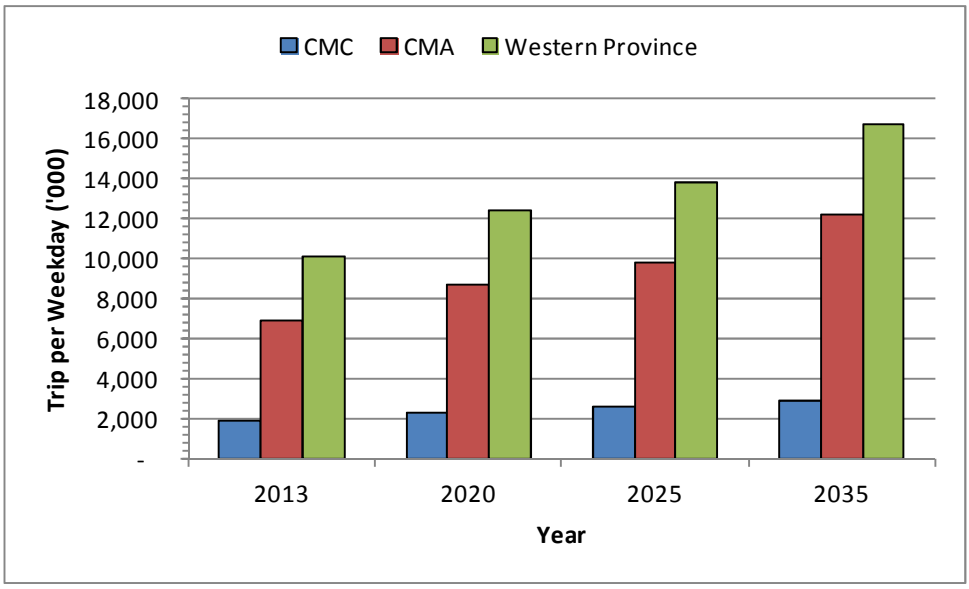
CHAPTER 4 Future Demand Forecast for the Master Plan

4.1 Trip Generation

4.1.1 Trip Generation: 2013 - 2035

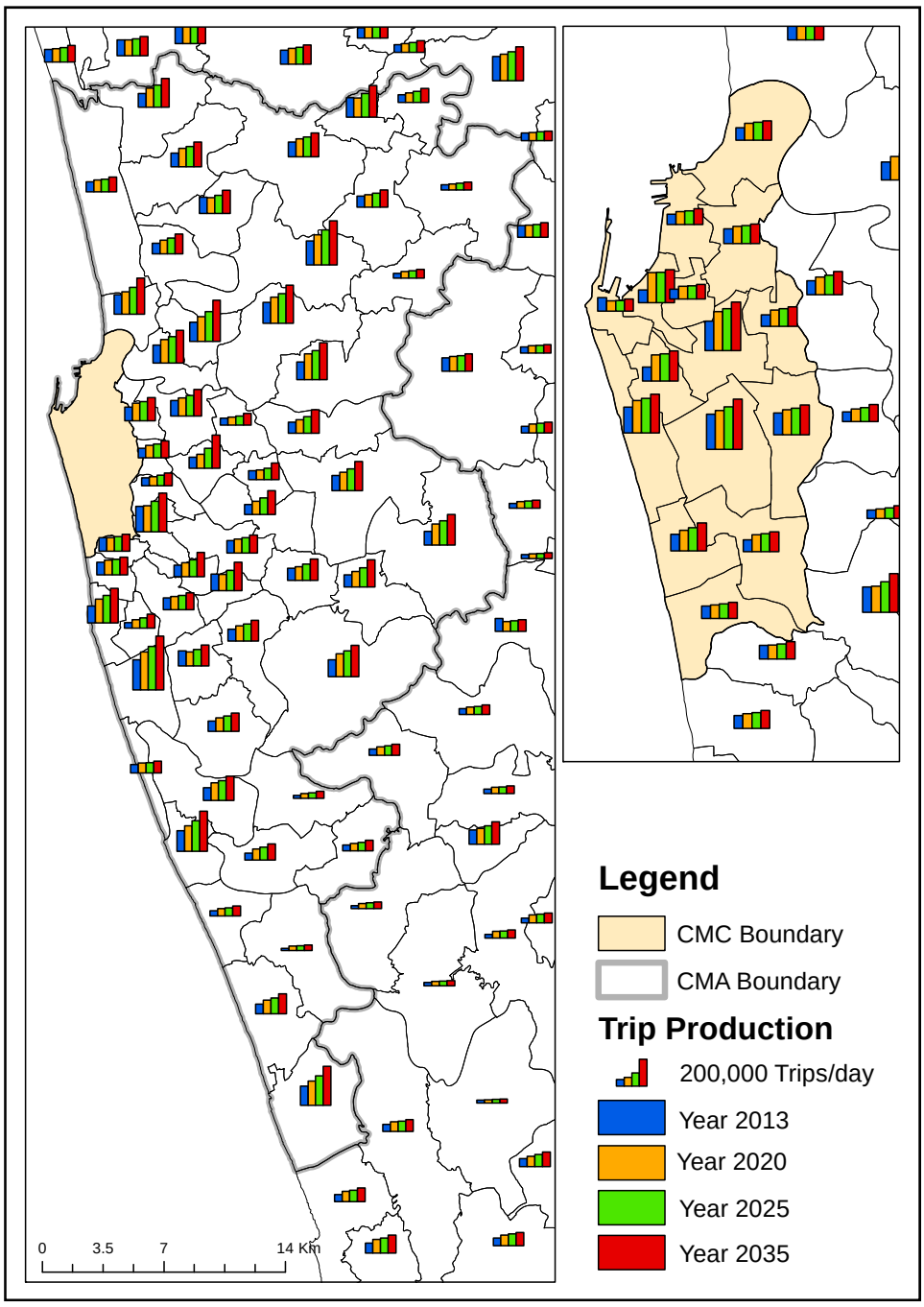
Based on the socio-economic framework of the CoMTrans project as mentioned in the Final Report Chapter 4 and 5 as well as Technical Report No. 4, trip generation was estimated by using the trip generation/attraction model. Trip production was forecast for 2020, 2025, and 2035. It is anticipated that by 2035, the total number of trips made in Western Province will increase by about 66%. The trip production in CMC and CMA are expected to increase around 56% and 75% respectively by the same year.



Source: CoMTrans Estimates

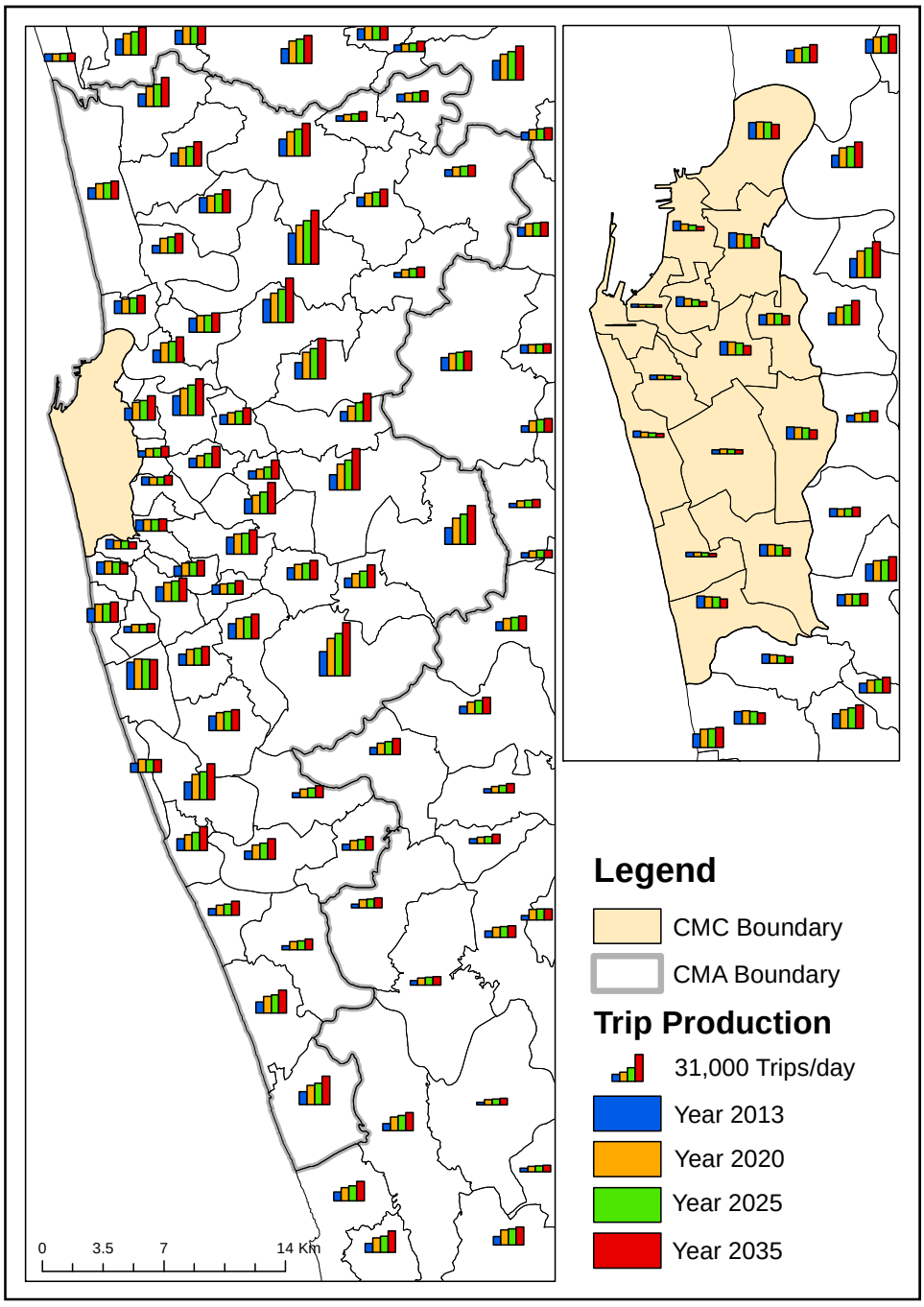
Figure 4.1.1 Present and Future Number of Trips

