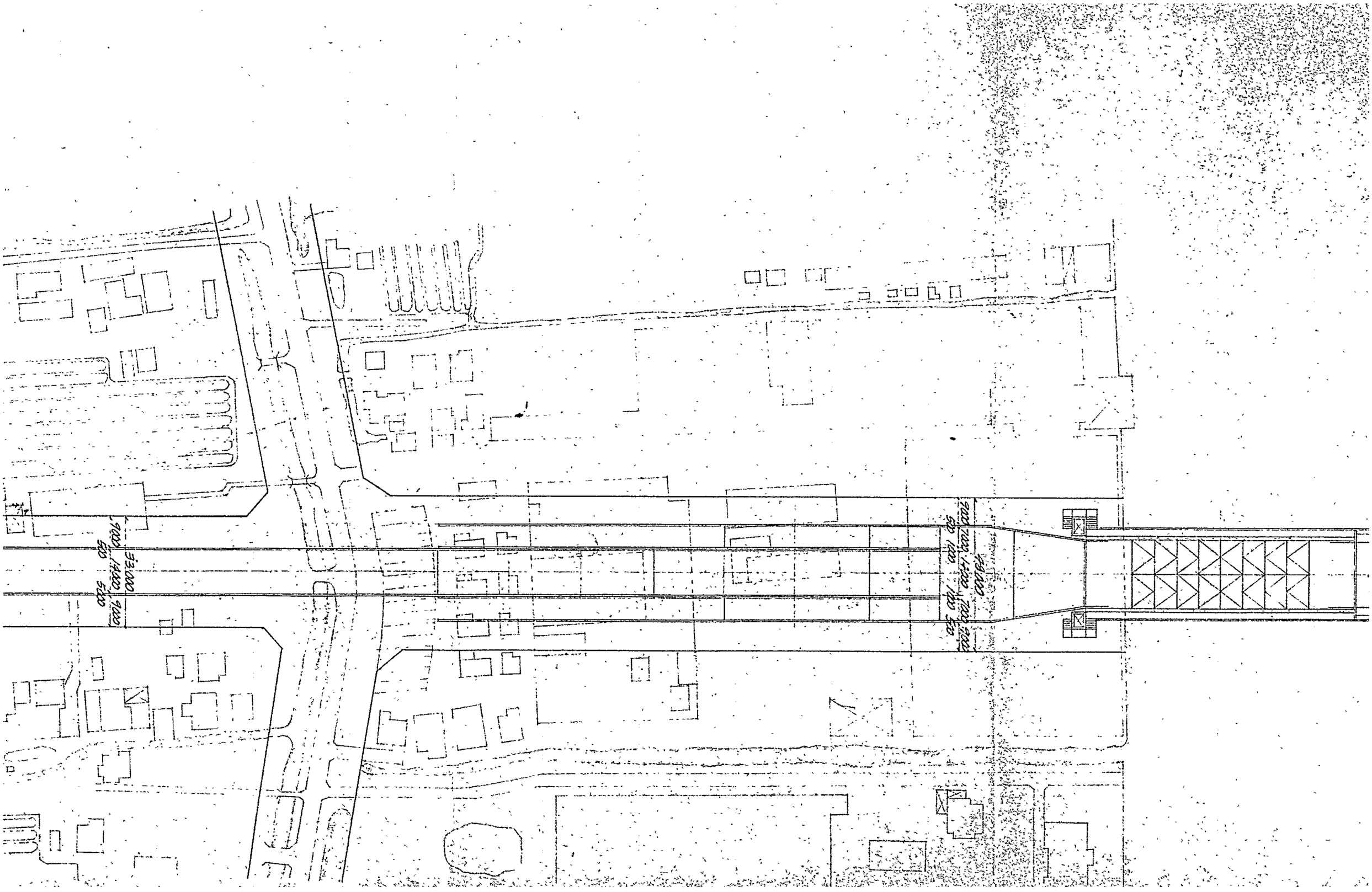
Existing Jetty

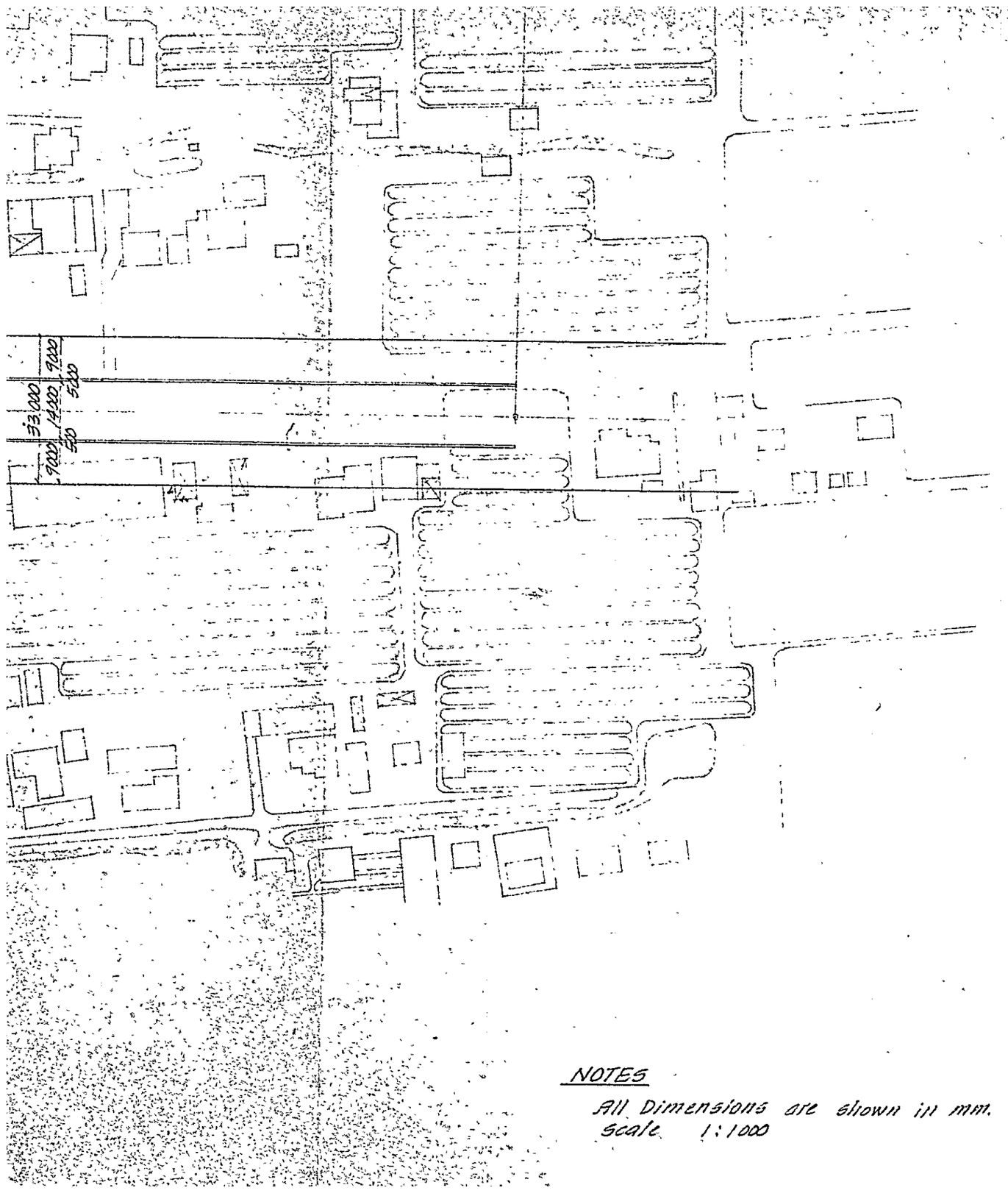
26.00

250 21.000 250

