17 PRELIMINARY DESIGN

17.1 Preliminary Road Design

The preliminary road design is conducted based on the premises and conditions of the design and the sections on which a Feasibility Study is to be conducted are the Alcalde Diaz and Sabanitas Sections, as mentioned previously.

The road length of Alcalde Diaz Section is about 20,200 meters. (STA. No.A 0+000 to STA. No.A 20+200) and the Sabanitas Section is about 26,200 meters. (STA. No.S 0+000 to STA. No.S 26+200). The total length of the road in the preliminary road design is about 46,400 meters.

The preliminary road design is conducted to examine the following design aspects;

a) Typical cross-section
b) Alignment design
c) Cross- Section design
d) Pavement design
e) Drainage design
f) Interchange design
g) Bus facilities design
h) Service area design
i) Construction quantities estimate

As the result of the preliminary design, a 4-Lane dual carriageway with design speed of 110 Km/h, and four interchanges at Alcalde Diaz Section and three interchanges at Sabanitas Section are adopted for the proposed road and six bus stops and two service areas are also included. The location of the above mentioned facilities are shown in Figure 17.1.1, and the general planning drawings in Figures 17.1.2 to 17.1.4. Preliminary design drawings are included in the "Drawings".

In addition to the above, the preliminary design is carried out to consider the environmental aspects based on the results of the initial environmental impact study. The main design items for the environmental aspects are as follows:

a) Noise protection walls are designed on both roadsides of 1,000 meters length on the Alcarde Diaz Section (STA.NO.A 0+000-STA.NO.A 1+000), to reduce the noise pollution for the people who living along the roadside.
b) Three ecology roads made using concrete box culverts in the Sabanitas Section for animals to cross the proposed road.
c) The slopes of embankments and cuttings are protected with grass, to avoid soil erosion and water contamination in Gatun Lake.
d) Three bridges are included in the design at STA.NO.S 20+200, 20+500 and 21+500 in Sabanitas Section, to

avoid soil erosion and water contamination in Gatun Lake.

e) Plantations are located in the central median of the proposed road to maintain a good natural environment.
f) Over path bridges at points where existing roads cross the proposed road are designed in consideration of the local people.
g) Protection fences made of wire netting are designed on both sides of the proposed road, to prevent animals and persons entering the proposed road areas, in consideration of the natural environment and traffic safety.

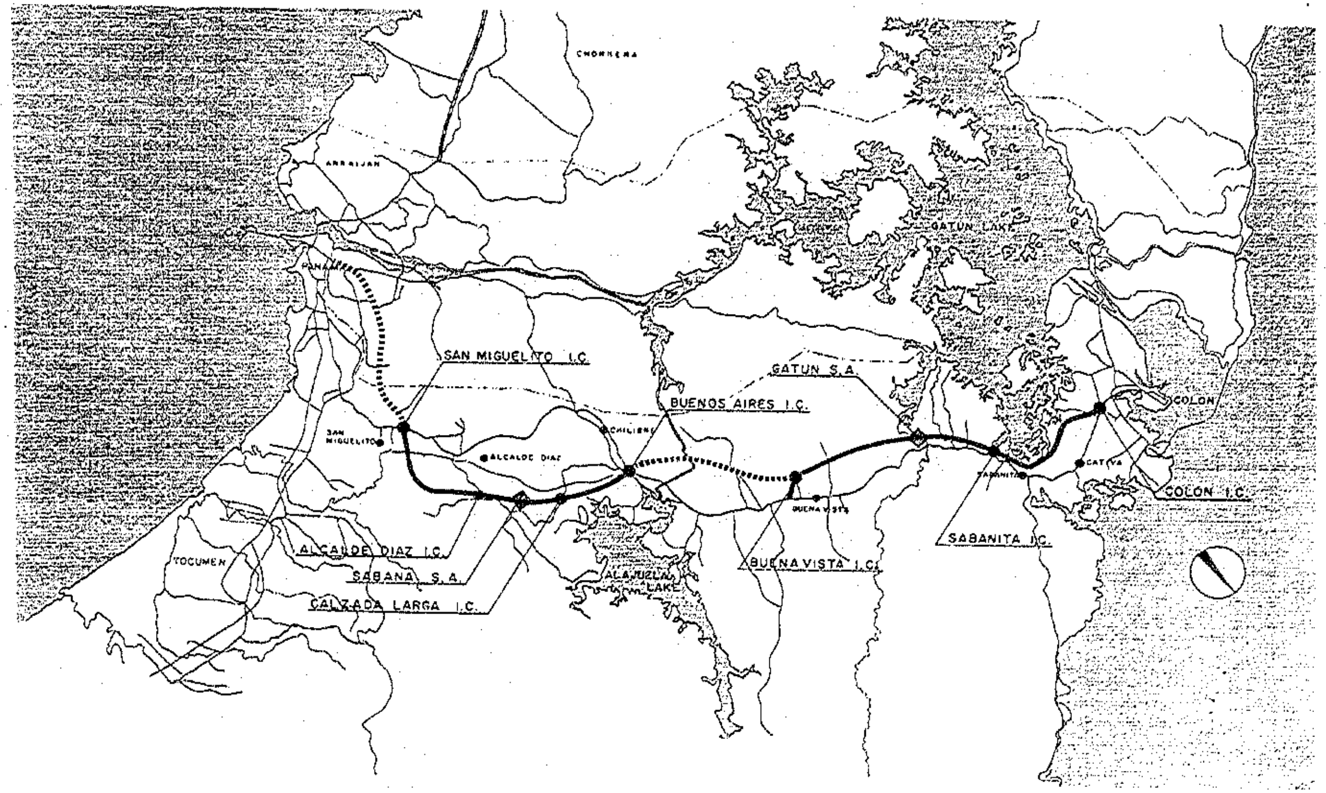


Figure 17.1.1 General Plan of Designed Road

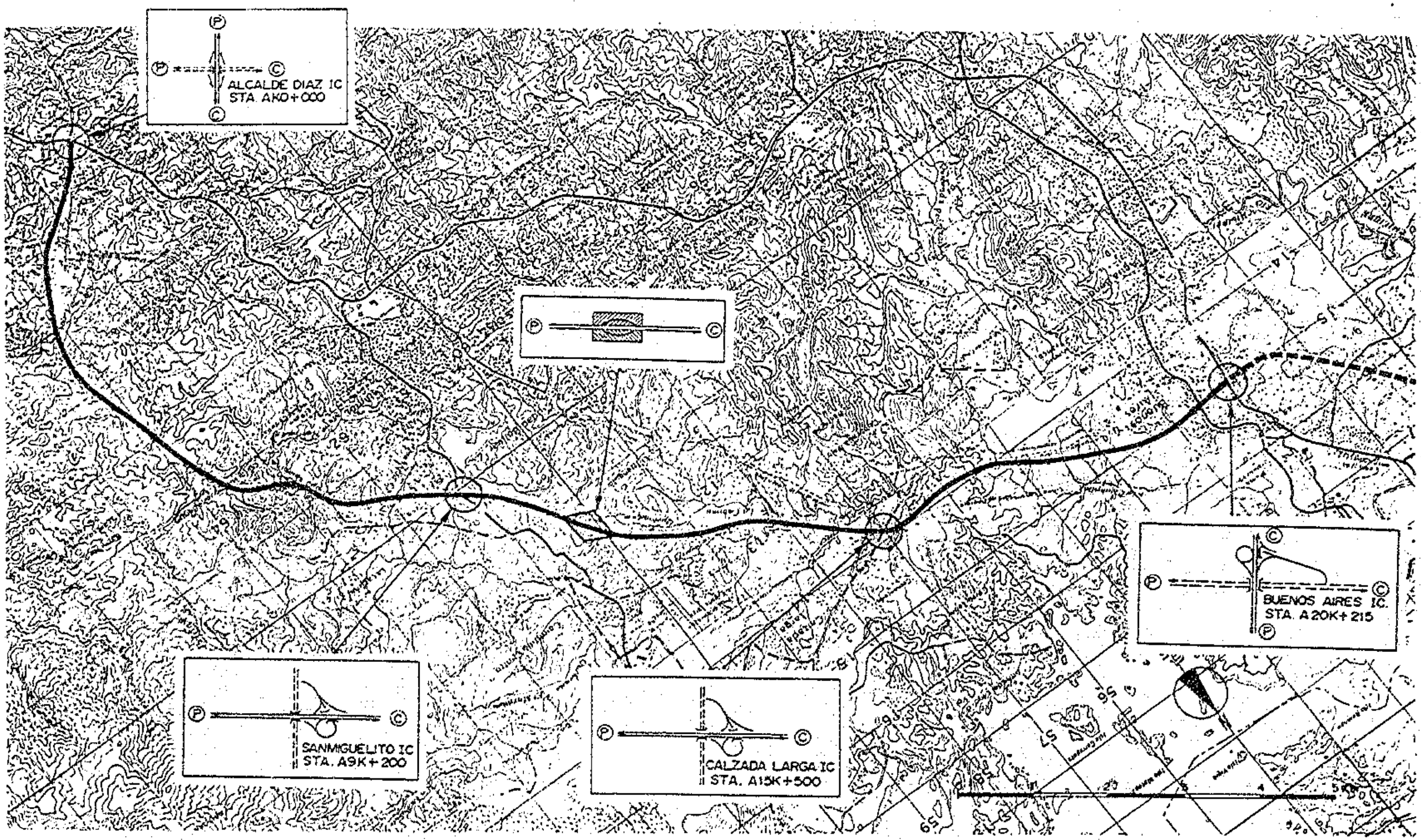


Figure 17.1.2 General Route Location Map
(Alcalde Diaz Section)

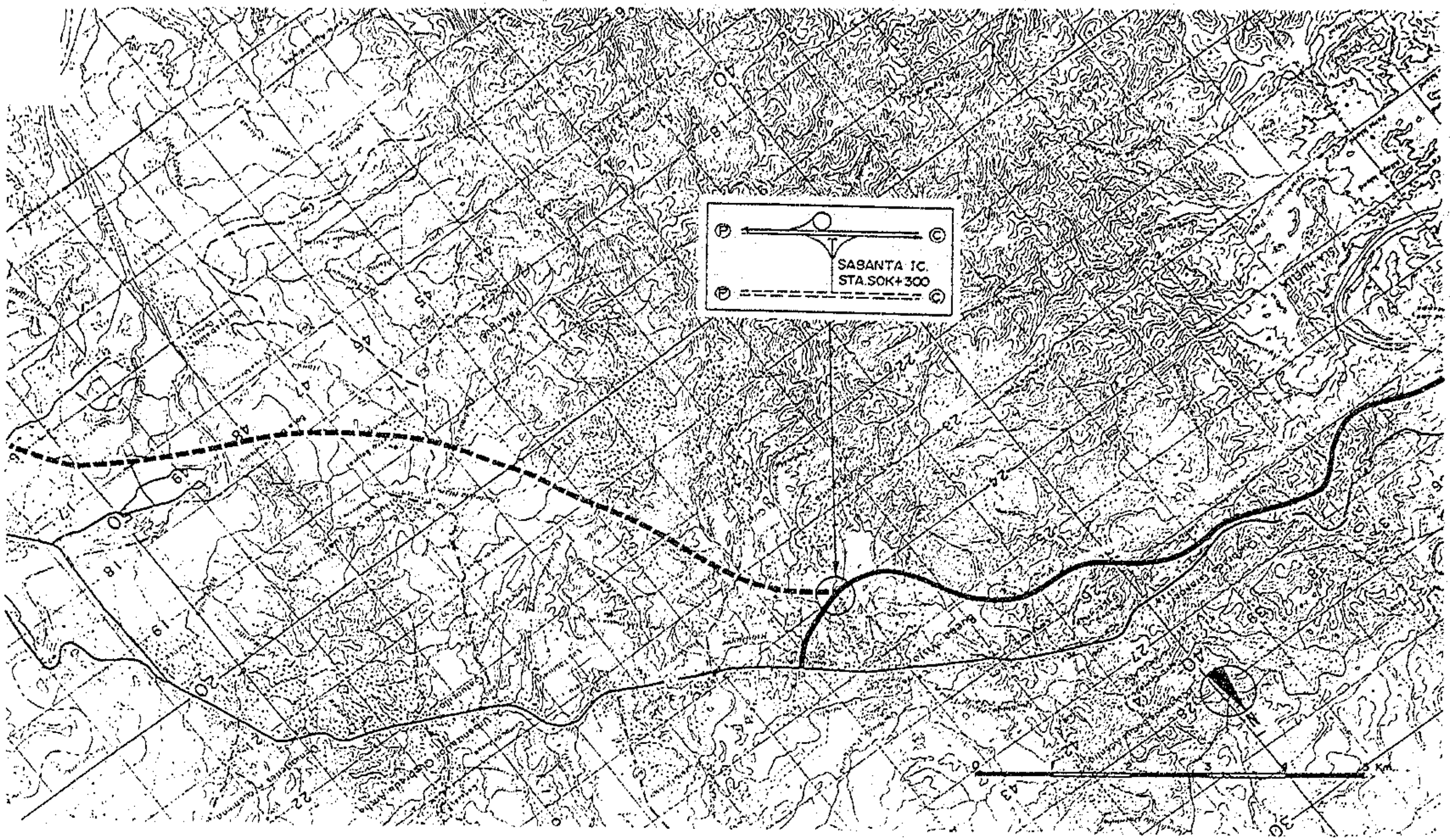


Figure 17.1.3 General Route Location Map (Chagres Section)

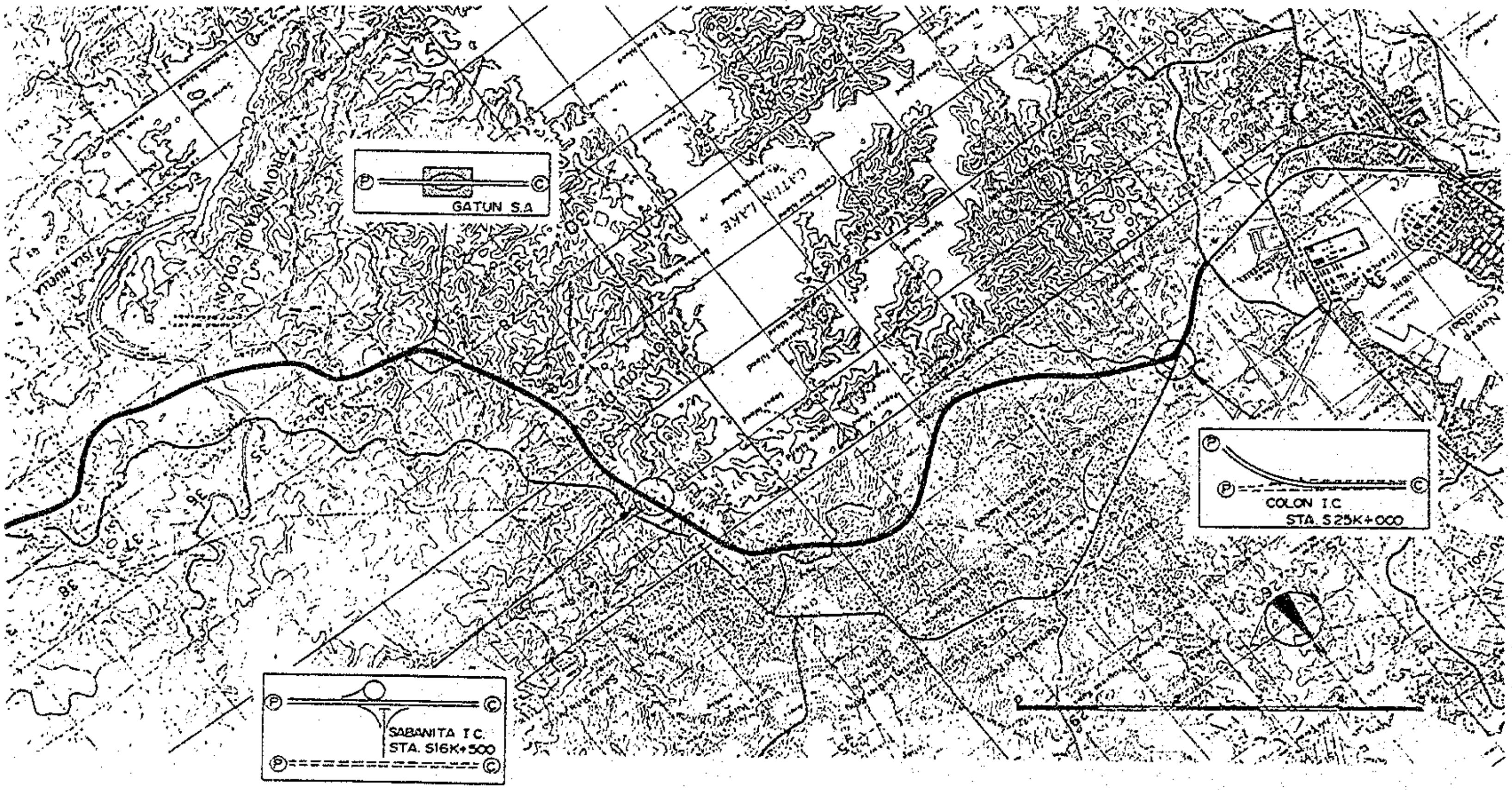


Figure 17.1.4 General Route Location Map (Sabanitas Section)

17.1.1 Typical Cross-Section

The typical cross-section is determined in consideration of the following:

a) Function and characteristics of the road.
b) Design speed of the road.
c) Future traffic demand.
d) Design standards.
e) Related road cross-sections.

