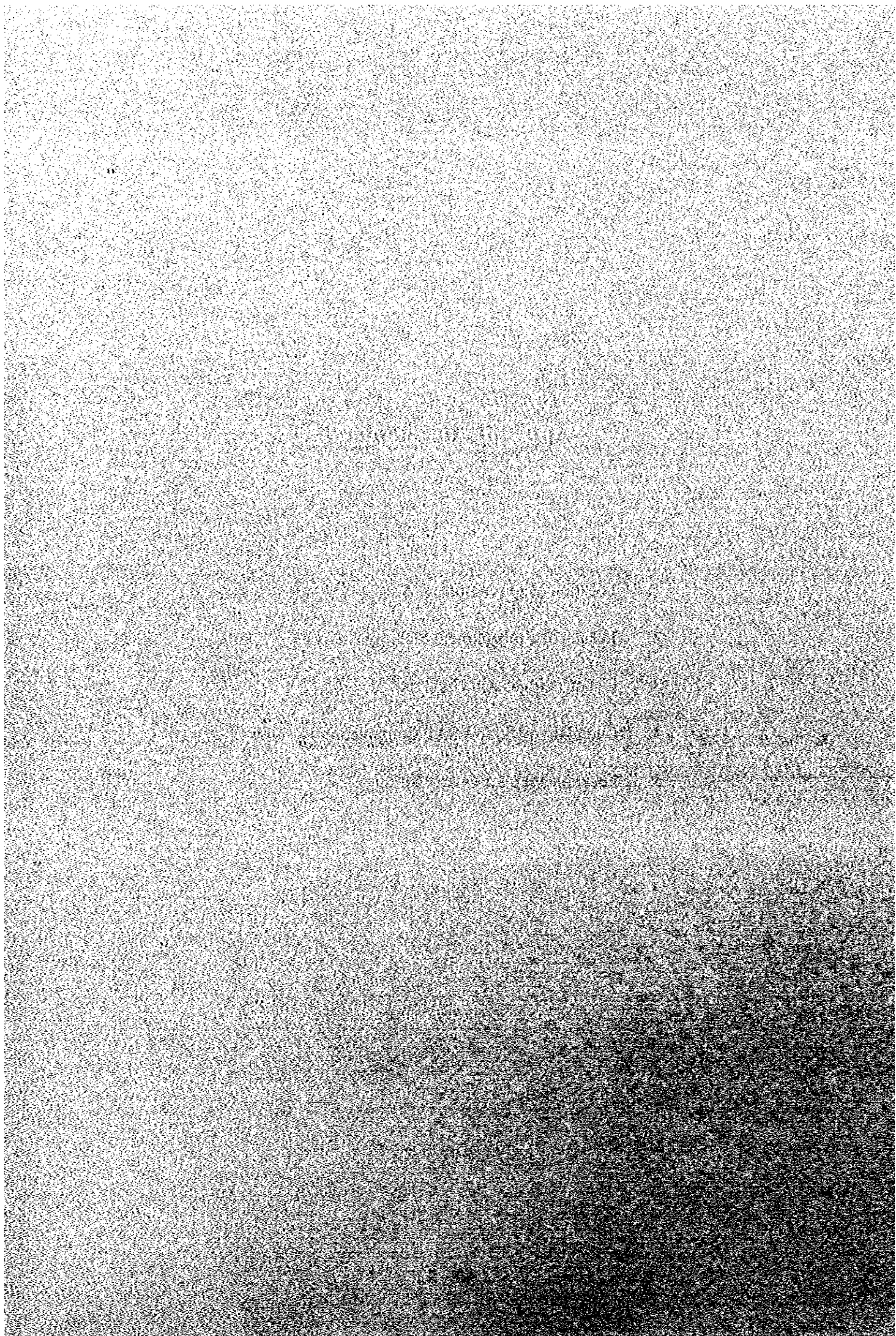
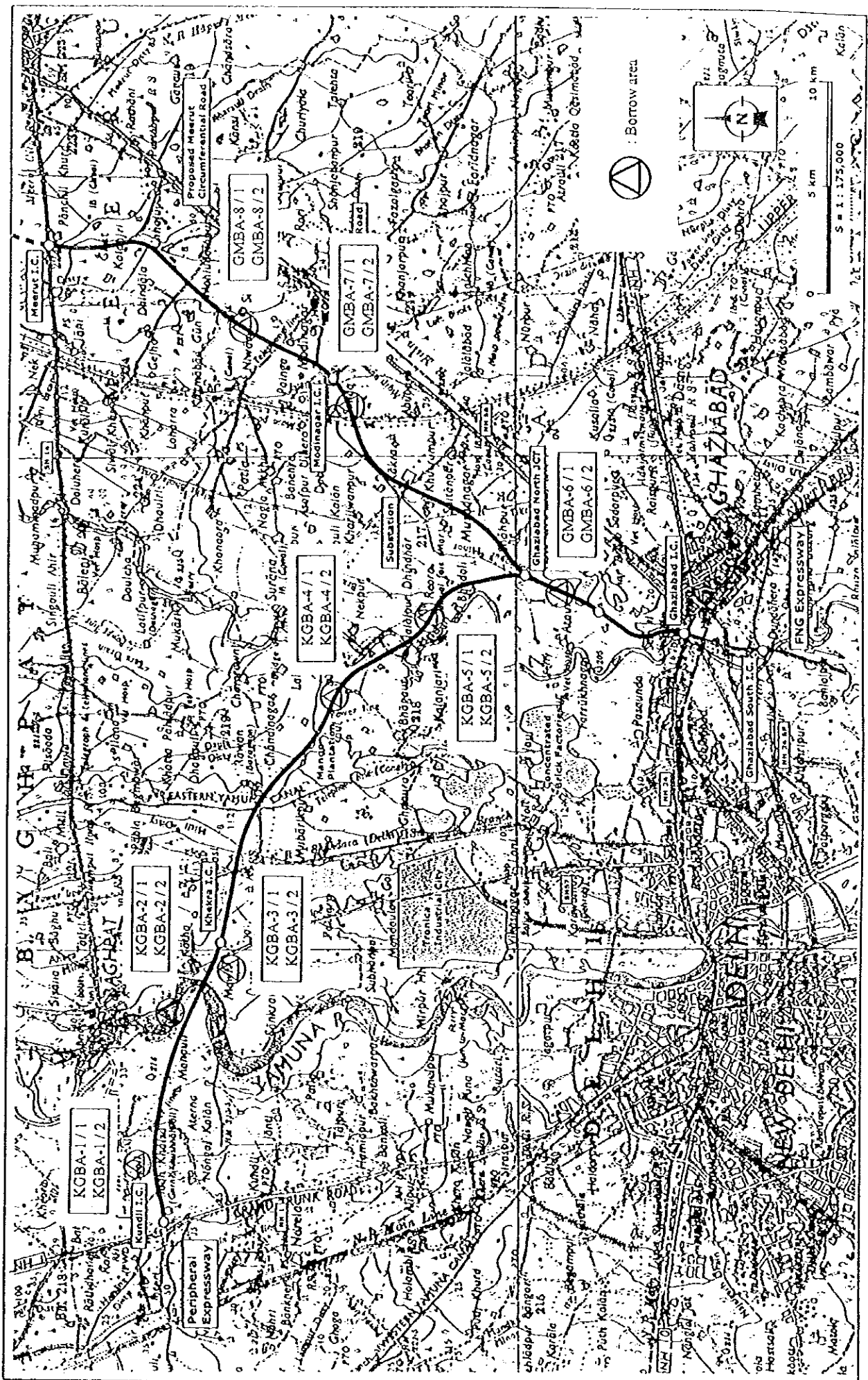


Appendix to Chapter 9

1. **Location Map for Borrow Area**
2. **Results of Embankment Stability Analysis**
3. **List of Bridges and Culverts**
4. **Cumulative 18 kip ESAL Computation Results**
5. **Location Map for Quarry Sites**



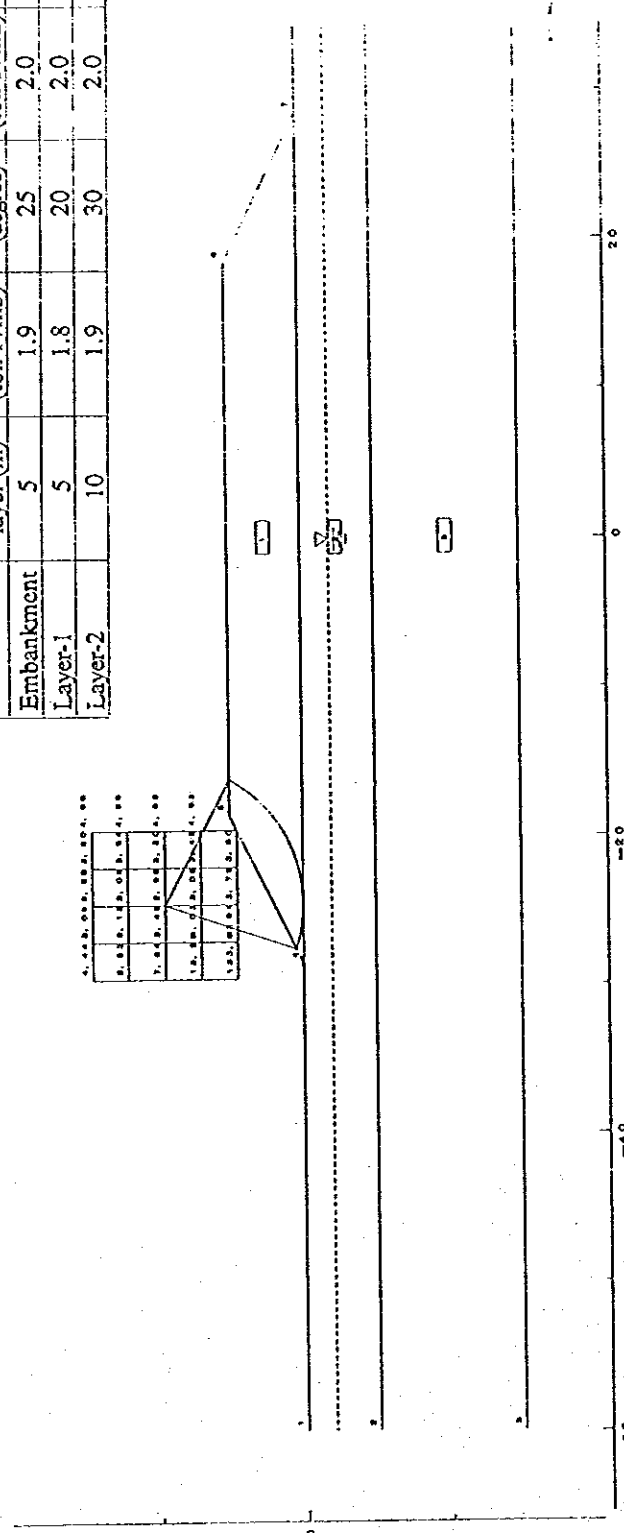
Appendix 9.1: Location Map for Borrow Area



Appendix 9.2: Results of Embankment Stability Analysis

Stability of analysis:	Embankment
Height of embankment:	H = 5 m
Width of embankment:	W = 37 m
Minimum safety factor:	Fs min = 2.987
Radius of arc:	R = 9.50 m
Resisted moment:	Mr = 433.88 ton f * m
Sliding moment:	Ms = 145.27 ton f * m

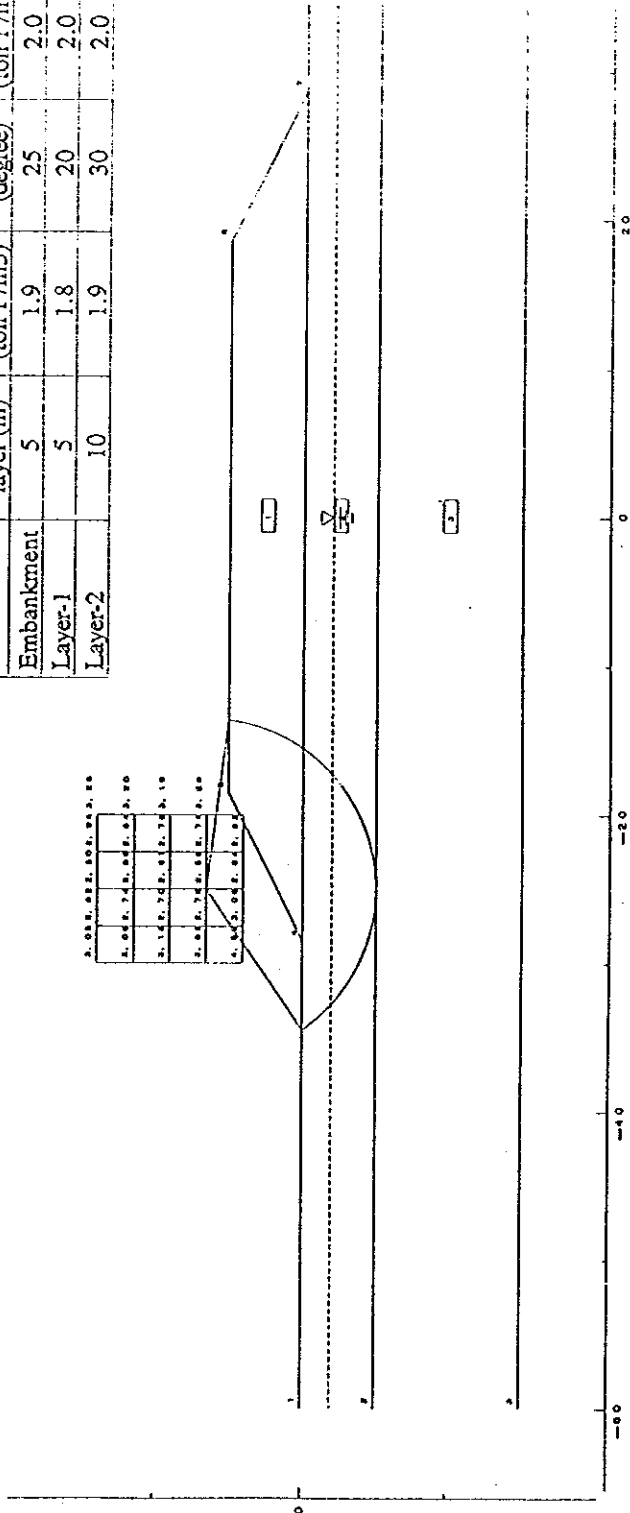
	Thickness of layer (m)	Unit weight (ton f / m3)	ϕ (degree)	C (ton f / m2)	Ground water level (m)
Embankment	5	1.9	25	2.0	
Layer-1	5	1.8	20	2.0	-2 m from top
Layer-2	10	1.9	30	2.0	