005

0006 0001C



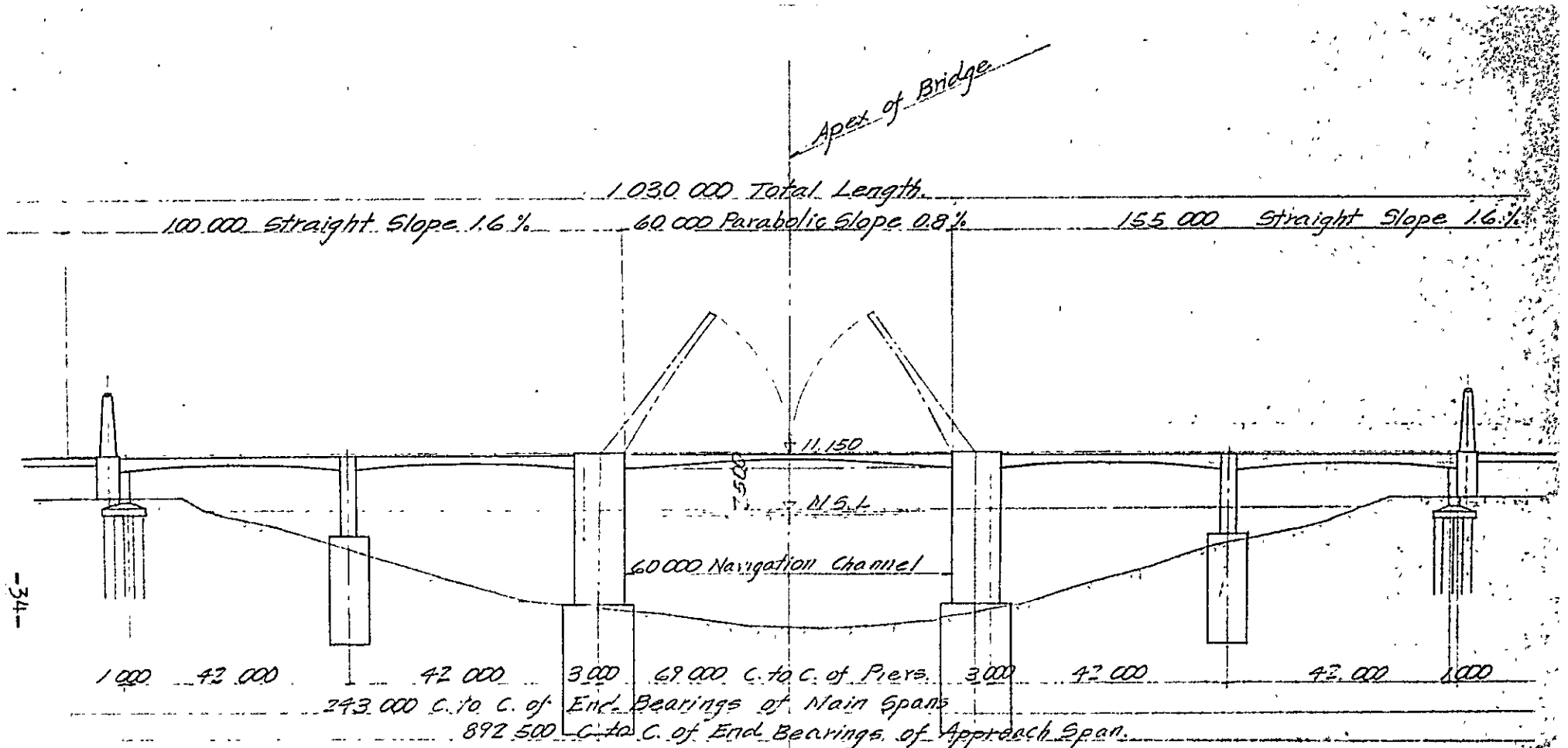


NOTES

All Dimensions are shown in mm.
