APPENDIX 6

MATERIALS RELATED TO "CHAPTER 5 THROUGH OPERATION POLICY"

6.1 Current Problems of through Operation between Different Railway Lines

6.1.1 Rail, Civil Engineering

(1) Current Conditions of Railway Companies Operating in the Manila Metropolitan Area

With respect to rail and civil engineering are as shown in Appendix 3, Table 3.1.4, 3.1.5, and 3.1.6.

As major characteristics of these railway companies, they use gauge (railway width) of 1,435 mm for LRT Line 1 and 3, overhead wire for electric trains, and train voltage is DC 750V. Furthermore, comparatively light body is used for the vehicles. MRT Line 2 is under construction for use on 1,435 mm gauge. It uses overhead wire in the same way as Line 1 and 3, but it uses train voltage of DC 1,500V, and the vehicle it uses is comparatively heavy. Lastly, PNR line features gauge of 1,067 mm, and non-electric trains are running.

Thus, railway companies operating in Manila metropolitan area can be grouped into three groups, Line 1 and 3, Line 2 and PNR line.

(2) Civil Engineering and Track Problems When Implementing Through Operation

The major items to be examined in terms of civil engineering and track when carrying out mutual through operation are as follows.

1) Items concerning structural dimensions (tunnel inside width, bridge flanges, etc.)

Unless car dimensions (width, length, height, axle arrangement (distance between bogy centers)) and jolting during running are held to set limits, rolling stock and structures will come into contact thus making it impossible to conduct mutual through operation. Moreover, running by rolling stock which is too small is not a problem between stations, however, since the gap between cars and platform edges increases and hinders the boarding and alighting of passengers, some sort of countermeasures are necessary. In reality, it is preferable to adopt the same dimensions on all rolling stock used in mutual through operation.

2) Items Related to Strength of Structures (Bridges, etc.)

The items in question are axle load and axle arrangement. Taking the stress generated when the axle load and arrangement of rolling stock to be used in mutual through operation are placed on a bridge, and comparing this with the allowable stress of the bridge in question, it is necessary to confirm running safety.

(3) Examination on Mutual Entry in Each Line

In Japan, through implementing mutual entry between different railway companies, good results have been obtained in increasing passengers, and easing congestion during rush hours. The following are results of examinations on railway and civil engineering in the case of mutual entry on the premises of current conditions of vehicles of railway companies operating in the Manila metropolitan area.

1) Vehicles

Fig. 6.1.1 show the form of vehicles and vehicle gauge to be used in the subsequent examinations.

According to this, width of the body and body gauge of vehicles operating in respective service sections are as follows.

① Line 1 : Body width : 2.50 m
Body gauge basic width : 2.860 m (including body jolt) (same as Line 3)

② Line 2 : Body width : 3.20 m
Body gauge basic width : 3.478 m (including body jolt)

③ Line 3 : Body width : 2.50 m
Body gauge basic width : 2.860 m (including body jolt)

According to materials obtained from PNR, body gauge basic width of PNR vehicles is 3.15 m.

2) Examinations on Center to Center Distance of the Adjacent Tracks

Since vehicles of PNR are the same as ordinary vehicles in Japan, expanded construction gauge was calculated as follows by using the equation of East Japan Railway Co.

$2 \times W = 2 \times (23{,}100 \div R) \div 1{,}000$, whereby W is an expanded construction gauge per one side of the rail $(23{,}100 \div R)$, Unit : mm

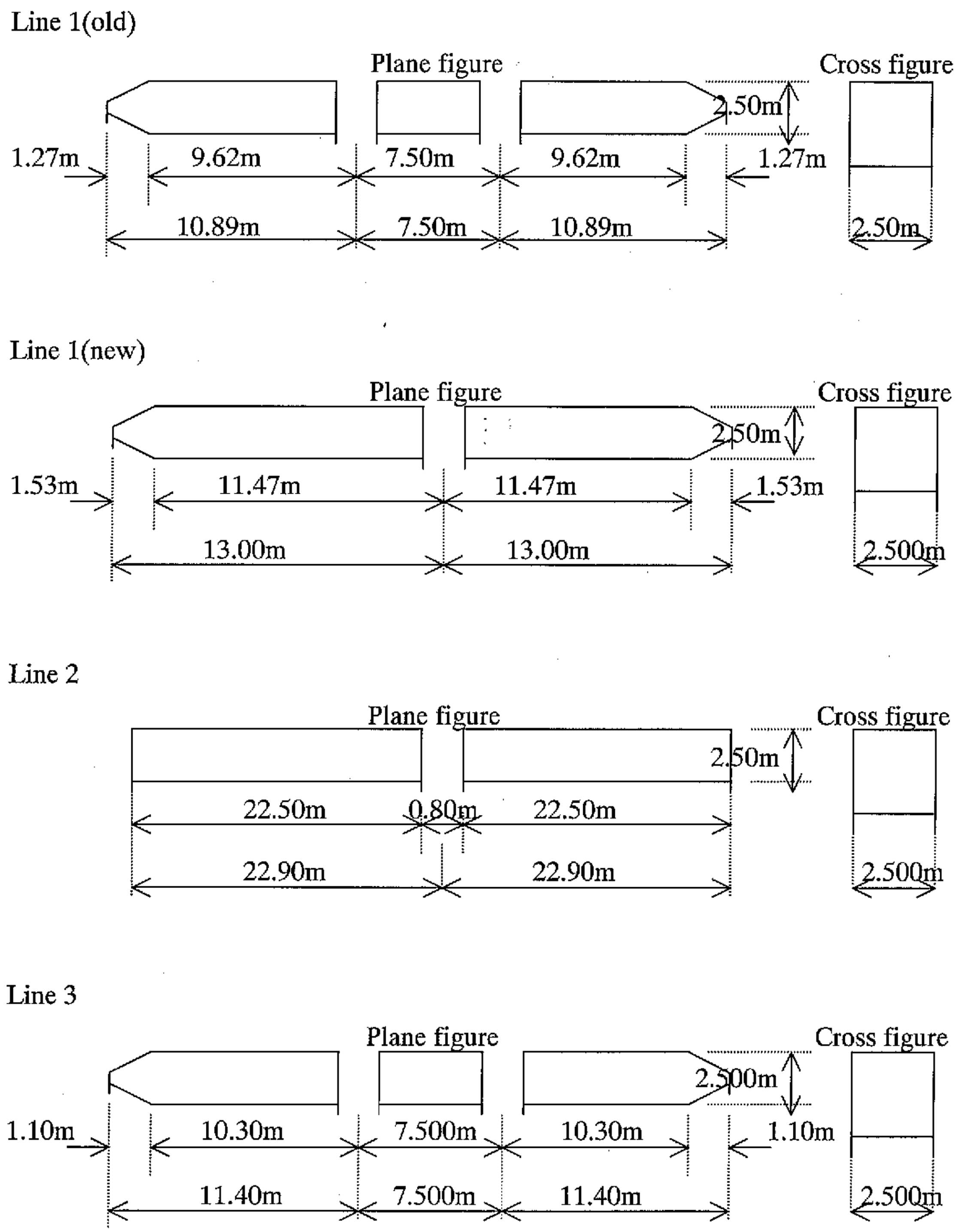
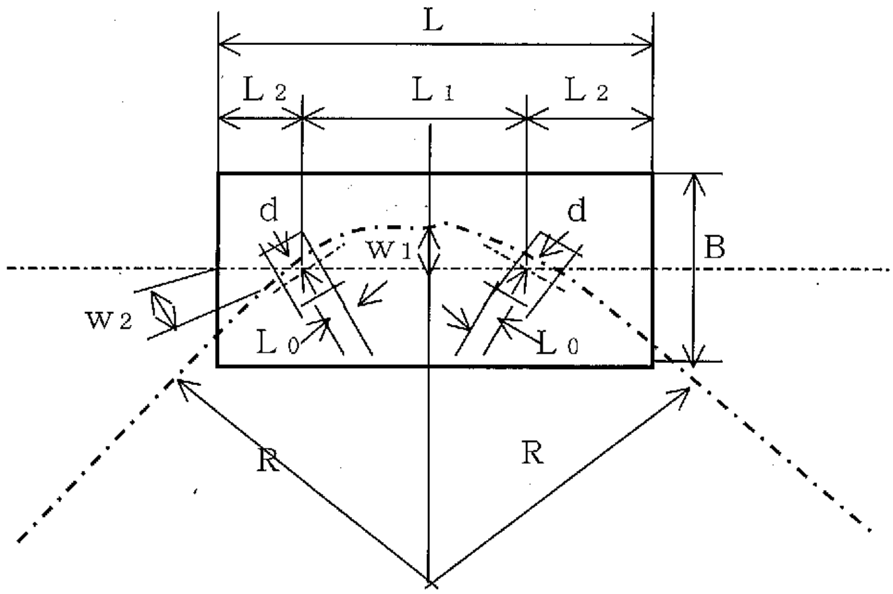


Fig. 6.1.1 Car Body Shape for the Calculation of Car Body Eccentricity

R : Curve radius , Unit : m



R : Curve radius

d : Bogie center eccentricity

w_1 : Body inside eccentricity

w_2 : Body outside eccentricity

B : Body width

L0 : Rigid wheel base

L : Body length

L_1 : Bogie center-to-center distance

L_2 : Body width-bogie center-to-center distance

Fig. 6.1.2 Car Body Eccentricity

Calculation example 1 : Necessary track center distance at curve with minimum radius on Line 1

$$
\begin{aligned}
2\times W &= 2\times(23,100\div R)\div 1,000\\
&= 2\times(23,100\div 170)\div 1,000\\
&= 0.27\text{m}
\end{aligned}
$$

3.20m (track center distance of Line 1) −3.15m (basic width of rolling stock gauge) −0.27m (2W)

=0.05m−0.27m

=−0.22m

Calculation example 2 : Necessary track center distance at curve wit minimum radius Line 2

$$2\times W=2\times(23,100\div R)\div 1,000$$
$$=2\times(23,100\div 175)\div 1,000$$
$$=0.26\text{m}$$

4.40m	−3.15m	−0.26m
(track center distance of Line 2)	(basic width of rolling stock gauge)	(2W)

$$=1.25\text{m}-0.26\text{m}$$
$$=0.99\text{m}$$

Calculation example 3 : Necessary track center distance at wire with minimum radius of Line 3

$$2\times W=2\times(23,100\div R)\div 1,000$$
$$=2\times(23,100\div 370)\div 1,000$$
$$=0.12\text{m}$$

3.40m	−3.15m	−0.12m
(track center distance of Line 3)	(basic width of rolling stock gauge)	(2W)

$$=0.25\text{m}-0.12\text{m}$$
$$=0.13\text{m}$$

From the above, it may be said as follows on 'center to center distance of the adjacent tracks'.

① Vehicles of Line 1 and 3 can enter each railway. (on condition that 'center to center distance of the adjacent tracks' of PNR line is not changed and gauge is kept at 1, 435 mm.)

② Vehicles of Line 2 cannot enter the railway of Line 1 and 3 even in the through operation section because of shortage of 'center to center distance'. It can enter PNR line (on condition that there is no change in 'center to center distance of the adjacent tracks' of PNR line, and the gauge is kept at 1.435 m).

③ The vehicles of PNR can enter the main line of Line 1 and 3 (providing PNR does not change 'center to center distance of the adjacent tracks' and the gauge length is kept at 1,435 m).

3) Examination on Construction Gauge and Structure Width

According to the construction gauge of PNR line, separation from the track center is 1.65 m, and 4.42 m in height from the surface of the rail. With respect to vehicle body gauge (including body jolt), deflection from the track center at the height of 0.4 m (height of duct along Line 1) is 1.364 m, deflection from the track center at the height of 0.55 (digit flange of Line 2) is 1.412 m, and deflection from the track center at 0.7 m(platform of Line 1) from the rail surface is 1.454 m, and deflection from the track center at the height of 0.9 m (platform of Line 3) is 1.515 m.

From the above examinations,. the following may be said with respect to construction gauge and structure width.

① Vehicles of Line 1 and 3 can enter railways of each company. But on Line 2, because of a big gap between the edge of the platform and the train, passengers may have difficulty when getting on and off the train.
Concerning PNR line, construction gauge height of PNR is not sufficient when collection method by overhead wire is adopted (on condition that 'center to center distance of the adjacent tracks' is not changed by PNR, and the gauge is kept at 1.435 m).