(1) Lane Width

In accordance with AASHTO, a 3.65 meters (12 feet) wide lane is adopted for the proposed road.

(2) Shoulder Width

In accordance with AASHTO, the minimum right and left shoulder widths are made 3.0 and 1.2 meters respectively. Considering the topographical features along the route, the right and left shoulder widths of the proposed road the 3.0 meters and 1.5 meters are made respectively.

However, considering economic aspects, the shoulder widths of long bridges (bridge length is over 50 meters) are made 1.80 and 1.20 meters in order to reduce the minimum shoulder width. A shoulder width of 1.00 is adopted for the installation of traffic signs, guardrails and information signs and a 3.00 meters wide shoulder is adopted on the outside of the shoulders for the installation of protection walls.

(3) Median Width

In accordance with the AASHTO, the median width is made 3.0 meters to 6.6 meters. Considering the traffic volume expected after year 2010, and environmental conditions, a 10.0 meters median width is adopted for the proposed road. When the 10.0 meters median width is constructed, the 6- Lane road will be maintained so that it can be use a 10.0 meters median width in the future.

(4) Right of Way

In accordance with the AASHTO, the typical of right of way for a ground level 6-Lane freeway without frontage roads is made about 70 meters. As the proposed road is located in rolling and mountainous areas, the right of way of proposed road is requires to be wider. In consideration of the cross-section design, a 100 meters right of way is adopted for the proposed road. The Fences are located along the border of the right of way to keep the road area clear and prevent the entry of animals and people. The typical cross section is shown in Figure 17.1.5.

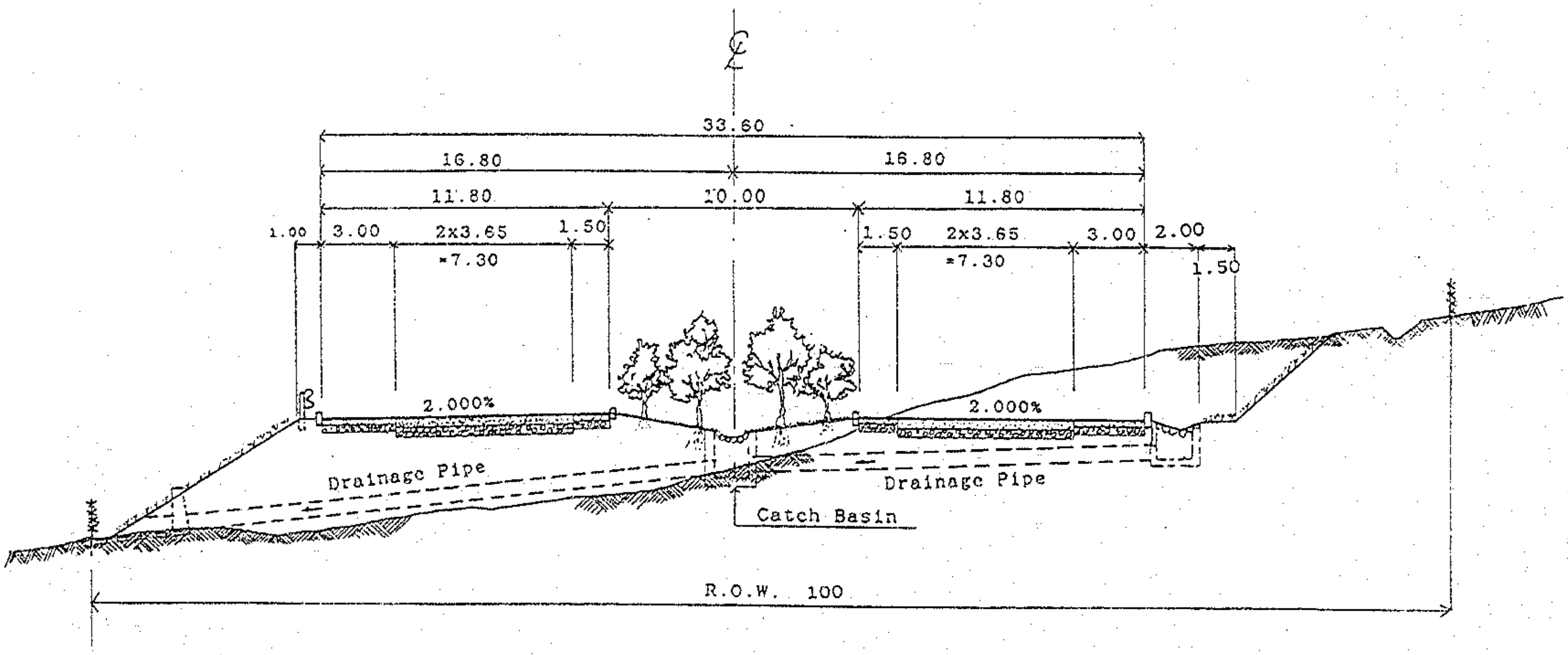


Figure 17.1.5 Typical Cross-Section

17.1.2 Alignment Design

The alignment design covers the horizontal and vertical alignment design, and carried out to consider the harmonizations of the horizontal and vertical alignment design as well as the cross section design.

(1) Horizontal Alignment Design.

Considering the following matters mainly, the route location study is carried out using topographic maps at a scale of 1:5,000 and was done by the JICA Study Team in August 1993.

a) Geometric design standard of a 110 km/h design speed adopted.
b) Future development conditions.
c) Existing development conditions.
d) Environmental Conditions.
e) Alignment of Corredor Norte.

As a result of the horizontal alignment design, the following points deserve attention. The elements of the horizontal alignment are shown in Table 17.1.1.

1) According to the detailed design of the Corredor Norte, the intersection between Corredor Norte and the existing Panama-Colon Highway is designed as an At-Grade intersection. If the Corredor Norte and the proposed road are constructed at the same time, the horizontal alignment and the intersection of Corredor Norte will have to be changed slightly. This is therefore, the intersection is designed as a Grade Separated Intersection (Diamond type) for the proposed road.

2) The route of the section between STA, No. A. 0+00 and STA. No. A. 0+ 300 passes through the existing housing area of Alcalde Diaz in Panama City, and is about 300 meters long. Housing developments pressure are ordering to spread gradually to the outside of the existing housing areas. Therefore, land for the construction of the proposed road should be acquired as soon as possible.

3)In section between STA. No. S 17+000 and STA. No. S 22+000, the route is located in consideration of the following facilities as shown in Figure 17.1.6.

a) Gatun Recreational Park.
b) Gatun Lake.
c) Housing Estates.
d) National Police Area.
e) Water Inlet.
f) Water Plant.

In consideration of the above mentioned facilities, three alternatives routes: route 1, route 2 and route 3 are suggested as shown in Figure 17.1.6.

Table 17.1.1 Designed Curve Element

No. of Inter-Angle Part	Inter Angle	Radius (m)	Tangent Length(TL) (m)	Curve Length(CL) (m)	Sign Length(SL) (m)
I.P.A- 1	21° 30′	1500	284.784	562.869	26.795
I.P.A- 2	29° 00′	1000	258.618	50.615	3.290
I.P.A- 3	50° 00′	1000	466.308	87.266	10.338
I.P.A- 4	58° 00′	800	443.447	809.833	114.683
I.P.A- 5	49° 00′	800	364.581	684.169	79.158
I.P.A- 6	48° 00′	1500	667.843	1256.637	141.954
I.P.A- 7	44° 00′	3000	1212.079	2303.835	235.604
I.P.A- 8	54° 30′	2000	1030.068	1902.409	249.675
I.P.A- 9	40° 30′	1000	368.919	706.858	65.881
I.P.A-10	57° 00′	1000	542.956	994.838	137.893
I.P.A-11	34° 00′	2000	611.461	1186.824	91.384
I.P.A-12	33° 00′	1500	444.320	863.938	64.423
I.P.S- 1	52° 30′	800	394.516	733.038	91.988
I.P.S- 2	54° 30′	1100	566.537	1046.325	137.321
I.P.S- 3	24° 00′	1400	297.579	586.431	31.277
I.P.S- 4	43° 30′	650	259.324	493.492	49.821
I.P.S- 5	56° 30′	650	349.258	640.972	87.889
I.P.S- 6	59° 00′	650	367.752	669.334	96.821
I.P.S- 7	30° 00′	950	254.552	497.419	33.512
I.P.S- 8	12° 00′	1400	147.146	293.215	7.712
I.P.S- 9	78° 30′	600	490.221	822.050	174.801
I.P.S-10	76° 30′	650	512.419	867.865	177.691
I.P.S-11	20° 30′	1100	198.912	393.572	17.840
I.P.S-12	17° 00′	1000	149.451	296.706	11.106
I.P.S-13	47° 30′	650	286.007	538.870	60.141
I.P.S-14	57° 30′	750	411.464	752.673	105.455
I.P.S-15	41° 30′	900	340.979	651.880	62.428
I.P.S-16	10° 30′	3000	275.661	549.779	12.638
I.P.S-17	29° 30′	1100	289.606	566.359	37.485
I.P.S-18	23° 30′	2500	520.001	1025.381	53.508
I.P.S-19	56° 00′	600	319.026	586.431	79.542
I.P.S-20	42° 00′	600	230.318	439.823	42.687
I.P.S-21	52° 30′	600	295.887	549.779	68.991
I.P.S-22	47° 30′	650	286.007	538.870	60.141
I.P.S-23	9° 30′	1750	145.414	290.161	6.031
I.P.S-24	55° 00′	750	390.425	719.948	95.536
I.P.S-25	23° 00′	1000	203.452	401.426	20.487
I.P.S-26	14° 30′	1000	127.216	253.073	8.059
I.P.S-27	53° 00′	600	299.149	555.015	70.440

Note:
A: Alcalde Diaz Section
B: Sabanitas Section

a) Route 1

Route 1 passes behind the water plant and follows the edge of Gatun lake and is about 1,000 meters in length.

b) Route 2

Route 2 passes through behind the water-plant but avoids the edge of Gatun lake, in order to avoid water contamination from Gatun lake due to the fact that the water inlet is located in Gatun lake at about 400 meters from edge of the water in the Sabanitas area. Route 2 is located in the northern part of the existing National Police Area in order to it.

c) Route 3

Route 3 passes through an area totally between the water plant and the existing Sabanitas housing area, to avoid going near the edge of Gatun lake, and for connection to Route 2.

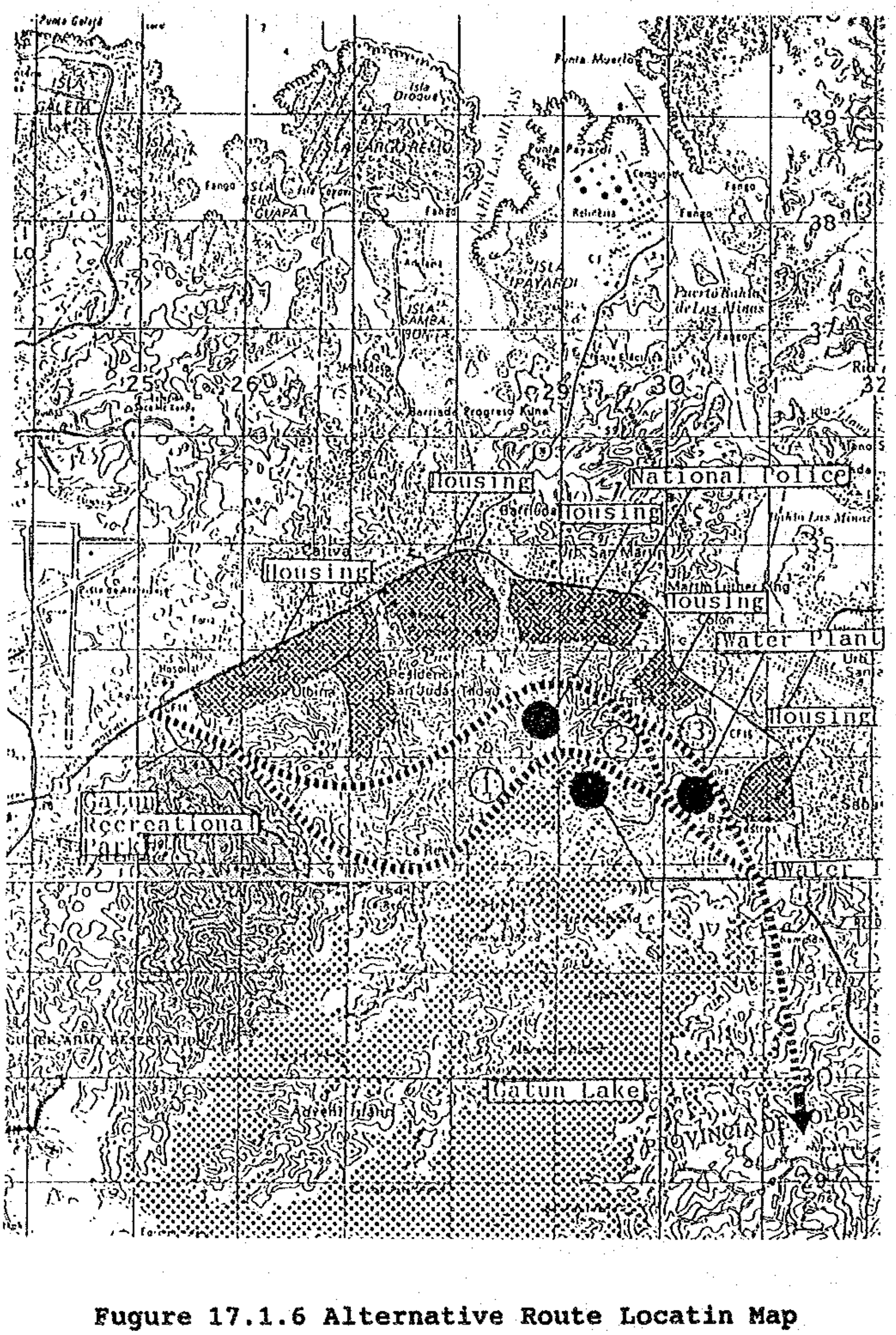
The rough horizontal and vertical alignments of each alternative routes are shown in Figure 17.1.6 and 17.1.7, respectively, and construction cost of each route is shown in Table 17.1.2.

Table 17.1.2 Cost Comparison of Alternative Routes
(Unit ; 1,000 Balboas)

Items	Route 1	Route 2	Route 3
Earth Work	32,200	30,600	28,000
Pavement	8,050	7,650	7,000
Bridge	16,000	4,000	8,000
Tunnel	4,500	34,500	48,000
No. Housing	22	26	41
Compensation			
* Housing	220	260	410
* Water Pipe	2,000	-	-
Total	62,970	77,010	91,410

As the result of a comparison of the three alternative routes, the Route 1 is recommended for the following reasons;

a) Route 1 is the most economical route and also maintains a good landscape, however, some measures to avoid water inlet contamination should be considered.
b) Some housing will have to be demolished on Routes 2 and 3, especially in the Maestro Housing Estate. However, little housing needs to be demolished for Route 1.
c) Routes 2 and 3 will affect National Police the area. So it will have to be relocated.