Calculation result of embankment stability (Embankment height = 5 m)

Stability of analysis:	Ground
Height of embankment:	H = 5 m
Width of embankment:	W = 37 m
Minimum safety factor:	Fs min = 2.582
Radius of arc:	R = 11.49 m
Resisted moment:	Mr = 1,267.37 ton f * m
Sliding moment:	Ms = 490.82 ton f * m

	Thickness of layer (m)	Unit weight (ton f /m3)	ϕ (degree)	C (ton f /m2)	Ground water level (m)
Embankment	5	1.9	25	2.0	
Layer-1	5	1.8	20	2.0	-2 m from top
Layer-2	10	1.9	30	2.0	



Calculation result of ground stability (Embankment height = 5 m)

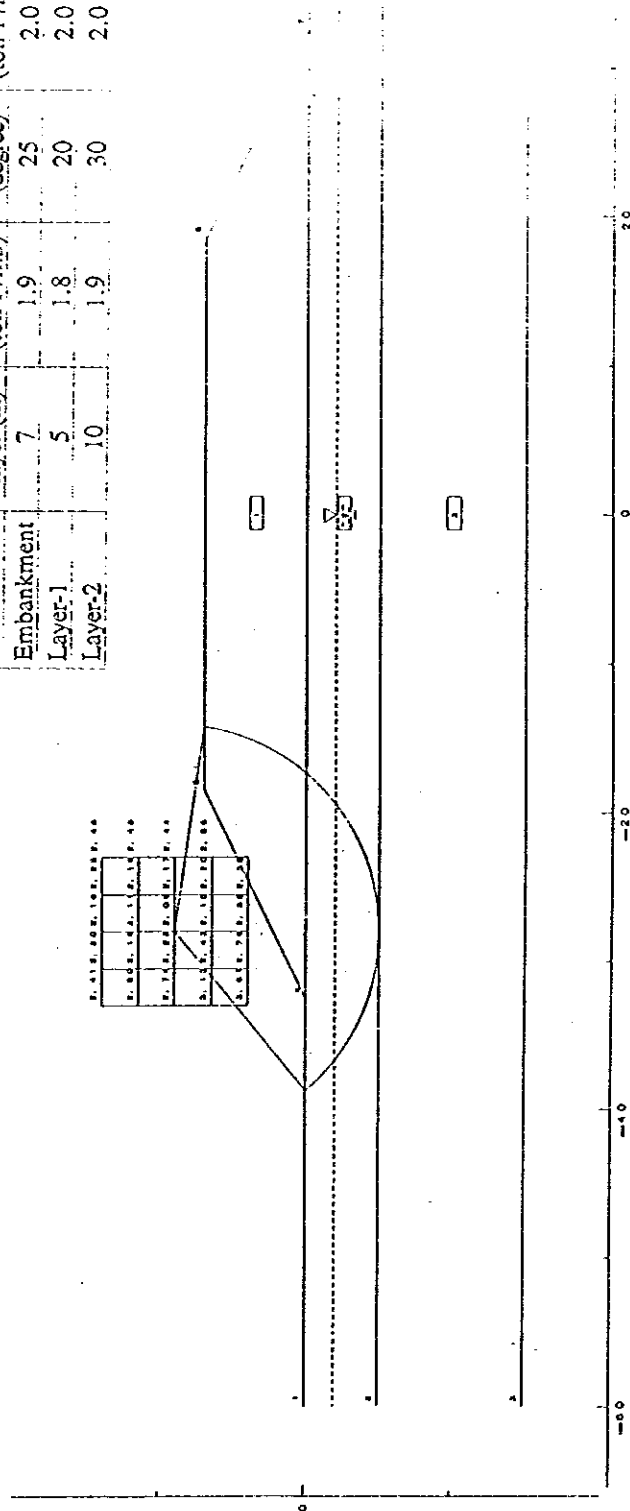
Stability of analysis:	Embankment
Height of embankment:	H = 7 m
Width of embankment:	W = 37 m
Minimum safety factor:	Fs min = 2.456
Radius of arc:	R = 14.00 m
Resisted moment:	Mr = 975.19 ton f * m
Sliding moment:	Ms = 397.11 ton f * m

	Thickness of layer (m)	Unit weight (ton f / m3)	ϕ (degree)	C (ton f / m2)	Ground water level (m)
Embankment	7	1.9	25	2.0	
Layer-1	5	1.8	20	2.0	
Layer-2	10	1.9	30	2.0	-2 m from top