4.1.2 Trip Production and Attraction: 2013 – 2035



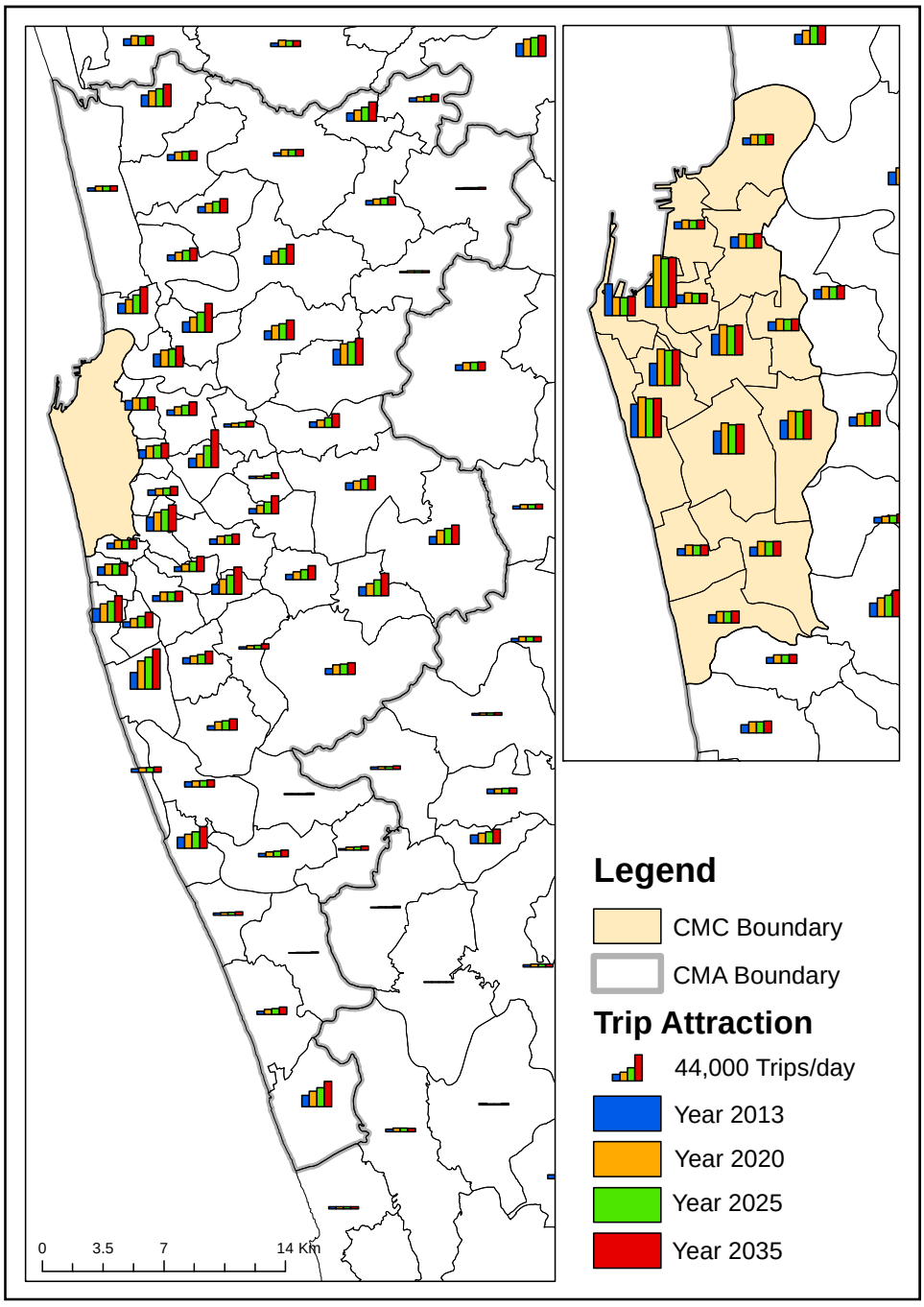
Source: CoMTrans Estimates

Figure 4.1.2 Total Trip Production



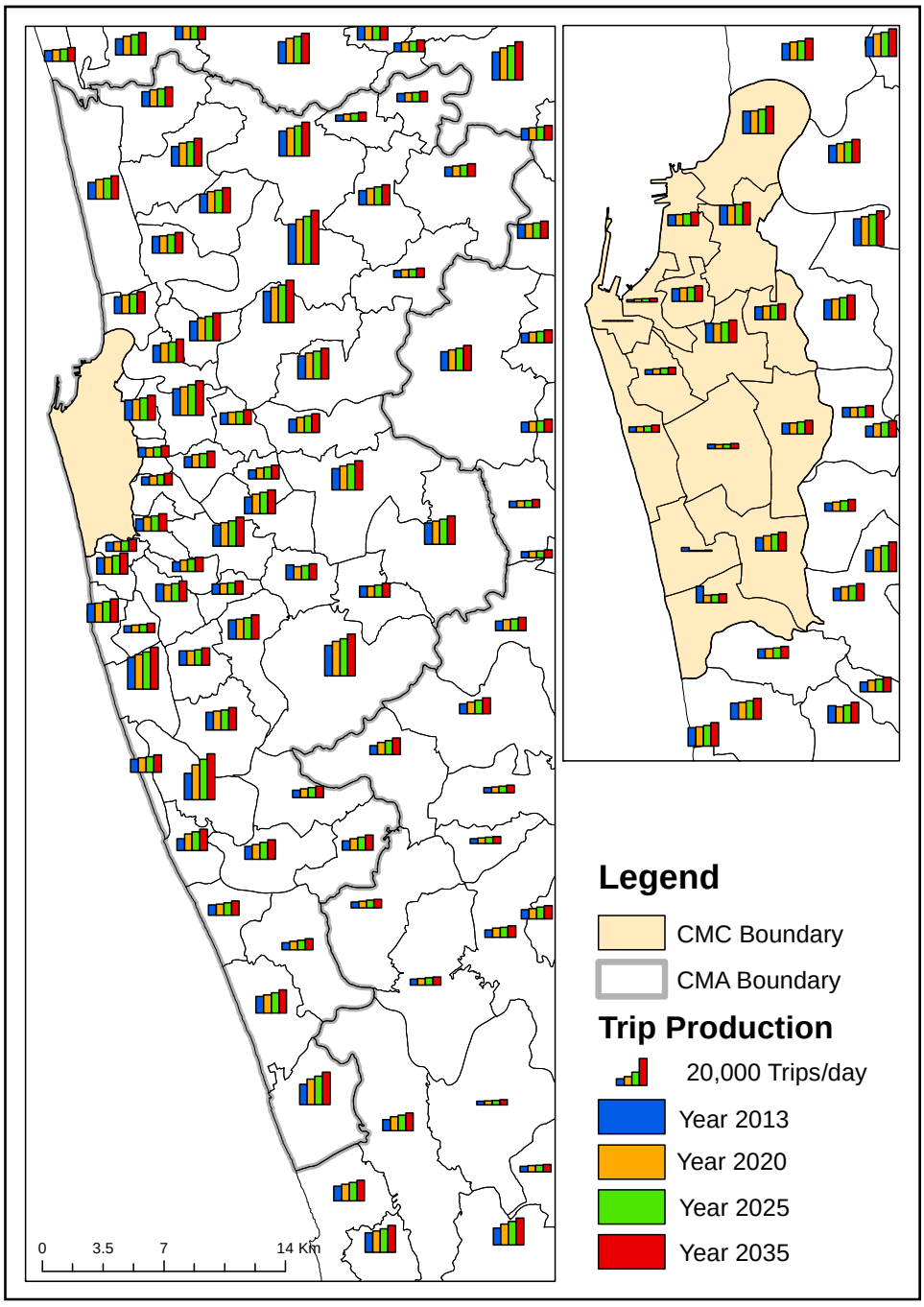
Source: CoMTrans Estimates

Figure 4.1.3 Home to Work Trip Production



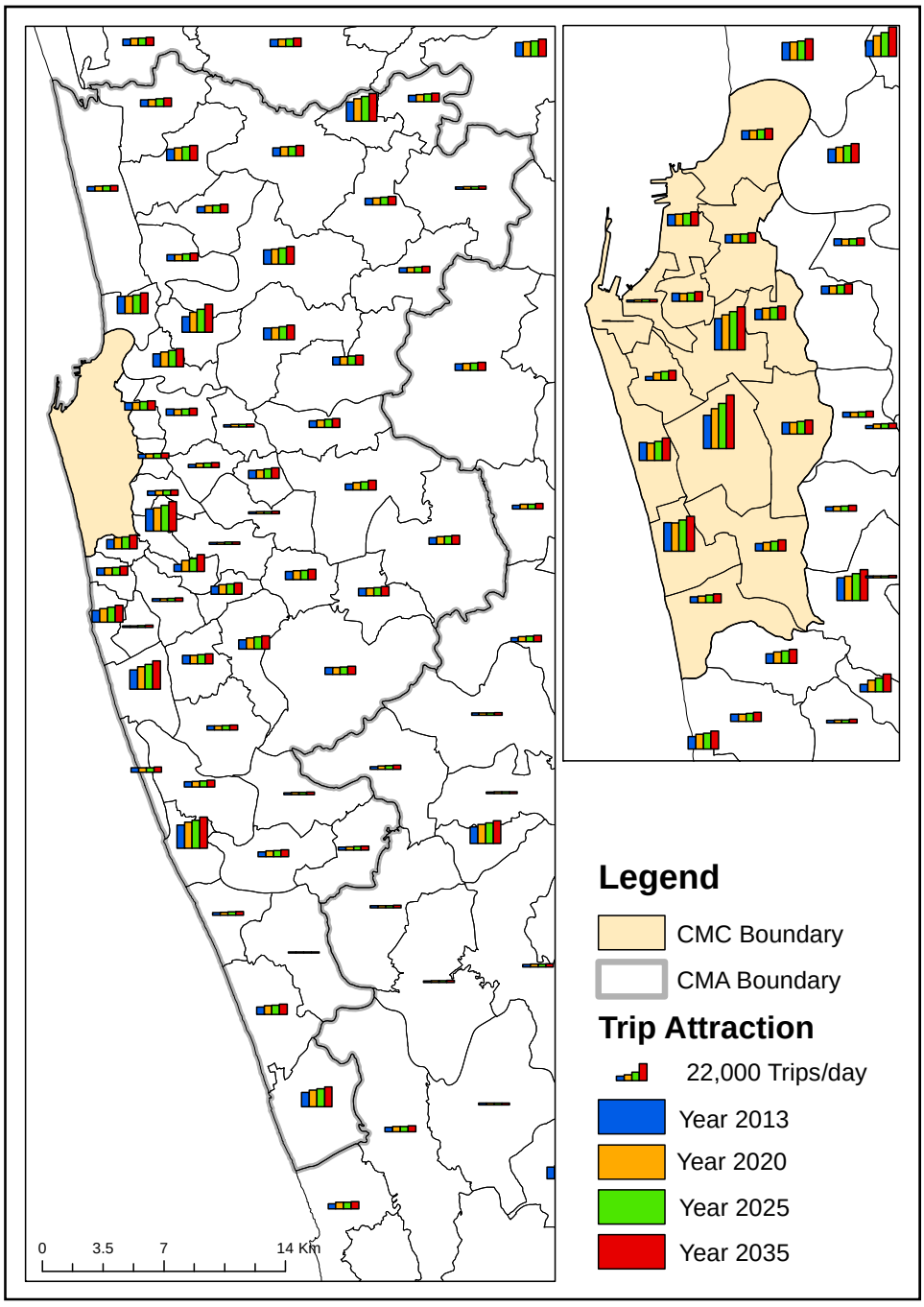
Source: CoMTrans Estimates

Figure 4.1.4 Home to Work Trip Attraction



Source: CoMTrans Estimates

Figure 4.1.5 Home to Education Trip Production

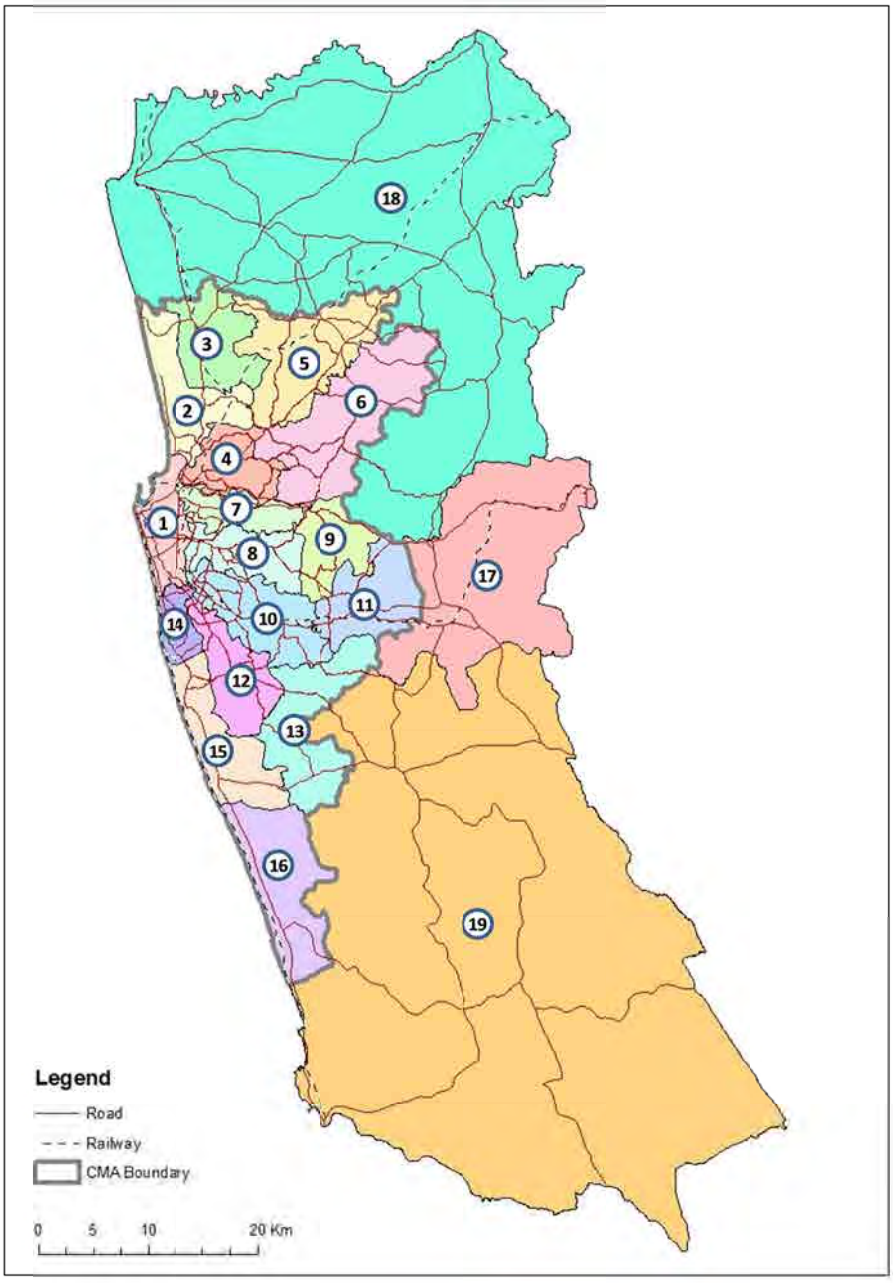


Source: CoMTrans Estimates

Figure 4.1.6 Home to Education Trip Attraction

4.2 Trip Distribution

Estimated trip distributions are presented by total person-trip OD matrices and desire lines using a large zone block.



Source: CoMTrans Estimates

Figure 4.2.1 Large Zone Block

Table 4.2.1 Total Person-Trip OD Matrices

Block Matrix 2013 - Total Person-Trip OD Matrix

O-D	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	Total
1	1,123,230	34,418	20,781	51,452	30,754	24,006	77,797	80,327	12,774	103,373	14,728	37,985	8,726	73,959	44,408	12,077	10,401	53,477	20,789	1,835,462
2	36,716	224,442	26,869	27,685	12,254	3,113	1,287	2,013	652	2,224	192	943	222	814	368	63	294	18,574	194	358,919
3	20,739	27,888	154,388	5,185	12,931	1,151	494	1,540	0	1,204	148	597	125	655	434	0	44	25,218	0	252,741
4	50,846	25,291	5,482	223,170	21,196	40,527	5,407	4,858	1,159	3,626	371	1,151	304	2,688	1,375	771	783	11,998	1,337	402,340
5	26,885	11,164	14,880	21,447	269,523	29,885	1,542	2,517	369	1,628	697	121	0	1,703	462	554	448	61,959	382	446,166
6	24,933	4,435	1,367	40,561	29,528	191,428	3,435	2,846	4,063	2,660	542	727	140	1,394	959	225	928	21,840	2,075	334,086