Scale 1:1000

GENERAL VIEW
OF
BANGKOK-THONBURI BRIDGE

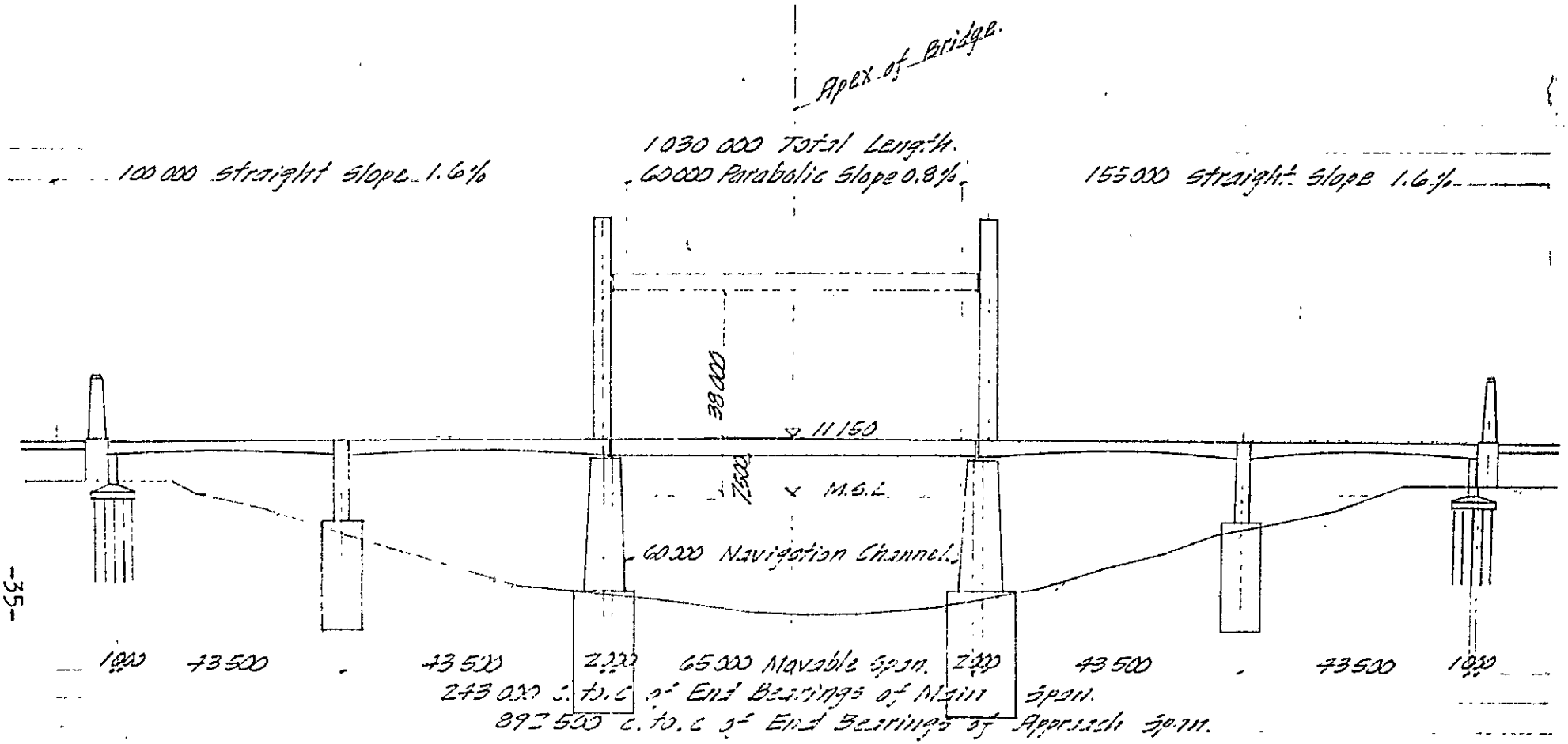
FIG. 2 SATHORN ROAD



GENERAL ELEVATION

Scale 1:1 000

TYPE A



-35-

SENERAL ELEVATION

Scale 1:1000

TYPE. B

① Land costs basis ?