Fugure 17.1.6 Alternative Route Locatin Map

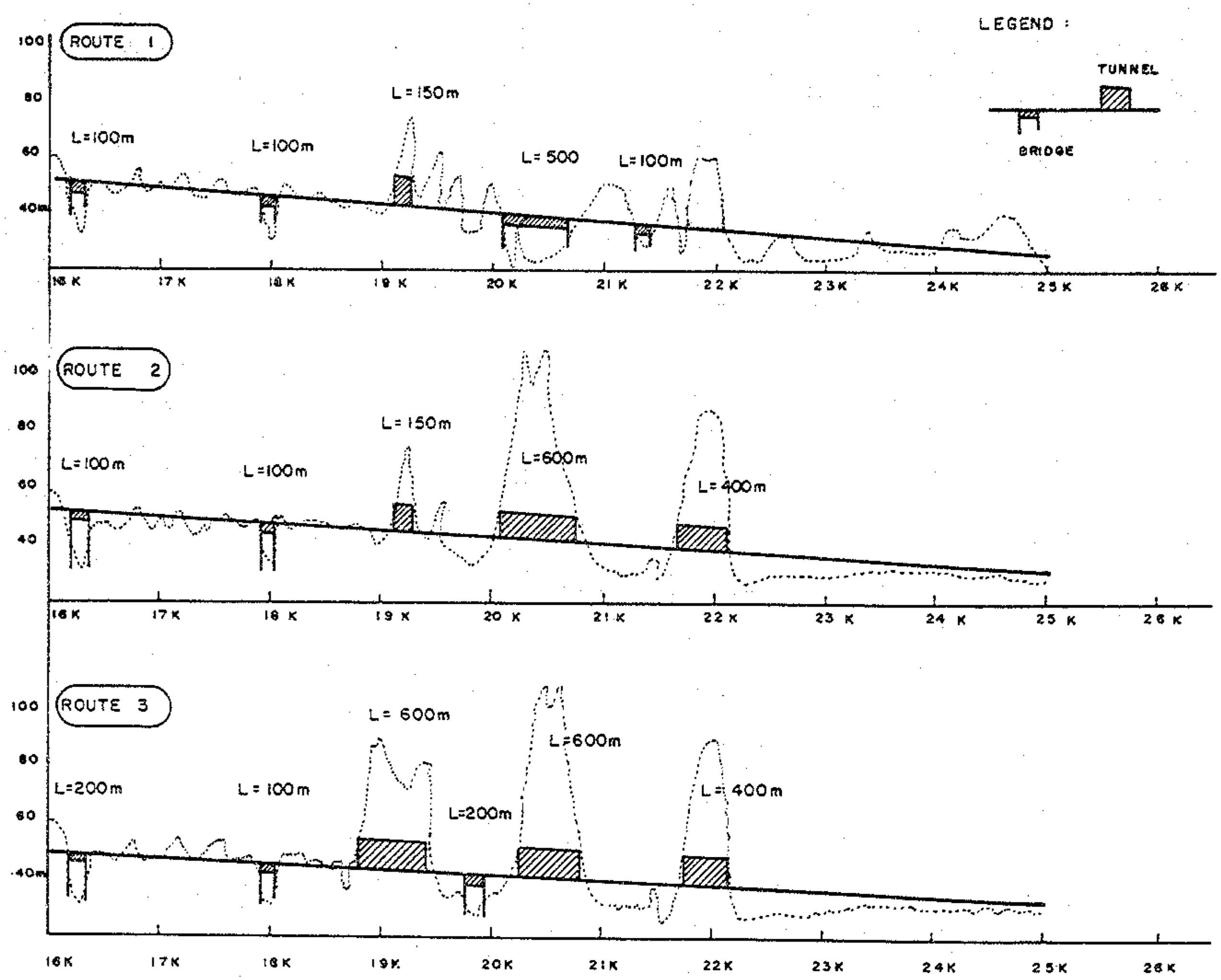


Figure 17.1.7 Profile of Alternative Route

In addition to the above, many discussions regarding the selection of alternative routes are conducted with the Panamanian organizations, INRENARE and IDAAN. The results of these discussions are summarized as follows:

a) It is possible for the route to pass near the edge of Gatun Lake, considering the economic aspects and characteristics of the road.
b) However, slope protection, such as grass, concrete bricks or other methods should be considered in order to avoid water contamination in Gatun Lake.
c) The prevention of water pollution should also be con sidered during the construction stage.
d) It is possible to shift the water inlet to another place if necessary. In this case, the cost of relocation of the water pipeline and other required facilities required should be included in this road construction project for compensation purposes.

4) The route of the section between STA. No. S. 22+000 and 25+000 is located at the right bank of the existing river, to avoid passing through the area of the National Park (Gatun National Park).

5) A 600 meters minimum horizontal curvature is adopted in the comparatively steep mountainous area is located in the area between STA. No. S. 8+000 and STA. No. S. 15+000.

(2) Vertical Alignment Design

In consideration of the following points, the vertical alignment design are carried out using topographic maps at a scale of 1:5,000 as for the maps for the horizontal alignment design.

a) Geometric design standards
b) Horizontal alignment conditions
c) Geographic features conditions
d) Access to the existing road
e) Large structures in the design.

Based on the results of vertical alignment design, the gradient of the proposed new highway is summarized in Table 17.1.3. The main works of the vertical alignment design are as follows:

1) The maximum longitudinal gradient is made 3.0 percent and a 0.3 percent gradient is adopted for the minimum longitudinal gradient.

2) Even though, a 3.0 percent maximum longitudinal gradients is adopted for rolling terrain, there will be little difference in construction cost between a 3.0 percent and 4.0 percent.

3) The high water level of Gatun Lake since 1913 is 26.70 meters from the Cristobal Mean Sea Level. The Panama Canal Commission has determined the high water level as 30.0 meters (100 feet) in future.

Table 17.1.3 Degigned Longitudinal Gradients

No. of Station	Distance (m)	Proposed Road Hieght (m)	Gradients (%)
A No. 0+000	---	92.800	----
A No. 0+900	900	74.800	- 2.00
A No. 2+000	1,100	80.300	+ 0.50
A No. 3+300	1,300	60.800	- 1.50
A No. 5+100	1,800	78.800	+ 1.00
A No. 6+400	1,300	98.300	+ 1.50
A No. 7+100	700	101.800	+ 0.50
A No. 8+000	900	128.800	+ 3.00
A No. 9+400	1,400	149.800	+ 1.50
A No. 10+400	1,000	129.800	- 2.00
A No. 11+200	800	133.800	+ 0.50
A No. 11+800	600	123.600	- 1.70
A No. 12+900	1,100	107.100	- 1.50
A No. 14+400	1,500	99.600	- 0.50
A No. 15+400	1,000	96.600	- 0.30
A No. 16+200	800	99.000	+ 0.30
A No. 16+900	700	78.000	- 3.00
A No. 17+800	900	69.000	- 1.00
A No. 18+700	900	78.000	+ 1.00
A No. 19+400	700	57.000	- 3.00
A No. 19+950	550	68.000	+ 2.00
A No. 20+200	250	60.500	- 3.00
Chagres Section	---	------	---
Chagres Section	---	------	---
S No. 0+000	---	85.000	---
S No. 0+600	600	76.000	+ 1.50
S No. 1+300	700	83.000	+ 1.00
S No. 3+700	2,400	73.400	- 0.40
S No. 4+500	800	87.800	+ 1.80
S No. 5+000	500	77.600	- 2.04
S No. 6+500	1,500	122.600	+ 3.00
S No. 8+100	1,600	74.600	- 3.00
S No. 10+600	2,500	44.600	- 1.20
S No. 13+100	2,500	114.600	+ 2.80
S No. 15+900	2,800	53.000	- 2.20
S No. 20+800	4,900	35.800	- 0.35
S No. 21+800	1,000	41.000	+ 0.52
S No. 22+600	800	17.000	- 3.00
S No. 23+900	1,300	13.100	- 0.30
S No. 24+500	600	29.900	+ 2.80
S No. 25+500	1,000	9.900	- 2.00

Same as existing road

Notes;
A No. ; Alcalde Diaz Section

S No. ; Sabanita Section

4) The lowest height of the proposed road is set at about 36.2 meters when it passes near Gatun Lake. This is to cater to the high water level which the Panama Canal Commission has been determined.

(3) Relation Between the Proposed Road and Saddle Dam

There are six saddle dams along the Sabanitas area as shown in Figure 17.1.8. The major function of saddle dam is to protect a flood of the existing housing area which are located at the behind of Gatun Lake from the water of Gatun Lake. The proposed road passes through near these saddle dams, therefore, it is required to examine the flood conditions to the existing housing area.

The relationship between the structure conditions of proposed road such as horizontal or vertical alignment and cross-section, and the structure conditions of saddle dam are shown in Table 17.1.4 and also are illustrated in Figure 17.1.9.

Judging from these tables and figures, the proposed road is designed as the bridges and causeways on the these critical areas for protection of the flood and to keep a good environmental conditions. It seems to that the proposed road will not have effect to the existing housing areas, however, the following conditions should be conducted.

1) In the final design and construction stage, more ditailed environmental studies are required in accordance with the future socio-economic and environmental conditions.

2) In the final design stage, MOP should be cordinated with related agencies such as underground facilities and tel-commumication facilities.

3) During the construction stage of the road and bridges, the careful implementation should be required, especially to keep a good natural environmental conditions and social environmental conditions such as traffic accidents or traffic congestions and traffic noise.

Table 17.1.4 Relation Between Proposed Road and Saddle Dam

Name of Dam	Classifications
Baro 1	a) The lowest watershed level is about 40.0 m. b) H.H.W.L of Gatun Lake is 28.8 m (95 feet). c) The width of watershed (35 m) is about 50 m. ----- d) Proposed road level is 40.0 m. e) Bridge is designed on Gatun Lake. f) Embankment is designed on the watershed.
Baro 2	a) The lowest watershed level is about 50.0 m. b) Watershed is located 100m far from the road. c) H.H.W.L of Gatun Lake is about 28.8 m. d) The width of watershed (50 m) is about 50 m. ----- e) Proposed road level is 36.5 m. f) Bridge is designed on Gatun Lake.
Baro 3	a) The lowest watershed level is about 35.0 m. b) H.H.W.L of Gatun Lake is 28.8 m. c) The width of watershed (35 m) is about 50 m. d) Watershed is located 50 m far from the road. ----- e) Proposed road level is 37.0 m. f) Causeway is designed on Gatun Lake.
Cana 1 & 2	a) The lowest watershed level is about 35.0 m b) H.H.W.L of Gatun Lake is 28.8 m. c) The width of watershed (35 m) is about 30 m. d) Watershed is located 50 m far from the road. ----- e) Proposed road level is 38.5 m. f) Causeway is designed on Gatun Lake.
Cana 3	a) The lowest watershed level is about 35.0 m. b) H.H.W.L of Gatun Lake is 28.8 m. c) The width of watershed (35 m) is about 50 m. d) Watershed is located 150 m far from the road. ----- e) Proposed road level is about 45.5 m. f) Bridge is designed on Gatun Lake.

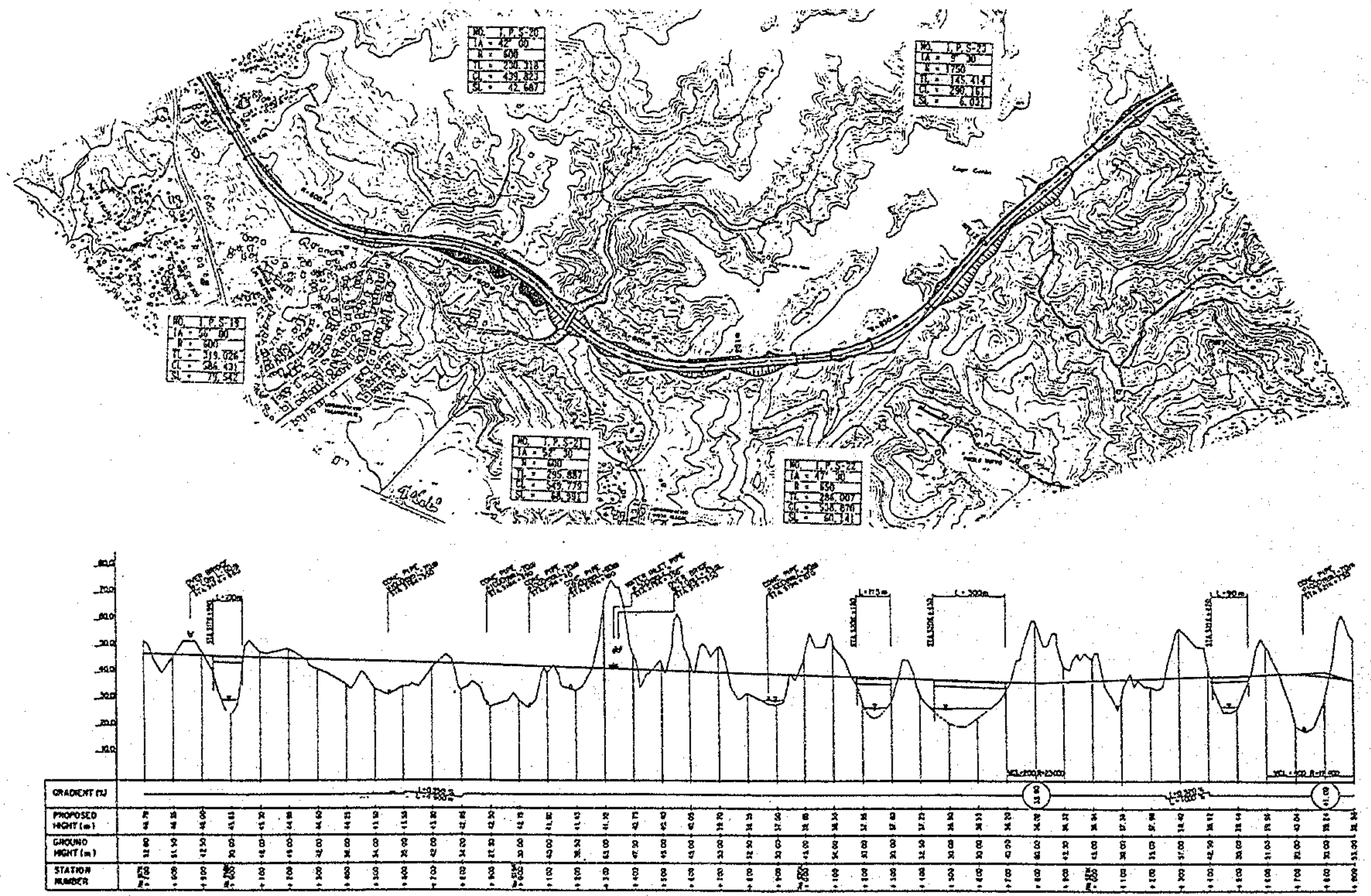
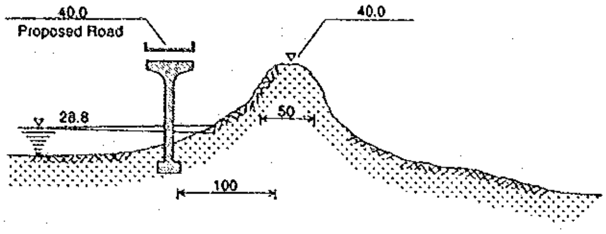
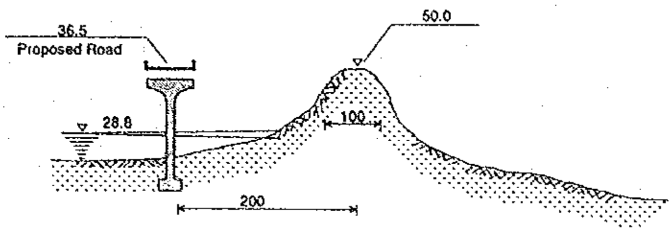


Figure 17.1.8 Location of Saddle Dam

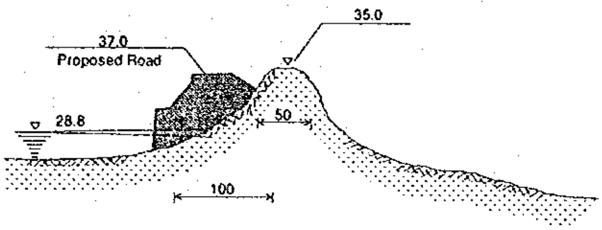
a) Baro 1



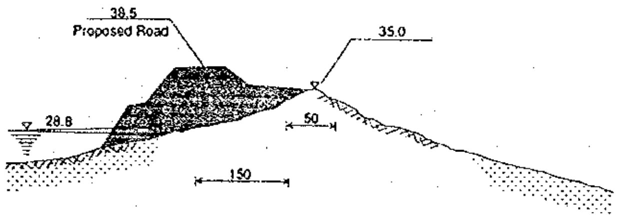
b) Baro 2



c) Baro 3



d) Cana 1 & 2



e) Cana 3

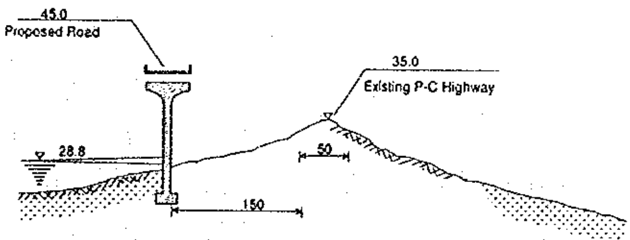


Figure 17.1.9 Cross - Section of Saddle Dam

17.1.3 Cross-Section Design

The cross-section design is carried out based on the typical cross-section mentioned previously as well as in consideration of future traffic conditions, the construction plan and topographic and soil conditions along the proposed road.

(1) Number of Lanes Required

1) Future Traffic Volume

The number of lane required is examined based on a comparison between the future traffic volume and lane capacity, as well as in consideration of the function and characteristics of the proposed road and the future and existing road network configuration. The future traffic volumes on each road segment in years 2010 are shown in Table 17.1.5.

Table 17.1.5 Future Traffic Volume
(Unit: PCU/D)

Road Section	Traffic Volume in 2010
San Miguelito-Alcarde Diaz	60,000
Alcarde Diaz- Calzada Larga	42,000
Calzade Laega-Buenos Aires	38,000
Buenos Aires-Buena Vista	33,000
Buena Vista-Sabanitas	36,000
Sabanitas- Colon	58,000

2) Traffic Capacity of Lanes

The traffic capacity is calculated depending on the type of road; 2-lane road or multi-lane road, width of cross-section elements, traffic characteristics and service level of road (LOS). The vehicle capacity is calculated based on the Highway Capacity Manual (HCM).

a) Traffic Capacity for a 2-lane Road

The traffic capacity is calculated using the following formula:

$$C=Bc*Cg*Cl*Cs*Cu*LOS$$

C ; Capacity per Lane
Bc; Basic Capacity (1,400 V/H/L)(2,000V/H/L)
Cg; Adjustment Factor per Heavy Vehicle (0.83)
Cl; Adjustment Factor per Lane Width (1.00)
Cs; Adjustment Factor per Clearance(0.70)(1.0)
Cu; Adjustment Factor per Land Use (1.00)

LOS; Level of Service (C)(0.77)

C=1,400*0.83*0.70* 1.00* 1.00* 0.77
=626 PCU/H/Lane
=6,200 PCU/D/Lane(10% peak hour ratio)

b) Traffic Capacity for a Multi-lane Road

C=2,000*0.83*1.00*1.00*1.00*0.77
=1,278 PCU/H/Lane
=13,000 PCU/D/Lane (10% peak hour ratio)

3) Number of Lanes Required

A 4-lane dual carriageway is adopted for the proposed road for the following reasons:

a) From the viewpoint of traffic volume on Alcalde Diaz Section, a 2-lane road will suffice until the year 2000. However, the traffic volume in 2010 will be exceeded the traffic capacity of the 2-Lane road.
b) In addition the above, the future traffic volume will be exceeded the traffic capacity of 2-Lane by the year 2002 to 2004.
c) The future traffic volume in 2000 on the Sabanitas Section will exceed the capacity of 2-lane road.
d) The proposed road is classified as a primary road in view of its functions. Such a primary road requires to be a 4-lane road even though the future traffic volume is forecast to be smaller than the capacity of a 4-lane road.ty.