7	82,242	2,039	495	6,229	1,285	3,667	148,563	16,492	6,420	4,713	1,167	1,693	210	2,581	695	448	1,577	2,516	980	284,012
8	77,467	1,890	1,913	5,404	2,234	2,411	15,407	164,007	13,408	46,840	6,292	4,604	1,252	10,987	3,349	801	2,548	6,921	1,540	369,275
9	11,624	247	0	1,110	371	4,365	7,225	15,788	79,844	8,131	7,986	666	507	1,134	172	125	4,798	3,773	441	148,307
10	96,099	1,379	963	3,832	1,837	3,336	5,118	47,290	5,251	364,595	23,550	38,587	12,850	35,155	7,400	2,475	9,593	4,056	4,825	668,191
11	16,053	192	148	845	287	1,259	837	8,004	7,427	22,649	99,466	1,869	7,785	2,641	382	115	13,098	1,330	2,469	186,856
12	39,658	170	637	1,914	79	781	2,273	4,551	666	37,118	1,718	169,900	8,765	17,974	11,134	651	1,236	1,756	3,739	304,720
13	8,613	222	124	410	0	140	209	1,814	597	15,186	7,939	9,776	77,379	2,864	12,537	2,667	1,137	347	18,793	160,754
14	73,609	811	616	1,960	1,704	2,494	2,498	9,693	1,121	33,268	1,398	18,698	2,516	153,905	32,633	5,088	1,411	3,792	5,927	353,142
15	50,278	856	386	1,335	462	562	654	2,467	172	7,029	492	11,135	12,325	35,242	391,496	26,979	217	2,078	12,686	556,851
16	13,341	99	0	430	370	225	448	697	122	2,520	115	1,038	2,306	3,887	25,935	172,227	124	720	37,213	261,817
17	9,534	293	81	1,030	363	969	1,518	2,887	4,256	9,621	14,187	1,546	1,299	1,479	217	254	216,730	5,515	5,123	276,902
18	57,961	18,828	28,355	13,392	61,837	21,588	3,081	6,819	2,008	5,205	1,705	1,730	390	4,082	2,313	776	5,291	1,596,644	1,504	1,833,509
19	20,205	555	155	685	433	1,299	1,268	1,544	440	4,338	3,248	5,832	16,850	5,475	11,984	36,616	5,317	1,843	835,617	953,704
Total	1,840,033	355,219	257,640	408,076	447,448	333,206	279,061	376,154	140,749	675,928	185,941	308,598	153,951	358,619	548,253	262,912	275,975	1,824,357	955,634	9,987,754