② The vehicles of Line 2 cannot enter any railway of other service sections because track center of the vehicle comes into contact with the platform of Line 1 or 3, and marginal basic width of the body infringes the construction gauge of PNR.
Same as the case of Line 1 and 3, construction gauge height of PNR line is not enough when overhead wire is used for collection purpose (on condition that 'center to center distance of the adjacent tracks' is not changed by PNR, and the gauge is kept at 1.435 m).

③ The vehicles of PNR cannot enter other service sections because the body gauge of the vehicle contacts with the platform of Line 1 or 3. With respect to entry into Line2, when eccentric body deflection (W = 23, 100/R) is taken into consideration, the vehicle comes into contact with the flange of Line 2 at a curve less than 607.89 m of curved radius. (on condition that 'center to center distance of the adjacent tracks' is not changed, and the gauge is kept at 1.435).

4) Examination on Longitudinal Curved Radius

① Floating of vehicle body

Floating of the body can be examined by the following equation.

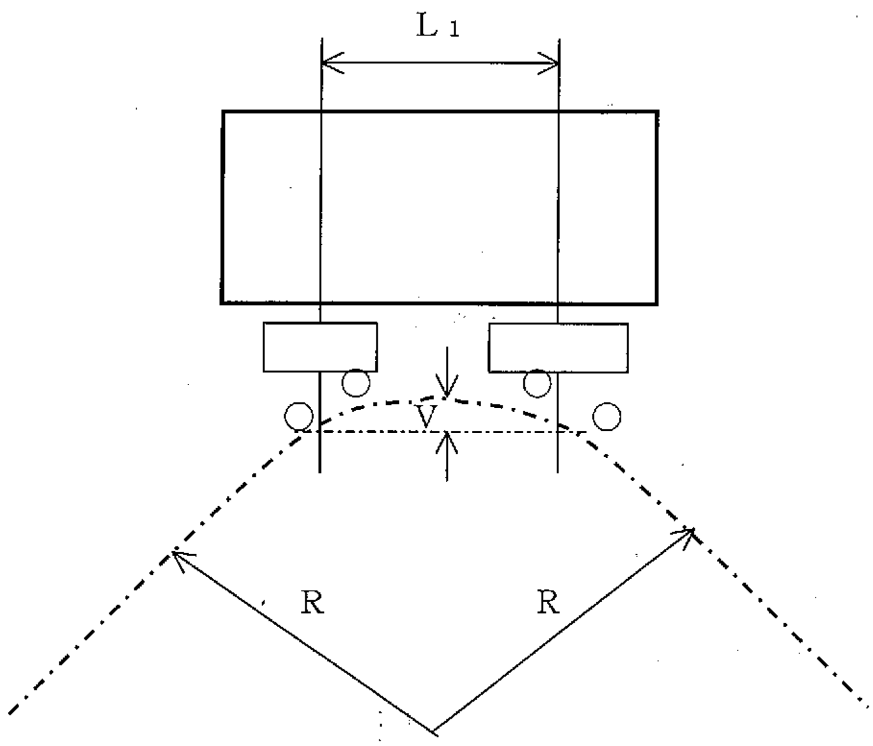
$\alpha = 1/Rg \times (V/3.6)^2$

α	: Vertical acceleration (gravity unit)
R	: Longitudinal curved radius (m)
g	: Gravitational acceleration (9.8 m/sec ^{2})
V	: Velocity (km/h)

Tolerance of α is said to be in the order of 0.1. By substituting "V=100 km/h" and α = 0.1 in the above equation, R = 787m is obtained. Vertical curved radius of main line of each service section is as shown in Table 3.3.1 (tentative), and the minimum vertical curved radius is 1,000 m. The maximum speed in each section is less than 100 km/h, so there is no problem of floating body in each section.

② Construction gauge at the bottom of the body

The distance of the rail and the bottom of the body on the vertical curve where the distance becomes narrow can be expressed by the following equation.
$V = (L_1)^2 \div (8R)$ (Refer to Fig. 6.3.)
Suppose L_1 = 15.8 m (center to center distance of cart of Line 2) and R = 1,000 m, $V = (15.8)^2 \div (8 \times 1.000) \fallingdotseq 31$mm. According to construction gauge of the vehicle of Line 2, the distance between the bottom of the vehicle bottom and the rail is 75 mm, basically bottom gauge on Line 2 is not infringed.



R : Longitudinal curve radius

L_1 : Bogie center-to-center distance

V : Difference in rail height in center between bogie center and bogie center

Fig.6.1.3 Difference in Rail Height According to Longitudinal Curve

5) Examinations on Load

Table6.1.1 shows maximum shearing power and maximum bending moment generated on a single beam when weight of vehicle (weight of the shaft only without taking into consideration of the beam itself, impact load, etc. E-16 is under the assumption of PNR) span by span. (Refer to attached material No.20 and No.21 for axis arrangement). According to this table, influence by Line 3 is the smallest both in shearing strength and bending moment, while influence of PNR vehicle is the largest.

Consequently, in respect to entry into other service section, the vehicles of Line 3 has the smallest problem, while the entry of the vehicle of Line 2 or PNR into Line 1 or Line 3 seems considerably difficult.

(4) Results of Examination

From the results of examinations of 6.1.1 concerning the rail and civil engineering, the following may be said about mutual entry of trains of railway companies, on the premises of the existing vehicles, rails, and civil engineering facilities of the Manila metropolitan area.

1) It seems it is possible for the vehicles of Line 1 and 3 enter into other railways in the metropolitan area.

2) It seems that entry of the vehicles of Line 3 into Line 1 is easiest, subject to the condition that detailed examinations be made in Philippines on width of the structure, proof stress of the bridges, etc.

3) Concerning entry of the vehicles into Line 3, providing that detailed examination on width of structure as well as measures for reinforcing strength of the bridges are possible in Philippines, and that such reinforcement can be made locally, entry may by possible, although it may be difficult.

4) Entry of the vehicles of Line 1 and 3 into Line 2 is considered possible, providing some additional facilities (vehicles or platform) to help passengers get on or off the platform be arranged.

5) Entry of the vehicles of Line 2 or PNR to the other service sections is considered impossible.

Table 6.1.1 Maximum Bending Moment and Shearing Force of Simple Girder by Load

Bridge length(m)	Span(m)	Item	LINE-1(old)	LINE-1(new)	LINE-2	LINE-3	E-16
5.000	4.300	Smax(tf)	15.97	16.17	25.70	13.71	28.52
		Mmax(tfm)	13.58	13.14	20.88	11.48	22.27
		e(m)	0.450	0.525	0.525	0.475	0.099
10.000	9.300	Smax(tf)	21.83	23.01	33.82	17.51	40.59
		Mmax(tfm)	38.32	40.37	62.21	32.99	83.45
		e(m)	0.450	0.383	0.525	0.475	0.099
15.000	14.000	Smax(tf)	28.06	29.05	45.17	23.38	54.45
		Mmax(tfm)	77.47	83.95	122.11	62.13	164.84
		e(m)	1.214	1.100	1.300	1.401	0.08
20.000	19.000	Smax(tf)	35.24	34.75	51.18	29.32	67.71
		Mmax(tfm)	135.17	136.48	204.95	111.07	288.72
		e(m)	0.325	1.100	1.300	0.475	0.18
25.000	24.200	Smax(tf)	42.57	41.08	56.62	34.98	83.3
		Mmax(tfm)	213.88	203.88	292.05	179.57	442.44
		e(m)	0.325	1.108	1.300	0.475	0.508
30.000	29.200	Smax(tf)	49.12	46.25	64.42	40.99	98.31
		Mmax(tfm)	307.61	283.58	370.24	264.06	633.0
		e(m)	1.425	1.109	1.302	1.402	0.363
40.000	39.200	Smax(tf)	62.22	59.10	81.79	51.87	125.7
		Mmax(tfm)	534.15	488.42	618.12	449.11	1128.88
		e(m)	0.375	1.098	1.735	0.370	0.955
50.000	48.700	Smax(tf)	75.18	70.48	95.12	62.74	150.71
		Mmax(tfm)	807.87	727.69	941.73	678.58	1698.22
		e(m)	0.478	1.224	1.551	1.572	0.27
60.000	58.700	Smax(tf)	88.78	82.05	111.73	74.30	176.1
		Mmax(tfm)	1162.79	1055.56	1389.67	981.99	2386.06
		e(m)	0.088	1.028	1.300	0.736	0.208

Smax : Maximum shering force
Mmax : Absolute maximum bending moment
e : Position of the absolute maximum bending moment (distance from the span center)

(5) Civil Engineering and Track Problems in Railway Sections in Metro Manila

Railways in Metro Manila have been rationally constructed according to purpose and necessity, etc. on each line section, and there is thought to be no room for complaint concerning separate plans in the areas of civil engineering and track (track structure, design load, etc.).

As an example, maximum train speeds and track structure on PNR and urban railways are as indicated in Table 1, and when the contents of this are compared with Table 2 (Notification establishing detailed engineering criteria concerning ordinary railway facilities in Japan - taken from Ministry of Transport Notification No. 177, March 23, 1987), it can be said that adequate safety is secured on both lines. Also, concerning detailed design of civil engineering structures, this should be in accordance with the rolling stock considered to be most appropriate for use on the sections in question. Moreover, trains carrying passengers are currently in actual operation on existing structures.

However, operating problems and problems linked to future through operation which will aid the smooth movement of passengers are sometimes observed. Therefore, problems concerning railway lines in Metro Manila shall be identified not in the area of planning but with respect to operating safety on each line, cost cutting and the future implementation of through operation.

1) Current Operating Problems Concerning Civil Structures and Track

① Safety

a) There are no standards concerning track maintenance, and there are sections where it is difficult to implement maintenance which has a direct impact on train operating safety.

b) Not only are there no maintenance standards concerning civil structures, but since the whereabouts of drawings are unknown, problems will arise in structure maintenance and disaster restoration in the future.

c) There are some sections where dimensions of rolling stock (width, length, axle arrangement) and axle load are not unified; moreover, if even more diverse rolling stocks were to be adopted on the same sections, the impact of competing rolling stock bodies and structures and concentrated train loads would lead to future problems.

d) Track structure is safe in terms of design and standards, however, in reality, there are some sections where track is in a dangerous state because ballast is non-existent and sleepers are badly damaged.

e) On some sections, large-scale excavation work next to operating line has been left unfinished and unstable foundations create potential danger.

② Reduction of Construction Costs and Maintenance Costs

Since rolling stock dimensions (width, length, axle arrangement) and axle load are not unified and standardization of structures (compatibility of design drawings and forms) is impossible between lines, it is not possible to reduce structure design costs and fabrication costs of pre-cast members (for example, PC girders).

Table6.1.2 Example of Track Structure in Metro Manila

Line Name	Maximum Speed	Rail Type	Number of Sleepers (or fasteners)	Ballast Thickness (solid bed track should be displayed as such)
PNR	75km/h	JIS 37kg	1,600/1km (40/25m)	150~300mm
Line 3	65km/h	UIC 54	750 mm intervals (32.5/25 m)	Solid bed (viaduct)

Table6.1.3 Lower Limits of Track Structure on Ordinary Railways in Japan

Design Passing Tonnage	Design Maximum Speed (km/h)	Rail Weight (kg/m)	Number of Sleepers	Ballast Thickness
More than 20 million tons/year	More than 110	50	39/25m	250
	More than 91-110	50	39/25m	200
	More than 71-90	50	39/25m	200
	70 or less	50	39/25m	200
10,000,001-20,000,000 tons/year	More than 110	50	37/25m	200
	More than 91-110	50	37/25m	200
	More than 71-90	50	37/25m	200
	70 or less	50	37/25m	200
5,000,001-10,000,000 tons/year	More than 110	50	37/25m	200
	More than 91-110	37	37/25m	200
	More than 71-90	37	37/25m	150
	70 or less	37	37/25m	120
5,000,000 tons year or less	More than 110	50	37/25m	200
	More than 91-110	37	37/25m	200
	More than 71-90	30	34/25m	150
	70 or less	30	34/25m	120

6.1.2 Power, Signals and Communications

Railway lines currently in operation or under construction in Metro Manila have been constructed with equipment (including rolling) of differing standards according to line conditions at the time of construction.