(2) Gradients of Cuttings and Embankment Slope

The gradient of cuttings and embankment slopes is examined in construction of soil conditions in the cuttings and embankments. The subsurface soil investigation by was conducted by boring 18 holes along the proposed road. The detailed survey results and boring logs are shown in the "Technical Report".

1) Gradient of Cutting Slopes

The gradients of cutting slopes depend on the type of soil which will be excavated. Generally, the gradient of slopes is decided with reference to Table 17.1.6 as well in consideration of the gradient of existing cutting slopes in surrounding areas.

Table 17.1.6 Gradient of Slopes by Soil Conditions

Type of Soil		Cutting Height(H)(m)	Gradient (V:H)
Hard Rock		-	1:0.3 - 1:0.8
Soft Rock		-	1:0.5 - 1:1.2
Sand		-	1:1.5 - over
Sandy Clay	High Density	H<5m	1:0.8 - 1:1.0
		5<H<10m	1:1.0 - 1:1.2
	Low Density	H<5m	1:1.0 - 1:1.2
		5<H<10m	1:1.2 - 1:1.5
Sand with Gravel	High Density	H<5m	1:0.8 - 1:1.0
		5<H<10m	1:1.0 - 1:1.2
	Low Density	H<5m	1:1.0 - 1:1.2
		5<H<10m	1:1.2 - 1:1.5
Clay		H<10m	1:0.8 - 1:1.2
Clay with Gravel		H<5 m	1:1.0 - 1:1.2
		5<H<10m	1:1.2 - 1:1.5

From the results of subsurface investigation, the subsurface consists of two layers; one is surface soil consisting of silty clay and silty clay with gravels, and the other is soft rock consisting of granite with an observed 40 to 50. Taking the above soil conditions into account, a 1:1.0 (V:H) slope gradient for the surface soil layer and 1:0.5 (V:H) slop gradient for the soft rock layer are adopted. However, more subsurface investigations should be conducted when the actual slope gradients will are decided in the detailed (final) design stage.

2) Gradient of Embankment Slopes

Embankments will use the materials excavated from the existing ground as the result of a comparison between the embankment and cutting volumes based on the preliminary road design. The relationship between the gradient of embankment slopes and soil conditions is shown in Table 17.1.7.

Table 17.1.7 Gradient of Embankment Slope by Type of Soil

Type of Soil	Embankment Height(H)(m)	Gradient (V:H)
Soil (Good Grading)	0<H<6m	1:1.5
Sand with Gravel	6<H<15m	1:1.8
Sand (Bad Grading)	0<H<10m	1:1.8
Gravel	0<H<10m	1:1.5
	10<H<20m	1:1.8
Sandy Clay	0<H<6m	1:1.5
	6<H<10m	1:1.8

As mentioned the above, embankments use soft soil and silty clay in a mixture similar to mar of material excavated for the road bed. Taking the embankment materials for the proposed road into account, a 1:1.5 (V:H) slope gradient is adopted for embankments of less than 5.00 meters in height and a 1:1.8 gradient for embankment of over 5.0 meters in height. However, a circular ship study should be carried out when the detailed (final) design is made.

17.1.4 Pavement Design

(1) Design Standards

In Panama there are no established regulations for road design regarding geometric aspects and interrelationships with ground-structures. The Executive Direction of Study and Designs in M.O.P., uses the norms of AASHTO, those of the American Asphalt Institution, some adapted from the Mexican Manual, Hickerdon's book on geometric design and some of the ideas of the Portland Cement Association for the design of concrete structures.

However, the types of pavements to be adopted in Panama are defined according to volume of traffic that uses them:

a) 50	to 100 (V/D)	Gravel Pavement
b) 500		Surface Bituminous Treatment
c) 1400		Asphalt Concrete Pavement
d) 2000		Cement Concrete Pavement

(2) Pavement Type to be Adopted in this Study

The type of cement concrete pavement for the proposed road is adopted in consideration of the following points.

a) In Panama, there is more experience with cement concrete pavement than asphalt concrete pavement.
b) The materials for cement concrete pavement can be produced in Panama. The materials for asphalt concrete pavement also can be produced in Panama, but, there is one asphalt plant which is the MOP and three plants which are private company.
c) The maintenance of cement concrete pavement is more economical than that of asphalt concrete pavement. The initial construction cost of cement concrete pavement (40.5 Balboas/m2) is lower than for asphalt concrete pavement (45.95 Balboas/m2).

(3) Pavement Thickness

1) Concrete Slab Thickness

A 25 centimeters thick cement concrete slab is adopted for the proposed road as the result of a calculation of pavement thickness based on the AASHTO Design of Pavement Structure.

2) Base Course Thickness and Materials

The base course thickness and materials for the cement concrete pavement are determined depending on the accumulated traffic volume. The base course thickness is generally determined according to the thickness of the cement concrete slab. For a concrete slab which is 25 centimeters thick, there are two thicknesses of base course with 3 different compositions as listed below.

a) 15.0 centimeters thick base course consisting of a cement stabilization layer with a 30 millimeters maximum aggregate size.
b) 15.0 centimeters base course thick consisting of a 4.0 centimeters thick cement asphalt layer and an 11.0 centimeters thick mechanical stabilization layer.
c) 20.0 centimeters thick base course consisting of a gravel stabilization layer.

In Panama, in several, c) is adopted for cement concrete pavement. However, it is comparatively difficult to acquire the aggregate in the project area. Considering difficulty of acquiring pavement materials, a) is adopted for this project. In addition, the cement materials can be produced in Panama. The pavement structure is illustrated in Figure 17.1.10.

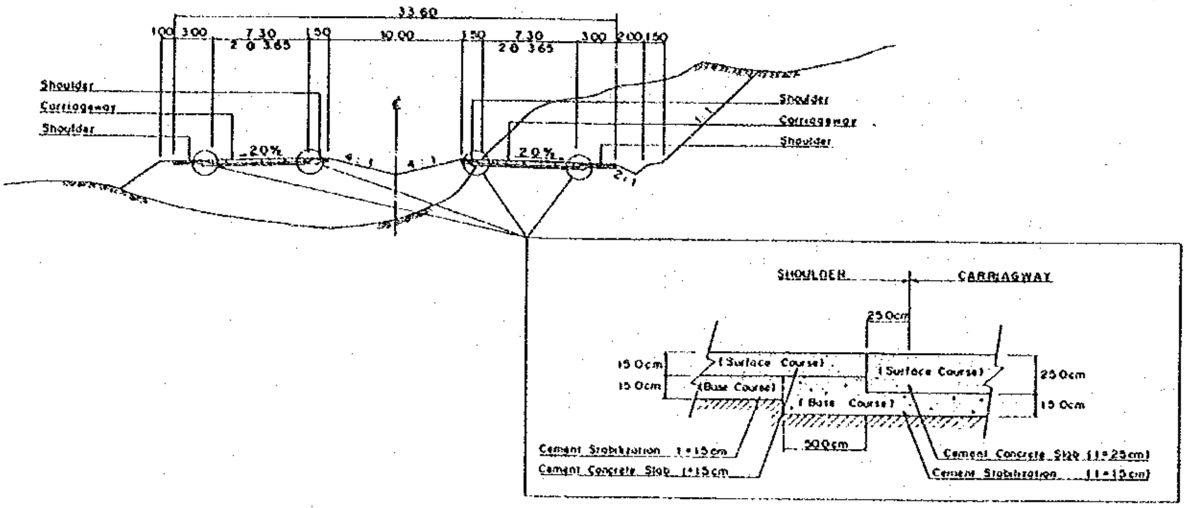


Figure 17.1.10 Pavement Structure Cross Section

17.1.5 Drainage Design

(1) Drainage System

It is examined in consideration of past experience of road construction in Panama, the environmental aspects of soil erosion and vehicle safety. The details of the basic drainage system are as follows;

a) On the top of cutting slopes, a water channel is con trolled for collecting rainwater from the surrounding area which should prevent it running through into the road area.
b) At the bottom of cutting slopes, a water channel is provided for collecting the rainwater from the cutting slope area which should prevent it running through onto the carriageways.
c) At the bottom of embankment slopes, a water channel is provided for collecting the rainwater from the embankment slope area.
d) Rainwater from carriageways is collected in the water channels provided at the bottom of cutting and embankment slopes.
e) Pipe culverts or box culverts are provided for the small rivers (quebrada) that across the proposed road.
f) The bridges are provided on rivers that cross the proposed road.

The above mentioned systems are illustrated in Figure 17.1.11.

(2) Drainage Design

The drainage design is conducted based on the drainage system and in consideration of the existing water flow situation and topographic conditions.

1) Rivers as an outlet for Rainwater

As the result of a field reconnaissance survey along the proposed road and topographic analysis, the following rivers is selected as outlets for rainwater.

a) Rio Las Lajas (Alcarde Diaz Section)
b) Rio Chilibrillo (Alcarde Diaz Section)
c) Rio Chagres (Chagres Section)
d) Rio Azote Caballo (Chagres Section)
e) Rio Duque (Sabanitas Section)
f) Rio Giral (Sabanitas Section)
g) Rio Agua Sucia (Sabanitas Section)
h) Rio Gatun (Sabanitas Section)
i) Rio Rita (Sabanitas Section)
j) Rio Coco Solo (Sabanitas Section)

The location of the above rivers and rainwater flow directions are shown in the rainfall flow direction maps in Figure 17.1.12 to 17.1.14.

2) Box Culverts and Pipe

Box Culverts have been provided at the following points considering the topographical conditions and run-off volumes based on the field reconnaissance survey. The minimum size adopted for the box culverts is 3.00 * 3.00 (H*B) considering the preserve of soil, rocks of logs in the water.

a) At small rivers(Quebrada)
b) At large embankment sections
c) At animal roads

Pipe Culverts have been provided at small casements-areas and the small areas of stagnant water on embankment sections. The minimum diameter of pipe culverts adopted is 1.00 meter, in consideration if maintenance.

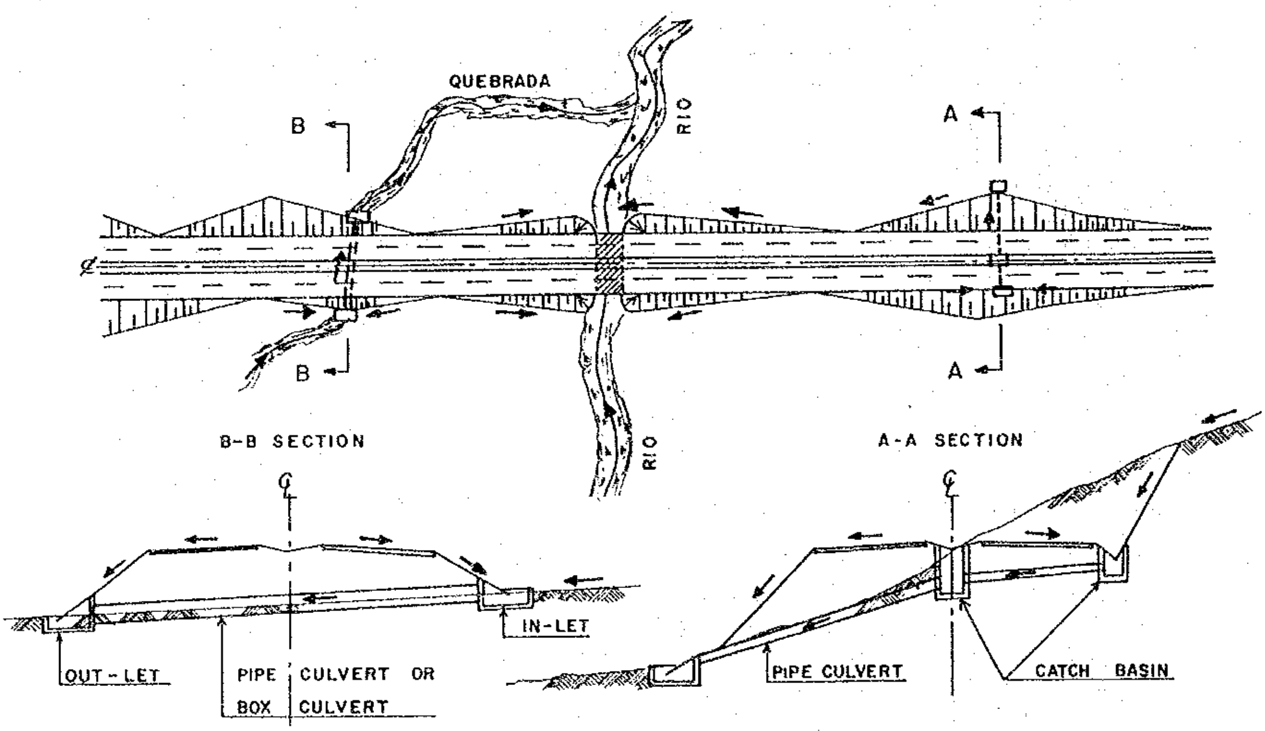


Figure 17.1.11 Typical Drainage Systems

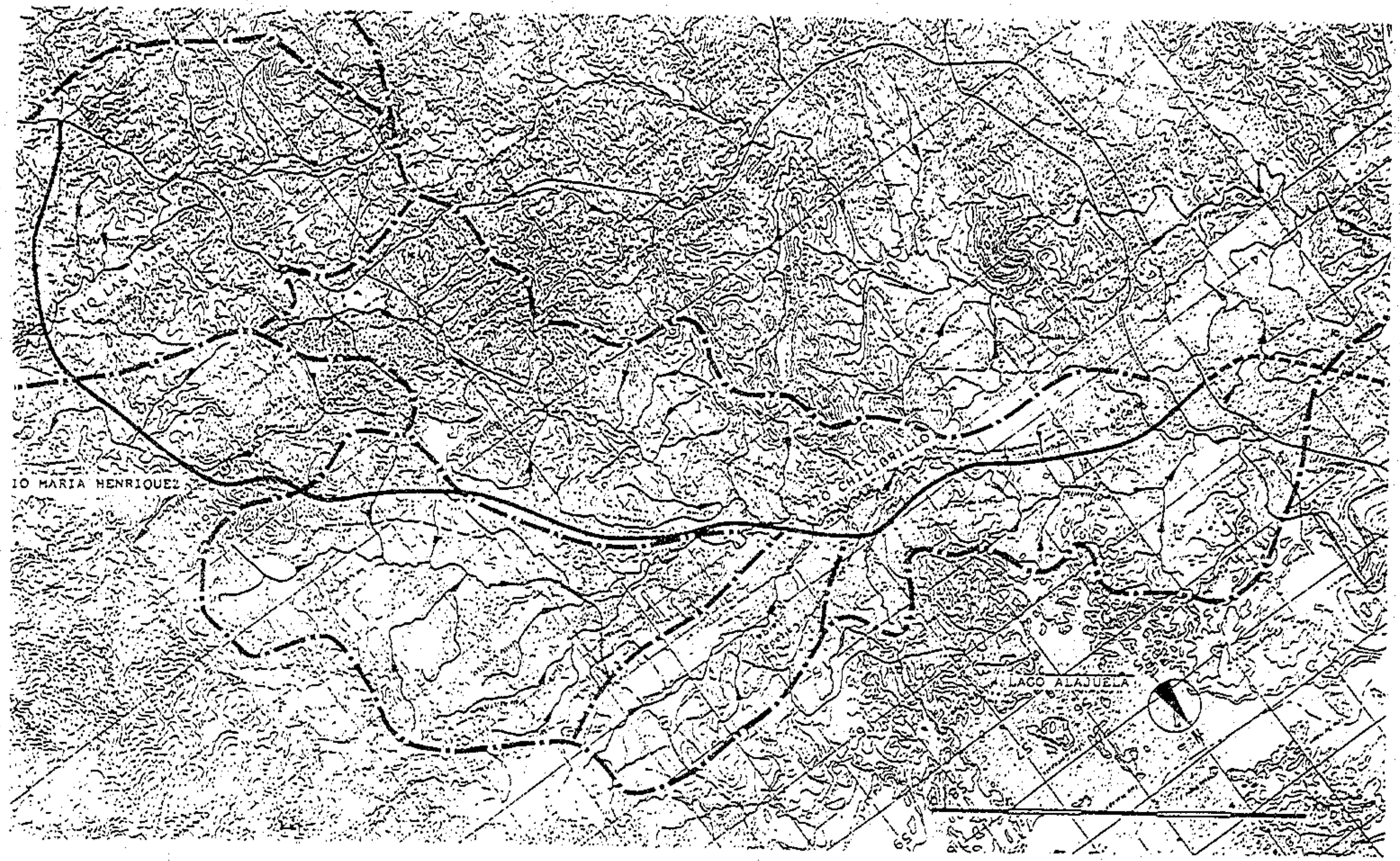


Figure 17.1.12 Rainfall Flow Direction Map
(Alcalde Diaz Section)