2.10 1.81 1.64 1.50 1.38 1.28	1.10 1.00 0.90 0.80 0.70 0.60	0.50 0.40 0.30 0.20 0.10 0.00
3.10 2.81 2.64 2.50 2.38 2.28	2.10 2.00 1.90 1.80 1.70 1.60	1.50 1.40 1.30 1.20 1.10 1.00
4.10 3.81 3.64 3.50 3.38 3.28	3.10 3.00 2.90 2.80 2.70 2.60	2.50 2.40 2.30 2.20 2.10 2.00
5.10 4.81 4.64 4.50 4.38 4.28	4.10 4.00 3.90 3.80 3.70 3.60	3.50 3.40 3.30 3.20 3.10 3.00
6.10 5.81 5.64 5.50 5.38 5.28	5.10 5.00 4.90 4.80 4.70 4.60	4.50 4.40 4.30 4.20 4.10 4.00
7.10 6.81 6.64 6.50 6.38 6.28	6.10 6.00 5.90 5.80 5.70 5.60	5.50 5.40 5.30 5.20 5.10 5.00
8.10 7.81 7.64 7.50 7.38 7.28	7.10 7.00 6.90 6.80 6.70 6.60	6.50 6.40 6.30 6.20 6.10 6.00
9.10 8.81 8.64 8.50 8.38 8.28	8.10 8.00 7.90 7.80 7.70 7.60	7.50 7.40 7.30 7.20 7.10 7.00
10.10 9.81 9.64 9.50 9.38 9.28	9.10 9.00 8.90 8.80 8.70 8.60	8.50 8.40 8.30 8.20 8.10 8.00
11.10 10.81 10.64 10.50 10.38 10.28	10.10 10.00 9.90 9.80 9.70 9.60	9.50 9.40 9.30 9.20 9.10 9.00
12.10 11.81 11.64 11.50 11.38 11.28	11.10 11.00 10.90 10.80 10.70 10.60	10.50 10.40 10.30 10.20 10.10 10.00
13.10 12.81 12.64 12.50 12.38 12.28	12.10 12.00 11.90 11.80 11.70 11.60	11.50 11.40 11.30 11.20 11.10 11.00
14.10 13.81 13.64 13.50 13.38 13.28	13.10 13.00 12.90 12.80 12.70 12.60	12.50 12.40 12.30 12.20 12.10 12.00
15.10 14.81 14.64 14.50 14.38 14.28	14.10 14.00 13.90 13.80 13.70 13.60	13.50 13.40 13.30 13.20 13.10 13.00
16.10 15.81 15.64 15.50 15.38 15.28	15.10 15.00 14.90 14.80 14.70 14.60	14.50 14.40 14.30 14.20 14.10 14.00
17.10 16.81 16.64 16.50 16.38 16.28	16.10 16.00 15.90 15.80 15.70 15.60	15.50 15.40 15.30 15.20 15.10 15.00
18.10 17.81 17.64 17.50 17.38 17.28	17.10 17.00 16.90 16.80 16.70 16.60	16.50 16.40 16.30 16.20 16.10 16.00
19.10 18.81 18.64 18.50 18.38 18.28	18.10 18.00 17.90 17.80 17.70 17.60	17.50 17.40 17.30 17.20 17.10 17.00
20.10 19.81 19.64 19.50 19.38 19.28	19.10 19.00 18.90 18.80 18.70 18.60	18.50 18.40 18.30 18.20 18.10 18.00
21.10 20.81 20.64 20.50 20.38 20.28	20.10 20.00 19.90 19.80 19.70 19.60	19.50 19.40 19.30 19.20 19.10 19.00
22.10 21.81 21.64 21.50 21.38 21.28	21.10 21.00 20.90 20.80 20.70 20.60	20.50 20.40 20.30 20.20 20.10 20.00
23.10 22.81 22.64 22.50 22.38 22.28	22.10 22.00 21.90 21.80 21.70 21.60	21.50 21.40 21.30 21.20 21.10 21.00
24.10 23.81 23.64 23.50 23.38 23.28	23.10 23.00 22.90 22.80 22.70 22.60	22.50 22.40 22.30 22.20 22.10 22.00
25.10 24.81 24.64 24.50 24.38 24.28	24.10 24.00 23.90 23.80 23.70 23.60	23.50 23.40 23.30 23.20 23.10 23.00
26.10 25.81 25.64 25.50 25.38 25.28	25.10 25.00 24.90 24.80 24.70 24.60	24.50 24.40 24.30 24.20 24.10 24.00
27.10 26.81 26.64 26.50 26.38 26.28	26.10 26.00 25.90 25.80 25.70 25.60	25.50 25.40 25.30 25.20 25.10 25.00
28.10 27.81 27.64 27.50 27.38 27.28	27.10 27.00 26.90 26.80 26.70 26.60	26.50 26.40 26.30 26.20 26.10 26.00
29.10 28.81 28.64 28.50 28.38 28.28	28.10 28.00 27.90 27.80 27.70 27.60	27.50 27.40 27.30 27.20 27.10 27.00
30.10 29.81 29.64 29.50 29.38 29.28	29.10 29.00 28.90 28.80 28.70 28.60	28.50 28.40 28.30 28.20 28.10 28.00
31.10 30.81 30.64 30.50 30.38 30.28	30.10 30.00 29.90 29.80 29.70 29.60	29.50 29.40 29.30 29.20 29.10 29.00
32.10 31.81 31.64 31.50 31.38 31.28	31.10 31.00 30.90 30.80 30.70 30.60	30.50 30.40 30.30 30.20 30.10 30.00
33.10 32.81 32.64 32.50 32.38 32.28	32.10 32.00 31.90 31.80 31.70 31.60	31.50 31.40 31.30 31.20 31.10 31.00
34.10 33.81 33.64 33.50 33.38 33.28	33.10 33.00 32.90 32.80 32.70 32.60	32.50 32.40 32.30 32.20 32.10 32.00
35.10 34.81 34.64 34.50 34.38 34.28	34.10 34.00 33.90 33.80 33.70 33.60	33.50 33.40 33.30 33.20 33.10 33.00
36.10 35.81 35.64 35.50 35.38 35.28	35.10 35.00 34.90 34.80 34.70 34.60	34.50 34.40 34.30 34.20 34.10 34.00
37.10 36.81 36.64 36.50 36.38 36.28	36.10 36.00 35.90 35.80 35.70 35.60	35.50 35.40 35.30 35.20 35.10 35.00
38.10 37.81 37.64 37.50 37.38 37.28	37.10 37.00 36.90 36.80 36.70 36.60	36.50 36.40 36.30 36.20 36.10 36.00
39.10 38.81 38.64 38.50 38.38 38.28	38.10 38.00 37.90 37.80 37.70 37.60	37.50 37.40 37.30 37.20 37.10 37.00
40.10 39.81 39.64 39.50 39.38 39.28	39.10 39.00 38.90 38.80 38.70 38.60	38.50 38.40 38.30 38.20 38.10 38.00
41.10 40.81 40.64 40.50 40.38 40.28	40.10 40.00 39.90 39.80 39.70 39.60	39.50 39.40 39.30 39.20 39.10 39.00
42.10 41.81 41.64 41.50 41.38 41.28	41.10 41.00 40.90 40.80 40.70 40.60	40.50 40.40 40.30 40.20 40.10 40.00
43.10 42.81 42.64 42.50 42.38 42.28	42.10 42.00 41.90 41.80 41.70 41.60	41.50 41.40 41.30 41.20 41.10 41.00
44.10 43.81 43.64 43.50 43.38 43.28	43.10 43.00 42.90 42.80 42.70 42.60	42.50 42.40 42.30 42.20 42.10 42.00
45.10 44.81 44.64 44.50 44.38 44.28	44.10 44.00 43.90 43.80 43.70 43.60	43.50 43.40 43.30 43.20 43.10 43.00
46.10 45.81 45.64 45.50 45.38 45.28	45.10 45.00 44.90 44.80 44.70 44.60	44.50 44.40 44.30 44.20 44.10 44.00
47.10 46.81 46.64 46.50 46.38 46.28	46.10 46.00 45.90 45.80 45.70 45.60	45.50 45.40 45.30 45.20 45.10 45.00
48.10 47.81 47.64 47.50 47.38 47.28	47.10 47.00 46.90 46.80 46.70 46.60	46.50 46.40 46.30 46.20 46.10 46.00
49.10 48.81 48.64 48.50 48.38 48.28	48.10 48.00 47.90 47.80 47.70 47.60	47.50 47.40 47.30 47.20 47.10 47.00
50.10 49.81 49.64 49.50 49.38 49.28	49.10 49.00 48.90 48.80 48.70 48.60	48.50 48.40 48.30 48.20 48.10 48.00
51.10 50.81 50.64 50.50 50.38 50.28	50.10 50.00 49.90 49.80 49.70 49.60	49.50 49.40 49.30 49.20 49.10 49.00
52.10 51.81 51.64 51.50 51.38 51.28	51.10 51.00 50.90 50.80 50.70 50.60	50.50 50.40 50.30 50.20 50.10 50.00
53.10 52.81 52.64 52.50 52.38 52.28	52.10 52.00 51.90 51.80 51.70 51.60	51.50 51.40 51.30 51.20 51.10 51.00
54.10 53.81 53.64 53.50 53.38 53.28	53.10 53.00 52.90 52.80 52.70 52.60	52.50 52.40 52.30 52.20 52.10 52.00
55.10 54.81 54.64 54.50 54.38 54.28	54.10 54.00 53.90 53.80 53.70 53.60	53.50 53.40 53.30 53.20 53.10 53.00
56.10 55.81 55.64 55.50 55.38 55.28	55.10 55.00 54.90 54.80 54.70 54.60	54.50 54.40 54.30 54.20 54.10 54.00
57.10 56.81 56.64 56.50 56.38 56.28	56.10 56.00 55.90 55.80 55.70 55.60	55.50 55.40 55.30 55.20 55.10 55.00
58.10 57.81 57.64 57.50 57.38 57.28	57.10 57.00 56.90 56.80 56.70 56.60	56.50 56.40 56.30 56.20 56.10 56.00
59.10 58.81 58.64 58.50 58.38 58.28	58.10 58.00 57.90 57.80 57.70 57.60	57.50 57.40 57.30 57.20 57.10 57.00
60.10 59.81 59.64 59.50 59.38 59.28	59.10 59.00 58.90 58.80 58.70 58.60	58.50 58.40 58.30 58.20 58.10 58.00
61.10 60.81 60.64 60.50 60.38 60.28	60.10 60.00 59.90 59.80 59.70 59.60	59.50 59.40 59.30 59.20 59.10 59.00
62.10 61.81 61.64 61.50 61.38 61.28	61.10 61.00 60.90 60.80 60.70 60.60	60.50 60.40 60.30 60.20 60.10 60.00
63.10 62.81 62.64 62.50 62.38 62.28	62.10 62.00 61.90 61.80 61.70 61.60	61.50 61.40 61.30 61.20 61.10 61.00
64.10 63.81 63.64 63.50 63.38 63.28	63.10 63.00 62.90 62.80 62.70 62.60	62.50 62.40 62.30 62.20 62.10 62.00
65.10 64.81 64.64 64.50 64.38 64.28	64.10 64.00 63.90 63.80 63.70 63.60	63.50 63.40 63.30 63.20 63.10 63.00
66.10 65.81 65.64 65.50 65.38 65.28	65.10 65.00 64.90 64.80 64.70 64.60	64.50 64.40 64.30 64.20 64.10 64.00
67.10 66.81 66.64 66.50 66.38 66.28	66.10 66.00 65.90 65.80 65.70 65.60	65.50 65.40 65.30 65.20 65.10 65.00
68.10 67.81 67.64 67.50 67.38 67.28	67.10 67.00 66.90 66.80 66.70 66.60	66.50 66.40 66.30 66.20 66.10 66.00
69.10 68.81 68.64 68.50 68.38 68.28	68.10 68.00 67.90 67.80 67.70 67.60	67.50 67.40 67.30 67.20 67.10 67.00
70.10 69.81 69.64 69.50 69.38 69.28	69.10 69.00 68.90 68.80 68.70 68.60	68.50 68.40 68.30 68.20 68.10 68.00
71.10 70.81 70.64 70.50 70.38 70.28	70.10 70.00 69.90 69.80 69.70 69.60	69.50 69.40 69.30 69.20 69.10 69.00
72.10 71.81 71.64 71.50 71.38 71.28	71.10 71.00 70.90 70.80 70.70 70.60	70.50 70.40 70.30 70.20 70.10 70.00
73.10 72.81 72.64 72.50 72.38 72.28	72.10 72.00 71.90 71.80 71.70 71.60	71.50 71.40 71.30 71.20 71.10 71.00
74.10 73.81 73.64 73.50 73.38 73.28	73.10 73.00 72.90 72.80 72.70 72.60	72.50 72.40 72.30 72.20 72.10 72.00
75.10 74.81 74.64 74.50 74.38 74.28	74.10 74.00 73.90 73.80 73.70 73.60	73.50 73.40 73.30 73.20 73.10 73.00
76.10 75.81 75.64 75.50 75.38 75.28	75.10 75.00 74.90 74.80 74.70 74.60	74.50 74.40 74.30 74.20 74.10 74.00
77.10 76.81 76.64 76.50 76.38 76.28	76.10 76.00 75.90 75.80 75.70 75.60	75.50 75.40 75.30 75.20 75.10 75.00
78.10 77.81 77.64 77.50 77.38 77.28	77.10 77.00 76.90 76.80 76.70 76.60	76.50 76.40 76.30 76.20 76.10 76.00
79.10 78.81 78.64 78.50 78.38 78.28	78.10 78.00 77.90 77.80 77.70 77.60	77.50 77.40 77.30 77.20 77.10 77.00
80.10 79.81 79.64 79.50 79.38 79.28	79.10 79.00 78.90 78.80 78.70 78.60	78.50 78.40 78.30 78.20 78.10 78.00
81.10 80.81 80.64 80.50 80.38 80.28	80.10 80.00 79.90 79.80 79.70 79.60	79.50 79.40 79.30 79.20 79.10 79.00
82.10 81.81 81.64 81.50 81.38 81.28	81.10 81.00 80.90 80.80 80.70 80.60	80.50 80.40 80.30 80.20 80.10 80.00
83.10 82.81 82.64 82.50 82.38 82.28	82.10 82.00 81.90 81.80 81.70 81.60	81.50 81.40 81.30 81.20 81.10 81.00
84.10 83.81 83.64 83.50 83.38 83.28	83.10 83.00 82.90 82.80 82.70 82.60	82.50 82.40 82.30 82.20 82.10 82.00
85.10 84.81 84.64 84.50 84.38 84.28	84.10 84.00 83.90 83.80 83.70 83.60	83.50 83.40 83.30 83.20 83.10 83.00
86.10 85.81 85.64 85.50 85.38 85.28	85.10 85.00 84.90 84.80 84.70 84.60	84.50 84.40 84.30 84.20 84.10 84.00
87.10 86.81 86.64 86.50 86.38 86.28	86.10 86.00 85.90 85.80 85.70 85.60	85.50 85.40 85.30 85.20 85.10 85.00
88.10 87.81 87.64 87.50 87.38 87.28	87.10 87.00 86.90 86.80 86.70 86.60	86.50 86.40 86.30 86.20 86.10 86.00
89.10 88.81 88.64 88.50 88.38 88.28	88.10 88.00 87.90 87.80 87.70 87.60	87.50 87.40 87.30 87.20 87.10 87.00
90.10 89.81 89.64 89.50 89.38 89.28	89.10 89.00 88.90 88.80 88.70 88.60	88.50 88.40 88.30 88.20 88.10 88.00
91.10 90.81 90.64 90.50 90.38 90.28	90.10 90.00 89.90 89.80 89.70 89.60	89.50 89.40 89.30 89.20 89.10 89.00
92.10 91.81 91.64 91.50 91.38 91.28	91.10 91.00 90.90 90.80 90.70 90.60	90.50 90.40 90.30 90.20 90.10 90.00
93.10 92.81 92.64 92.50 92.38 92.28	92.10 92.00 91.90 91.80 91.70 91.60	91.50 91.40 91.30 91.20 91.10 91.00
94.10 93.81 93.64 93.50 93.38 93.28	93.10 93.00 92.90 92.80 92.70 92.60	92.50 92.40 92.30 92.20 92.10 92.00
95.10 94.81 94.64 94.50 94.38 94.28	94.10 94.00 93.90 93.80 93.70 93.60	93.50 93.40 93.30 93.20 93.10 93.00
96.10 95.81 95.64 95.50 95.38 95.28	95.10 95.00 94.90 94.80 94.70 94.60	94.50 94.40 94.30 94.20 94.10 94.00
97.10 96.81 96.64 96.50 96.38 96.28	96.10 96.00 95.90 95.80 95.70 95.60	95.50 95.40 95.30 95.20 95.10 95.00

Stability of analysis:	Ground
Height of embankment:	H = 7 m
Width of embankment:	W = 37 m
Minimum safety factor:	Fs min = 2.097
Radius of arc:	R = 13.99 m
Resisted moment:	Mr = 1,935.54 ton f * m
Sliding moment:	Ms = 922.86 ton f * m

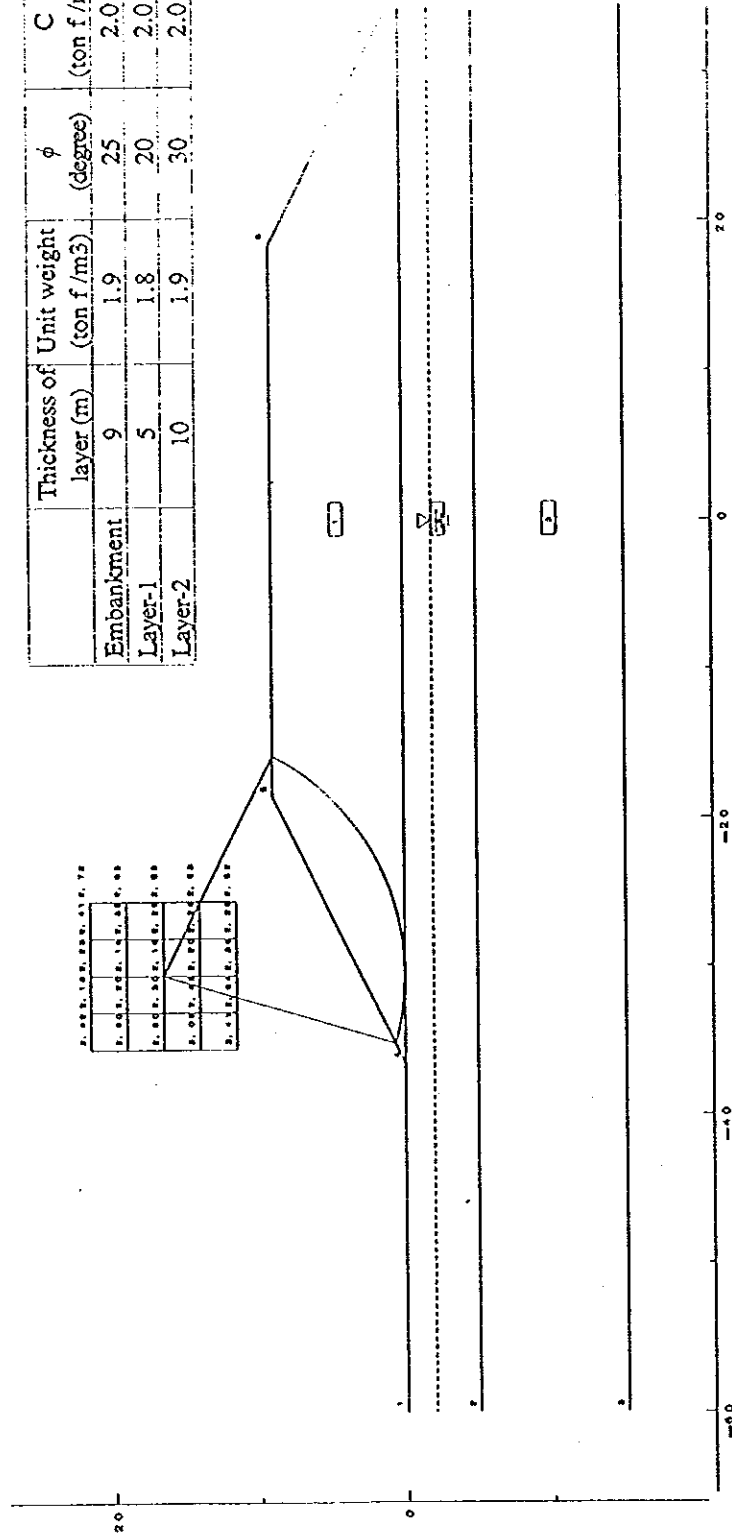
	Thickness of layer (m)	Unit weight (ton f/m ³)	ϕ (degree)	C (ton f/m ²)	Ground water level (m)
Embankment	7	1.9	25	2.0	
Layer-1	5	1.8	20	2.0	
Layer-2	10	1.9	30	2.0	-2 m from top