Block Matrix 2020 - Total Person-Trip OD Matrix

O-D	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	Total
1	1,436,489	41,293	30,296	113,901	38,413	35,757	111,763	106,217	20,615	137,238	20,444	51,870	14,130	97,800	61,777	12,270	13,861	65,154	22,041	2,431,329
2	62,317	191,971	34,292	38,823	15,459	5,939	2,920	9,412	1,153	4,788	962	916	326	2,950	1,375	249	286	26,698	83	400,919
3	39,213	47,379	145,355	11,632	26,786	5,607	1,523	3,645	857	4,636	357	1,202	107	2,010	1,116	75	207	51,487	47	343,241
4	103,022	39,095	14,486	174,920	35,968	47,406	11,648	15,419	7,251	15,939	3,194	3,276	893	9,747	4,657	1,190	2,445	25,565	2,023	518,144
5	42,061	21,141	30,773	28,598	253,680	37,762	2,507	3,586	2,890	3,800	1,328	756	75	4,304	1,031	588	2,437	77,771	69	515,157
6	44,304	18,872	5,890	51,457	37,655	208,557	6,306	8,320	7,306	5,941	2,670	1,390	267	3,949	2,001	1,222	3,239	33,063	3,124	445,533
7	99,216	2,137	2,529	19,945	4,392	9,043	139,021	18,894	8,221	14,297	3,328	3,384	546	10,170	3,397	739	3,082	4,153	1,195	347,689
8	89,530	6,703	4,064	19,216	10,072	9,323	20,529	146,047	19,093	58,910	16,138	12,017	3,250	22,347	12,607	1,316	3,662	9,190	1,305	465,319
9	18,270	362	1,162	7,697	3,430	9,666	11,108	20,255	59,581	10,897	14,198	2,028	759	3,959	3,121	396	6,418	3,415	470	177,192
10	130,761	1,454	3,190	14,993	4,212	7,313	6,774	63,137	12,228	298,632	25,732	46,545	16,465	56,423	28,874	2,626	11,360	6,191	8,387	745,297
11	20,054	387	657	4,104	1,764	3,394	2,053	14,049	15,265	34,966	112,396	6,686	10,604	5,883	7,563	666	19,305	2,601	4,489	266,886
12	51,934	328	1,215	5,080	879	1,864	3,811	12,815	2,154	47,270	6,382	123,974	11,892	24,956	37,054	2,296	1,392	2,931	4,182	342,409
13	15,848	291	331	1,163	344	895	484	5,044	2,575	18,903	7,260	12,865	91,721	4,487	28,482	9,274	3,788	391	27,764	231,910
14	95,015	843	1,726	8,194	6,041	7,110	13,840	21,868	2,789	50,950	4,440	27,045	2,866	124,222	61,595	5,034	2,157	5,828	5,726	447,289
15	82,827	1,241	1,442	5,000	1,372	1,947	1,405	9,280	2,079	28,396	5,974	30,077	22,803	60,659	401,571	37,384	580	2,866	20,844	717,747
16	29,115	155	93	492	396	1,451	1,061	888	341	3,689	1,001	3,938	9,259	5,740	36,410	216,645	307	49	53,947	364,977
17	10,512	198	993	3,905	4,338	3,939	2,723	5,076	6,650	8,229	21,463	2,120	5,671	2,265	2,341	556	215,350	10,266	7,363	313,958
18	102,134	27,825	56,366	16,375	83,609	39,859	6,410	8,317	5,669	10,129	4,315	3,537	426	4,695	1,828	34	10,787	1,733,480	715	2,116,510
19	37,563	1,028	229	2,260	701	1,701	2,649	3,827	2,112	10,043	12,601	10,502	31,038	9,756	31,335	74,415	9,718	1,254	1,092,051	1,334,783
Total	2,510,185	402,703	335,089	527,755	529,511	438,533	348,535	476,096	178,829	767,653	264,183	344,128	223,098	456,322	728,135	366,975	310,381	2,062,353	1,255,825	12,526,289

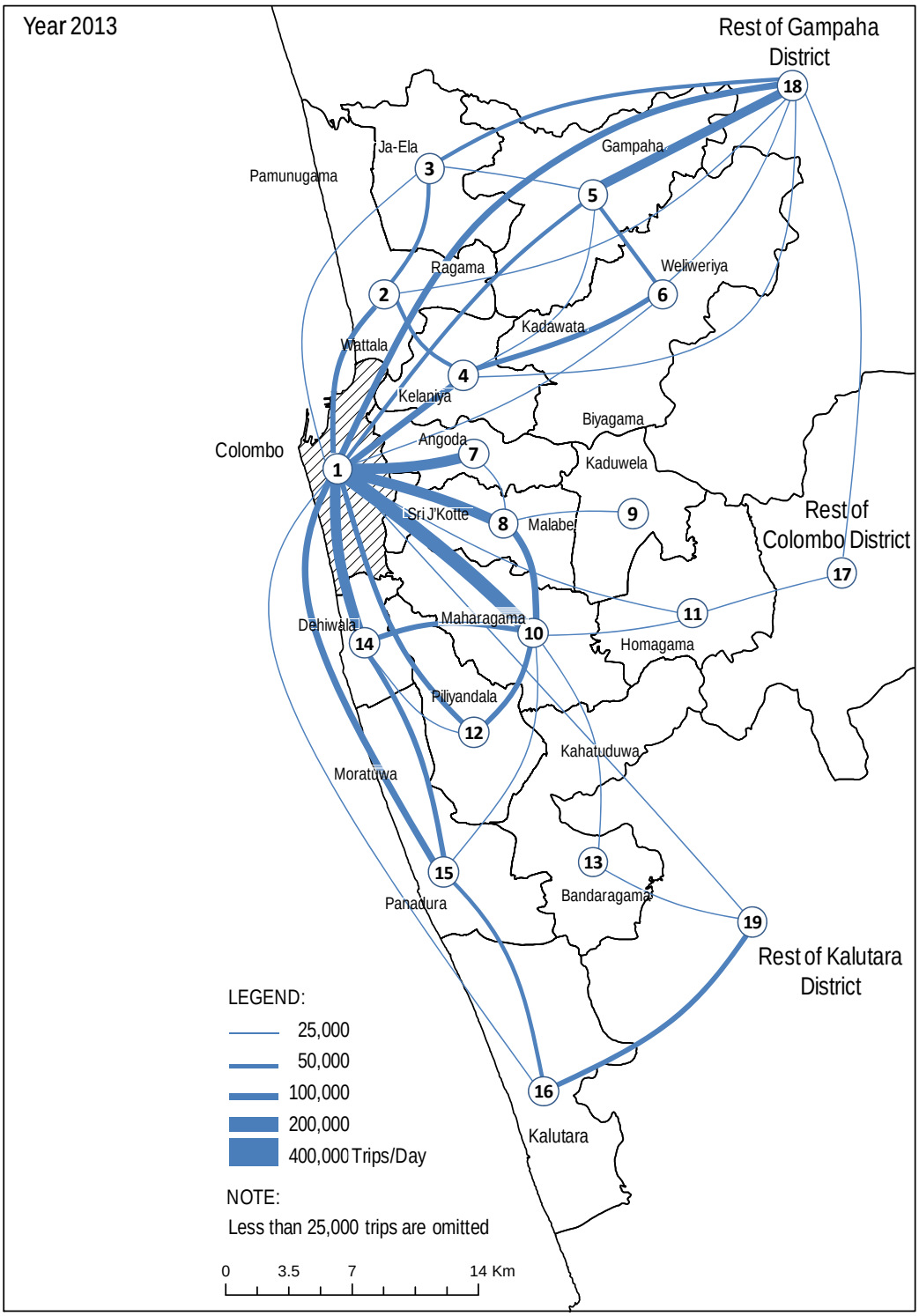
Block Matrix 2025 - Total Person-Trip OD Matrix

O-D	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	Total
1	1,475,342	42,699	30,657	129,020	41,244	43,128	121,249	128,252	23,775	153,040	24,202	58,292	15,577	101,716	71,982	13,608	12,545	62,988	21,473	2,570,789
2	80,230	198,915	40,108	53,673	19,803	7,100	4,065	14,200	1,476	6,387	1,332	1,081	559	3,693	1,802	406	350	32,678	87	467,945
3	43,021	62,836	155,976	14,206	30,836	6,615	1,803	4,715	1,072	6,168	442	1,641	85	2,482	1,444	75	266	55,326	59	389,068
4	116,273	51,516	17,491	183,486	42,782	54,793	13,254	21,286	8,814	20,740	4,559	4,219	1,377	12,259	5,877	1,239	3,457	33,824	3,310	600,556
5	47,024	29,824	38,725	38,229	278,817	44,883	3,094	4,851	3,857	5,055	1,831	1,137	153	6,274	1,452	632	3,543	92,421	106	601,908
6	46,790	23,613	6,796	62,791	44,686	223,497	8,791	11,804	9,290	7,200	3,378	1,747	366	4,372	2,518	1,233	4,849	37,137	3,483	504,341
7	114,246	2,648	2,855	23,108	5,138	11,656	147,736	23,450	10,145	17,872	4,203	4,226	675	12,865	3,870	834	4,929	5,145	1,286	396,887
8	108,368	12,195	5,015	23,460	16,728	11,659	26,403	169,799	22,806	73,210	21,862	17,024	4,776	27,879	16,532	1,835	5,073	13,021	1,816	579,461
9	21,569	600	1,385	9,506	4,075	12,336	14,272	25,819	64,228	13,335	16,875	2,545	1,120	5,100	4,058	490	6,527	4,291	691	208,822
10	157,994	1,762	3,792	17,369	4,859	8,077	8,366	75,723	15,119	336,522	31,538	54,228	18,292	70,801	34,910	3,019	13,290	6,443	9,633	871,737
11	22,521	501	807	6,096	2,203	4,578	2,916	19,211	18,604	46,052	126,361	9,744	13,110	7,405	10,238	835	21,096	2,672	6,412	321,362
12	57,734	350	1,310	5,861	1,140	2,154	5,842	16,931	2,598	56,880	8,125	124,603	13,061	29,685	46,613	2,520	1,470	2,788	5,381	385,046
13	18,169	442	493	1,441	471	1,268	540	7,424	3,141	19,681	8,869	15,928	91,972	5,123	37,332	10,630	4,721	390	35,766	263,801
14	102,625	944	1,748	9,376	6,780	10,172	21,023	29,078	3,493	59,145	4,902	30,049	3,315	124,782	72,310	6,174	2,139	6,930	6,500	501,485
15	103,699	962	1,661	5,797	1,527	2,240	1,690	13,094	2,486	35,210	7,381	36,593	29,770	73,587	430,158	42,964	833	3,467	26,046	819,165
16	30,785	240	107	715	412	1,596	1,232	1,205	525	4,677	1,280	5,970	10,990	6,476	46,974	244,638	389	41	66,717	424,969
17	9,474	222	1,406	5,547	5,955	5,409	3,860	6,131	8,020	9,655	25,215	2,752	8,438	2,645	3,214	669	220,882	12,419	8,964	340,877
18	112,040	36,985	67,929	21,821	104,912	48,132	7,903	11,093	7,808	12,695	4,942	4,177	470	6,127	2,083	34	13,720	1,811,319	1,201	2,275,391
19	35,969	764	243	2,941	840	1,943	3,117	4,881	2,681	12,435	15,173	13,275	40,393	10,467	40,324	94,462	11,462	1,823	1,161,053	1,454,246
Total	2,703,873	468,018	378,504	614,443	613,208	501,236	397,156	588,947	209,938	895,959	312,470	389,231	254,499	513,738	833,691	426,297	331,541	2,185,123	1,359,984	13,977,856