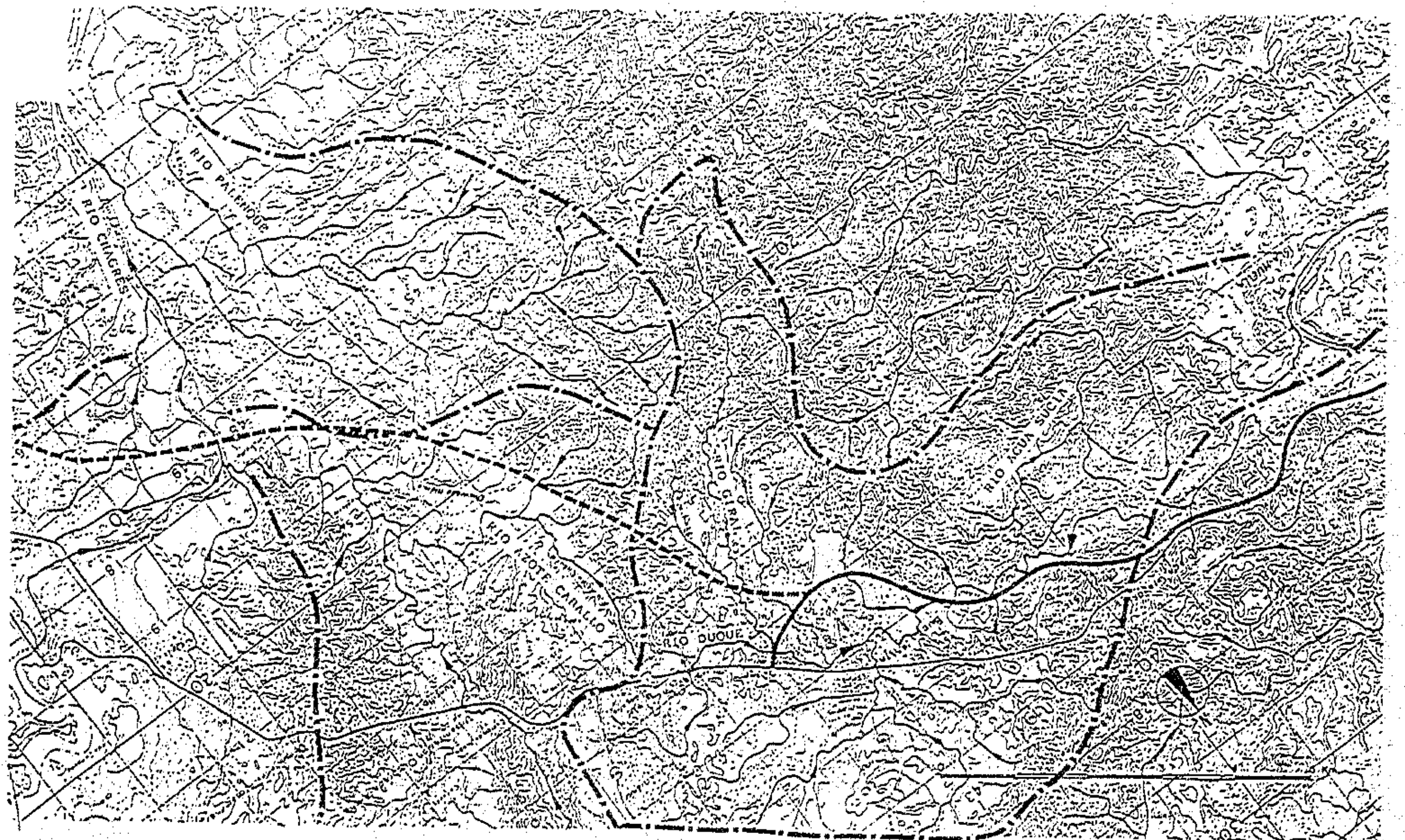


Figure 17.1.13 Rainfall Flow Direction Map
(Chagres Section)

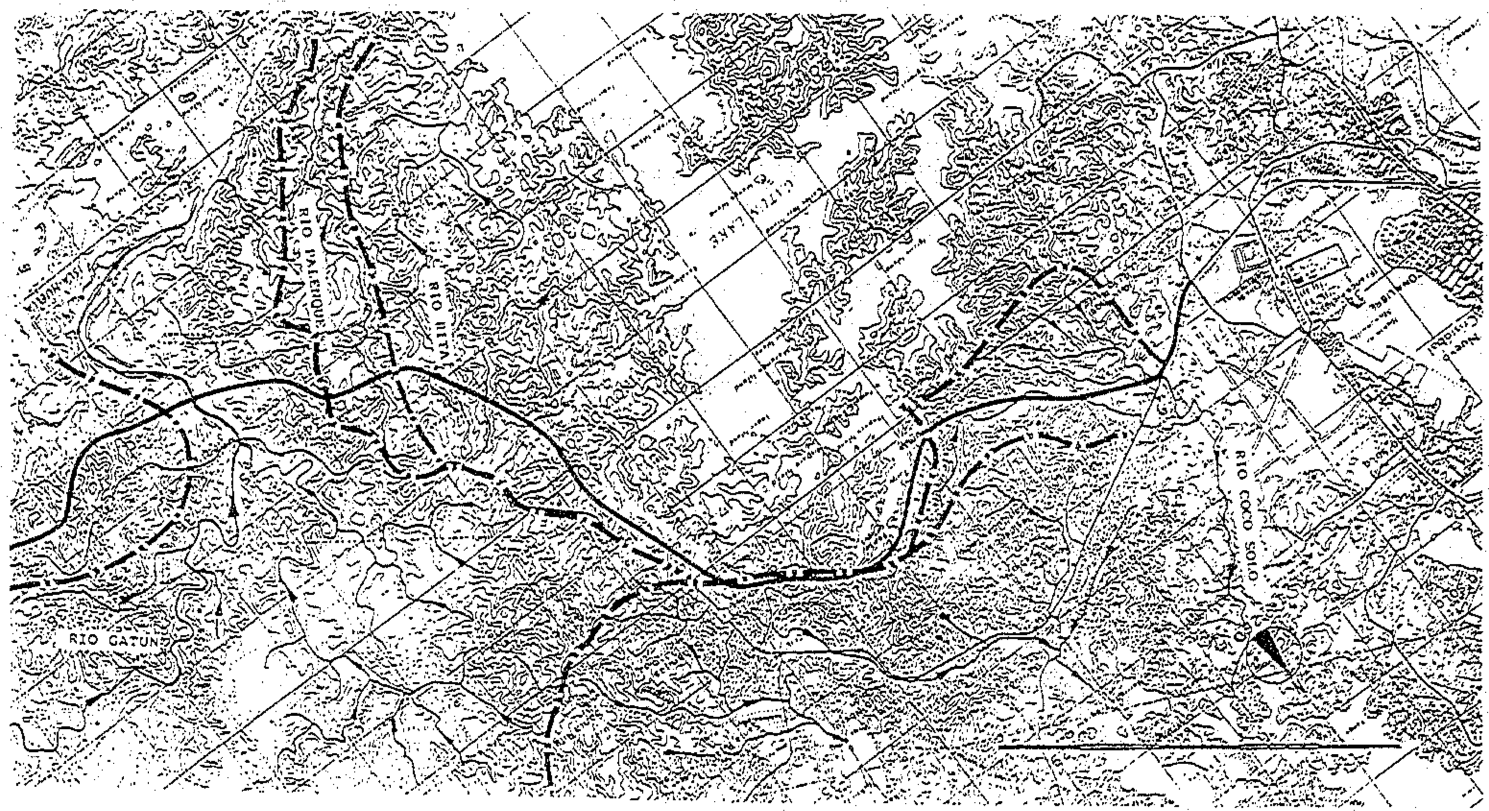


Figure 17.1.14 Rainfall Flow Direction Map
(Sabanitas Section)

17.1.6 Interchange (I.C.) Design

The interchange design has been in consideration of the following points:

a) Highway classification and road network
b) Characteristics and traffic composition
c) Design Speed
d) Traffic control and toll systems
e) Economic aspects
f) Geographical features (Terrain)
g) Housing development and land acquisition

Before doing the interchange design, the future road network expected in the Study Area is clarified in order to consider the long-term road network configuration.

(1) Future Road Network Expected

1) Panama Metropolitan Area (See Figure 17.1.15)

There are three primary road network plans in the Panama Metropolitan Area. In 1982, the detailed design of Arraijan-Panama Highway, a toll road system was completed by MOP. In 1984 and 1987, Corredor Norte and Corredor Sur were recommended as the primary road network by the Feasibility Study on Urban Transport Project prepared by JICA, and in 1988, a detailed study on Corredor Norte was carried out by MOP.

The proposed road is connected directly to the Corredor Norte in order to contribute to the economic development between the cities of Panama and Colon. The housing and industrial development in Tocumen area has been progressing gradually. In the case of occurrence of necessity to connect between colon and Tocumen, the proposed road may be required to connect directly with the Autopista Arraijan-Panama Highway and Corredor Norte Extending in Figure 17.1.15.

2) Alcalde Diaz Area (See Figure 17.1.15)

The proposed road is located outside the Alcalde Diaz area as the primary road network.

The road networks of in the Alcalde Diaz area is not sufficient to be developed into a functional road network. The housing development has been expanding into the suburbs of Alcalde Diaz area rapidly. Considering the future population and traffic conditions in the Alcalde Diaz area, a functional road network should be developed as soon as possible.

Considering the existing road network and geographical features in the Alcalde Diaz area, a ladder road network pattern can be suggested as a secondary road network, as shown in Figure 17.1.15. In addition , the function of the existing Panama-Colon Highway will be degraded to form part of a secondary road network, in consideration of future traffic conditions and the functions of the proposed road.

3) Colon Metropolitan Area (See Figure 17.1.16)

Colon Metropolitan Area covers the Colon, Cativa and Sabanitas areas. There is a future road network plan for this area.

In 1993, the ring road network has recommended as the primary road by the Cristobal Port Improvement Study conducted by JICA. The proposed road is connected to this ring road directly as the primary road network.

Housing developments in the Colon Metropolitan area has expanded into the Cativa and Sabanitas areas gradually. However, there is not enough space for roads in this area. Considering future traffic demand, some new roads may be required in the northern parts of the Cativa and Sabanitas areas as a part of the secondary road network.

The traffic going long distances may use the proposed road and that going short distances, may use the existing Panama-Colon Highway.

(2) Location of Interchanges

In the location of interchanges, the following points should be taken into consideration:

a) Characteristics of Traffics using interchanges
b) Road network and connected roads
c) Economic aspects
d) Environmental and development conditions where interchanges are to be located

Generally, the intervals been interchanges in urban areas, suburban area and rural areas are recommended as 3.0 to 5.0 kilometers, 5.0 to 10.0 kilometers, and 15.0 to 25.0 kilometers, respectively.

Regarding the future road network in the Alcalde Diaz area, two new roads ; one North-South and the other East-West will be required as the secondary road network in this area in order to contribute to its future development. In addition to the above, it will be necessary for that the other new roads to be connected to the Arraijan-Panama Autopista as a primary road network to contribute to the areas between the housing and industrial developments in the Tocumen areas and the Colon development areas, as shown in Figure 17.1.15.

Taking into account the progress in housing developments and the future secondary road network configuration, interchanges are provided at four points in Alcalde Diaz, are for connection to existing roads, that is, Panama-Colon Highway, Route No. 860 and Route No. 8306.