ROUGH COST ESTIMATION (Fig1.Fig2)　　BANGKOK - THONBURI BRIDGE NO.2

ITEM. \ ROAD NAME / COST			SILOM ROAD				SATHORN ROAD			
			Million ¥.	TOTAL Million ¥	Million Bahts.	TOTAL Million Bahts	Million ¥.	TOTAL Million ¥.	Million Bahts	TOTAL Million Bahts
BRIDGE & STRUCTURES	MAIN SPAN	SUPER STRUCTURE	600		33.3		600		33.3	
		SUB STRUCTURE	574		32.1		574		32.1	
		TOTAL		1174		65.4		1174		65.4
	BANGKOK -SIDE APPROACH	SUPER STRUCTURE	66		3.7		153		8.5	
		SUB STRUCTURE	65		3.6		164		9.0	
		TOTAL		131		7.3		317		17.5
	THONBURI - SIDE APPROACH	SUPER STRUCTURE	161		9.0		144		8.0	
		SUB STRUCTURE	187		10.3		164		9.1	
		TOTAL		348		19.3		308		17.1
	TOTAL			1653		92.0		1799		100
LAND	BANGKOK - SIDE		576		32.0					
	THONBURI - SIDE		234		13.0		198		11.0	
	TOTAL			810		45.0		198		11.0
GRAND TOTAL				2463		137.0		1997		111.0

¥ = Yen

ROUGH COST ESTIMATION (TYPE-A)　　BANGKOK - THONBURI BRIDGE NO.2

ITEM. (ROAD NAME / COST)			SILOM ROAD				SATHORN ROAD			
			Million ¥.	TOTAL Million ¥	Million Bahts	TOTAL Million Bahts	Million ¥	TOTAL Million ¥	Million Bahts	TOTAL Million Bahts
BRIDGE & STRUCTURES	MAIN SPAN	SUPER STRUCTURE	500		27.8		500		27.8	
		SUB STRUCTURE	735		40.8		735		40.8	
		TOTAL		1235		68.6		1235		68.6
	BANGKOK -SIDE APPROACH	SUPER STRUCTURE	66		3.7		153		8.5	
		SUB STRUCTURE	65		3.6		164		9.0	
		TOTAL		131		7.3		317		17.5
	THONBURI -SIDE APPROACH	SUPER STRUCTURE	161		9.0		144		8.0	
		SUB STRUCTURE	187		10.3		164		9.1	
		TOTAL		348		19.3		308		17.1
	TOTAL			1714		95.2		1860		103.2
LAND	BANGKOK - SIDE		576		32.0					
	THONBURI - SIDE		234		13.0		198		11.0	
	TOTAL			810				198		11.0
GRAND TOTAL				2524		140.2		2058		114.2

¥ = Yen

ROUTH COST ESTIMATION (TYPE.B) BANGKOK - THONBURI BRIDGE NO.2

ITEM. \ ROAD NAME / COST			SILOM ROAD				SATHORN ROAD			
			Million ¥.	TOTAL Million ¥	Million Bahts	TOTAL Million Bahts	Million ¥	TOTAL Million ¥	Million Bahts	TOTAL Million Bahts
BRIDGE & STRUCTURES	MAIN SPAN	SUPER STRUCTURE	590		32.7		590		32.7	
		SUB STRUCTURE	660		36.6		660		36.6	
		TOTAL		1250		69.3		1250		69.3
	BANGKOK -SIDE APPROACH	SUPER STRUCTURE	66		3.7		153		8.5	
		SUB STRUCTURE	65		3.6		164		9.0	
		TOTAL		131		7.3		317		17.5
	THONBURI -SIDE APPROACH	SUPER STRUCTURE	161		9.0		144		8.0.	
		SUB STRUCTURE	187		10.3		164		9.1	
		TOTAL		348		19.3		308		17.1
	TOTAL			1729		95.9		1875		103.9
LAND	BANGKOK - SIDE		576		32.0					
	THONBURI - SIDE		234		13.0		198		11.0	
	TOTAL			810		45.0		198		11.0
GRAND TOTAL				2539		140.9		2073		114.9

¥ = Yen

Art. 7. Surveys required for preparing the feasibility report

7-1) Survey on the vertical, horizontal and traverse right-of-ways in the vicinity of the proposed bridge errection site.

7-2) Survey on the natural of the Soil in Chao Phya River and the approach areas.

7-3) Outline of proposed main bridge and approach.

7-4) Briet estimation of the project cost.

7-5) Basic surveys for traffic forecasting.

Suggestion No.1

1-1 Traffic observation.

1-2 Vehicle OD survey

Suggestion No.2

2-1 Economic statistics.

2-2 Land use map.

2-3 Present road map.

2-4 Situations of other means of transportation.

2-5 Person trip survey

2-6 Future road plan, traffic plan, city plan and economic plan.

2-7 Vehicular movement survey