Block Matrix 2035 - Total Person-Trip OD Matrix

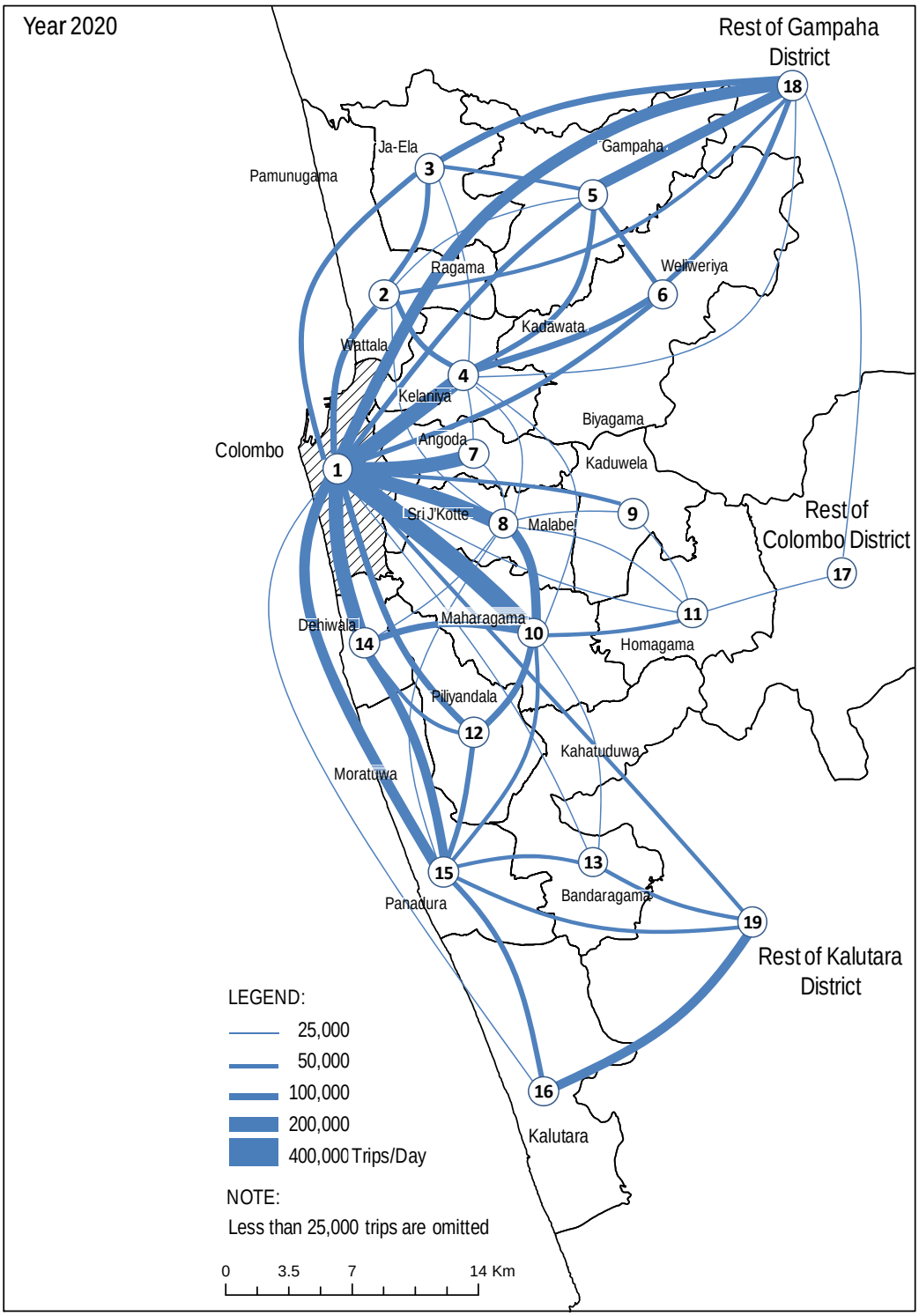
O-D	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	Total
1	1,543,312	45,203	32,385	162,655	47,734	57,773	146,765	201,398	31,592	185,297	32,316	67,488	18,916	111,364	94,171	15,926	10,980	63,339	22,494	2,891,102
2	110,896	214,797	50,324	86,631	27,579	9,670	6,529	25,393	2,229	9,764	2,067	1,444	1,035	5,139	2,859	731	460	42,557	115	600,219
3	49,908	89,720	186,442	20,145	39,640	8,904	2,183	7,344	1,642	9,514	603	2,268	76	3,175	1,954	75	394	61,426	112	485,525
4	141,922	73,806	23,330	209,782	53,454	72,069	17,093	36,679	12,383	29,282	7,616	6,450	2,342	16,241	8,313	1,355	5,483	47,363	6,539	771,502
5	55,844	47,049	53,871	55,627	334,974	59,839	3,878	8,004	5,985	8,067	2,977	1,976	272	8,179	2,284	604	5,157	116,647	168	771,402
6	53,723	36,634	8,767	81,392	58,727	257,496	12,837	21,191	13,587	9,541	4,881	2,378	533	5,597	3,737	1,233	7,716	43,598	3,375	626,943
7	141,696	3,789	3,527	29,343	6,391	16,050	173,322	34,367	14,210	24,194	5,726	5,771	765	17,313	4,949	975	8,346	6,564	1,414	498,712
8	146,358	31,280	7,216	33,077	28,641	17,383	39,702	207,825	30,273	112,993	34,320	28,609	8,199	40,951	25,421	3,322	8,397	19,161	2,854	825,982
9	27,367	1,591	1,740	12,766	5,205	17,801	21,985	37,955	76,495	18,601	21,953	3,486	1,703	7,275	5,846	705	7,059	6,042	1,067	276,642
10	190,150	2,382	5,059	22,259	6,479	10,099	11,714	106,656	20,766	428,265	44,078	70,332	23,430	101,991	47,988	3,608	15,583	8,326	11,595	1,130,760
11	26,552	559	1,136	9,913	2,880	6,996	4,118	31,666	25,201	65,385	156,132	16,295	18,925	9,522	15,523	1,207	24,108	2,862	10,072	429,052
12	67,150	331	1,546	7,444	1,534	2,684	8,045	25,679	3,542	73,329	11,549	130,382	15,286	36,927	64,003	3,090	1,701	3,197	7,159	464,578
13	23,436	675	797	2,002	753	1,984	564	12,872	4,104	22,042	12,126	21,021	93,948	5,948	53,255	12,594	5,983	378	49,241	323,723
14	120,618	1,195	1,828	11,640	7,152	18,045	32,082	43,251	5,425	72,694	6,276	35,926	4,046	127,252	93,446	8,530	1,913	8,863	6,930	607,112
15	146,274	757	2,046	7,169	1,844	2,820	1,997	20,444	3,229	46,474	10,202	48,012	42,495	98,169	491,081	54,397	1,196	4,126	35,778	1,018,510
16	33,635	388	136	1,139	429	1,710	1,322	1,985	792	6,356	1,869	9,308	12,974	8,055	65,446	307,704	539	35	89,711	543,533
17	8,828	227	1,917	8,695	8,390	7,121	6,454	8,543	10,586	12,016	31,727	3,743	12,686	2,836	4,447	857	229,153	15,258	11,426	384,910
18	123,582	52,245	88,905	31,121	142,449	60,494	9,503	17,367	11,993	16,000	6,115	5,140	534	8,495	2,674	32	18,025	1,979,029	2,078	2,575,781
19	35,760	531	272	4,285	996	2,429	3,707	7,256	3,687	15,767	20,049	17,180	55,728	10,649	53,627	131,317	14,405	3,024	1,296,440	1,677,109
Total	3,047,011	603,159	471,244	797,085	775,251	631,367	503,800	855,875	277,721	1,165,581	412,582	477,209	313,893	625,078	1,041,024	548,256	366,598	2,431,795	1,558,568	16,903,097

Source: CoMTrans Estimates



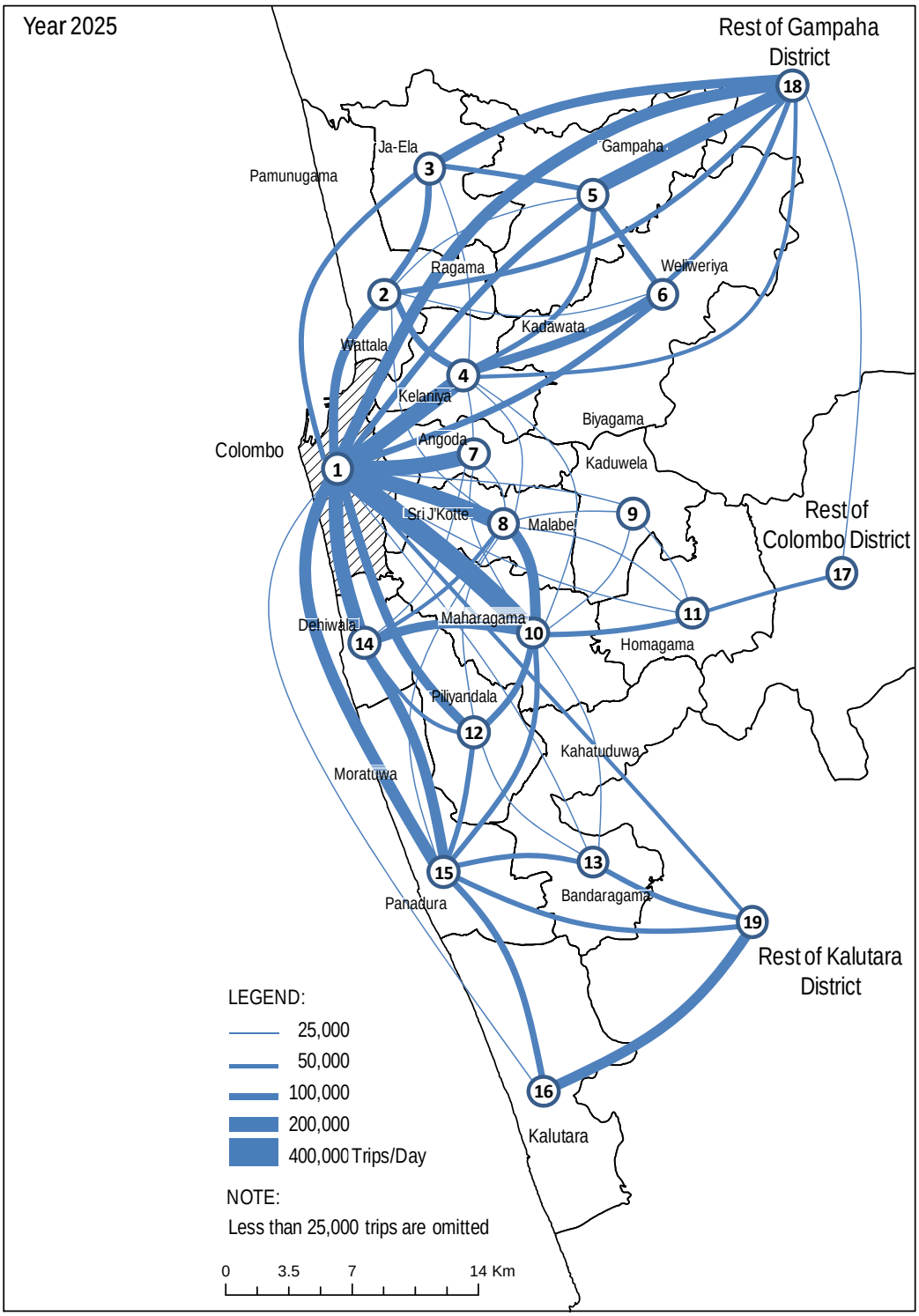
Source: CoMTrans Estimates

Figure 4.2.2 Person-Trip Desire Line (All Purposes) in Western Province Year 2013