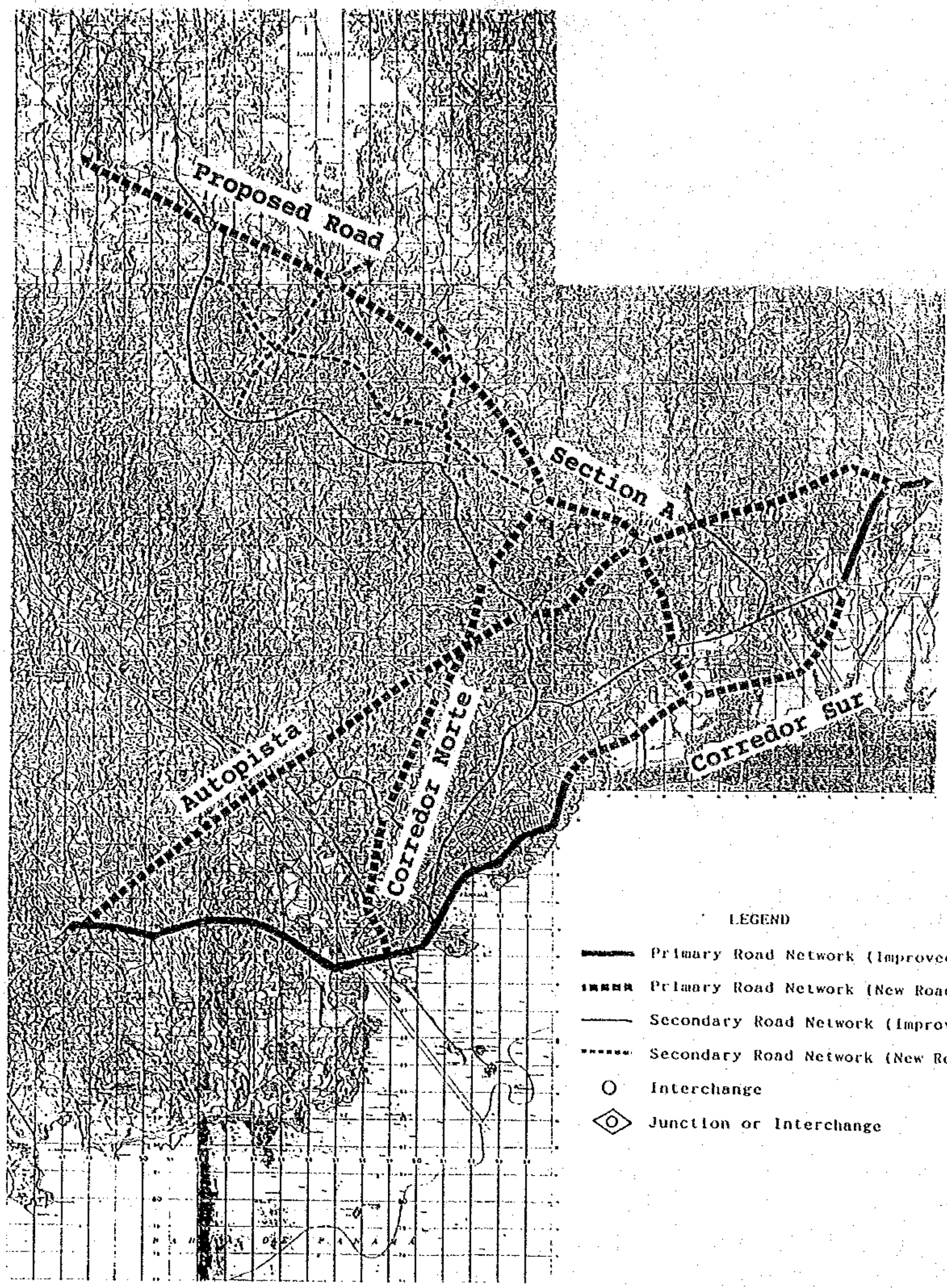


Figure 17.1.15 Future Road Network in Panama Area

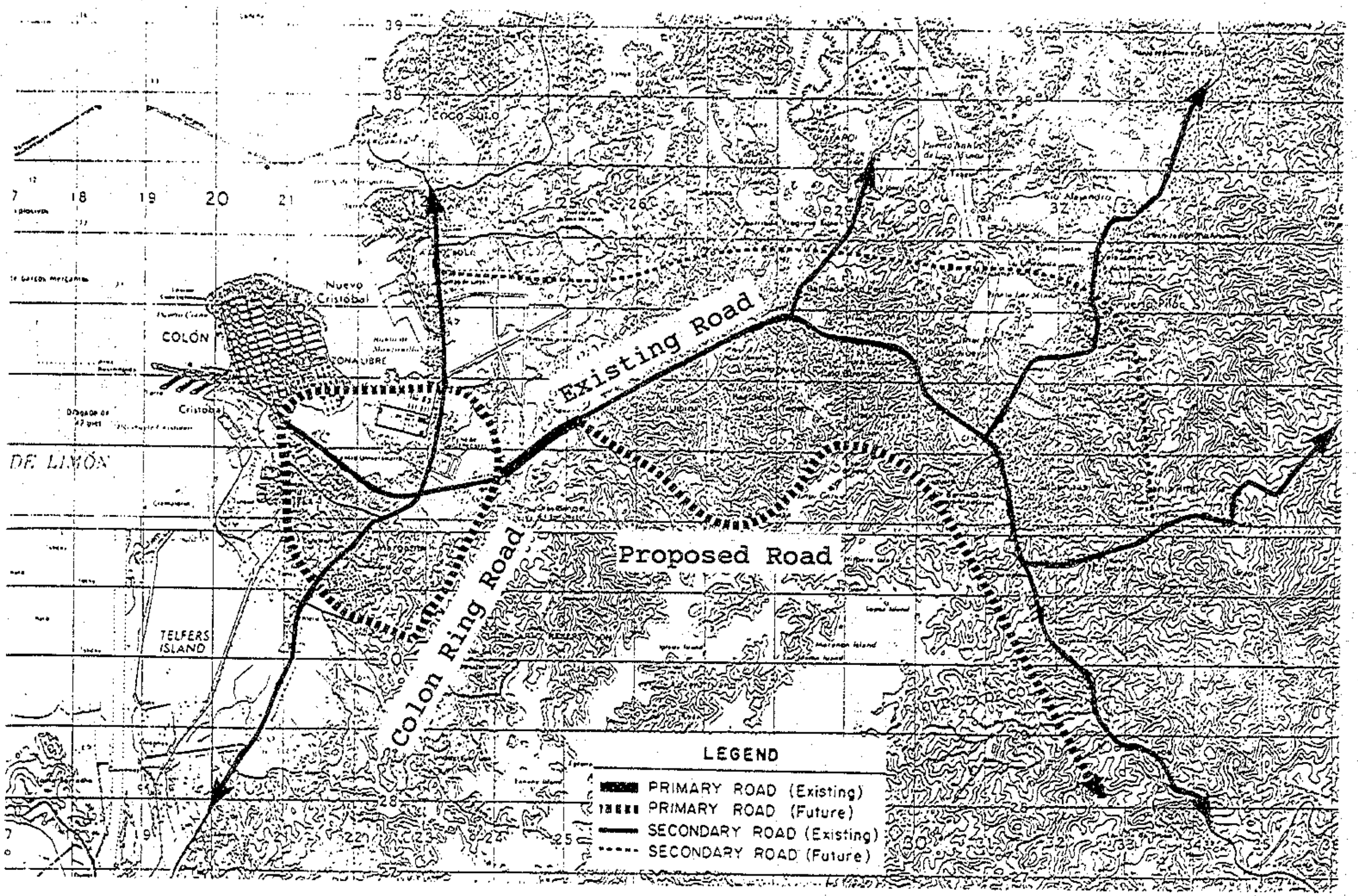


Figure 17.1.16 Future Road Network in Colon Area

An intersection for the proposed road and connecting road to the Arraijan-Panama Autopista may be planned after the year 2010. However, it is necessary for this intersection to be planned as a junction with a high design speed or full service interchange, because it is an intersection between primary roads. In other sections of Alcalde Diaz, the interchanges are located at Buena Vista and Sabanitas, in consideration of up-grading local city and traffic characteristics between the cities of Panama and Colon.

The location of the interchanges are shown in Figure 17.1.17 and the distance between the interchanges is shown in Table 17.1.8.

Table 17.1.8 Location and Interval of Interchanges

Location	Distance (km)
1. Panama-Colon Highway(San Miguelito I.C.)	---
2. Route No. 860 (Alcalde diaz I.C.)	7.0
3. Route No. 8306 (Calzada Larga I.C.)	5.0
4. Panama-Colon Highway (Buenos Aires I.C.)	8.0
5. Buena Vista (Buena Vista I.C.)	12.0
6. Sabanitas (Sabanitas I.C.)	20.0
7. Panama-Colon Highway (Colon I.C.)	10.0

(3) Types of Interchange

1) General Type of Interchanges

The general types of interchanges are shown in Figure 17,1,18. Any one type can vary extensively in shape and scope, and there are numerous combined types to which it is difficult to give separate names. An important element of interchange design is the assembly of one on more of the basic types of ramps.

The layout for any specific ramp and type of traffic movement will reflect the site conditions of topography and social aspect, cost, and the degree of flexibility in traffic operation desired. The last factor should predominate in design, but the practical aspects of cost and site conditions are frequently deciding factors in the type and scope of ramps.

The Trumpet and Three-Leg Directional types of interchange are suitable for three-leg intersections between primary roads and secondary roads or intersection between primary roads.

The One Quadrant type is an interchange with ramps in one quadrant that is not suitable for freeway systems but becomes very practical for an interchange between a major highway and a parkway. This design is appropriate for parkways because the design speed is usually low, large trucks are prohibited, and turning movements are small.

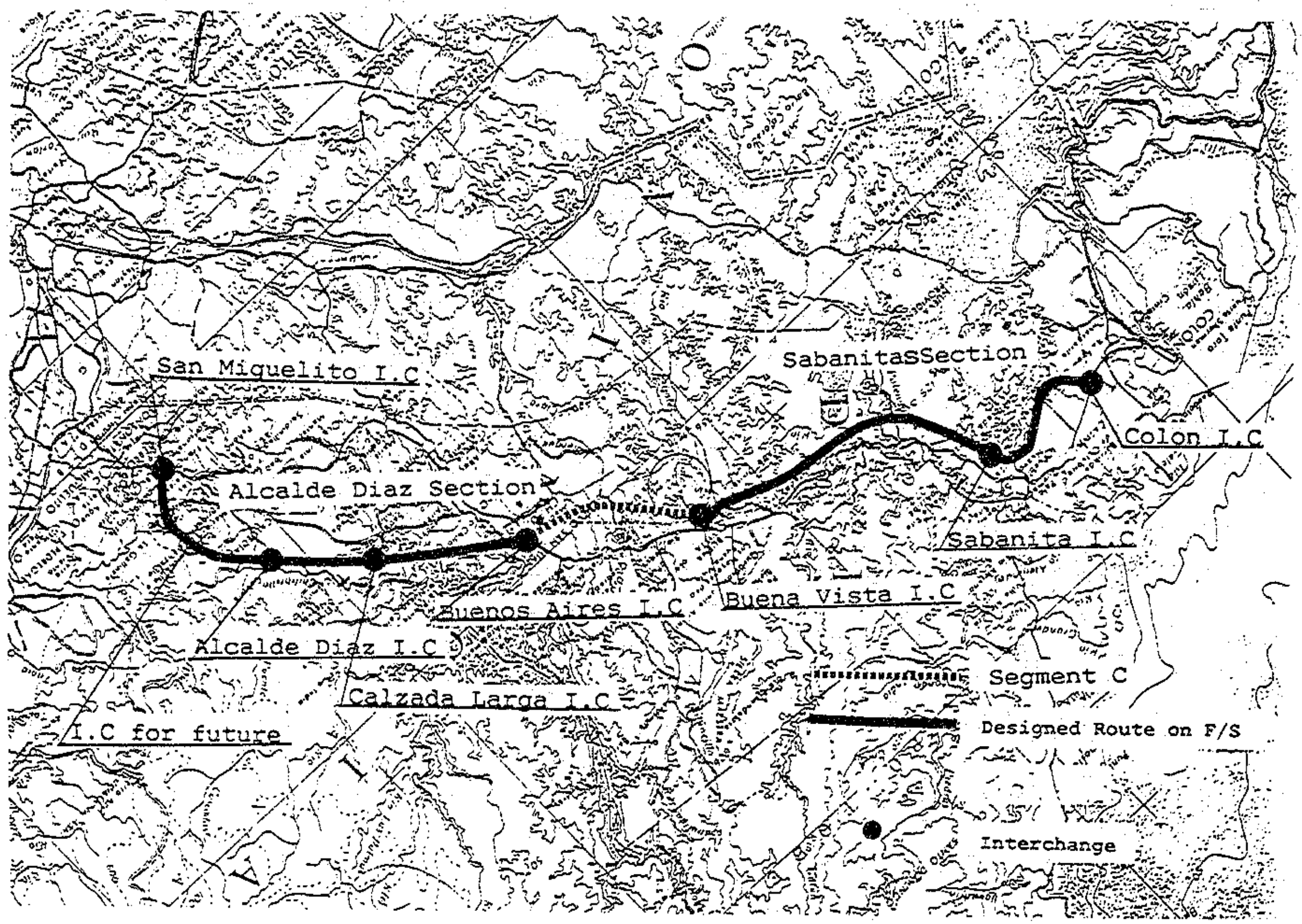


Figure 17.1.17 Interchange Location Map

The Diamond interchanges have numerous other configurations incorporating frontage roads and continuous collector or distributor roads.

A Partial Cloverleaf intersection contains two cloverleaf-type loops and two diagonal ramps. Varying configurations favor heavier traffic movements. A Full Cloverleaf, gives each interchange stream an independent ramp. However, it produces weaving maneuvers that must occur either in the area adjacent to the through lanes or on collector-distributor roads. The interchange type to be adopted in this Study is determined in consideration of the above points.

2) Type of Interchange to be Adopted

a) San Miguelito I.C.

San Miguelito I.C. is located at the intersection between the proposed new highway and the existing Panama-Colon Highway in the Lucha Franco area. This area has been developed into housing estates and commercial areas. The land value is estimated as about 30 to 50 Balboas per square meter.

There are three interchange types to be considered in this area as shown in Figure 17.1.19. As the results of comparing them, Type 3, the Diamond type interchange, has been adopted in consideration of the following:

- The Diamond type interchange is the most economical.
- The numbers of houses to be demolished for Type 1, Type 2, and Type 3 are 20, 10 and 2 respectively. Considering the land acquisition and compensation aspects, the Diamond type interchange has been adopted because it requires the smallest land acquisition and compensation.

b) Alcalde Diaz, Calzada Larga and Buenos Aires I.C.

There are three interchanges located in the suburban areas and there is enough land in these price of interchange areas for the construction of interchanges. In addition, the land value is very low. Considering future increases in traffic volume, it is necessary to plan a flexible type of interchange.

Taking construction stage into account, the single trumpet type interchange has been adopted. When the traffic volume on the existing road increases in the future, the Double Trumpet type interchange should constructed.

c) Buena Vista and Sabanitas I.C.

These interchanges are planned to be Three-leg intersection. As mentioned previously, the Trumpet type interchange is desirable for three-leg intersections. In addition, the price of land in these areas is low. Considering these points, the Trumpet type interchange has been adopted.

d) Colon I.C.

The Colon I.C. is located at the intersection between the proposed road and the existing Panama-Colon Highway in Coco Solo area.

Long distance traffic will use the proposed road and short distance traffic, such as commuter traffic between Colon and Cativ and Sabanitas will use on the existing Panama-Colon Highway.

From a consideration of traffic characteristics and road function, it is necessary for the proposed road to be directly connected to the existing Panama-Colon Highway.

(4) Design Criteria

1) Design Speed

According to the AASHTO, the design speed of an interchange should be 55 km/h, using the lower range of design speed. However, the design speed of a loop section of an interchange should be 40 km/h considering economic aspects and the land available for the construction of the interchange.

2) Deceleration and Acceleration Length

According to the AASHTO, the minimum deceleration and acceleration lengths for one lane ramps should be 150 meters and 380 meters, respectively.

3) Cross-Section

The following cross-section dimensions are adopted in consideration of the traffic characteristics and the function of the proposed road.

a) a 3.65 meters lane width
b) a 2.50 meters right shoulder width
c) a 1.00 meters left shoulder width
d) a 2.50 meters median width, including a 1.0 meters wide left shoulder

(5) Toll Road System

Generally, roads constructed without a toll system are classified as basic public infrastructure. Some roads, however, are constructed with a toll system because the construction of the road requires a large investment. When a road is constructed, it contributes to road users and provides economic benefits for people who own land along the road. So it is reasonable to charge a toll for using them.

Considering the above mentioned matters, some roads are constructed to introduce a burden share by beneficiary system. This is toll road.

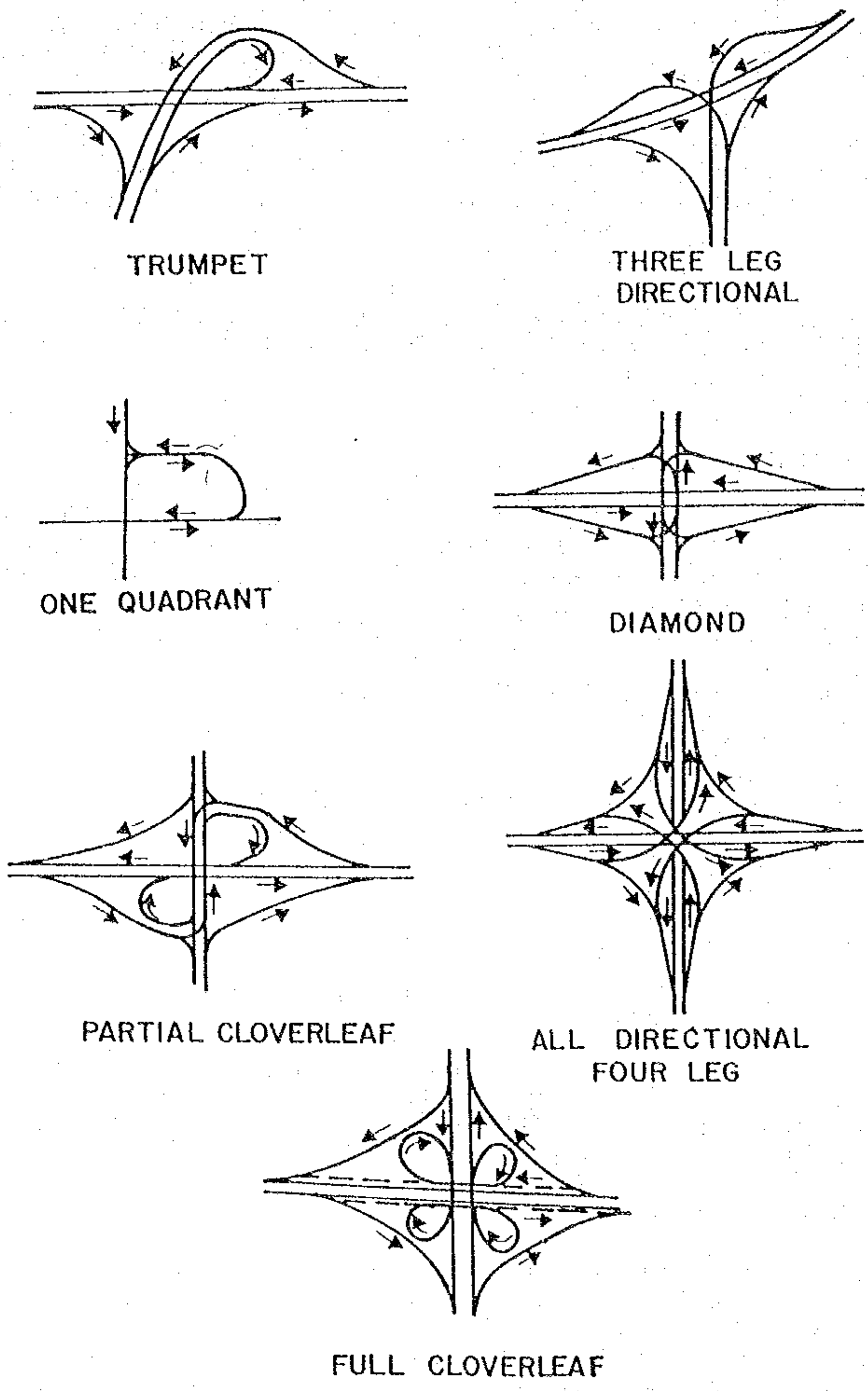
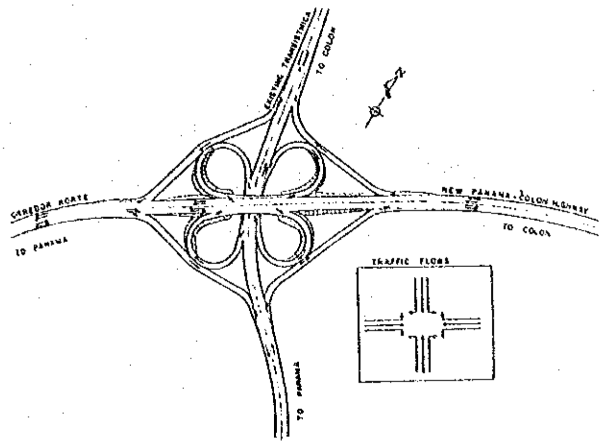
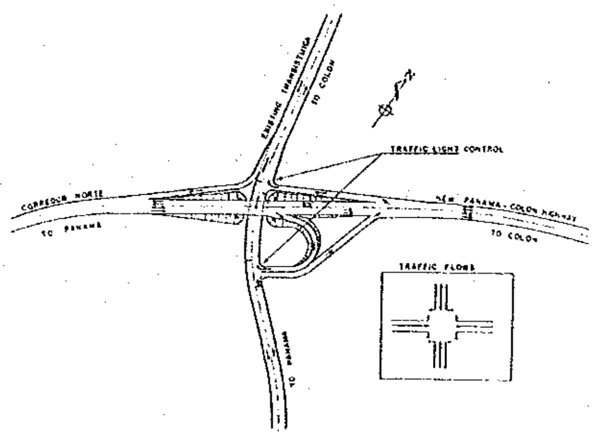


Figure 17.1.18 General Type of Interchange

Type 1; Full Cloverleaf



Type 2; Partial Cloverleaf



Type 3; Diamond

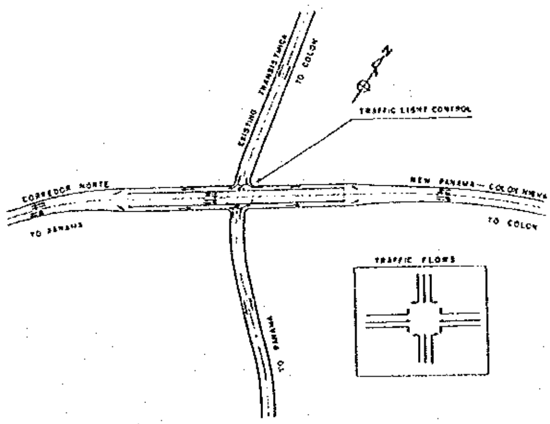


Figure 17.1.19 Alternative Interchange Types

in this section, comes toll system of the proposed road are examined when the proposed road will be required to introduce the toll road system.