Calculation result of ground stability (Embankment height = 7 m)

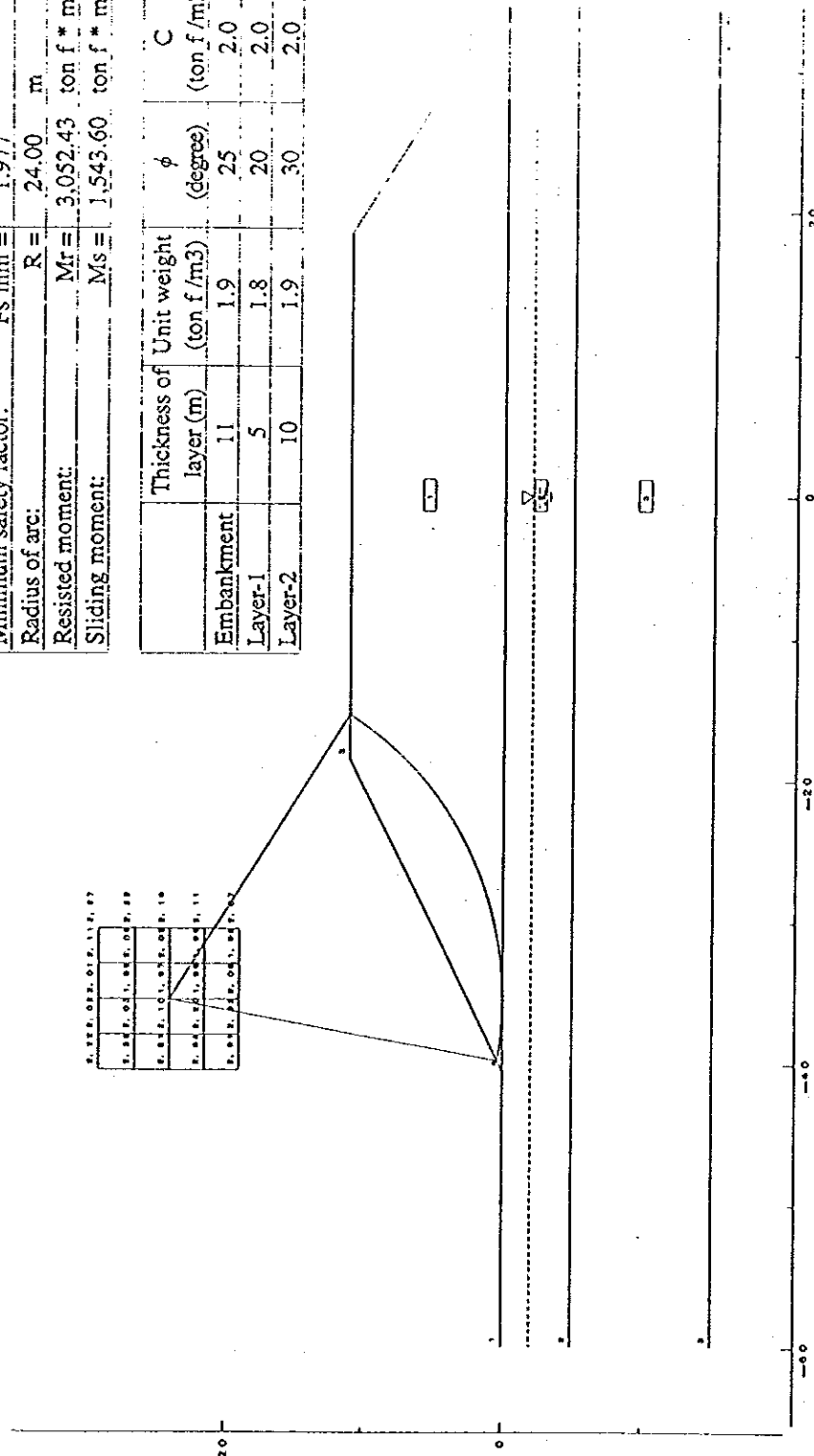
Stability of analysis:		Embankment	
Height of embankment:	H =	9	m
Width of embankment:	W =	37	m
Minimum safety factor:	Fs min =	2.168	
Radius of arc:	R =	16.50	m
Resisted moment:	Mr =	1,608.44	ton f * m
Sliding moment:	Ms =	742.00	ton f * m

	Thickness of layer (m)	Unit weight (ton f / m3)	ϕ (degree)	C (ton f / m2)	Ground water level (m)
Embankment	9	1.9	25	2.0	
Layer-1	5	1.8	20	2.0	-2 m from top
Layer-2	10	1.9	30	2.0	



Stability of analysis:		
Height of embankment:	H =	11 m
Width of embankment:	W =	37 m
Minimum safety factor:	Fs min =	1.977
Radius of arc:	R =	24.00 m
Resisted moment:	Mr =	3,052.43 ton f * m
Sliding moment:	Ms =	1,543.60 ton f * m

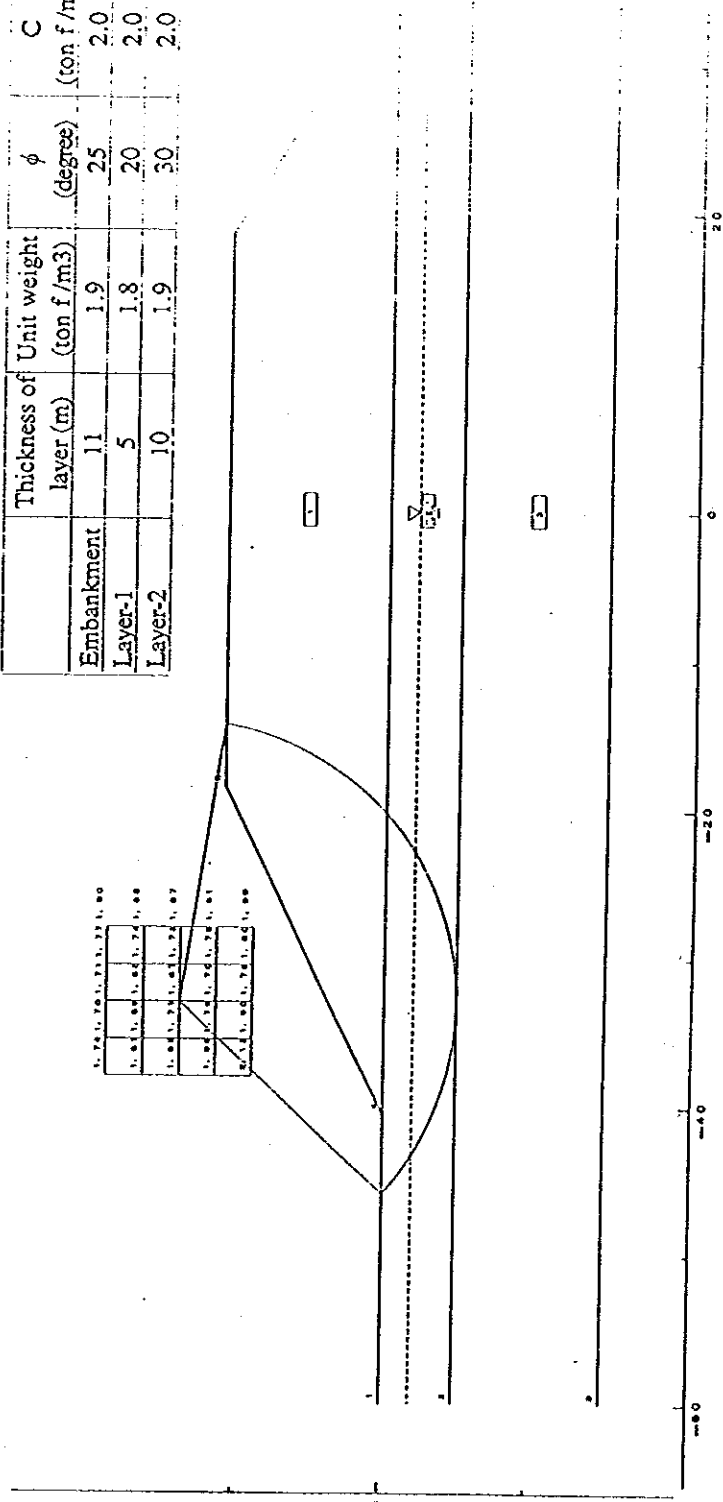
	Thickness of layer (m)	Unit weight (ton f /m3)	ϕ (degree)	C (ton f /m2)	Ground water level (m)
Embankment	11	1.9	25	2.0	
Layer-1	5	1.8	20	2.0	-2 m from top
Layer-2	10	1.9	30	2.0	



Calculation result of embankment stability (Embankment height = 11 m)

Stability of analysis:	Ground
Height of embankment:	H = 11 m
Width of embankment:	W = 37 m
Minimum safety factor:	Fs min = 1.676
Radius of arc:	R = 18.99 m
Resisted moment:	Mr = 3,951.75 ton f * m
Sliding moment:	Ms = 2,358.20 ton f * m

	Thickness of layer (m)	Unit weight (ton f /m3)	ϕ (degree)	C (ton f /m2)	Ground water level (m)
Embankment	11	1.9	25	2.0	
Layer-1	5	1.8	20	2.0	-2 m from top
Layer-2	10	1.9	30	2.0	



Calculation result of ground stability (Embankment height = 11 m)

Appendix 9.3: List of Bridges and Culverts

Bridge List (Throughway Bridge)

Route : Kundli - Ghaziabad

Station (km)	Length (m)	Span	Crossing	Remarks
0 - 10	90	25+40+25	National Highway No.1	Out of Construction
0 + 600	25	25	Kundli IC Ramp	Out of Construction
0 + 990	11	11	Village Road	Relocation L = 750m
1 + 975	20	20	1 L Minor (Distributary)	Relocation CT/IR L = 180m
3 + 400	11	11	Village Road	Relocation L = 170m
7 + 120	11	11	Village Road	Relocation L = 160m
11 + 975	25	25	Yamuna River	
12 + 600	600	15 @ 40	Yamuna River	Guide Bunds
14 + 100	40	40	State Highway No.57	Relocation (VR) L = 350m
18 + 440	40	40	Railway	
18 + 555	11	11	Village Road	
19 + 230	20	20	Khekra Distributary	Relocation CT/IR L = 170m
19 + 610	20	20	Mitli Distributary	Relocation CT/IR L = 170m
21 + 840	40	40	Eastern Yamuna Canal	
22 + 230	11	11	Village Road	Relocation L = 360m
22 + 640	20	20	Daula Drain (Irrigation)	Relocation CT/IR L = 190m
25 + 195	11	11	Village Road	Relocation L = 160m
29 + 540	11	11	Village Road	
31 + 300	11	11	Village Road	Relocation L = 270m
33 + 300	240	6 @ 40	Hindan River	Guide Bunds
36 + 880	11	11	Village Road	
38 + 490	11	11	Village Road	Relocation L = 230m
39 + 660	20	20	Sultanpur Minor (Distribution)	Relocation CT/IR L = 250m
39 + 855	11	11	District Road	
Total : L = 1,206 22Nos				
L= 11m 11Nos				
L= 20m 5Nos				
L= 25m 1No				
L= 40m 3Nos				
L=240m 1No				
L=600m 1No				