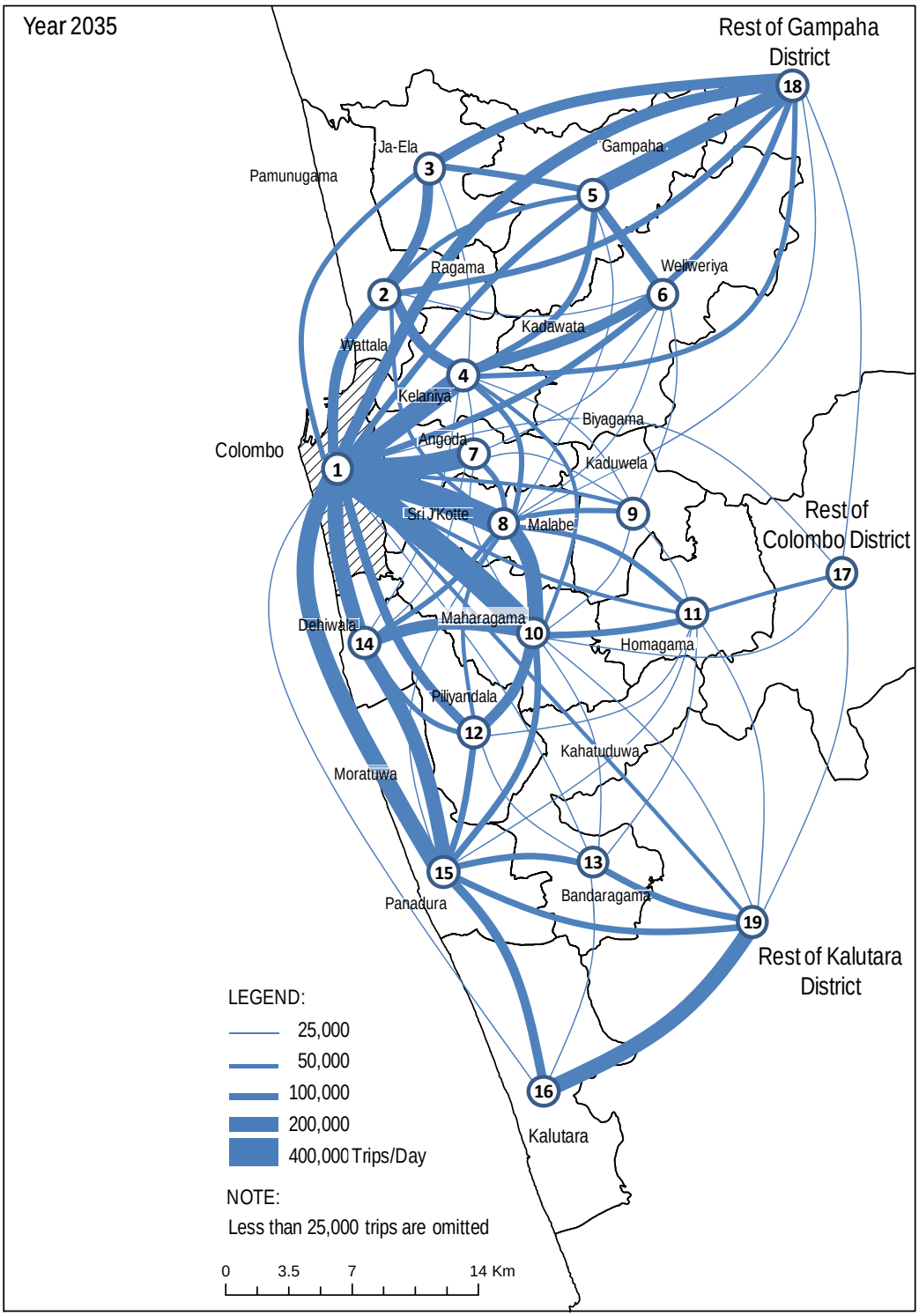
Source: CoMTrans Estimates

Figure 4.2.3 Person-Trip Desire Line (All Purposes) in Western Province Year 2020



Source: CoMTrans Estimates

Figure 4.2.4 Person-Trip Desire Line (All Purposes) in Western Province Year 2025



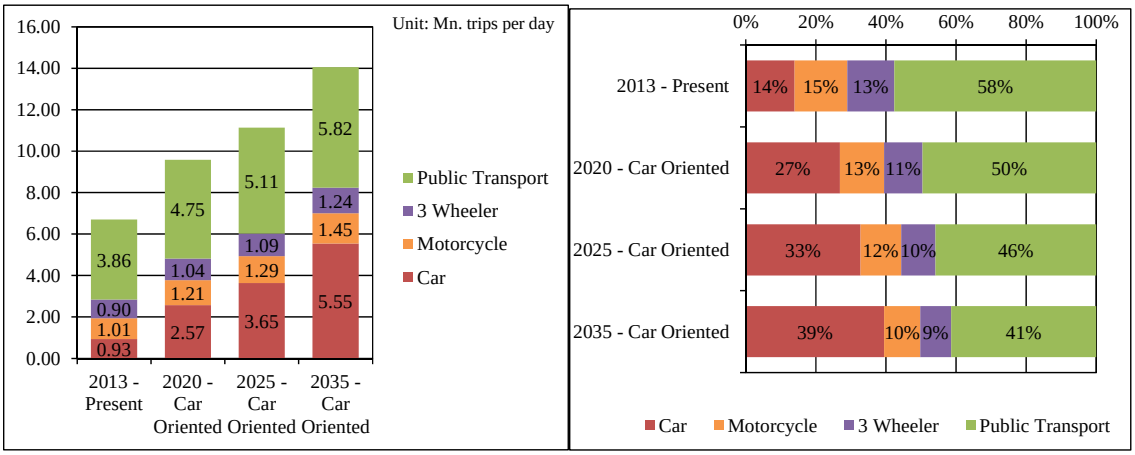
Source: CoMTrans Estimates

Figure 4.2.5 Person-Trip Desire Line (All Purposes) in Westin Province Year 2035

4.3 Modal Share

The estimated origin-destination (OD) tables by 4 trip purposes by 3 income groups by trip generation and distribution model are divided into 5 transport modes; cars, motorcycles, three wheelers, public transports (railway and buses) and non-motorised transport. Therefore, a total of 60 OD tables were estimated by scenario by year. Modal share was estimated by iteration calculations of modal split and traffic assignment as mode share is affected by service level and travel speeds as shown in the flow chart of Figure 1.2.1 and Figure 3.5.1.

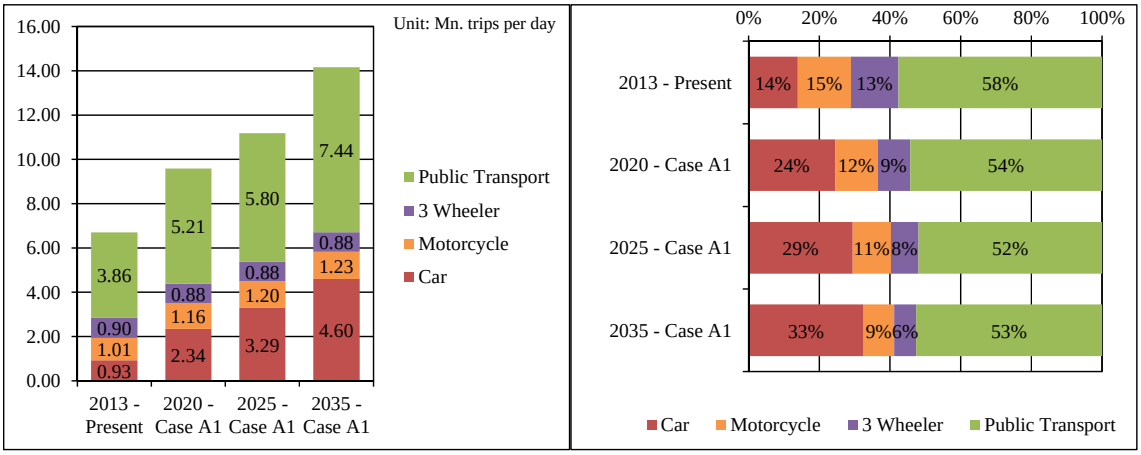
In addition to the master plan evaluation, 6 scenarios from A1 to C2, mode share of one additional model, a car-oriented scenario, was estimated. Apart from the master plan scenarios; impedance tables, which represent service level of road transport, were assumed to be equal in the future. This implies that the government will provide as much road as possible so as not exceed the current congestion level. Thus, it can be said that this is in line with the current policy of mainly developing the road network. The estimated results of the 7 scenarios are summarised from Figure 4.3.1 to Figure 4.3.7.



Note: the number of trips and mode share of inter-zonal trips exclude non-motorised trips.

Source: CoMTrans Estimates

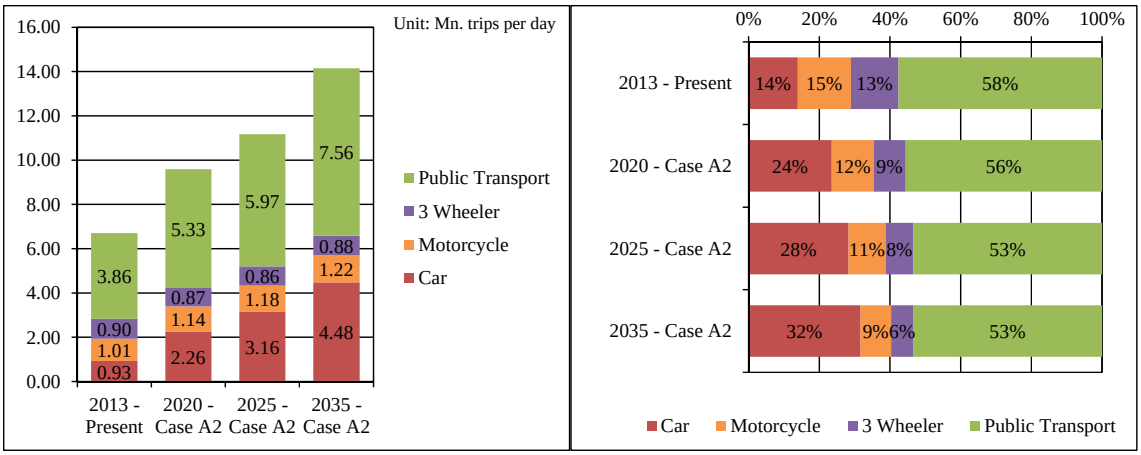
Figure 4.3.1 No. of Trips by Mode and Modal Share of Car Oriented Scenario (Status Quo Policy)



Note: the number of trips and mode share of inter-zonal trips exclude non-motorised trips.