There are two kinds of toll system as shown in Figure 17.1.20 : the distance related and fixed rate system. The fixed rate system is further divided into two systems: fixed rate for all road sections and fixed rate for certain road sections as shown in Figure 17.1.20.

The fixed rate for certain road section system is suggested for the Study considering for the following reasons.

a) Generally, the distance proportional system (A) is adopted for a comparatively long road. However, the total road length of the proposed road, at 60 kilometers is not so long.
b) The fixed rate for all road sections system (B) is generally adopted for a comparatively short road or a ring road network, considering the balance between rate and distance.
c) In the traffic survey conducted in February 1993, traffic on the proposed road is classified into three different patterns; traffic from Panama to Alcalde Diaz, from Panama to Colon and from Colon to Sabanitas. Taking these patterns into account, the proposed road will need to be divided into two or three sections to achieve a balanced toll rate.
d) As the proposed road will be constructed in stages, the flat rate for certain sections is the most flexible system.

17.1.7 Bus Facility Design

(1) General

Basically, there are two ways of solving traffic congestion as shown below;

a) To control traffic demand
b) To increase traffic capacity

The improvement of the public transportation system is one way of controlling traffic demand and the widening of the existing road or new road construction are ways of increasing the traffic capacity.

The construction of proposed road construction would be effective in solving traffic congestion and contributes to socio economic activities. However, the construction costs are very high and a long construction period will be required.

On the other hand, the improvement of the public transportation system, especially bus operation, would be effective in solving

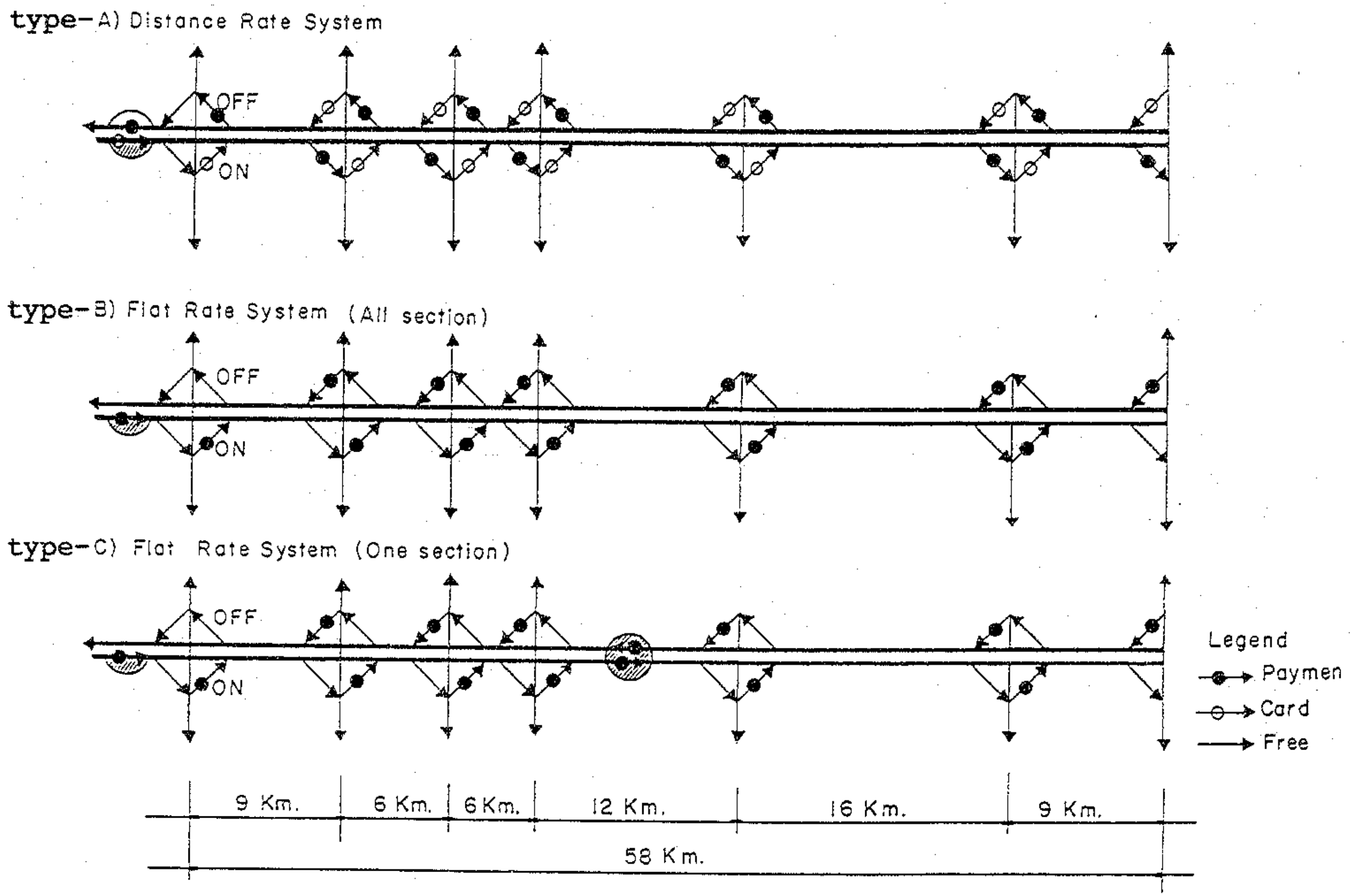


Figure 17.1.20 Conceptual Plan of Toll System

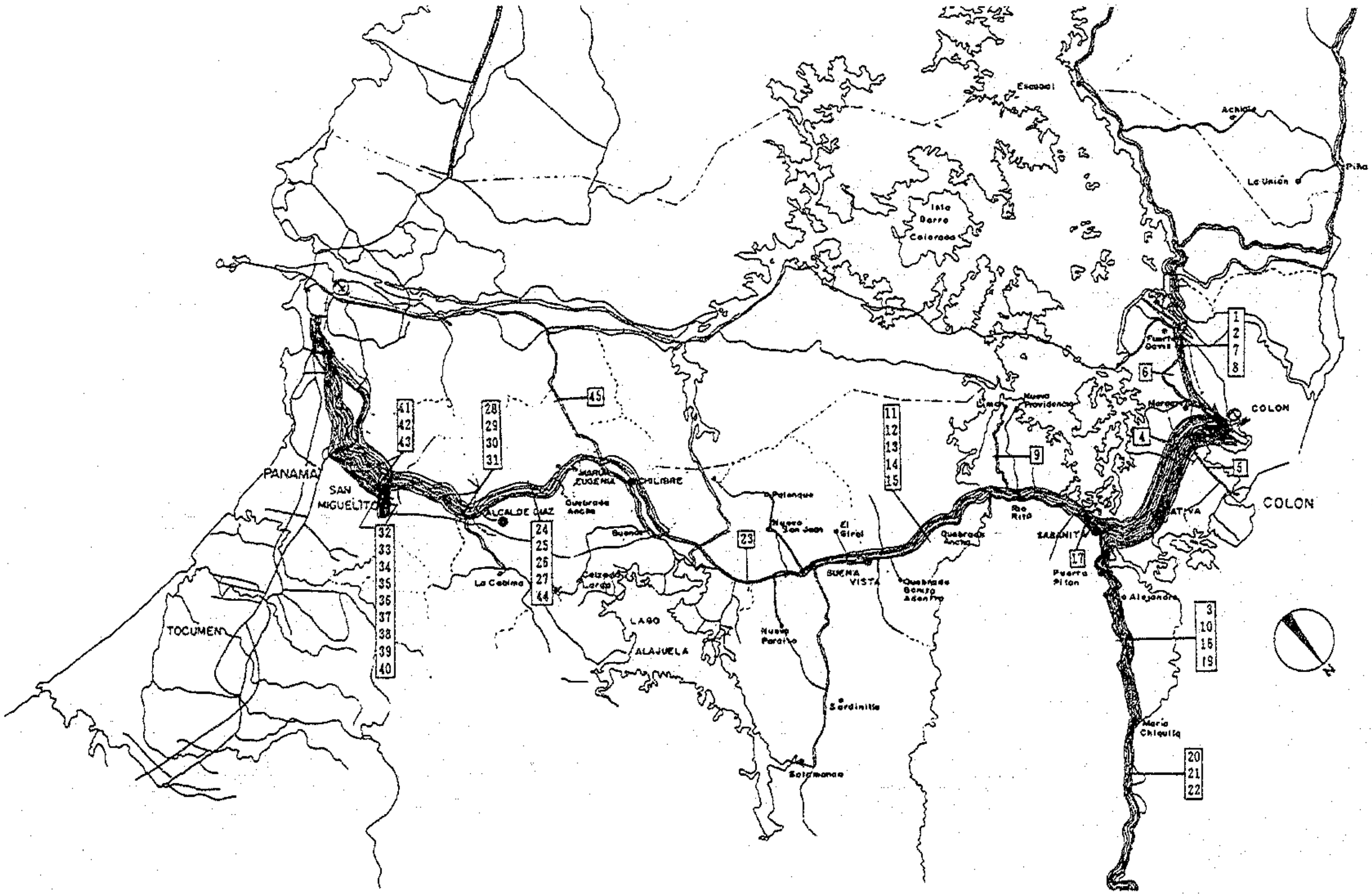


Figure 17.1.21 Existing Bus Route

traffic congestion would also be good environmentally decreasing air pollution. In addition, it is relatively easy to improve public transportation systems. Considering the above, it is very important to improve the bus transportation system.

(2) Existing Bus Routes and Traffic Volume

The existing bus routes in the area between the cities of Panama and Colon are shown in Figure 17.1.21. As shown in this figure, the main bus routes connect Panama's CBD to San Miguelito, Alcalde Diaz, and Colon's CBD to Cativa, Sabanitas.

However Bus routes cover the small villages such as Palenque, Nuevo Paraiso, and Salamanca. On the route between the cities of Panama and Colon, there are about 100 buses in the regular system and about 20 buses for the express system at present.

The traffic counting survey for the existing Panama-Colon Highway was conducted in February 1993 by the JICA Study Team. At that time, the bus traffic volume at various points was also counted as shown in Table 17.1.9.

Table 17.1.9 Bus Traffic Volume in 1993

(Unit: V/D)

Survey Point	No. of Mini Buses	No. of Buses	Total of Buses
Los Andes (4) South	3,366	3,593	6,959
Los Andes (5) North	1,926	2,718	4,644
San Isidoro (6) South	1,759	660	2,419
San Isidoro (7) North	1,089	456	1,545
Alcalde Diaz (8) South	1,049	382	1,431
Alcalde Diaz (9) North	508	345	853
Chilibre (10) South	481	453	934
Chagres (11) South	891	435	1,326
Chagres (12) North	736	400	1,136
Buena Vista (13) South	740	400	1,140
Rio Gatun (14)	1,091	319	1,410
Sabanitas (15) South	936	555	1,491
Sabanitas (16) North	1,152	782	1,934
Cativa (17) South	1,491	855	2,346
Cativa (18) North	1,446	845	2,291
Colon (19) South	1,271	908	2,179

From this table, the major part of bus operation is concentrated near the cities. However, about 1,000 buses operate between the cities of Panama and Colon. About 10 to 15 percent of total traffic volume is made up by buses and Min. buses.

(3) Bus Operation System

At present, there are two bus operation systems; the general bus system and the express bus system, operating on routes between the cities of Panama and Colon on the existing Panama-Colon Highway. It is very difficult to decide what the future bus system between the cities of Panama and Colon, therefore more detailed study on the public transportation system should be carried out in the future. For this purpose, a conceptual future public transportation system is presented in Figure 17.1.22. This conceptual plan would be adopted after construction of the proposed road.

1) Operation Systems

Generally, two operation systems can be considered: an express buses and a local bus system. Air-conditioned express buses with reclining seats may be operated on the proposed new highway, and the local buses may be operated on the existing Panama-Colon Highway.

The speed of an express bus will be taken as 110 Km/h and the travel time between the cities of Panama and Colon is expected to be about 40 to 45 minutes. Local buses stop are settled at each bus stop on the existing Panama-Colon Highway. The local buses should also serve the small villages located along the existing Panama-Colon Highway. The express buses will connect with the local buses at bus stops on the proposed road and existing roads.

2) Bus Terminals.

In the location of bus terminals, the following should be considered:

a) Bus operation systems
b) Bus operation routes
c) Existing and future bus traffic volume
d) Existing future traffic volume and its characteristics
e) Other public transportation networks
f) Existing and future developments
g) Land acquisition situation.

Generally, the bus terminals are located in urban areas and suburban areas. At bus terminals located in urban areas, it is very convenient for passengers to change routes. However, traffic congestion in urban area are expected, because, the bus traffic volume in 1993 in San Isidro area was seen to be about 7,000 V/D, and in the future, this will obviously increase. On the other hand, when bus terminals are located outside urban area, traffic congestion will decrease, but this will be relatively trouble save for the operation of the bus routes.

The conceptual plan of 1) 2) above are illustrated in Figure 17.1.22 as a conceptual plan for bus systems.