Culvert List

Route : Kundli - Ghaziabad

Station (km)	Size (m) W*H	Over- burden (m)	Length (m)	Crossing	Remarks
1 + 360	3*3	5	58	Cart Track	
2 + 360	3*3	2	46	Cart Track	
2 + 710	3*3	1	42	Cart Track	
2 + 975	3*3	1	42	Cart Track	Relocation L = 100m
3 + 740	3*3	2	46	Cart Track	Relocation L = 210m
4 + 150	3*3	2	46	Cart Track	
4 + 865	3*3	1	42	Cart Track	Relocation L = 190m
5 + 395	3*3	2	46	Cart Track / Drain	
6 + 150	3*3	1	42	Cart Track	
7 + 470	3*3	3	50	Cart Track	Relocation L = 80m
7 + 980	3*3	1	42	Cart Track	Relocation L = 410m
8 + 465	3*3	3	50	Cart Track	
9 + 570	3*3	1	42	Cart Track / Drain	Relocation L = 200m
10 + 525	3*3	2	46	Cart Track (River Bank)	Relocation L = 120m
13 + 205	3*3	4	54	Cart Track	
15 + 400	3*3	1	42	Cart Track	Relocation L = 260m
16 + 430	3*3	1	42	Cart Track	Relocation L = 200m
16 + 660	3*3	3	50	Cart Track	
17 + 110	3*3	3	50	Cart Track	
17 + 425	3*3	1	42	Cart Track	
18 + 155	3*3	5	58	Cart Track	
19 + 430	3*3	5	58	Basi Drain	
21 + 605	3*3	2	46	Cart Track	
23 + 900	3*3	1	42	Cart Track / Drain	Relocation L = 750m
24 + 900	3*3	2	46	Cart Track	
26 + 475	3*3	1	42	Cart Track	
26 + 720	6*3	3	50	Daula Drain	
27 + 675	3*3	1	42	Cart Track	
29 + 300	3*3	1	42	Cart Track	Relocation L = 1470+210m
31 + 0	3*3	1	42	Cart Track	Relocation L = 240m
31 + 600	3*3	1	42	Cart Track	
33 + 470	3*3	3	50	Cart Track	
34 + 635	3*3	2	46	Cart Track	Relocation L = 300m
34 + 850	3*3	2	46	Cart Track	Relocation L = 170m
35 + 190	3*3	1	42	Cart Track	
36 + 555	3*3	4	54	Sonda Drain	
37 + 300	3*3	1	42	Cart Track / Drain	Relocation L = 150m
39 + 190	3*3	3	50	Cart Track	Relocation L = 190m
39 + 770	6*3	5	58	Bhikampur Drain	

Total :

Box Culvert 3(W)*3(H)*1Cell

37Nos (1,710m)

Box Culvert 3(W)*3(H)*2Cells

2Nos (108m)

Pipe Culvert List

Route : Kundli - Ghaziabad

Station (km)	Size (m) D*No	Over- burden (m)	Length (m)	Crossing	Remarks
24 + 650	1*1	3	50	Drain	
25 + 700	1*1	5	58	Drain	Detour L = 230m
Total :					
Pipe Culvert 1(D)*1(No)			2Nos (108m)		

Bridge List (Throughway Bridge)

Route : Ghaziabad - Meerut

Station (km)	Length (m)	Span	Crossing	Remarks
1 + 525	11	11 (8lanes)	Village Road	
3 + 680	11	11 (8lanes)	Village Road	
5 + 460	11	11 (8lanes)	Village Road	Relocation CT/IR L = 270m
7 + 755	11	11 (8lanes)	Village Road	
11 + 300	11	11	District Road	Relocation L = 80m
12 + 895	20	20	Tikri Distributary	Relocation CT/IR L = 250m
15 + 25	11	11	Village Road	
16 + 235	11	11	District Road	
19 + 460	20	20	Kuaila Minor (Distributary)	Relocation CT/IR L = 460m
20 + 840	90	25+40+25	Upper Ganga Canal	Relocation (V/R) L = 120m
22 + 640	20	20	Jalalabad Distributary	Relocation CT/IR L = 180m
23 + 325	11	11	Village Road	Relocation L = 500m
26 + 490	11	11	District Road	
32 + 150	11	11	Village Road	Relocation L = 470m
34 + 455	20	20	Left Bhola Distributary	Relocation CT/IR L = 300m
35 + 865	20	20	Sheikhpuri Drain	Detour L = 180m
37 + 480	20	20	Sheikhpuri Drain	Detour L = 870m
39 + 10	20	20	Sheikhpuri Drain	Detour L = 170m
39 + 750	25	25	Meerut IC Ramp	Out of Construction
39 + 940	20	20	Puth Distributary	Out of Construction
40 + 240	40	40	State Highway No.14	Out of Construction
Total : L = 340 18Nos				
L= 11m 6Nos (6lanes)				
L= 11m 4Nos (8lanes)				
L= 20m 7Nos				
L= 90m 1No				

Box Culvert List

Route : Ghaziabad - Meerut

Station (km)	Size (m) W*H	Over- burden (m)	Length (m)	Crossing	Remarks
0 + 800	3*3	1	49	Cart Track	
2 + 795	3*3	1	49	Cart Track	
4 + 270	3*3	2	53	Cart Track	
5 + 945	3*3	4	61	Cart Track	
7 + 490	3*3	3	57	Cart Track	
8 + 345	3*3	2	53	Cart Track	
10 + 510	3*3	1	42	Cart Track	
10 + 735	6*3	4	54	Bhikampur Drain	
11 + 575	3*3	1	42	Cart Track	
12 + 200	3*3	2	46	Cart Track	Relocation L = 350m
15 + 475	3*3	1	42	Cart Track	
17 + 890	3*3	1	42	Cart Track	
19 + 0	3*3	1	42	Cart Track	Relocation L = 110m
20 + 60	3*3	1	42	Cart Track	Relocation L = 130m
21 + 950	3*3	1	42	Cart Track	Relocation L = 150m
23 + 880	3*3	1	42	Cart Track	
25 + 800	3*3	1	42	Cart Track	
26 + 190	3*3	3	50	Cart Track	
26 + 705	3*3	2	46	Cart Track	Relocation L = 55m
28 + 730	3*3	2	46	Cart Track	
29 + 255	3*3	2	46	Cart Track	
29 + 725	6*3	2	46	Qadirabad Drain	Detour of Drain L = 240m
31 + 350	3*3	1	42	Cart Track	
32 + 630	3*3	3	50	Cart Track	
33 + 35	3*3	1	42	Cart Track	
33 + 300	3*3	1	42	Cart Track	Relocation L = 60m
33 + 830	3*3	2	46	Cart Track	
34 + 175	3*3	5	58	Cart Track	Relocation L = 260m
34 + 720	3*3	2	46	Cart Track	Relocation L = 190m
36 + 180	3*3	1	42	Cart Track	
37 + 735	3*3	1	42	Cart Track	Relocation L = 430m
38 + 895	3*3	1	42	Cart Track	Relocation L = 150m

Total :

Box Culvert 3(W)*3(H)*1Cell

30Nos (1,386m)

Box Culvert 3(W)*3(H)*2Cells

2Nos (100m)

Pipe Culvert List

Route : Ghaziabad - Meerut

Station (km)	Size (m) D*No	Over- burden (m)	Length (m)	Crossing	Remarks
1 + 200	1*1	5	58		
25 + 35	1*2	1	42	Sherpur Minor (Distributary)	
26 + 380	1*2	5	58	Mawi Minor (Distributary)	
27 + 665	1*2	2	46	Niwari Drain	
27 + 940	1*1	2	46	Aghera Minor (Distributary)	
31 + 920	1*2	5	58	Kalaniri Minor(Distributery)	
32 + 370	1*2	5	58	Dhidala drain	
34 + 975	1*1	2	46	Drain	
Total :					
Pipe Culvert 1(D)*1(No)			3Nos (134m)		
Pipe Culvert 1(D)*2(Nos)			5Nos(262m)		

Bridge List (Flyover)

Rute : Kundli - Ghaziabad & Ghaziabad - Meerut

IC	Location of Ramp	Length (m)	Span	Crossing
Kundli IC	NH No.1 Side	50	2@25	National Highway No.1
Khekra IC	Expressway Side	50	2@25	Expressway (Throughway)
Ghaziabad IC	Expressway Side	80	2@40	Expressway (Throughway)
	NH No.24 Side	80	2@40	National Highway No.24
Modinagar IC	Expressway Side	50	2@25	Expressway (Throughway)

Bridge List (Box Culvert)

Rute : Kundli - Ghaziabad & Ghaziabad - Meerut

JCT	Location of Ramp	Size (m)	Length (m)	Crossing
Ghaziabad JCT	Kundli - Ghaziabad	10.5(W)*5(H)	90	GM Expressway
	Meerut - Kundli	7.5(W)*5(H)	45	GM Expressway
		7.5(W)*5(H)	40	KG Ramp

Bridge List (L = 11m)

Route : Kundli - Ghaziabad

Station (km)	PL (m)	GL (m)	H (m)
0 + 990	226.66	218.50	8.16
3 + 400	223.69	217.60	6.09
7 + 120	222.72	215.20	7.52
18 + 555	231.35	220.50	10.85
22 + 230	230.42	219.40	11.02
25 + 195	225.79	217.00	8.79
29 + 540	217.35	210.00	7.35
31 + 300	214.35	207.30	7.05
36 + 880	214.36	207.50	6.86
38 + 490	218.86	211.50	7.36
39 + 855	221.93	215.00	6.93

Route : Ghaziabad - Meerut

Station (km)	PL (m)	GL (m)	H (m)
*1 + 525	207.30	200.80	6.50
*3 + 680	213.75	206.20	7.55
*5 + 460	219.64	213.00	6.64
*7 + 755	220.88	214.00	6.88
11 + 300	219.76	212.20	7.56
15 + 25	219.65	212.20	7.45
16 + 235	219.85	213.50	6.35
23 + 325	224.28	217.50	6.78
26 + 490	224.73	218.50	6.23
32 + 150	226.65	220.00	6.65
+			0.00

* : 8lanes

Bridge List (L = 20m)

Route : Kundli - Ghaziabad

Station (km)	PL (m)	GL (m)	H (m)
1 + 975	224.58	218.00	6.58
19 + 230	227.37	220.40	6.97
19 + 615	227.85	220.50	7.35
22 + 640	226.05	217.80	8.25
*39 + 660	222.65	213.50	9.15

* : Road PL - Canal PL = 8.15

Route : Ghaziabad - Meerut

Station (km)	PL (m)	GL (m)	H (m)
**12 + 895	222.36	213.40	8.96
19 + 460	223.86	216.90	6.96
22 + 640	225.37	217.40	7.97
34 + 455	228.70	220.40	8.30
*35 + 865	224.72	219.40	5.32
*37 + 480	225.63	220.50	5.13
*39 + 10	227.40	221.60	5.80

* : Clearance height for drain is more than 3.0m.

** : Road PL - Canal PL = 6.86

Bridge List (L = 25m)