Source: CoMTrans Estimates

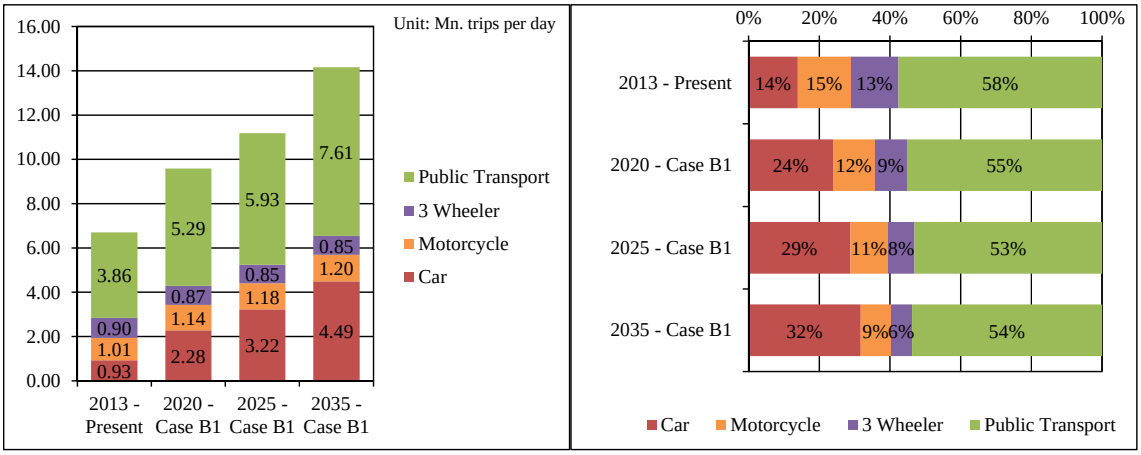
Figure 4.3.2 No. of Trips by Mode and Modal Share of Master Plan A1 Scenario



Note: the number of trips and mode share of inter-zonal trips exclude non-motorised trips.

Source: CoMTrans Estimates

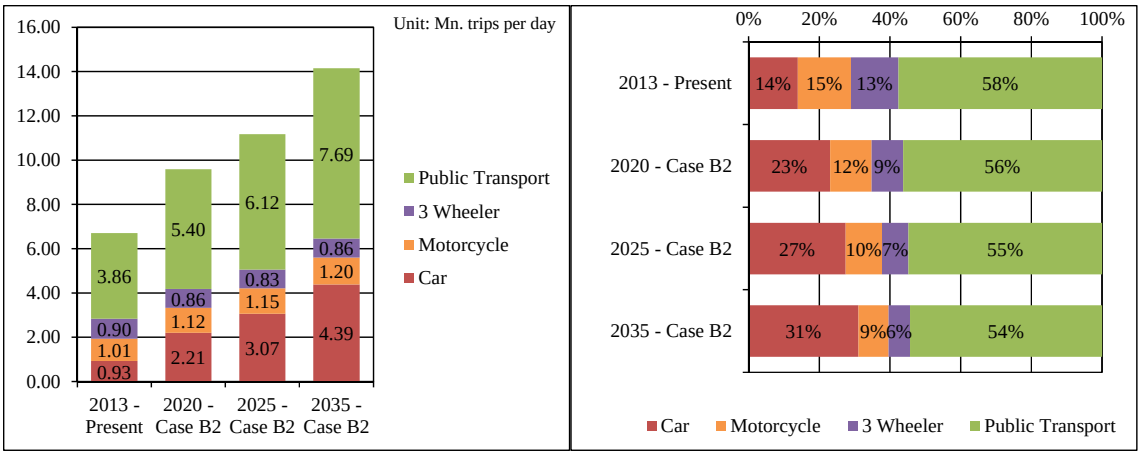
Figure 4.3.3 No. of Trips by Mode and Modal Share of Master Plan A2 Scenario



Note: the number of trips and mode share of inter-zonal trips exclude non-motorised trips.

Source: CoMTrans Estimates

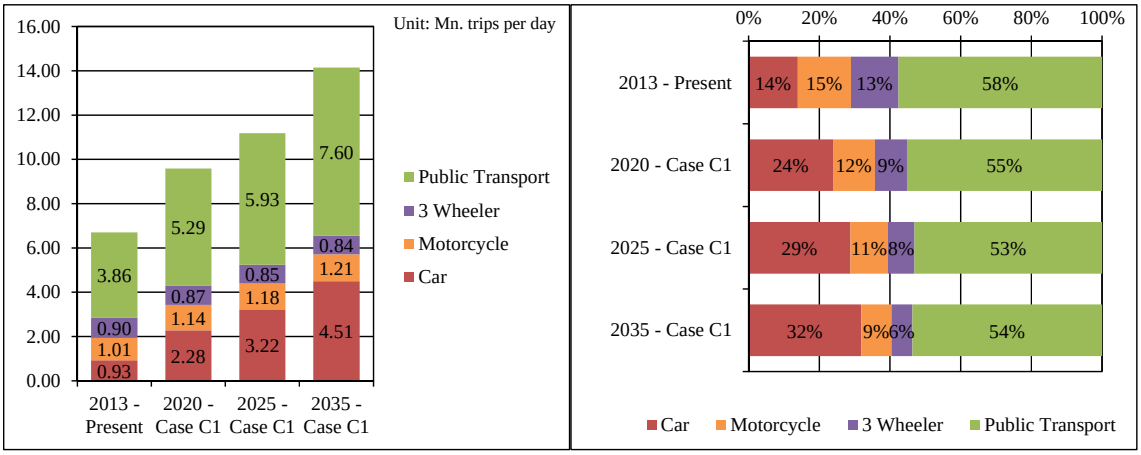
Figure 4.3.4 No. of Trips by Mode and Modal Share of Master Plan B1 Scenario



Note: the number of trips and mode share of inter-zonal trips exclude non-motorised trips.

Source: CoMTrans Estimates

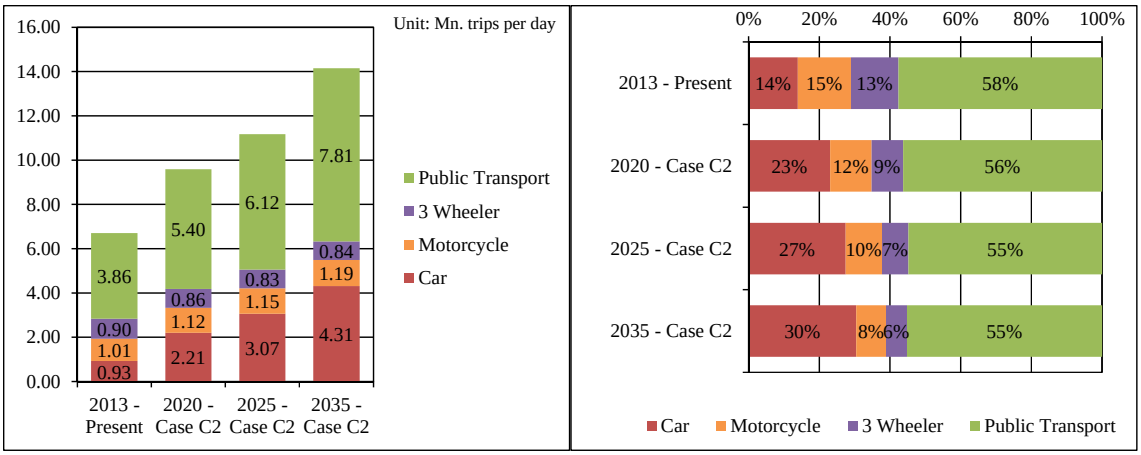
Figure 4.3.5 No. of Trips by Mode and Modal Share of Master Plan B2 Scenario



Note: the number of trips and mode share of inter-zonal trips exclude non-motorised trips.

Source: CoMTrans Estimates

Figure 4.3.6 No. of Trips by Mode and Modal Share of Master Plan C1 Scenario



Note: the number of trips and mode share of inter-zonal trips exclude non-motorised trips.