Concerning power, signal and communications facilities, by unifying the specifications of train and ground equipment, major impact can be anticipated in terms of, for example, reduced construction costs, reduced maintenance costs, and easier training of maintenance staff, etc.

Problems concerning power, signals and communications in the case where run-through services are adopted between Line 1 and Line 3 are as follows.

(1) Electric Car Line

Since both Line 1 and Line 3 use catenaries and a standard voltage of DC 750 V, there is basically no problem with implementing run-through services.

However, in future survey, adjustment of the following points is required with respect to rolling stock.

1) Maximum and minimum electric car line voltage (in particular, is rolling stock acceleration performance not affected by minimum voltage?)
2) Maximum and minimum height of electric car lines
3) Lateral bias of electric car lines

(2) Signal Facilities

It is necessary to install Line 3 signal on-train systems on Line 1 rolling stock, and vice versa.

It is necessary in future survey to examine the kind of equipment which needs to be installed on Line 1 rolling stock and Line 3 rolling stock.

(3) Communication Facilities

It is necessary to install direct telephone equipment between the Line 1 and Line 3 traffic command centers and power command centers.

6.2 Materials of Through Operation Policy

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6.2 Materials of Through Operation Policy

6.2.1 (1) Passenger Transport Volume and In & Out (Line 1 & Line 3)

Year.2000.1.

Line 1 Average Ridership Summary Passengers IN & OUT

	IN				OUT			
Time	SB Total	ratio	NB Total	ratio	SB Total	ratio	NB Total	ratio
5:00~	7,234	3.6	4,001	2.3	7,234	3.6	4,000	2.3
6:00~	12,485	6.2	5,855	3.3	12,485	6.2	5,854	3.3
7:00~	15,812	7.8	9,392	5.3	15,812	7.8	9,392	5.3
8:00~	16,612	8.2	9,770	5.5	16,612	8.2	9,770	5.5
9:00~	15,324	7.5	9,861	5.6	15,324	7.5	9,861	5.6
10:00~	12,892	6.4	10,263	5.8	12,891	6.4	10,265	5.8
11:00~	12,331	6.1	10,125	5.7	12,331	6.1	10,125	5.7
12:00~	12,509	6.2	10,149	5.7	12,509	6.2	10,149	5.7
13:00~	13,776	6.8	12,518	7.1	13,776	6.8	12,518	7.1
14:00~	13,206	6.5	12,007	6.8	13,207	6.5	12,007	6.8
15:00~	12,827	6.3	12,849	7.3	12,827	6.3	12,849	7.3
16:00~	13,560	6.7	14,497	8.2	13,560	6.7	14,497	8.2
17:00~	13,758	6.8	15,981	9.0	13,759	6.8	15,980	9.0
18:00~	13,347	6.6	18,140	10.3	13,346	6.6	18,141	10.3
19:00~	9,464	4.7	13,350	7.6	9,465	4.7	13,349	7.6
20:00~	6,377	3.1	7,664	4.3	6,377	3.1	7,664	4.3
21:00~	1,476	0.7	185	0.1	1,476	0.7	185	0.1
22:00~	0	0.0	0	0.0	0	0.0	0	0.0
Total	202,990	100.0	176,607	100.0	202,991	100.0	176,606	100.0
Traonsport Volume =					379,597		(Persons/Day)	

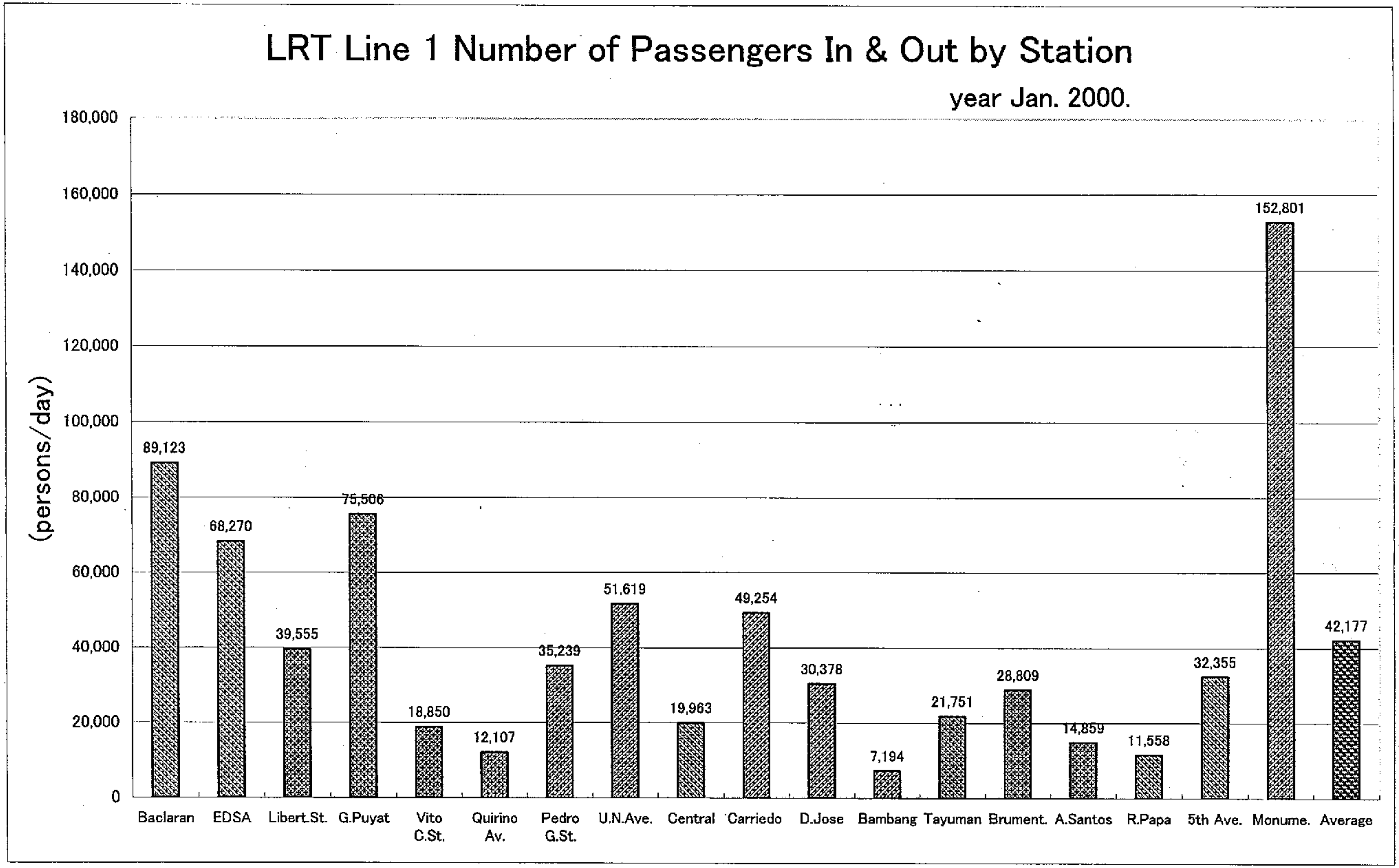
Note: Data of LRTA

Line 3 Year.2000.3.

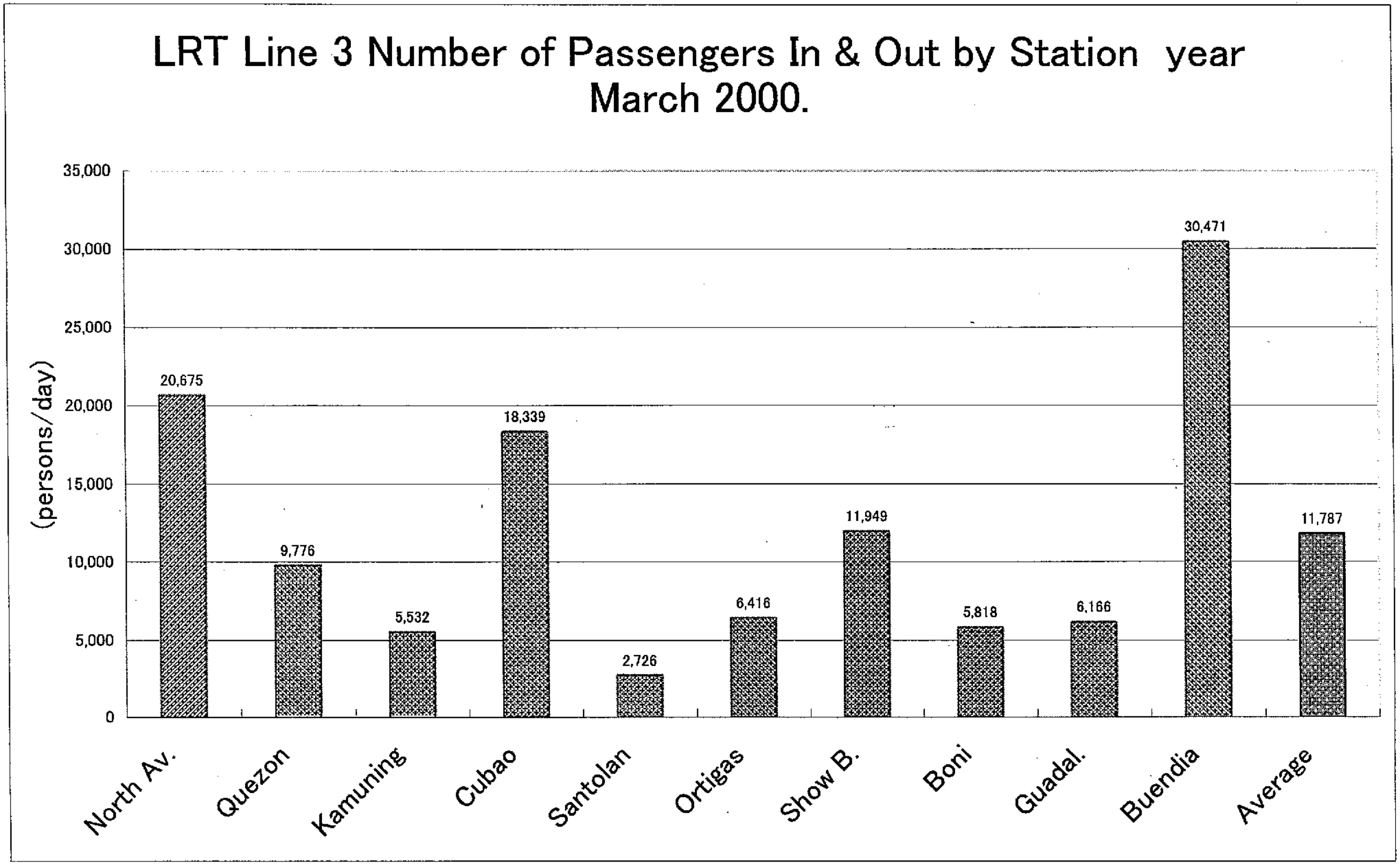
Time	In	Out	Total	Ratio
5:00~	227	66	293	0.2
6:00~	2,027	1,178	3,205	2.7
7:00~	7,073	5,450	12,523	10.6
8:00~	6,739	7,703	14,442	12.3
9:00~	3,879	4,536	8,415	7.1
10:00~	2,836	2,932	5,768	4.9
11:00~	2,492	2,622	5,114	4.3
12:00~	2,306	2,340	4,646	3.9
13:00~	2,320	2,261	4,581	3.9
14:00~	2,737	2,659	5,396	4.6
15:00~	2,731	2,767	5,498	4.7
16:00~	3,721	3,321	7,042	6.0
17:00~	6,157	5,311	11,468	9.7
18:00~	6,497	6,875	13,372	11.3
19:00~	4,066	4,598	8,664	7.4
20:00~	2,211	2,788	4,999	4.2
21:00~	947	1,402	2,349	2.0
22:00~	3	90	93	0.1
Total	58,969	58,899	117,868	100.0
Transport Volume			58,934 (pers/day)	

Note: Data of SYSTRA

6.2.1 (2) LRT Line 1 Number of Passengers In & Out by Station



6.2.1 (3) LRT Line 3 Number of Passengers In & Out by Station



6.2.2 (1) Line 1 Cross-sectional Transport Volume (Jan. 2000)