Route : Kundli - Ghaziabad

Station (km)	PL (m)	GL (m)	H (m)
11 + 975	221.72	214.00	7.72

Route : Ghaziabad - Meerut

Station (km)	PL (m)	GL (m)	H (m)
+			0.00

Appendix 9.4: Cumulative 18 kip ESAL Computation Results

Cumulative 18-kip ESAL for Flexible Pavement

Section	Vehicle Type	AADT Forecast (HV)			ESAL Factor	Lane Factor**		Analysis Period ESAL**	Performance Period ESAL Combination**										Total
		2006	2016			A	B		1st Period	2nd Period	3rd period	4th period	5th period	6th period	7th period				
			2006	2016												2026			
1	Kundli	Large Bus	7,556	12,075	19,594	0.63	0.8	0.6	30 yrs	39,573,812	7,913,149	6,094,387	5,223,103	5,153,609	5,213,044	5,290,796	Initial:		
		LCV	5,444	8,700	14,118	0.19	0.8	0.6	8,599,600	1,719,570	1,494,880	1,324,343	1,135,008	1,119,907	1,132,822	1,149,718	49mil (9.3 yrs)		
		2-Axle Truck	10,685	17,076	27,709	2.18	0.8	0.6	193,649,630	38,722,033	33,662,375	29,822,140	25,558,619	25,218,557	25,509,397	25,889,868	Overlay: 6 times		
		Multi-Axle Truck	1,730	2,765	4,486	0.26	0.8	0.6	3,739,324	747,712	650,012	575,858	493,530	486,964	492,580	499,927			
	Total	25,441	40,656	65,974				245,562,367	49,102,464	42,686,436	37,816,727	32,410,260	31,979,036	32,347,844	32,830,309	259,173,076			
2	Khekra	Large Bus	5,690	10,264	18,515	0.63	0.8	0.6	36,307,652	7,964,617	6,763,185	5,960,952	5,275,430	5,144,435	5,199,032	Initial:			
		LCV	4,100	7,395	13,341	0.19	0.8	0.6	7,889,846	1,730,754	1,469,676	1,295,347	1,146,379	1,117,913	1,129,777	49mil (11.1 yrs)			
		2-Axle Truck	8,046	14,514	26,182	2.18	0.8	0.6	177,667,075	38,973,882	33,094,825	29,169,195	25,814,675	25,173,668	25,440,831	Overlay: 5 times			
		Multi-Axle Truck	1,303	2,350	4,239	0.26	0.8	0.6	3,430,705	752,576	639,053	563,250	498,475	486,097	491,256				
	Total	19,158	34,558	62,339				225,295,279	49,421,828	41,966,739	36,988,744	32,734,959	31,922,113	32,260,896		225,295,279			
3	Meerut	Large Bus	4,409	9,166	13,758	0.63	0.8	0.6	27,424,768	7,936,265	6,801,609	6,030,881	5,154,363	5,174,600	Initial:				
		LCV	3,177	6,604	9,913	0.19	0.8	0.6	5,959,548	1,724,593	1,478,026	1,310,543	1,120,070	1,124,468	49mil (12.5 yrs)				
		2-Axle Truck	6,235	12,962	19,456	2.18	0.8	0.6	134,199,762	38,835,145	33,282,846	29,511,381	25,222,246	25,321,275	Overlay: 4 times				
		Multi-Axle Truck	1,010	2,099	3,150	0.26	0.8	0.6	2,591,363	749,897	642,683	569,857	487,035	488,947					
	Total	14,846	30,862	46,323				170,175,441	49,245,900	42,205,165	37,422,662	31,983,714	32,109,291		192,966,731				
4	Modinagar	Large Bus	5,086	9,422	18,661	0.63	0.8	0.6	36,134,138	7,970,186	6,786,432	6,053,408	5,242,799	5,261,952	5,315,453	Initial:			
		LCV	3,665	6,789	13,446	0.19	0.8	0.6	7,852,141	1,731,964	1,474,728	1,315,438	1,139,288	1,143,450	49mil (11.9 yrs)				
		2-Axle Truck	7,192	13,324	26,389	2.18	0.8	0.6	176,818,006	39,001,135	33,208,576	29,621,617	25,654,999	25,748,722	26,010,521	Overlay: 5 times			
		Multi-Axle Truck	1,164	2,157	4,273	0.26	0.8	0.6	3,414,310	753,102	641,249	571,986	495,391	497,201	502,256				
	Total	17,125	31,724	62,832				224,218,595	49,456,387	42,110,985	37,562,449	32,532,477	32,651,326	32,983,306		227,296,931			
5	Junction	Large Bus	7,958	14,526	25,504	0.63	0.6	0.5	39,519,551	7,899,934	6,771,756	5,999,338	5,227,015	5,263,541	5,315,160	Initial:			
		LCV	5,734	10,467	18,376	0.19	0.6	0.5	8,587,809	1,716,698	1,471,539	1,303,688	1,135,858	1,143,796	1,154,586	49mil (10.6 yrs)			
		2-Axle Truck	11,254	20,542	36,066	2.18	0.6	0.5	193,384,111	38,657,367	33,136,762	29,357,031	25,577,764	25,756,497	25,949,111	Overlay: 6 times			
		Multi-Axle Truck	1,822	3,326	5,839	0.26	0.6	0.5	3,734,197	746,454	639,862	566,877	493,900	497,351	499,872				
	Total	26,796	48,910	85,870				245,225,669	49,020,463	42,019,919	37,226,934	32,434,538	32,661,185	32,998,204	32,170,005	257,931,248			
* Lane Distribution Factor: A: 2006-2026, B: 2026-2036																			
Average Years		11.1 yrs	17 yrs	25 yrs	30 yrs	30 yrs	30 yrs	30 yrs	30 yrs	30 yrs	30 yrs	30 yrs	30 yrs	30 yrs	30 yrs	30 yrs	30 yrs		
Cumulative		11.1 yrs	17 yrs	25 yrs	30 yrs	30 yrs	30 yrs	30 yrs	30 yrs	30 yrs	30 yrs	30 yrs	30 yrs	30 yrs	30 yrs	30 yrs	30 yrs		

* Lane Distribution Factor: A: 2006-2026, B: 2026-2036

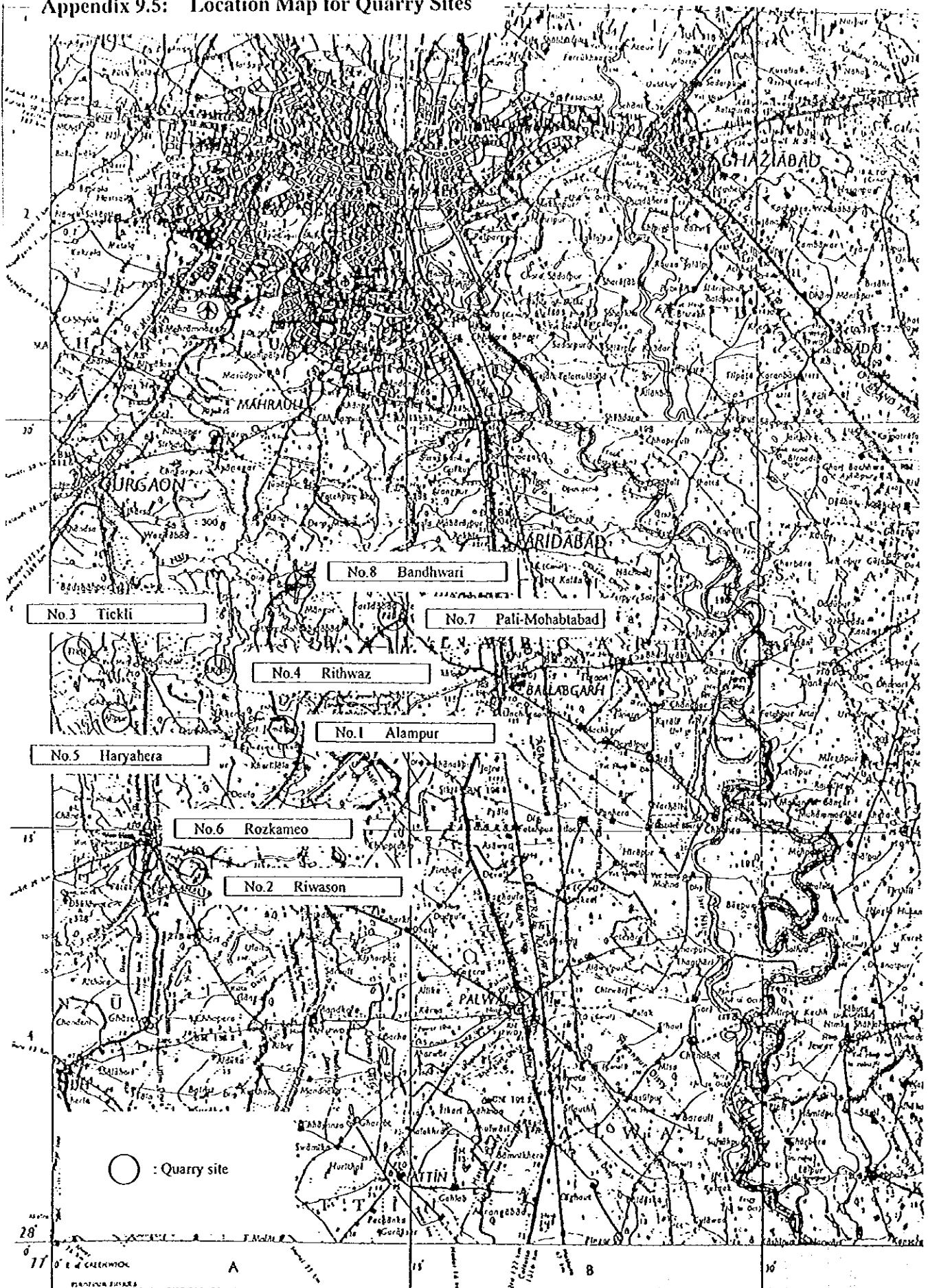
** Directional Factor=50%

Cumulative 18-kip ESAL for Rigid Pavement

Section	Vehicle Type	AADT Forecast (HV)			ESAL Factor	Lane Factor**		Analysis Period ESAL**	Performance Period ESAL** Combination			
		2006	2016	2026		A	B		1st	2nd	3rd	Total
1 Kundli	Large Bus	7,556	12,075	19,594	0.61	0.8	0.6	30 yrs	18.8 yrs	10.0 yrs	6.9 yrs	35.7 yrs
	LCV	5,444	8,700	14,118	0.18	0.8	0.6	30 yrs	19,900,667	16,000,321	16,022,600	Initial: 135mil (18.8 yrs)
	2-Axle Truck	10,685	17,076	27,709	2.34	0.8	0.6	30 yrs	4,231,240	3,401,956	3,406,693	Overlay: 2 times
	Multi-Axle Truck	1,730	2,765	4,486	0.44	0.8	0.6	30 yrs	107,955,929	86,797,569	86,918,426	
	Total	25,441	40,656	65,974				260,655,025	135,374,406	108,842,279	108,993,832	353,210,517
2 Khekra	Large Bus	5,690	10,264	18,515	0.61	0.8	0.6	30 yrs	20.9 yrs	9.4 yrs		30.3 yrs
	LCV	4,100	7,395	13,341	0.18	0.8	0.6	30 yrs	19,904,991	15,905,542		Initial: 135mil (20.9 yrs)
	2-Axle Truck	8,046	14,514	26,182	2.34	0.8	0.6	30 yrs	4,232,159	3,381,804		Overlay: 1 time
	Multi-Axle Truck	1,303	2,350	4,239	0.44	0.8	0.6	30 yrs	107,979,383	86,283,418		
	Total	19,158	34,558	62,339				239,142,289	135,403,817	108,197,545		243,601,362
3 Meerut	Large Bus	4,409	9,166	13,758	0.61	0.8	0.6	30 yrs	24.5 yrs	11.5 yrs		36.1 yrs
	LCV	3,177	6,604	9,913	0.18	0.8	0.6	30 yrs	19,892,351	16,017,268		Initial: 135mil (24.5 yrs)
	2-Axle Truck	6,235	12,962	19,456	2.34	0.8	0.6	30 yrs	4,229,472	3,405,559		Overlay: 1 time
	Multi-Axle Truck	1,010	2,099	3,150	0.44	0.8	0.6	30 yrs	107,910,817	86,889,503		
	Total	14,846	30,862	46,323				180,634,697	135,317,837	108,957,562		244,275,399
4 Modinagar	Large Bus	5,086	9,422	18,661	0.61	0.8	0.6	30 yrs	21.7 yrs	8.7 yrs		30.4 yrs
	LCV	3,665	6,789	13,446	0.18	0.8	0.6	30 yrs	19,876,986	16,077,332		Initial: 135mil (21.7 yrs)
	2-Axle Truck	7,192	13,324	26,389	2.34	0.8	0.6	30 yrs	4,226,205	3,418,330		Overlay: 1 time
	Multi-Axle Truck	1,164	2,157	4,273	0.44	0.8	0.6	30 yrs	107,827,468	87,215,335		
	Total	17,125	31,724	62,832				237,999,430	135,213,319	109,366,149		244,579,468
5 Junction	Large Bus	7,958	14,526	25,504	0.61	0.6	0.5	30 yrs	20.1 yrs	8.9 yrs	5.9 yrs	34.9 yrs
	LCV	5,734	10,467	18,376	0.18	0.6	0.5	30 yrs	19,875,634	16,033,408	16,026,454	Initial: 135mil (20.1 yrs)
	2-Axle Truck	11,254	20,542	36,066	2.34	0.6	0.5	30 yrs	4,225,917	3,408,991	3,407,512	Overlay: 2 times
	Multi-Axle Truck	1,822	3,326	5,839	0.44	0.6	0.5	30 yrs	107,820,129	86,977,055	86,939,333	
	Total	26,796	48,910	85,870				260,297,633	135,204,116	109,067,351	109,020,049	353,291,516
* Lane Distribution Factor: A: 2006-2026, B: 2026-2036									Average Years	21.2 yrs	9.7 yrs	33.5 yrs
** Directional Factor=50%									Cumulative	21 yrs	31 yrs	33 yrs

Appendix 9.5: Location Map for Quarry Sites

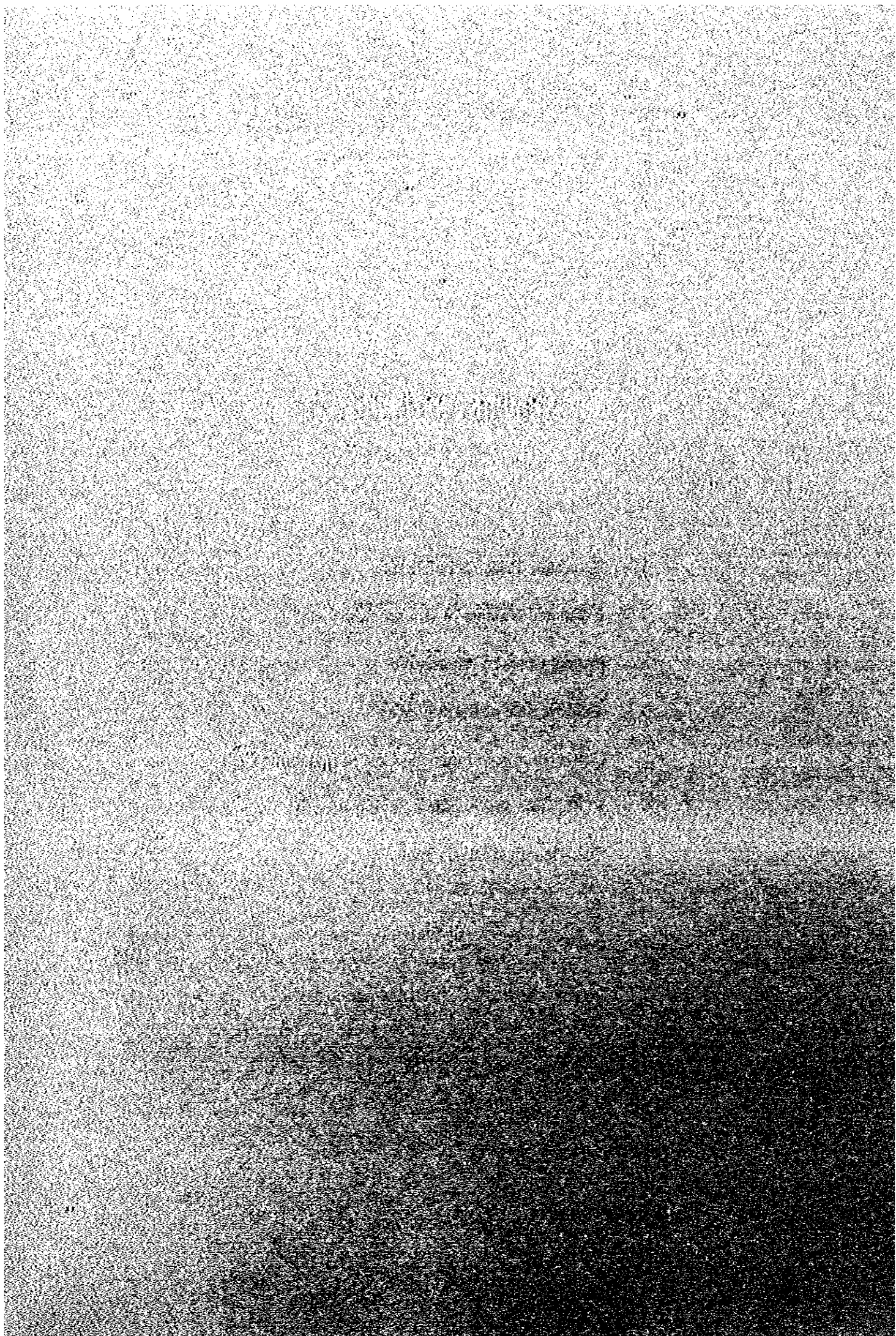
Appendix 8.12 Location map of quarry site