(4) Location of Bus Stops

The stops for express buses on the proposed road is located in

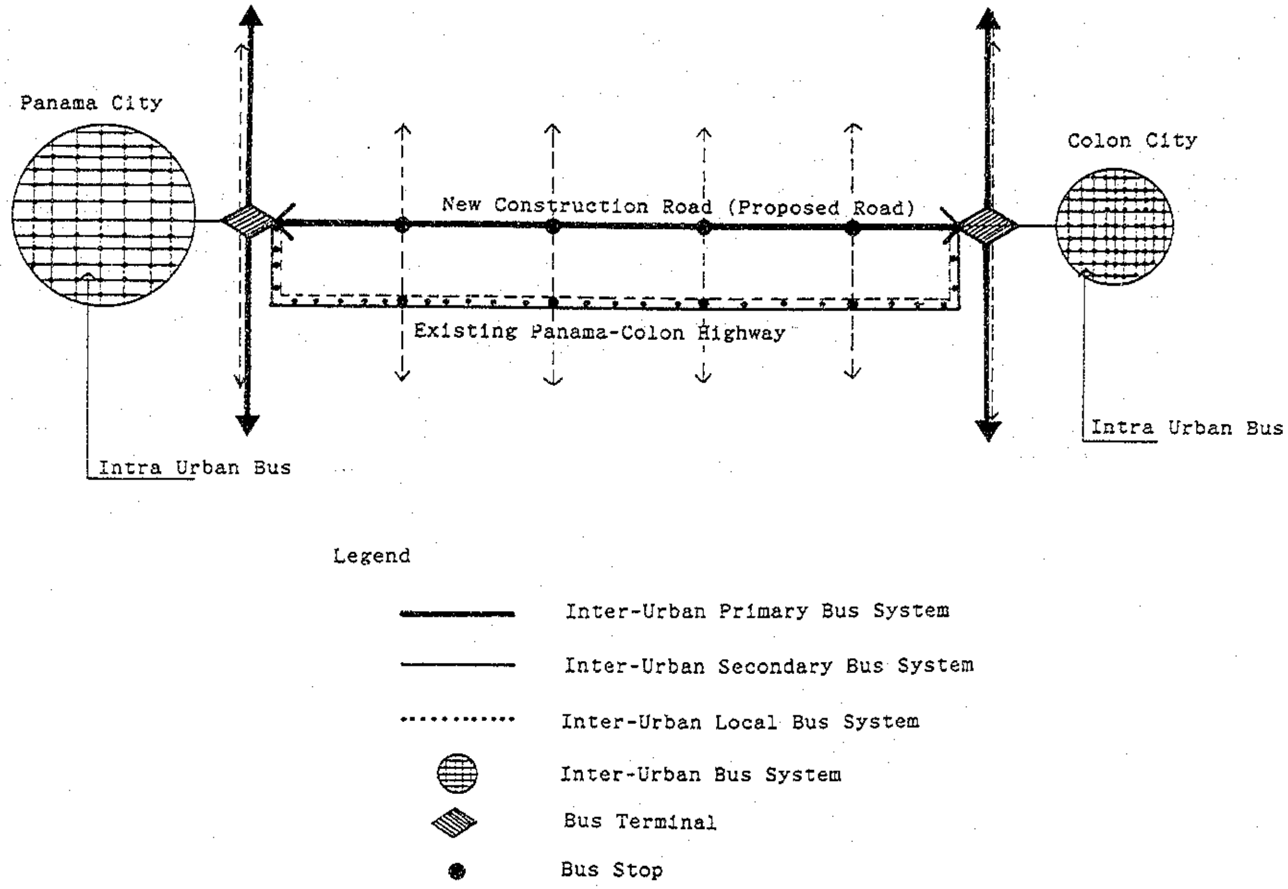


Figure 17.1.22 Concept of Bus Operation System

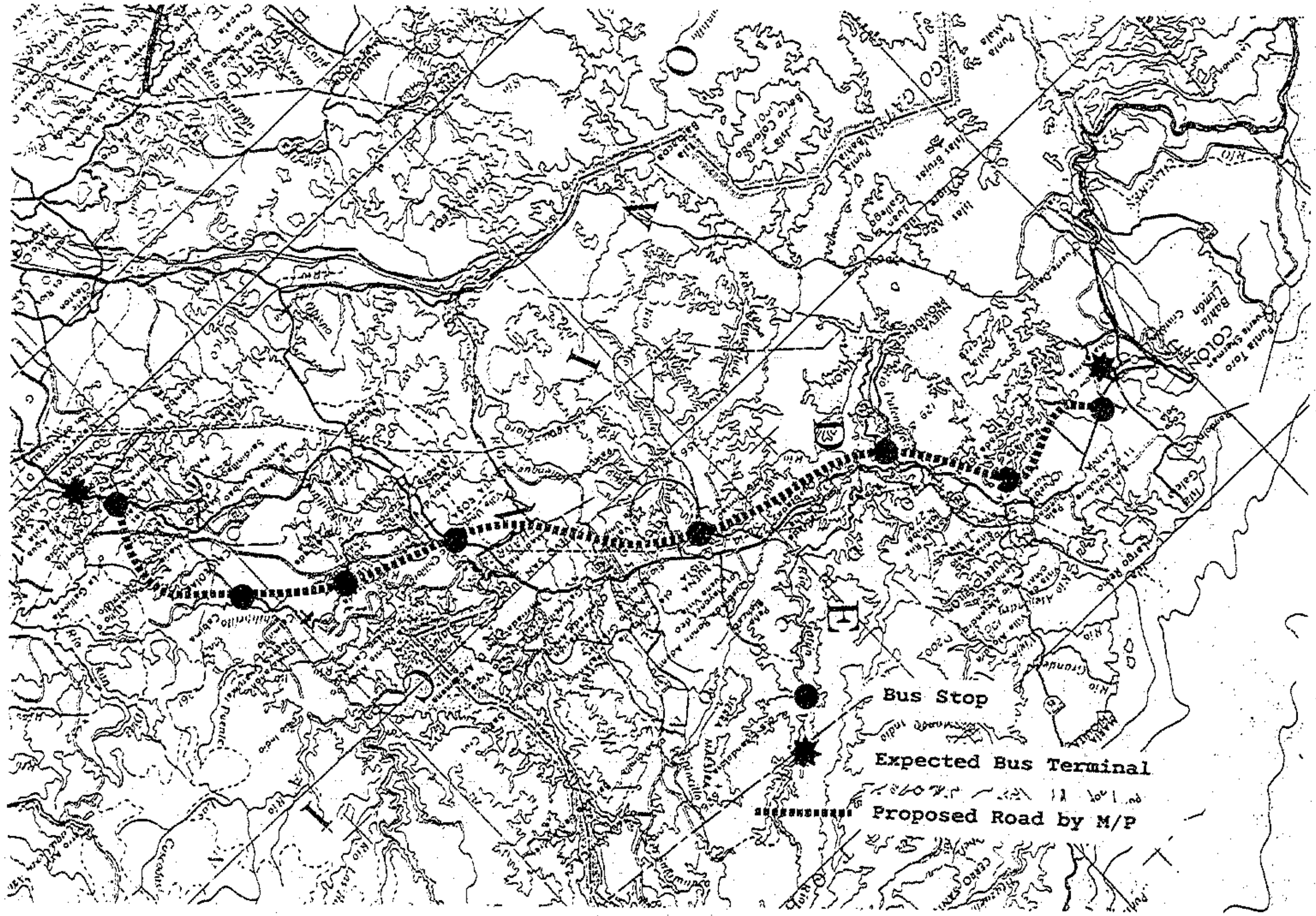
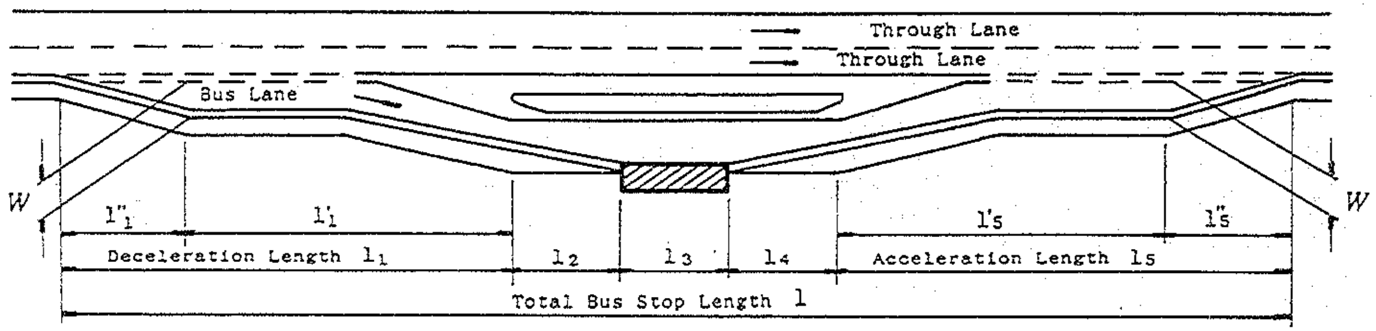


Figure 17.1.23 Bus Stops Location Map

consideration of the following points:

a) Connections with to the local bus.
b) Connections to the small villages along the existing Panama-Colon Highway.

The design details of the bus stops located on the road are shown in Figure 17.1.24.



Design Speed (km/h)		120	100	80	60	50
Taper	l_1'' (m)	70	60	50	45	40
Deceleration	l_1 (m)	180	160	140	105	75
Second Deceleration	l_2 (m)	50(40)	50(40)	40(30)	30	20
Bus Platform	l_3 (m)	30(20)	30(20)	20(15)	15	15
Second Acceleration	l_4 (m)	40(30)	40(30)	30(25)	25	20
Acceleration	l_5 (m)	220	190	160	115	70
Taper	l_5'' (m)	70	60	50	45	40
Total Bus Stop	l (m)	520	470	390	290	200

Source: Japanese Standard Design

Figure 17.1.24 Design Elements of Bus Stop

17.1.8 Service Area Design

(1) Function of Service Areas

Service areas are required on a road with a full access control system for drivers and passengers.

The service areas should be provided in consideration main facilities of service area shown below:

a) Maintenance work shop
b) Gasoline Station
c) Restaurant and toilets
d) Shopping areas and telephone booths
e) Parking space

Generally, service areas are provided for each direction. If the distance rate toll system is adopted, the service areas for each traffic direction should be separated. However, if the flat rate toll system is adopted, the intensive type of service area can be adopted.

The concept of a service area is shown in Figure 17.1.25, in acceptance with each of its functions.

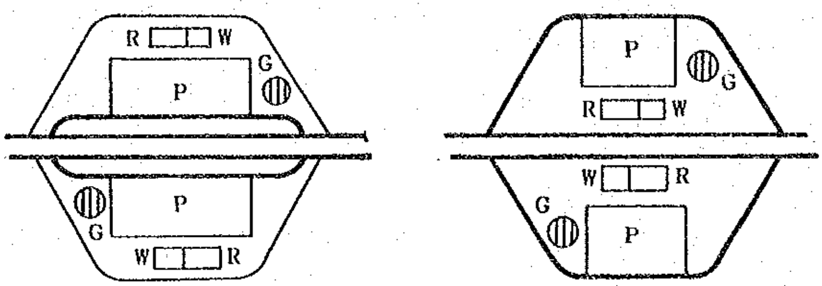
(2) Location of Service Areas

The size of service areas will be decided depending on the required parking space, restaurant sizes and size of maintenance work shops and gasoline stations. When parking space for 100 vehicles is required, about 5.0 hectors. is needed for the service area. In deciding the location of service areas, the following should be considered:

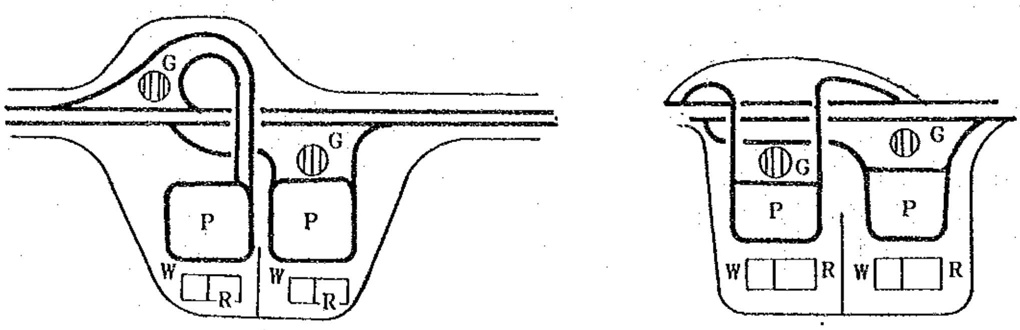
a) Generally, the interval between service areas should be about 15 to 25 kilometers depending on the functions of the service area.
b) A service area should be located at scenic spots.
c) A service area requires a comparatively wide area, so, a comparatively flat area should be selected.

As the result of a reconnaissance survey for the location of service areas, two service areas are placed one at STA. No. A 11+000 and the order of STA. No. S. 17+000.

A. Separated Type



B. Intensive Type



Legend
P: Parking Space
G: Gasoline, Maintenance
W: Toilet
R: Restaurant

Figure 17.1.25 Concept Plan of Service Area

17.1.9 Construction Quantities Estimate

The construction quantities is estimated based on the results of the road and bridge preliminary design mentioned previously. The construction quantities of main working items are shown in Table 17.1.10 and breakdown of construction quantities are shown in Table 17.1.11 to Table 17.1.14.

Table 17.1.10 Lists of Construction Quantities

Road Section/ Construction Items	Alcalde Diaz	Sabanitas
Road Length (km)	20.2	26.2
Excavation ('000 M3)	2,193	4,263
Embankment ('000 M3)	1,621	3,271
Pavement ('000 M2)	310	382
Bridge		
Road Bridge(Vol.)	5	10
Interchange(Vol.)	3	2
OV Bridge (Vol.)	4	6
Total (Vol.)	12	18
Interchange (Vol.)	3	2
Service Area (Vol.)	1	1
Bus Stop (Vol.)	3	3

Table 17.1.11 Construction Quantities in Alcalde Diaz (1)

V=110km/h		A 0K+00 ~ A 9K+200	A 9K+200 ~ A15K+500	A15K+500 ~ A20K+215	TOTAL
Working Items	Unit	Quantities	Quantities	Quantities	Quantities
1. Site Clearing	ha	40	28	22	90
2. Excavation (soil)	m3	652,468	604,352	416,015	1,672,835
3. Excavation (rock)	m3	195,684	161,277	164,875	521,836
4. Embankment(road)	m3	888,009	381,870	351,330	1,621,209
5. Wasted Soil(10km)	m3	0	343,902	229,560	533,605
6. Borrwed Soil (10km)	m3	39,857	0	0	0
7. Pavement Carriageway					
Surface t=25cm	m2	140,400	97,344	72,150	309,894
Base Couse t=15cm	m2	158,400	109,824	81,400	349,624
8. Pavement Shoulder					0
Surface t=15cm	m2	72,000	49,920	37,000	158,920
Base Couse t=15cm	m2	72,000	49,920	37,000	158,920
9. Pavement Sidewalk	m2	0	0	0	0
10. Slop Protection					
Grase	m2	143,009	70,361	61,860	275,230
11. Median					
Plantation	m2	90,000	62,400	46,250	198,650
Drainage	m	380	180	260	820
12. Drainage					
Roadway L-Type	m	6,855	5,055	2,395	14,305
Conc. Pipe φ1000mm	m	195	90	440	725
Conc. Pipe φ1500mm	m	220	60	50	330
Conc. Box 3.0m*3.0m	m	155	100	60	315
Conc. Box 5.0m*5.0m	m	0	0	0	0
Conc. Box 7.0m*5.0m	m	50	0	0	50
13. Additional					
Guard Rail	m	9,095	4,991	3,595	17,681
Lighting	vol	80	40	40	160
Lane Mark	km	9	6	5	21
Traffic Signal	vol	1	0	1	2
Traffic Sign	km	9	6	5	20
Noise Protection H=3.0m	m	4,000	0	0	4,000
		L=9,200	L=6,300	L=4,715	L=20,215

Table 17.1.12 Construction Quantities in Alcalde Diaz (2)

V=110km/h Working Items	Unit	A 0K+00 ~ A 9K+200 Quantities	A 9K+200 ~ A15K+500 Quantities	A15K+500 ~ A20K+215 Quantities	TOTAL Quantities
14. Wall					
Conc. Block H<5.0m	m	100	0	0	100
T-Type Retaining H<7.0m	m	360	0	0	360
15. Bridge					
20m<L<50m	m	70	60	50	180
50m<L	m	120	0	125	245
16. Other Facilities					
At-Grade Inter	vol	0	0	1	1
Interchenge					
Diamondo Type	vol	1	0	0	1
Trumpet Type	vol	1	1	0	2
Three Leg Directional	vol	0	0	0	0
Over Bridge	vol	2	2	0	4
Channel W=3.0m	m	1,450	0	170	1620
Service Area	vol	0	1	0	1
Bus Stop	vol	2	1	1	4
17. Land Acquisition					
Residenc Area A	ha	15	0	0	15
Residenc Area B	ha	15	5	8	28
Mountain Area	ha	62	58	40	160
18. Compensation					
House A	vol	15	0	0	15
House B	vol	12	3	9	24
House C	vol	15	6	18	39
Factory	vol	2	0	0	2
Water Indent	vol	0	0	1	1
Power Line	vol	0	0	0	0
		L=9,200	L=6,300	L=4,715	L=20,215

Table 17.1.13 Construction Quantities in Sabanitas (1)

V=110km/h		S 0K+00 ~ S16K+500	S16K+500 ~ S26K+200	TOTAL
Working Items	Unit	Quantities	Quantities	Quantities
1. Site Clearing	ha	108	51	159
2. Excavation (soil)	m3	1,479,162	605,508	2,084,670
3. Excavation (rock)	m3	1,450,182	728,955	2,179,137
4. Embankment(road)	m3	2,116,577	1,154,835	3,271,412
5. Wasted Soil(10km)	m3	812,767	179,628	992,395
6. Borrwed Soil (10km)	m3	0	0	0
7. Pavement Carriageway				
Surface t=25cm	m2	243,828	138,216	382,044
Base Couse t=15cm	m2	275,088	155,936	431,024
8. Pavement Shoulder				
Surface t=15cm	m2	85,965	48,730	134,695
Base Couse t=15cm	m2	85,965	48,730	134,695
9. Pavement Sidewalk	m2	0	6,000	6,000
10. Slop Protection				
Grase	m2	354,361	157,592	511,953
11. Median				
Plantation	m2	156,300	88,600	244,900
Drainage	m	820	500	1,320
12. Drainage				
Roadway L-Type	m	14,548	6,080	20,628
Conc. Pipe φ1000mm	m	970	895	1,865
Conc. Pipe φ1500mm	m	450	0	450
Conc. Box 3.0m*3.0m	m	300	90	390
Conc. Box 5.0m*5.0m	m	0	50	50
Conc. Box 7.0m*5.0m	m	0	0	0
13. Additional				
Guard Rail	m	8,880	5,850	14,730
Lighting	vol	40	40	80
Lane Mark	km	17	10	26
Traffic Signal	vol	1	0	1
Traffic Sign	km	16.5	9.7	26
Noise Protection H=3.0m	m	0	900	900
		L=16,500	L=9,700	L=26,200

Table 17.1.14 Construction Quantities in Sabanitas (2)

V=110km/h Working Items	Unit	S 0K+00 ~ S16K+500 Quantities	S16K+500 ~ S26K+200 Quantities	TOTAL Quantities
14. Wall				
Conc. Block H<5.0m	m	170	0	170
T-Type Retaining H<7.0m	m	0	1,490	1,490
15. Bridge				
20m<L<50m	m	50	0	50
50m<L	m	1,000	1,145	2,145
16. Other Facilities				
At-Grade Inter	vol	1	0	1
Interchenge				
Diamondo Type	vol	0	0	0
Trumpet Type	vol	1	0	1
Three Leg Directional	vol	0	1	1
Over Bridge	vol	3	3	6
Channel W=3.0m	m	500	600	1,100
Service Area	vol	1	0	1
Bus Stop	vol	1	2	3
17. Land Acquisition				
Residenc Area A	ha	0	1	1
Residenc Area B	ha	0	5	5
Mountain Area	ha	165	79	244
18. Compensation				
House A	vol	0	0	0
House B	vol	0	31	31
House C	vol	17	12	29
Factory	vol	0	1	1
Water Indent	vol	0	1	1
Power Line	vol			
		L=16,500	L=9,700	L=26,200