LRT Line 1 Average Ridership Summary – Passengers In & Out (North Bound)

(pa/day) 2000.1.1~1.31

Station	1	2	3	4	5	6	7	9	10	11	12	13	14	15	17	18	19	21	Total
	Baclaran	EDSA	Libert.St.	G.Puyat	Vito C.St	Quirino Av	Pedro G.St	U.N.Ave.	Central	Carriedo	D.Jose	Bambang	Tayuman	Brument.	A.Santos	R.Papa	5th Ave.	Monume.	
In	38,484	32,414	13,479	25,706	6,692	3,841	11,607	10,255	3,577	10,908	4,375	872	2,887	1,174	4,922	1,983	3,429	–	176,605
Out	–	0	719	2,008	2,232	2,017	6,956	9,696	7,212	12,182	10,219	2,552	7,626	12,287	3,913	4,918	10,116	81,952	176,605

Transport Volume Carried (Persons/day) Northband

Section	Bac~ED	ED~Lib	Lib.~G.P	G.Pu~Vi	Vit~Qui	Qui~Pe	Ped~U.N	N.~Cen	ent~Ca	arr~D.J	.Jo~Ba	am~Ta	Tay~Br	ru~A.S	San~R.P	Pa~5th	th.A.~Monu	
Sec.Tran.Vo.(p/day)	38,484	70,898	83,658	107,356	111,816	113,640	118,291	118,850	115,215	113,941	108,097	106,417	101,678	90,565	91,574	88,639	81,952	
Average(/17 (pa/h)	2,264	4,170	4,921	6,315	6,577	6,685	6,958	6,991	6,777	6,702	6,359	6,260	5,981	5,327	5,387	5,214	4,821	
peark hour (pa/h)	2,452	4,517	5,330	6,839	7,123	7,240	7,536	7,571	7,340	7,259	6,886	6,779	6,477	5,770	5,834	5,647	5,221	

LRT Line 1 Average Ridership Summary – Passengers In & Out (South Bound)

Station	1	2	3	4	5	6	7	9	10	11	12	13	14	15	17	18	19	21	Total
	Baclaran	EDSA	Libert.St.	G.Puyat	Vito C.St	Quirino Av	Pedro G.St	U.N.Ave.	Central	Carriedo	D.Jose	Bambang	Tayuman	Brument.	A.Santos	R.Papa	5th Ave.	Monume.	
In	–	1,666	8,774	15,099	2,052	1,618	7,284	10,266	5,441	14,488	10,584	2,928	9,050	14,091	5,637	4,522	18,642	70,849	202,991
Out	50,639	34,190	16,583	32,693	7,874	4,631	9,392	21,402	3,733	11,676	5,200	842	2,188	1,257	387	135	168	–	202,990

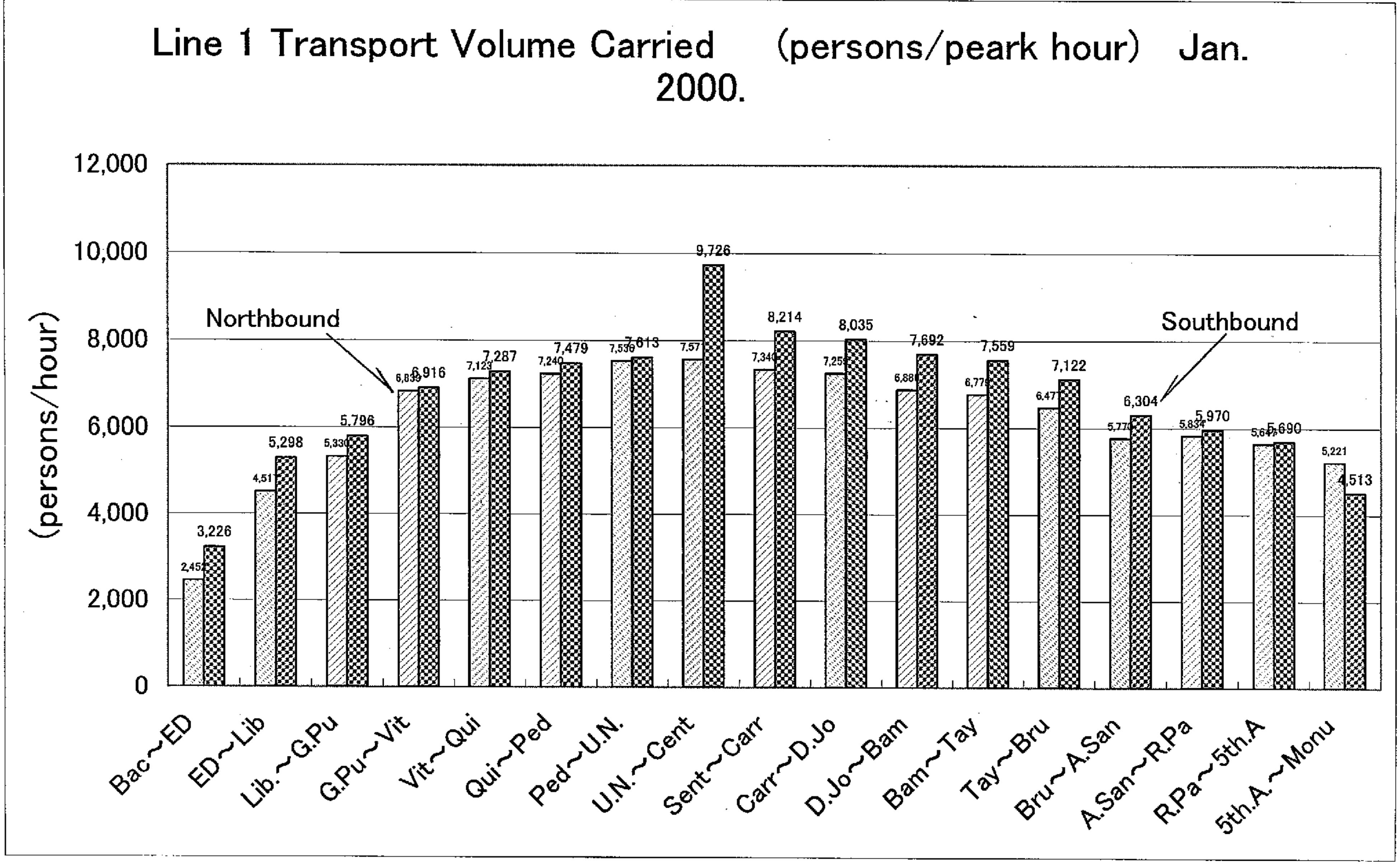
Transport Volume Carried (Persons/day) South Bound

Section	Bac~ED	ED~Lib	Lib.~G.P	G.Pu~Vi	Vit~Qui	Qui~Pe	Ped~U.N	N.~Cen	ent~Ca	arr~D.J	.Jo~Ba	am~Ta	Tay~Br	ru~A.S	San~R.P	Pa~5th	th.A.~Monu	
Sec.Tran.Vo.(p/day)	50,640	83,164	90,973	108,567	114,389	117,402	119,510	152,667	128,938	126,126	120,742	118,656	111,794	98,960	93,710	89,323	70,849	
Average(/17 (pa/h)	2,979	4,892	5,351	6,386	6,729	6,906	7,030	8,980	7,585	7,419	7,102	6,980	6,576	5,821	5,512	5,254	4,168	105,671
peark hour (pa/h)	3,226	5,298	5,796	6,916	7,287	7,479	7,613	9,726	8,214	8,035	7,692	7,559	7,122	6,304	5,970	5,690	4,513	114,442

Note. By METRO TRANSIT ORGANIZATION, INC. Operations Department Operations Planning Off.

Transport Volume (persons/day)=	379,596

6.2.2 (2) Line 1 Cross-sectional Transport Volume (Jan. 2000)



6.2.2 (3) Line 3 Cross-sectional Transport Volume (March. 2000)

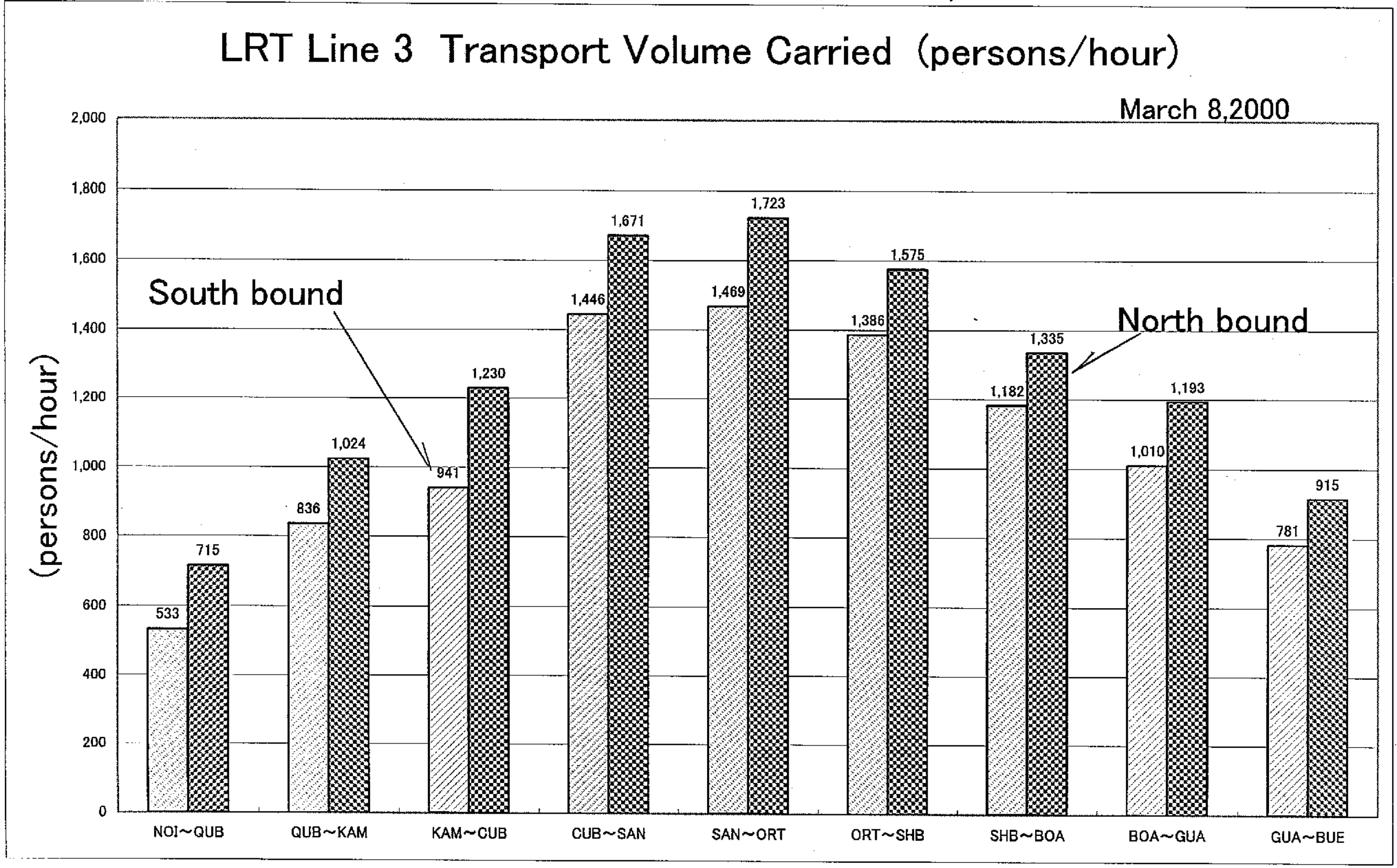
LRT Line 3 Transport Volume Carried March 2000.