Printed under the direction of Major-General Khushi Lal Khosla, B.Sc., B.E. (Civil), F.A.S., F.R.S., F.A.S.C. 1980

Appendix to Chapter 11

1. Economic Price Calculations
2. Estimated Number of Households
3. Project Costs by Alternatives
4. Shadow Rate of Right of Way
5. Conversion from Financial Cost to Economic Cost
6. VOC, Time and Accident Saving Benefit
7. Cost-Benefit Analysis Table



Appendix Table 11.1.1 Calculation of Economic Price of Small Bus

Unit: Rupee

Item	Calculation	Economic Cost		Financial Cost
		Cost	Tax/duty	Cumulative
a) CKD & Assembling Costs		218,947		218,947
b) Excise Duty(Include Cess)	27.98%		85,071	304,018
c) Whole sale price				304,018
d) Dealer Commission	2.81%	8,775		8,775
e) Retail price				312,793
f) Sales Tax	8%		25,023	337,817
g) Registration Tax	4% of Item(e)		12,512	350,328
On the road price(Financial Cost)		227,722	122,606	350,328
Cost Component %		65%	35%	100%

Source: Association of Indian Automobile Manufacturers

Note: CKD= Complete Knock Down

Appendix Table 11.1.2 Calculation of Economic Price of Large Bus

Unit: Rupee

Item	Calculation	Economic Cost		Financial Cost
		Cost	Tax/duty	Cumulative
a) CKD & Assembling Costs		329,134		329,134
b) Excise Duty(Include Cess)	15.13%		58,653	387,787
c) Whole sale price				387,787
d) Dealer Commission	3.48%	13,969		13,969
e) Retail price				401,756
f) Sales Tax	8%		32,140	433,896
g) Registration Tax	4% of Item(e)		16,070	449,967
On the road price(Financial Cost)		343,103	106,863	449,967
Cost Component %		76%	24%	100%

Source: Association of Indian Automobile Manufacturers

Note: CKD= Complete Knock Down

Appendix Table 11.1.3 Calculation of Economic Price of Small Truck

Unit: Rupee

Item	Calculation	Economic Cost		Financial Cost
		Cost	Tax/duty	Cumulative
a) CKD & Assembling Costs		237,269		237,269
b) Excise Duty(Include Cess)	17.63%		50,766	288,036
c) Whole sale price				288,036
d) Dealer Commission	2.98%	8,850		8,850
e) Retail price				296,886
f) Sales Tax	8%		23,751	320,636
g) Registration Tax	4% of Item(e)		11,875	332,512
On the road price(Financial Cost)		246,119	86,393	332,512
Cost Component %		74%	26%	100%

Note: CKD= Complete Knock Down

Source: Association of Indian Automobile Manufacturers

Appendix Table 11.1.4 Calculation of Economic Price of Large Size Truck

Unit: Rupee

Item	Calculation	Economic Cost		Financial Cost
		Cost	Tax/duty	Cumulative
a) CKD & Assembling Costs		418,306		418,306
b) Excise Duty(Include Cess)	15.13%		74,544	492,850
c) Whole sale price				492,850
d) Dealer Commission	3.60%	18,429		18,429
e) Retail price				511,280
f) Sales Tax	8%		40,902	552,182
g) Registration Tax	4% of Item(e)		20,451	572,633
On the road price(Financial Cost)		436,736	135,897	572,633
Cost Component %		76%	24%	100%

Note: CKD= Complete Knock Down

Source: Association of Indian Automobile Manufacturers

Appendix Table 11.1.5 Calculation of Economic Price of Motorcycle

Unit: Rupee

Item	Calculation	Economic Cost		Financial Cost
		Cost	Tax/duty	Cumulative
a) CKD & Assembling Costs		19,353		19,353
b) Excise Duty(Include Cess)	22.93%		5,757	25,111
c) Whole sale price				25,111
d) Dealer Commission	26.72%	9,154		9,154
e) Retail price				34,264
f) Sales Tax	8%		2741	37,006
g) Registration Tax	4% of Item(e)		1371	38,376
On the road price(Financial Cost)		28,507	9,869	38,376
Cost Component %		74%	26%	100%

Note: CKD= Complete Knock Down

Source: Association of Indian Automobile Manufacturers

**Appendix Table 11.1.6 Basic Data Estimated Number of Households
by Income Group in India (up to 2007)**

Unit: Million Household

Annual Income Level (Rupee)	Under 2255 Lowest	22501-45000 Second	45001-70000 Third	70001-96000 Fourth	Above 96000 Highest	Average
No. of Household (1994-95)	86,100	44,900	18,000	4,400	4,600	158,000
Component (%)	54.49%	28.42%	11.39%	2.78%	2.91%	100%
No. of Household (2000-02)	59,300	72,200	23,500	13,600	12,100	180,700
Component (%)	32.82%	39.96%	13.00%	7.53%	6.70%	100%
No. of Household (2006-07)	39,900	78,500	36,600	21,400	22,700	199,100
Component (%)	20.04%	39.43%	18.38%	10.75%	11.40%	100%
Estimated Annual Income per Worker by Income Group (1999)						
Annual Income by one Household	11,300	33,750	57,500	83,000	109,000	294,550
Annual Income Per Capita. 1)	2,047	6,114	10,417	15,036	19,746	53,361
Component (%)	3.84%	11.46%	19.52%	28.18%	37.01%	100.00%
No. of Household (1000)	59,300	72,200	23,500	13,600	12,100	180,700
Component (%)	20.04%	39.43%	18.38%	10.75%	11.40%	100%

Source: Based on study National Council of Applied Economic Research, New Delhi.

Persons per household as per 1991 Census (excluding Assam and J&K): 5.52

Appendix Table 11.2.1 Initial Project Cost of Expressway by Alternatives (Financial Price)

(Cost by Section and % of Foreign Portion)

K-G & G-M Case 80.75km

Item	Segment 1		Segment 2		Segment 3		Segment 4		Segment 5		Total		
	Local/P.	Foreign/P.	Local/P.	Foreign/P.	Local/P.	Foreign/P.	Local/P.	Foreign/P.	Local/P.	Foreign/P.	Local/P.	Foreign/P.	% of F./P.
Construction	1,981,841	164,219	2,431,593	148,014	677,884	41,294	1,546,070	94,105	1,260,027	76,704	7,897,415	524,336	6%
Land Acquisition	376,177	0	455,066	0	552,670	0	241,352	0	277,123	0	1,902,388	0	0%
Engineering	202,428	48,225	243,348	58,017	101,906	24,314	150,889	35,972	129,405	30,854	827,976	197,382	19%
Total	2,560,446	212,444	3,130,007	206,031	1,332,460	65,608	1,938,311	130,077	1,666,555	107,558	10,627,779	721,718	

Unit: 1,000Rs.

Kundli-Ghaziabad Case 49.00km

Item	Segment 1		Segment 2		Segment 3		Total		
	Local/P.	Foreign/P.	Local/P.	Foreign/P.	Local/P.	Foreign/P.	Local/P.	Foreign/P.	% of F./P.
Construction	1,981,841	164,219	2,431,593	148,014	677,884	41,294	5,091,318	353,527	6.5%
Land Acquisition	376,177	0	455,066	0	552,670	0	1,383,913	0	0.0%
Engineering	202,428	48,225	243,348	58,017	101,906	24,314	547,682	130,556	19.2%
Total	2,560,446	212,444	3,130,007	206,031	1,332,460	65,608	7,022,913	484,083	

Ghaziabad-Meerut Case 39.55km

Item	Segment 4		Segment 5		Segment 3		Total		
	Local/P.	Foreign/P.	Local/P.	Foreign/P.	Local/P.	Foreign/P.	Local/P.	Foreign/P.	% of F./P.
Construction	1,546,070	94,105	1,260,027	76,704	677,884	41,294	3,483,981	212,103	6%
Land Acquisition	241,352	0	277,123	0	552,670	0	1,071,145	0	0%
Engineering	150,889	35,972	129,405	30,854	101,906	24,314	382,200	91,140	19%
Total	1,938,311	130,077	1,666,555	107,558	1,332,460	65,608	4,937,326	303,243	

Note: Engineering cost is round off to decimal place.

Appendix Table 11.2.2. Cost of Overlay and Widening (Financial Cost and Economic Cost)

K-G & G-M Section 80.75km 1000Rs

	Financial Cost			Economic Cost		
	Widening	Ope.Ment.	Overlay(1)	Overlay(2)	Widening	Overlay(1)
Construction	1,994,442	2,193,886	722,773	982,032	1,952,523	
Land Acquisition						
Engineering	199,444	219,388			192,983	
Contingency	218,114		71,227	97,968		
	2,412,000	2,412,000	794,000	1,080,000	2,145,507	632,799
						860,734

Kundli-Ghaziabad Section 49.00km

	Financial Cost			Economic Cost		
	Widening	Ope.Ment.	Overlay(1)	Overlay(2)	Widening	Overlay(1)
Construction	1,341,849	1,476,034	425,840	596,197	1,313,646	
Land Acquisition						
Engineering	134,185	147,604			129,838	
Contingency	146,966		42,160	58,803		
	1,623,000	1,623,000	468,000	655,000	1,443,485	372,985
						522,019

Ghaziabad-Meerut Section 39.55km

	Financial Cost			Economic Cost		
	Widening	Ope.Ment.	Overlay(1)	Overlay(2)	Widening	Overlay(1)
Construction	935,874	1,029,461	368,196	485,607	916,204	
Land Acquisition						
Engineering	93,587	102,946			90,555	
Contingency	102,539		36,804	48,393		
	1,132,000	1,132,000	405,000	534,000	1,006,759	322,775
						425,585

Appendix Table 11.2.3 Shadow Rate of Right of Way (Land Productivity)

Unit: 1000Rs.

Items of Right of Way	Required Area (ha)	Market Price		Economic Price		Shadow Rate
		Total Cost	Adjusted Cost Solatium(-30%)	Present Value of Productivity 688,842/ha	Adjustment	
Village Area	572	1,187,954	831,568	394,018	788,035	
Agriculture Area	186	386,293	270,405	128,125	128,125	
Vacant	158	328,141	229,699	108,837	10,884	
Total	916	1,902,388	1,331,672	630,979	927,043	69.6%

Appendix Table 11.2.4 Conversion to Economic Cost from Financial Cost

K-G & G-M Case 80.75km

Unit: 1000 Rs.

Items	Investment Costs in Market Price	Foreign Portion	Local Portion					Overall Conversion Factor	Investment Costs in Economic Prices
			Tradable Goods	Non-tradable Goods	Skilled Labor	Unskilled Labor	Transfer (Tax)		
Conversion Factor		1.00	1.00	1.07	1.00	0.72	0.00		
Construction	8,421,751	0.07	0.03	0.72	0.03	0.07	0.10	0.91	7,620,656
Engineering	1,025,358	0.19	0.00	0.24	0.43	0.04	0.10	0.89	911,168
Land Acquisition	1,902,388			1.00			0.00	0.70	1,324,348
Total	11,349,497								9,856,172
Routine Mainte.			0.02	0.44	0.21	0.23	0.10	0.75	
Periodic Repair			0.03	0.67	0.05	0.15	0.10	0.83	

Appendix Table 11.2.5 Conversion to Economic Cost from Financial Cost

Kundli-Ghaziabad Case 49.00km

Unit: 1000 Rs.

Items	Investment Costs in Market Price	Foreign Portion	Local Portion					Overall Conversion Factor	Investment Costs in Economic Prices
			Tradable Goods	Non-tradable Goods	Skilled Labor	Unskilled Labor	Transfer (Tax)		
Conversion Factor		1.00	1.00	1.07	1.00	0.72	0.00		
Construction	5,444,845	0.07	0.03	0.72	0.03	0.07	0.10	0.91	4,926,920
Engineering	678,238	0.19		0.24	0.43	0.04	0.10	0.89	602,705
Land Acquisition	1,383,913			1.00				0.70	963,411
Total	7,506,996								6,493,036

Appendix Table 11.2.6 Conversion to Economic Cost from Financial Cost

Ghaziabad-Meerut Case 39.55km

Unit: 1000 Rs.

Items	Investment Costs in Market Price	Foreign Portion	Local Portion					Overall Conversion Factor	Investment Costs in Economic Prices
			Tradable Goods	Non-tradable Goods	Skilled Labor	Unskilled Labor	Transfer (Tax)		
Conversion Factor		1.00	1.00	1.07	1.00	0.72	0.00		
Construction	3,696,084	0.07	0.03	0.72	0.03	0.07	0.10	0.91	3,344,505
Engineering	473,340	0.19		0.24	0.43	0.04	0.10	0.89	420,626
Land Acquisition	1,071,145			1.00			0.00	0.70	745,678
Total	5,240,569								4,510,808

Appendix Table 11.3.1

Vehicle Operating Cost Saving Benefit

(K-G)+(G-M) Expressway 80.75km						1000Rs
Year	P.Car	Bus	Truck	Motorcycle	Total/year	
2006	1,155	-22	148	414	508,243	
2007	1,348	-19	225	686	671,799	
2008	1,558	-16	303	968	845,704	
2009	1,772	-13	381	1,259	1,019,770	
2010	1,989	-10	460	1,561	1,199,784	
2011	2,210	-7	538	1,871	1,383,531	
2012	2,433	-4	616	2,191	1,570,788	
2013	2,659	-2	694	2,520	1,761,324	
2014	2,887	1	771	2,858	1,954,902	
2015	3,117	3	847	3,205	2,151,277	
2016	3,347	5	922	3,560	2,350,192	
2017	3,945	27	1,259	3,799	2,709,140	
2018	4,575	51	1,651	4,051	3,098,463	
2019	5,239	76	2,105	4,316	3,520,984	
2020	5,937	103	2,631	4,595	3,979,819	
2021	6,672	132	3,236	4,888	4,478,414	
2022	7,445	161	3,932	5,197	5,020,574	
2023	8,257	193	4,731	5,521	5,610,509	
2024	9,110	226	5,644	5,862	6,252,874	
2025	10,006	262	6,688	6,220	6,952,817	
2026	10,947	299	7,878	6,596	7,716,036	
2027	11,934	338	9,232	6,991	8,548,835	
2028	12,970	380	10,772	7,407	9,458,196	
2029	14,055	423	12,519	7,843	10,451,845	
2030	15,193	469	14,499	8,300	11,538,341	
2031	16,386	517	16,740	8,780	12,727,158	
2032	17,635	568	19,275	9,284	14,028,793	
2033	18,943	621	22,138	9,813	15,454,872	

Appendix Table 11.3.2 Time Saving Benefit

(K-G)+(G-M) Expressway 80.75km						Mill Rs/year
Year	P.Car	Bus	Truck	Motorcycle	Total	
2006	1,742	189		1,267	3,198	
2007	1,934	207		1,383	3,525	
2008	2,145	227		1,509	3,880	
2009	2,374	248		1,644	4,265	
2010	2,623	271		1,789	4,683	
2011	2,894	296		1,947	5,137	
2012	3,189	323		2,116	5,628	
2013	3,510	352		2,298	6,161	
2014	3,859	383		2,495	6,737	
2015	4,238	417		2,707	7,362	
2016	4,649	454		2,934	8,037	
2017	4,978	486		3,184	8,648	
2018	5,323	521		3,451	9,294	
2019	5,685	557		3,736	9,978	
2020	6,066	595		4,039	10,700	
2021	6,466	635		4,363	11,464	
2022	6,885	677		4,709	12,272	
2023	7,326	722		5,077	13,125	
2024	7,788	769		5,469	14,026	
2025	8,273	818		5,887	14,978	
2026	8,782	869		6,332	15,984	
2027	9,316	924		6,806	17,045	
2028	9,875	981		7,310	18,166	
2029	10,461	1,041		7,846	19,348	
2030	11,076	1,104		8,417	20,596	
2031	11,720	1,170		9,023	21,913	
2032	12,395	1,239		9,668	23,302	
2033	13,101	1,312		10,354	24,767	

Appendix Table 11.3.3
Traffic Accident on Ordinary Highway and Expressway
(Accident/100,000,000 vehicle·Km)

Year	Other Road		Expressway		Ratio	
	Death	Accident	Death	Accident	Accident	Death
1966	229	95	38	42%	42%	16%
1967	223	78	39	35%	35%	18%
1968	219	61	32	28%	28%	15%
1969	210	56	31	27%	27%	15%
1970	179	60	28	33%	33%	16%
1971	162	60	22	37%	37%	14%
1972	144	53	18	37%	37%	12%
1973	120	49	16	41%	41%	13%
1974	104	42	12	41%	41%	11%
1975	93	35	12	37%	37%	13%
1976	86	34	11	40%	40%	13%
1977	76	34	10	45%	45%	13%
1978	72	28	9	39%	39%	12%
1979	69	24	7	34%	34%	10%
1980	69	21	6	30%	30%	9%
1981	69	20	6	29%	29%	9%
1982	72	19	6	27%	27%	8%
1983	73	21	7	29%	29%	9%
Average	126.12	43.9	17.12	34.93%	34.93%	12.49%

Source: Japan Expressway Public Corporation and Japan National Police Agency.

Appendix Table 11.3.4 Fatal Accident Saving Benefit
(K-G)-(G-M) Expressway, 80.75km

Year	Vehicle/km Expressway	No. of Fatal Accident/100MillionV.K			Benefit Mill.Rs
		Without	With	Saving	
2006	489,600	617	77	540	125
2007	525,131	662	83	579	135
2008	563,243	710	89	621	144
2009	604,124	761	95	666	155
2010	647,974	816	102	714	166
2011	695,010	876	109	766	178
2012	745,463	939	117	822	191
2013	799,583	1,007	126	882	205
2014	857,634	1,081	135	946	220
2015	919,905	1,159	145	1,014	236
2016	986,700	1,243	155	1,088	253
2017	1,022,071	1,288	161	1,127	262
2018	1,059,378	1,335	167	1,168	271
2019	1,098,767	1,384	173	1,212	282
2020	1,140,390	1,437	179	1,257	292
2021	1,184,415	1,492	186	1,306	303
2022	1,231,025	1,551	194	1,357	315
2023	1,280,416	1,613	202	1,412	328
2024	1,332,802	1,679	210	1,470	342
2025	1,388,413	1,749	219	1,531	356
2026	1,447,500	1,824	228	1,596	371
2027	1,510,335	1,903	238	1,665	387
2028	1,577,214	1,987	248	1,739	404
2029	1,648,455	2,077	259	1,818	422
2030	1,724,407	2,173	271	1,901	442
2031	1,805,444	2,275	284	1,991	463
2032	1,891,976	2,384	298	2,086	485
2033	1,984,446	2,500	312	2,188	508

Appendix Table 11.4.1 Cost Benefit Analysis for Investment Justification

K-G Section 49.00km					Unit: Million Rs						
No.	year	Economic Cost		Economic Benefits			Present Worth				
		Capital Routine & Periodic Operation	Total	Passenger Time Saving	Vehicle VOC Saving	Traffic Accident	Total	Discount Factor	Cost	Benefit	
1	2000	94	94					0.79	74		
2	2001	607	607					0.62	376		
3	2002	962	962					0.49	469		
4	2003	1,279	1,279					0.38	491		
5	2004	1,733	1,733					0.30	523		
6	2005	1,818	1,818					0.24	432		
7	2006		16	1,792	336	74	2,202	0.19	3	412	
8	2007		16	1,796	381	78	2,255	0.15	2	332	
9	2008		16	1,792	433	83	2,307	0.12	2	267	
10	2009		16	1,778	491	88	2,357	0.09	1	215	
11	2010		16	1,755	555	93	2,402	0.07	1	172	
12	2011		16	1,720	625	98	2,443	0.06	1	138	
13	2012		16	1,672	702	104	2,478	0.04	1	110	
14	2013		16	1,609	787	110	2,505	0.03	1	88	
15	2014		16	1,529	880	116	2,525	0.03	0	70	
16	2015		16	1,431	981	123	2,535	0.02	0	55	
17	2016	389	16	1,312	1,092	130	2,534	0.02	7	43	
18	2017		16	1,823	1,529	144	3,496	0.01	0	47	
19	2018		16	2,364	2,005	159	4,529	0.01	0	48	
20	2019		16	2,937	2,524	177	5,638	0.01	0	47	
21	2020		16	3,545	3,088	196	6,828	0.01	0	45	
22	2021		16	4,187	3,702	218	8,107	0.01	0	42	
23	2022	1,856	16	4,867	4,372	242	9,480	0.00	8	38	
24	2023		16	5,585	5,101	269	10,955	0.00	0	35	
25	2024		16	6,344	5,897	299	12,540	0.00	0	31	
26	2025		16	7,146	6,765	333	14,244	0.00	0	28	
27	2026	544	16	7,992	7,714	371	16,076	0.00	1	25	
28	2027		16	8,885	8,749	414	18,048	0.00	0	22	
29	2028		16	9,827	9,882	462	20,170	0.00	0	19	
30	2029		16	10,820	11,120	516	22,456	0.00	0	17	
31	2030	544	16	11,867	12,475	576	24,919	0.00	0	15	
32	2031		16	12,970	13,960	645	27,575	0.00	0	13	
33	2032		16	14,132	15,586	722	30,441	0.00	0	11	
34	2033	94	16	15,356	17,370	810	33,536	0.00	0	10	
		9,921	443	10,364	148,830	139,101	7,648	295,579	27.06%	2,395	2,395

Appendix Table 11.4.2 Cost Benefit Analysis for Investment Justification

G - M Section 39.55km					Unit: Million Rs						
No.	year	Economic Cost			Economic Benefits			Present Worth			
		Capital Periodic	Routine & Operation	Total	Passenger Time Saving	Vehicle VOC Saving	Traffic Accident	Total	Discount Factor	Cost	Benefit
1	2000	65		65					0.80	52	
2	2001	456		456					0.64	291	
3	2002	456		456					0.51	232	
4	2003	431		431					0.41	175	
5	2004	1,509		1,509					0.32	489	
6	2005	1,593		1,593					0.26	412	
7	2006		14	14	598	311	46	955	0.21	3	197
8	2007		14	14	648	386	50	1,084	0.16	2	178
9	2008		14	14	701	462	54	1,217	0.13	2	160
10	2009		14	14	759	535	59	1,352	0.10	1	142
11	2010		14	14	821	606	64	1,491	0.08	1	125
12	2011		14	14	888	675	69	1,632	0.07	1	109
13	2012		14	14	961	740	75	1,776	0.05	1	95
14	2013		14	14	1,039	802	81	1,922	0.04	1	82
15	2014		14	14	1,123	859	88	2,071	0.03	0	70
16	2015		14	14	1,214	911	96	2,222	0.03	0	60
17	2016	337	14	350	1,312	959	104	2,375	0.02	8	51
18	2017		14	14	1,535	1,148	106	2,790	0.02	0	48
19	2018		14	14	1,773	1,355	108	3,236	0.01	0	45
20	2019		14	14	2,026	1,581	111	3,717	0.01	0	41
21	2020		14	14	2,294	1,829	113	4,236	0.01	0	37
22	2021		14	14	2,579	2,100	115	4,794	0.01	0	34
23	2022	793	14	807	2,881	2,397	118	5,396	0.01	5	30
24	2023		14	14	3,202	2,722	121	6,045	0.00	0	27
25	2024		14	14	3,542	3,078	124	6,744	0.00	0	24
26	2025		14	14	3,902	3,470	127	7,499	0.00	0	21
27	2026	444	14	458	4,284	3,899	130	8,313	0.00	1	19
28	2027		14	14	4,688	4,371	133	9,192	0.00	0	17
29	2028		14	14	5,116	4,889	137	10,142	0.00	0	15
30	2029		14	14	5,569	5,459	141	11,169	0.00	0	13
31	2030	444	14	458	6,047	6,086	145	12,278	0.00	0	11
32	2031		14	14	6,554	6,776	149	13,479	0.00	0	10
33	2032		14	14	7,088	7,536	154	14,778	0.00	0	9
34	2033	130	14	143	7,654	8,374	159	16,186	0.00	0	8
		6,658	385	7,043	80,799	74,314	2,976	158,089	25.29%	1,678	1,678