	Direction	NOI~QUB	QUB~KAM	KAM~CUB	CUB~SAN	SAN~ORT	ORT~SHE	SHB~BOA	BOA~GUA	GUA~BUE
Transport. Volume. Carried (Pers./day)	NOI→TAI	7,595	11,914	13,410	20,601	20,927	19,749	16,838	14,388	11,130
	TAI→NOI	10,194	14,588	17,528	23,811	24,542	22,441	19,026	17,001	14,660
Pers./h	TAI→NOI	637	912	1,096	1,488	1,534	1,403	1,189	1,063	814
8:00˜9:00	*1.23	715	1,024	1,230	1,671	1,723	1,575	1,335	1,193	915
Pers./h	NOI→TAI	475	745	838	1,288	1,308	1,234	1,052	899	696
8:00˜9:00	*1.23	533	836	941	1,446	1,469	1,386	1,182	1,010	781

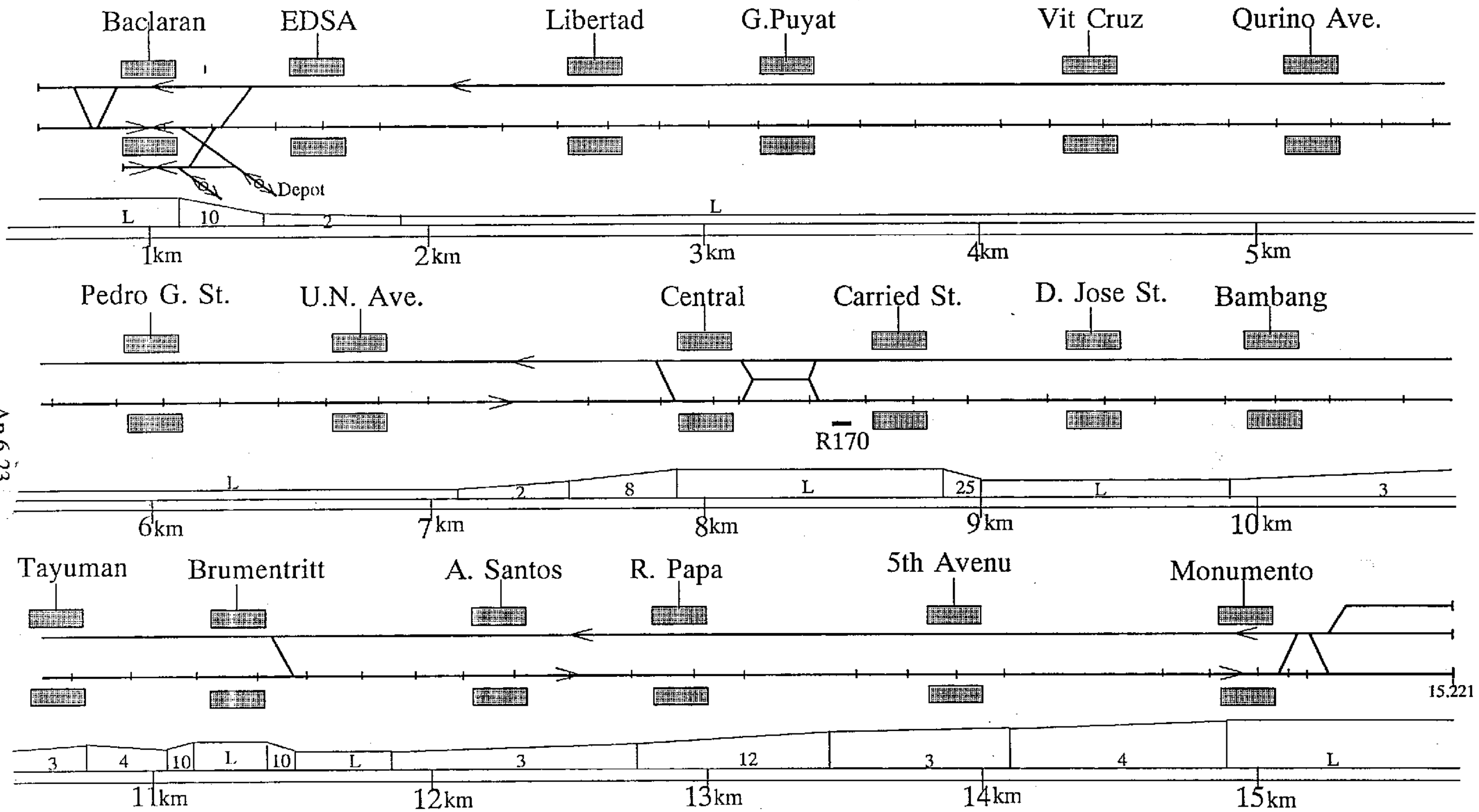
Commercial time:5:30˜21:30(16h)

Note:By Sales Report : SYSTR (by O-D chart)

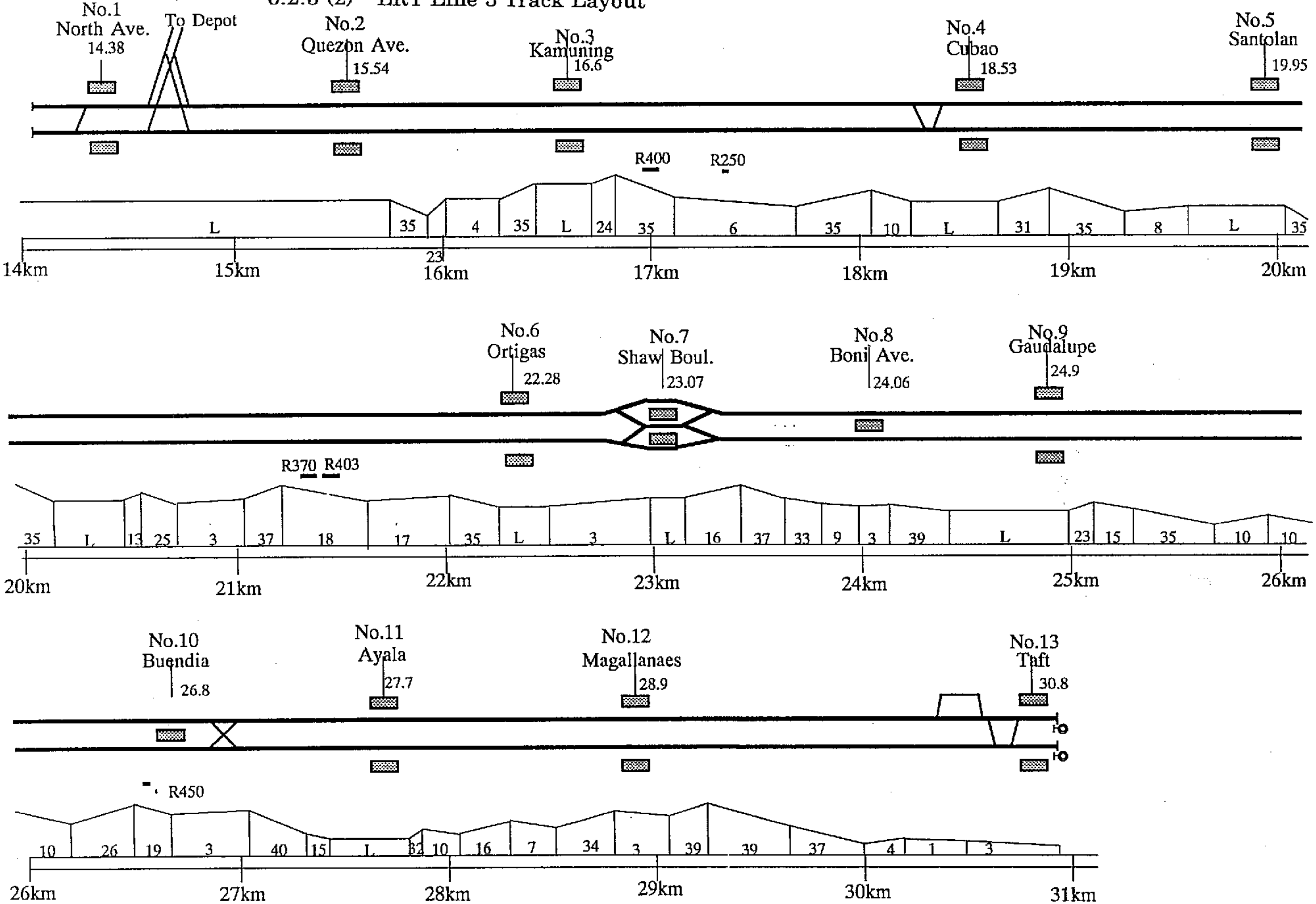
6.2.2 (4) Line 3 Cross-sectional Transport Volume (March.2000)



6.2.3 (1) LRT Line 1 Track Layout

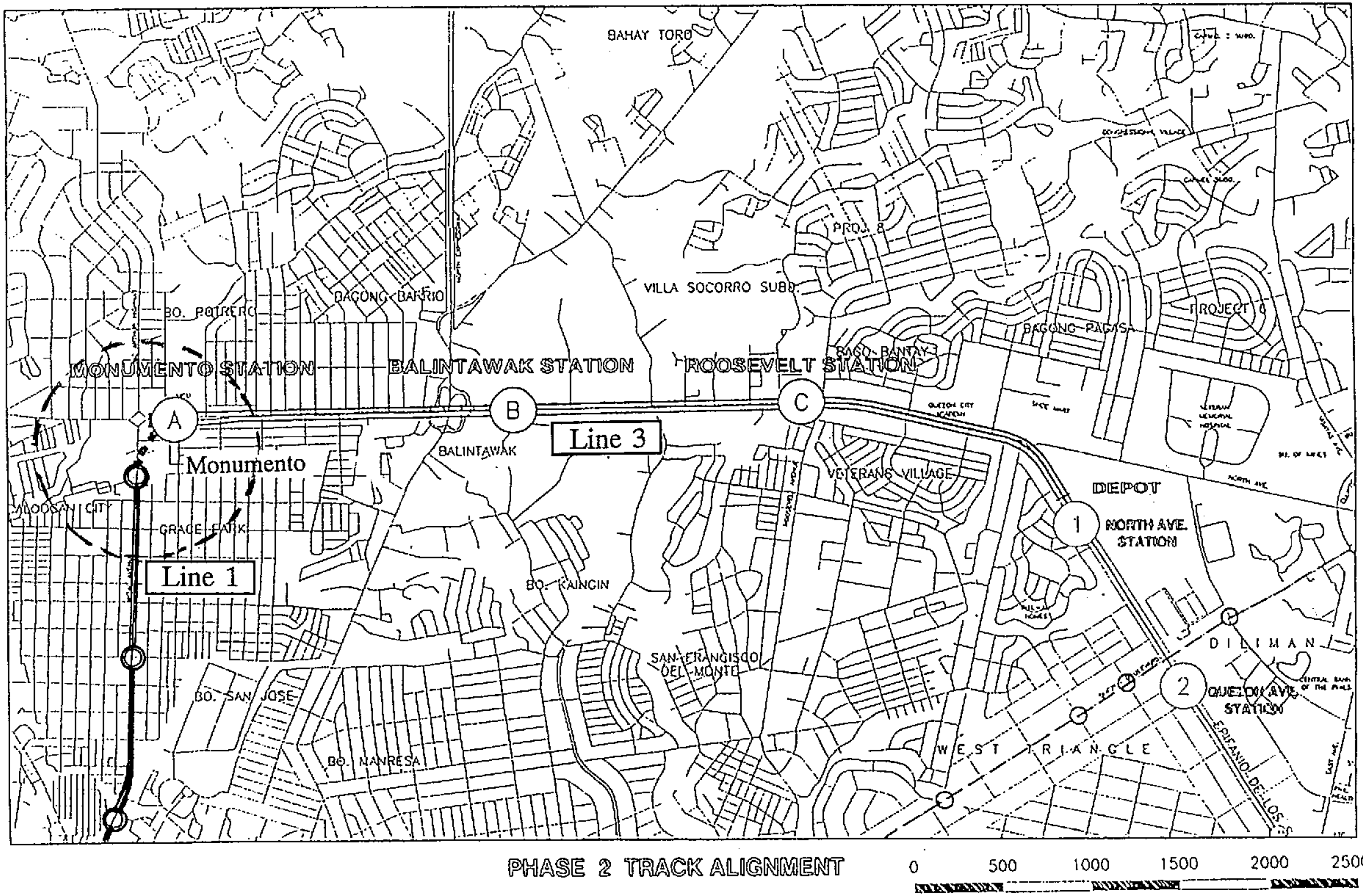


6.2.3 (2) LRT Line 3 Track Layout



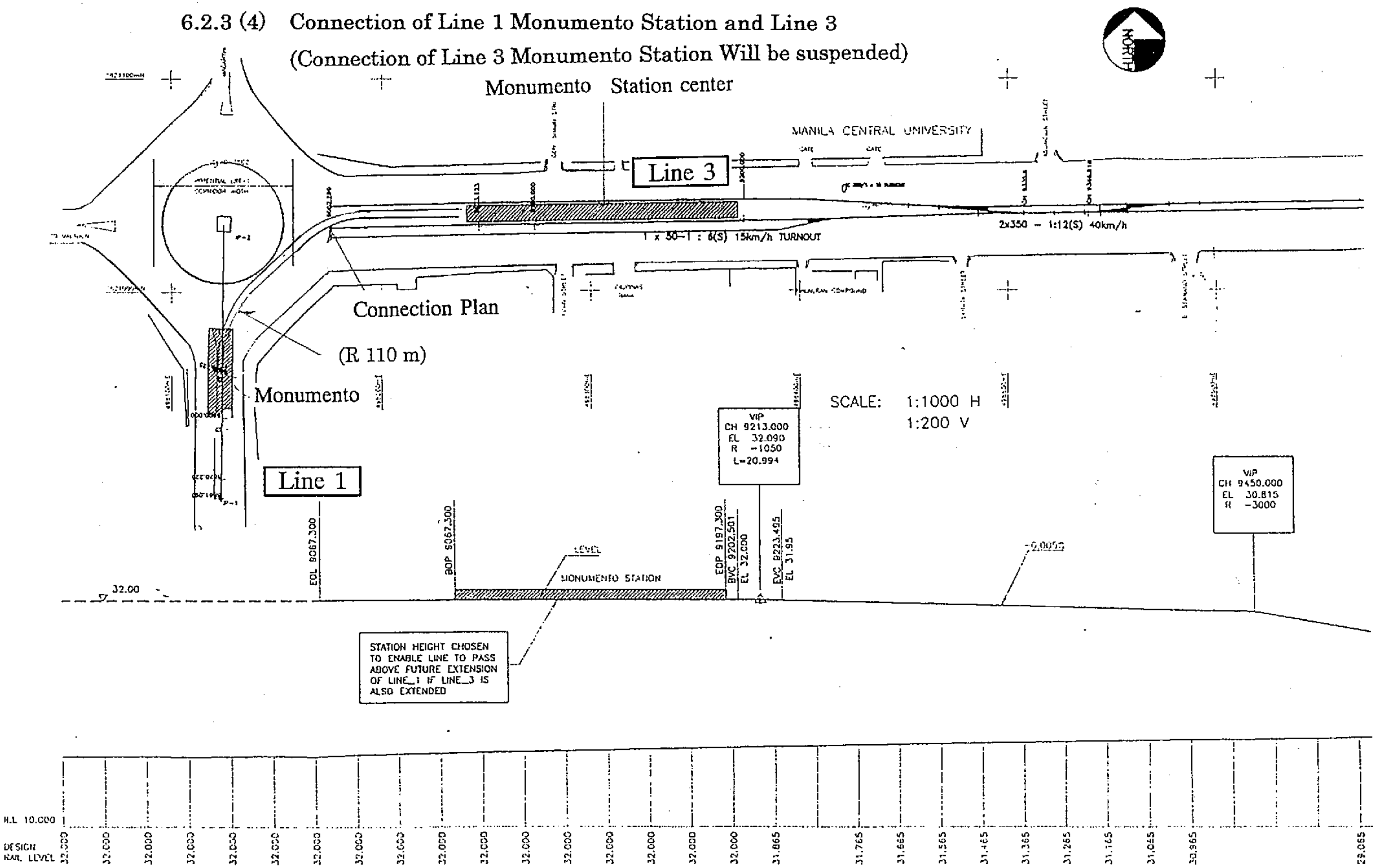
LRT Line 3 Track Layout

6.2.3 (3) Through Operation of LRT Line 1 and Line 3 (Connection Point)

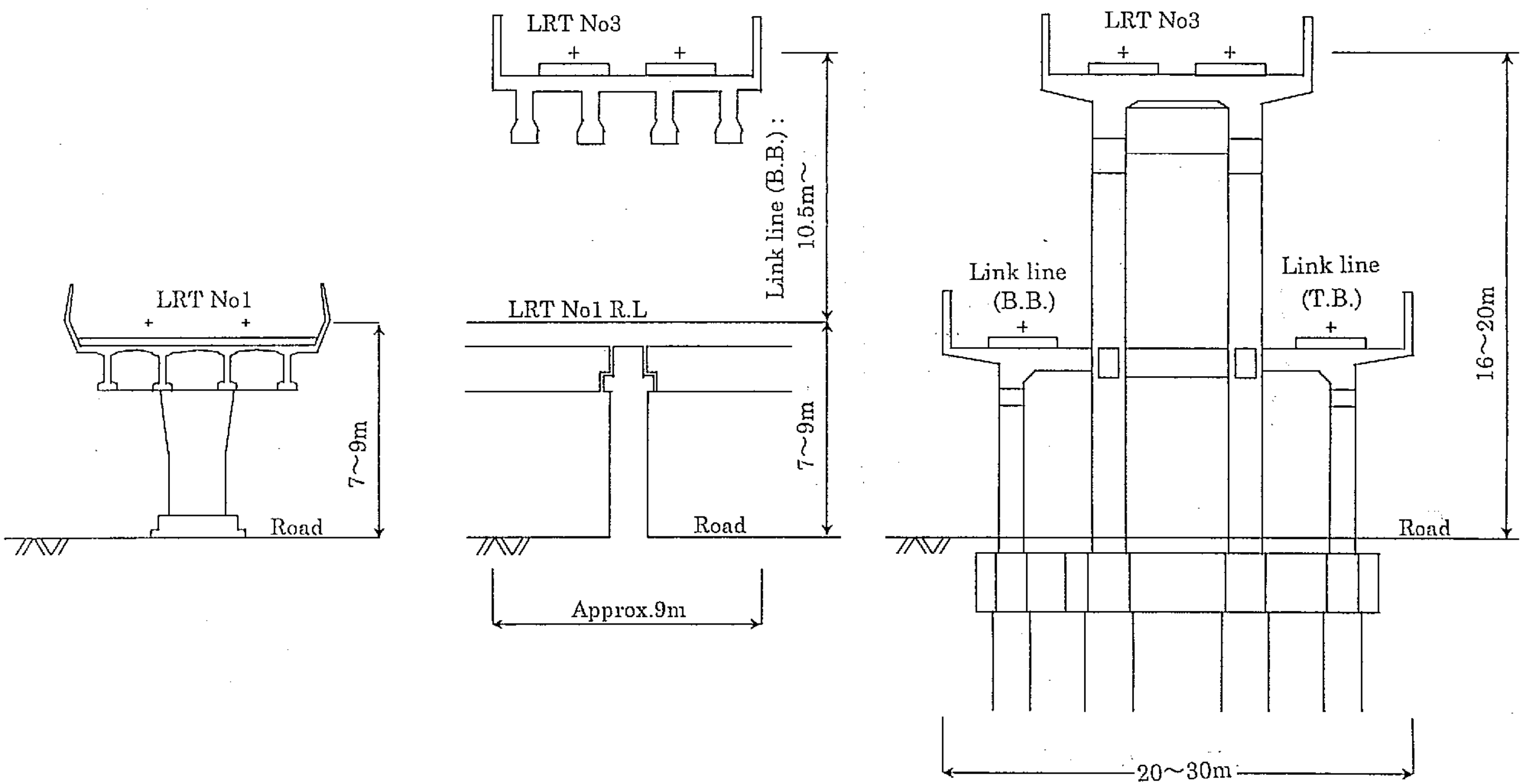


6.2.3 (4) Connection of Line 1 Monumento Station and Line 3

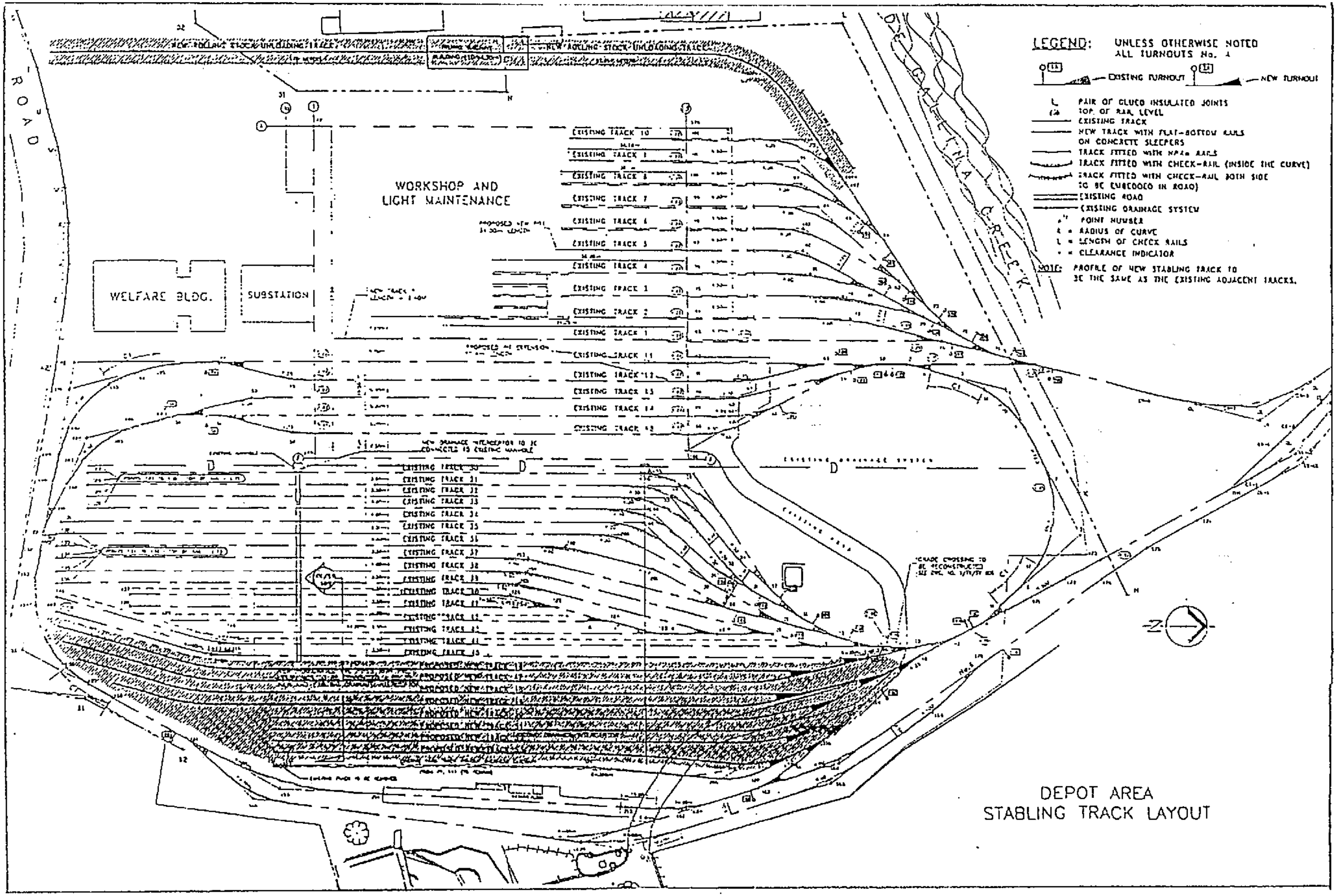
(Connection of Line 3 Monumento Station Will be suspended)



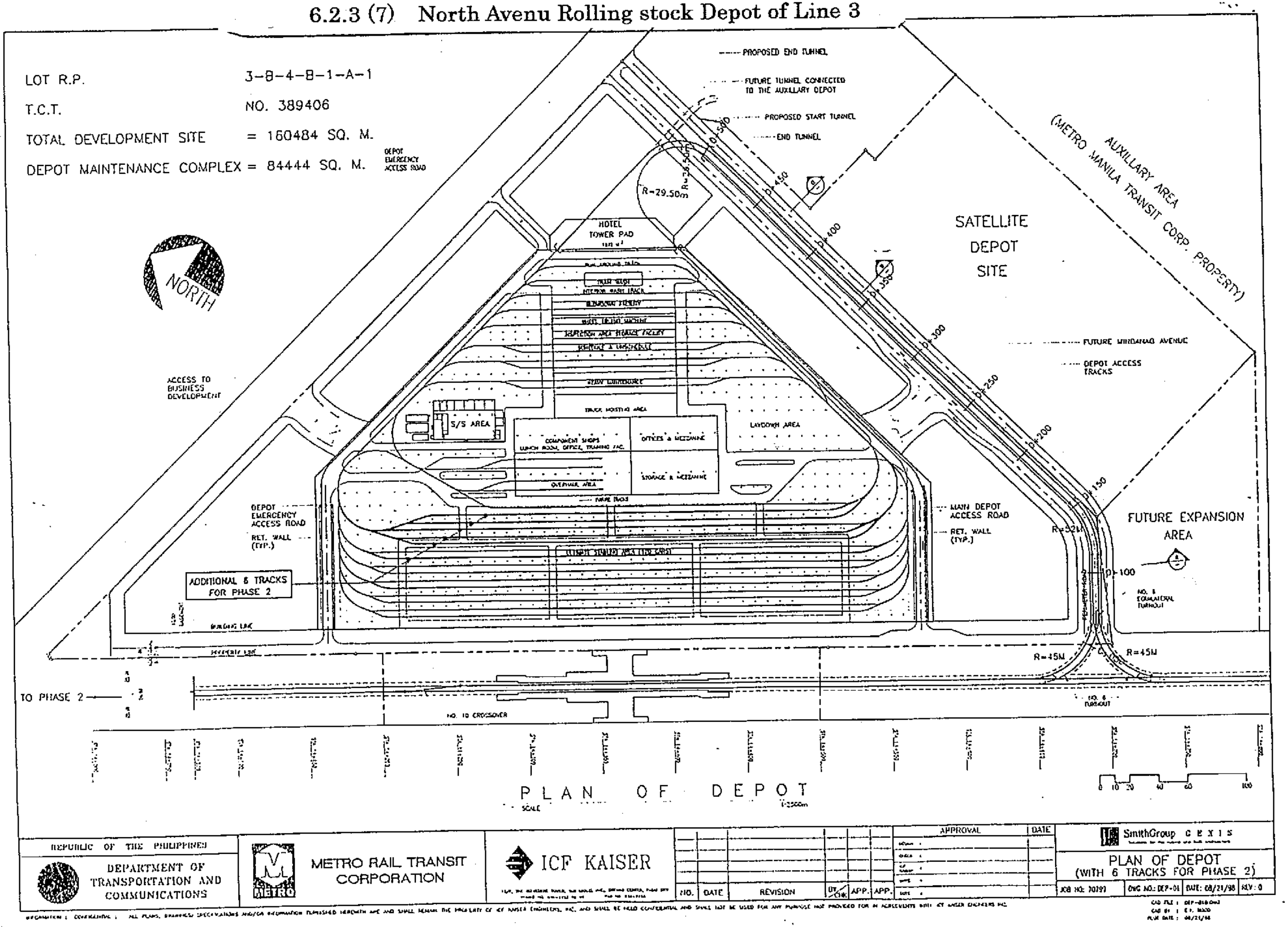
6.2.3 (5) Rough Vertical Cross Section of Link line in Through Operation Plan (Monumento station)



6.2.3 (6) Baclaran Rolling stock Depot of Line 1



6.2.3 (7) North Avenu Rolling stock Depot of Line 3



6.2.4 (1) Train Formation and Nominal Passenger Capacity

Line 1 Train formation and Number of Seat

		Mc	M	M	Mc	Total
4	Seated	78	82	82	78	320
(person/m^2)	Standee	144	152	152	144	592
	Total	222	234	234	222	912
7	Standee	252	267	267	252	1,038
(person/m^2)	Total	330	349	349	330	1,358

Line 3 Train formation and Number of Seat

		Mc	M	Mc	Total	3Unit
4	Seated				74	222
(person/m^2)	Standee				160	480
	Total				234	702
7	Standee				280	840
(person/m^2)	Total				354	1,062
8	Standee				320	960
(person/m^2)	Total				394	1,182

Line 2 Train formation and Number of Seat

		Mc	M	M	Mc	Total
4	Seated	54	62	62	54	232
(person/m^2)	Standee	193	206	206	193	798
	Total	247	268	268	247	1,030
7	Standee	338	360	360	338	1,396
(person/m^2)	Total	392	422	422	392	1,628

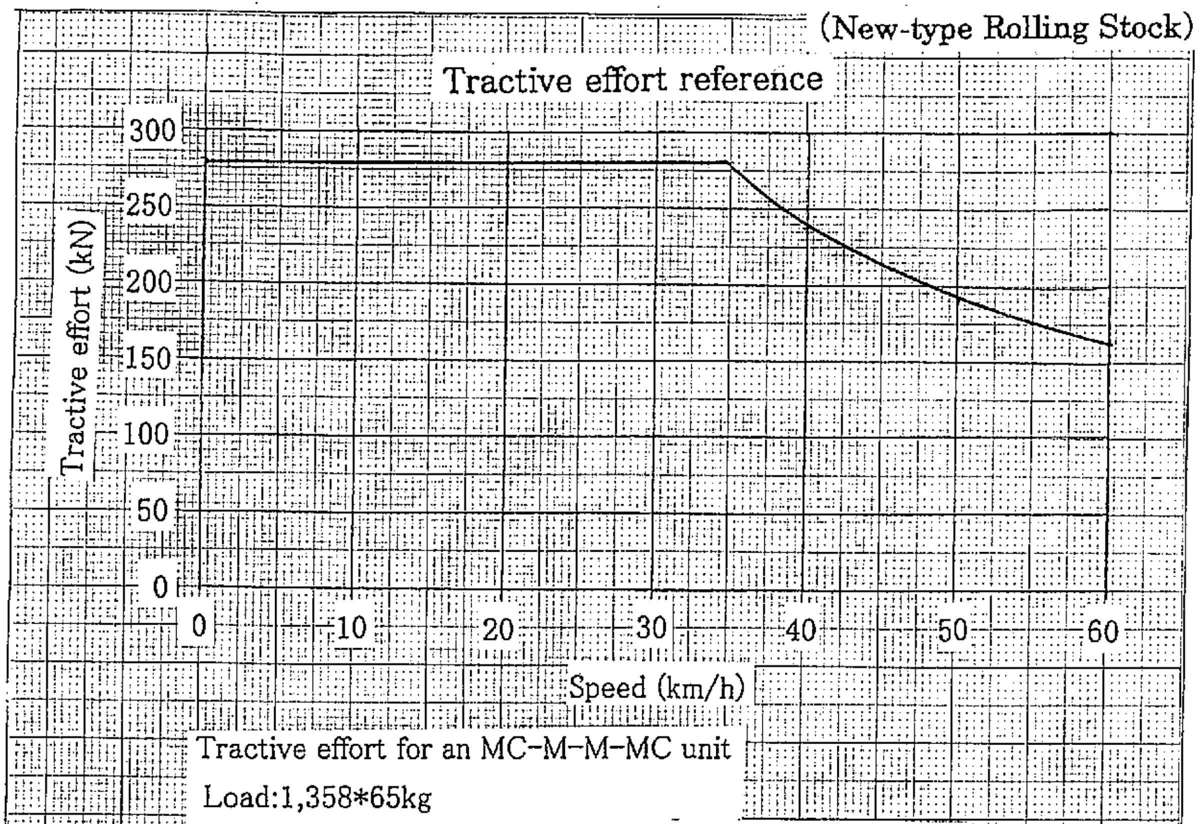
Source: LRT Line 1 Capacity Expansion Project Office,LRTA

6.2.4 (2) Maximum Transport Capacity by Line

Line		LRT 1	LRT 3	# LRT 1 & 3	MRT 2	LRT 4	LRT 6	North Rail/MCX
Section		Baclaran～Monument	Taft Ave.～North Ave	Baclaran～Taft Ave.	Recto～Santolan	uezon～Bata.	Baclaran～Niyog	Marilao～Cabuyao
(km)		13.95	16.40+5.40	35.75	13	12.52	10.9	63.2
Train Formation		4cars	3cars	4cars	4Unit	5Unit	4Unit	10car
Nom.Pas. Capacity	4 pa./m²	912	702	912	1,030		912	1740
	7 pa./m²	1,358	1,062	1,358	1,628		1358	2710
Train Head way (min:sec)		2:00	2:30	2:00	2:00	2:30	2:30	2:30
ditto (Phase 2)		1:30	—	1:30	1:30			
Max.No.of Trains(Train /l		30	24	30	30	24	24	24
ditto (Phase 2)		40	—	40	40			
Transport Capacity (p/h)	4 pa./m²	27,360	16,848	27,360	30,900		21,888	41,760
	7 pa./m²	40,740	25,488	40,740	48,840		32,592	65,040
ditto (Phase 2)	4 pa./m²	36,480	—	36,480	41,200			
	7 pa./m²	54,320	—	54,320	65,120			

Note. # LRT 1 & 3 is Through Train Operation Plane

6.2.4 (3) Calculation of Acceleration Ratio of Line 1



Source: LRT Line 1 Capacity Expansion Project Office,LRTA

Line 1 New car: Tractive effort reference

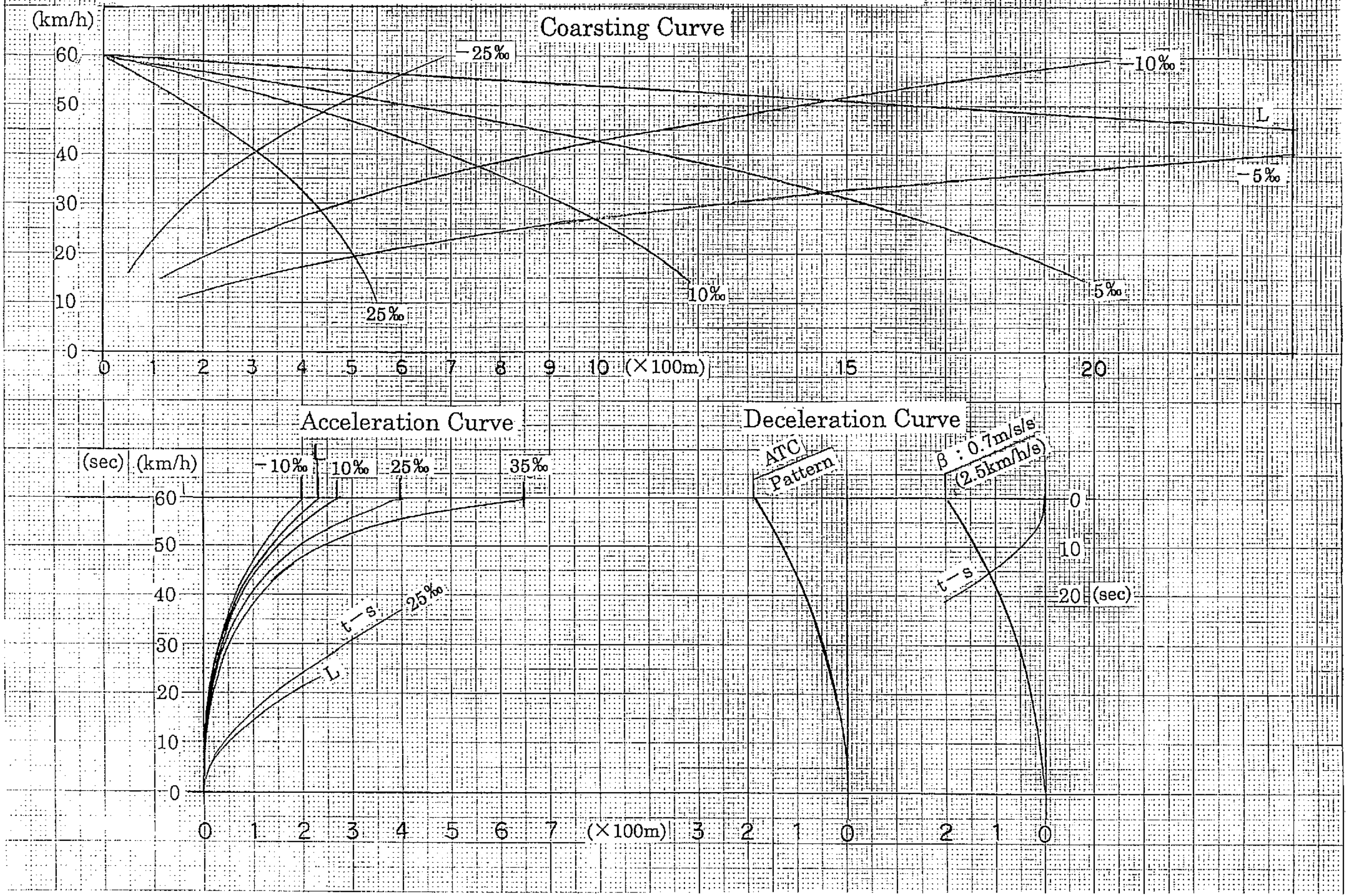
V	Tractive effort		rr	α
(km/h)	(kN)	(kg)	(kgf/ton)	(km/h/s)
0	280	28,554	3.0	3.77
3	280	28,554	1.4	3.82
5	280	28,554	1.4	3.82
10	280	28,554	1.5	3.82
15	280	28,554	1.6	3.81
20	280	28,554	1.8	3.81
25	280	28,554	1.9	3.80
30	280	28,554	2.1	3.80
35	280	28,554	2.3	3.79
40	240	24,475	2.5	3.23
45	215	21,925	2.8	2.88
50	190	19,376	3.0	2.53
55	175	17,846	3.3	2.31
60	160	16,317	3.6	2.10

Note: By LRTA Data

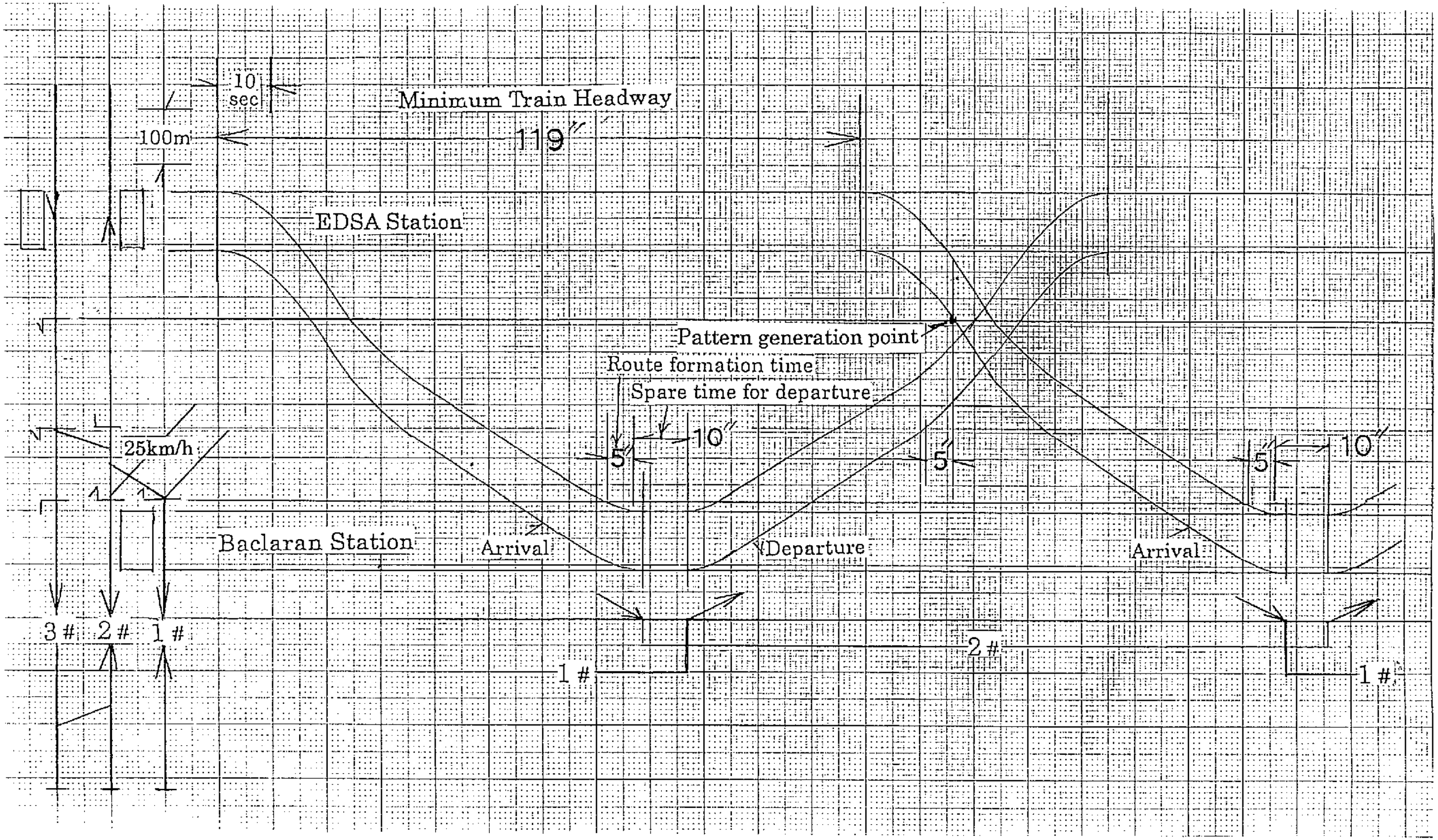
W(ton) = 37ton*4cars + 1,358pers*65kg
= 236 ton

rr=1.32+0.0164V+{0.028+0.0078(n−1)}V^2/W

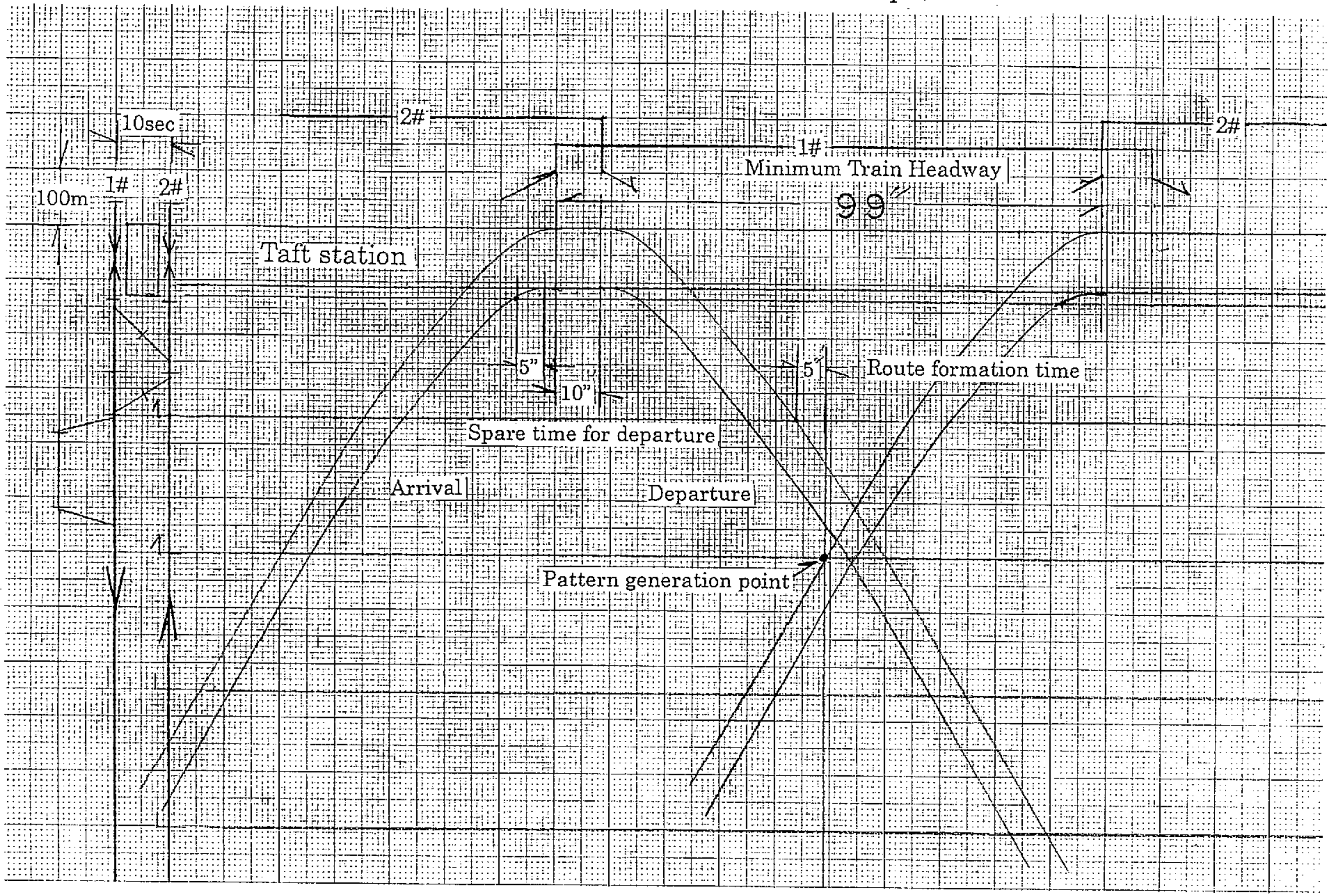
6.2.4 (4) Acceleration Curve, Deceleration Curve and Coarsting Curve



6.2.4 (5) Calculation of Train Headway at Baclaran Station (Example)



6.2.4 (6) Calculation of Train Headway at Taft Station (Example)



6.2.4 (7) Calculation of Train Operation Time
(Through Train Operation Plan : Line 1 & Line 3)

Line 1

No.	Station	(km)	(km)	Travel t (sec)	Dwell t (sec)
18	Monumento	14.95			
			1.09	90	
17	5th Avenu	13.86			40
			0.95	80	
16	R. Papa St.	12.91			40
			0.66	60	
15	A. Santos	12.25			40
			0.93	80	
14	Brumentritt St	11.32			40
			0.67	60	
13	Tayuman	10.65			40
			0.62	60	
12	Bambang St.	10.03			40
			0.65	60	
11	D. Jose St.	9.39			40
			0.68	70	
10	Carriedo St.	8.70			40
			0.73	70	
9	Central Station	7.98			40
			1.21	100	
8	U. N. Avenu	6.76			40
			0.75	70	
7	Pedro Gil. St.	6.01			40
			0.79	70	
6	Quirino Avenu	5.21			40
			0.83	70	
5	Vito Cruz St.	4.39			40
			1.06	90	
4	Gil. Puyat	3.33			40
			0.73	70	
3	Libertad St.	2.60			40
			1.01	80	
2	EDSA St.	1.59			40
			0.59	80	
1	Baclaran	1.00			
Allowance				20	
Total		(sec)		1,280	640
Total Travel Time		(sec)		1,920	
		(min)		32	

Line 3

No.	Station	(km)	(km)	Travel t. (sec)	Dwell t. (sec)
01	Monumento	9.00			40
			1.98	140	
02	Balintawak	10.98			40
			1.75	130	
03	Roosevelt	12.73			40
			1.65	120	
1	North Avenue	14.38			40
			1.26	100	
2	Quezon Ave.	15.64			40
			0.96	80	
3	Kamuning	16.60			40
			1.93	140	
4	Cubao	18.53			40
			1.42	110	
5	Santolan	19.95			40
			2.33	170	
6	Ortigas	22.28			40
			0.80	80	
7	Shaw blvd	23.08			40
			0.98	80	
8	Boni	24.06			40
			0.84	70	
9	Guadalupe	24.90			40
			1.90	140	
10	Buendia	26.80			40
			0.90	80	
11	Ayala	27.70			40
			1.20	90	
12	Magallanes	28.90			40
			1.90	140	
13	Taft	30.80			
Allowance				50	
Total		(sec)		1,720	560
Total Travel Time		(sec)		2,280	
		(min)		38.0	

Line 1

Section km	13.95	km
Travel Time	32	min
Commercial speed	26.2	km/h

Line 3

Section km	21.8	km
Travel Time	38	min
Commercial speed	34.4	km/h

Through Train Operation

Section km	35.75	km
Travel Time	70	min
Commercial speed	30.6	km/h

			Travel t.	Dwell t.
Through Train Operation Travel Time	(sec)		3,000	1,200
	(sec)		4,200	
	(min)		70	