Source: CoMTrans Estimates

Figure 4.3.7 No. of Trips by Mode and Modal Share of Master Plan C2 Scenario

4.4 Traffic Assignment

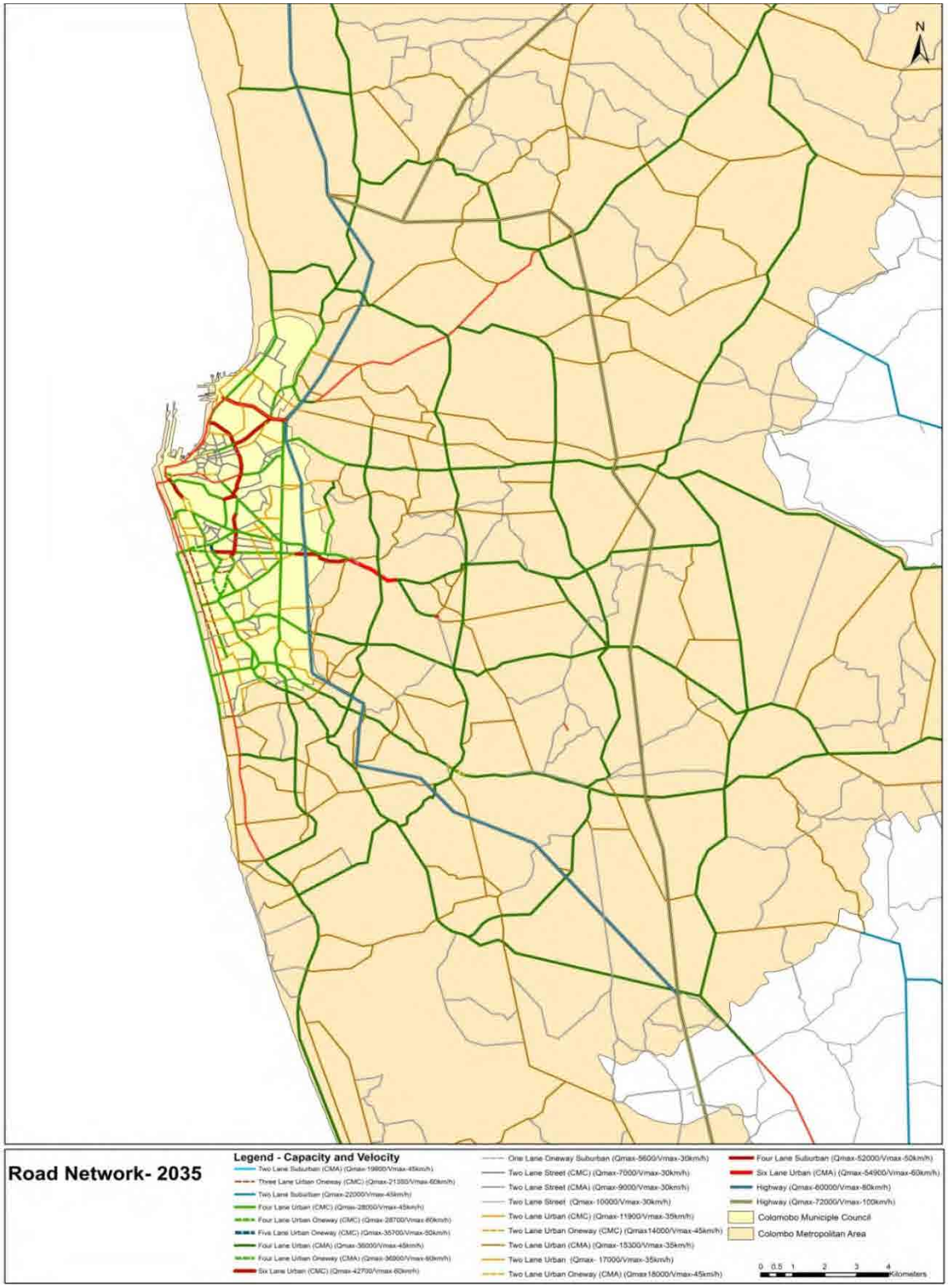
4.4.1 Assumptions on Road Network and Service Level

The road network (.INT) is forecast in three stages. Those are,

- Short term road development plan 2020
- Intermediate term road development plan 2025
- Long term road development plan 2035

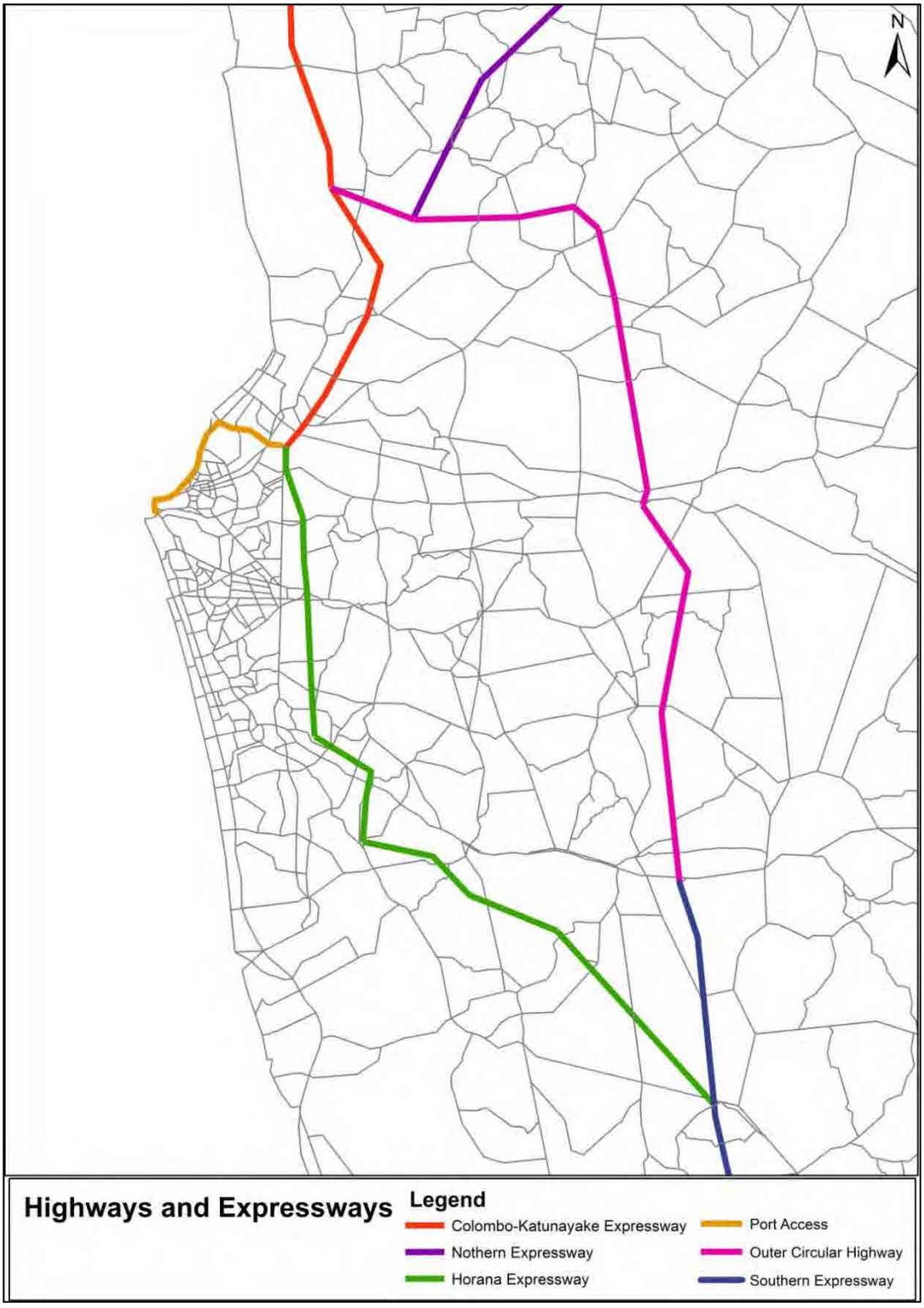
In 2020 the road network will see the completion of all ongoing projects of highways and expressways, traffic control measures, and road construction and improvements for priority systems. Road widening for BRT is included in the short term (see Figure 4.4.1). In 2025 baseline and marine drive extension are proposed due to the BRT operation on Baseline and Galle Road (Parallel to Marine Drive). The Central ring road is also proposed with the development of 6 lanes and a BRT system is also proposed along this section. Furthermore, Horana Expressway is also proposed as an intermediate plan. In 2020 the Northern Expressway is proposed and in 2035 some major roads are widened. All other maps are annexed to the report.

BRT operating roads should provide the space for the operation for BRT. As a result, one lane per direction is allocated for the BRT operation. According to the allocation of the number of lanes, road capacity and velocity was reduced. For an example, ring road will be developed as 6 lane in 2025, due to the BRT operation the capacity and velocity will be equal to 4 lanes. The total number of links and nodes are 3933 and 2557 respectively.



Source: CoMTrans Study Team

Figure 4.4.1 Long Term Road Network- 2035(Master Plan C2 Base)



Source: CoMTrans Study Team

Figure 4.4.2 Highways and Expressways Network

(1) Expressway Settings

Expressway toll development differs according to the road network development. The proposed highways and expressways network is shown in Figure 4.4.2. Table 4.4.1shows the development of expressways in three stages with the toll rate and velocity and capacity settings. The fare level for Colombo-Katunayake, Southern Expressway and Outer Circular Highway are the same as the current fare level.

Table 4.4.1 Expressway Toll Price for Demand Forecast of Master Plan

Year	Expressway	Toll Rate (Rs./km)		Velocity (km/h)	Capacity (PCU /both directions/ day)*no of lanes)	No of Lanes
		Car	Truck			
2020	Southern Expressway (SE)	4.20	15.60	100	72,000	4
	Colombo-Katunayake (CKE)	13.60	27.10	80	108,000	4
	Outer Circular Highway (OCH)	9.10	27.27	100	72,000	4
	Port Expressway	13.60	27.10	60	50,000	4
2025	Horana Expressway	13.60	27.10	60 (From Kottawa-Nugegoda 80km/h)	60,000	4
2035	Northern Expressway (NE)	4.20	15.60	100	72,000	4

Source-Road Development Authority (March, 2014)

(2) Parameter Setting

Table 4.4.2 shows the time values applied to run the JICA STRADA User Equilibrium Assignment for 2013, 2020, 2025 and 2035.

Table 4.4.2 Parameter Time Equivalence Settings- 2035

Mode	Time Value (Hour/Rs)			
	2013	2020	2025	2035
Mode 1 (Cars)	6	4.8	4.2	4.2
Mode 2 (Motorbikes)	13.2	9	7.8	6
Mode 3 (Three wheelers)	12.6	9	7.8	6
Mode 4 (Buses)	1123.8	1123.8	1123.8	1123.8
Mode 5 (Trucks)	18.6	18.6	18.6	18.6

Passenger Car Unit values are based on Table 2.4.2.

Source: CoMTrans Study Team

(3) Status Quo (SQ)

The network was created according to the current situation of the road network together with the ongoing projects like the Northern Expressway. The total number of links and nodes are 3932 and 2557 respectively.

Table 4.4.3 Status Quo Settings

Network	Classification	Settings
Expressways	Outer Circular Highway	Included
	Colombo- Katunayake Highway	Included
	Southern Expressway	Included
	Northern Expressway	Included
Road Projects	Base Line Extension	Not Included
	Marine Drive Extension	Not Included
	Middle Ring Road	Not Included
Road Capacity		10% reduction In the area between CMA and CMC, 30% reduction in CMC area

Source: CoMTrans Study Team

(4) Base Case

The settings of the base case are based on the corridor analysis. The total number of links and nodes are 3932 and 2557 respectively.

Table 4.4.4 Base Case Settings

Network	Classification	2020	2025	2035
Expressways	Outer Circular Highway	Included	Included	Included
	Colombo- Katunayake Expressway	Included	Included	Included
	Southern Expressway	Included	Included	Included
	Horana Expressway	-	Included	Included
	Port Access	-	-	-
	Northern Expressway	-	-	Included
Road Projects	Base Line Extension	Not Included	Not Included	Not Included
	Marine Drive Extension	Not Included	Not Included	Included
	Middle Ring Road	Not Included	Not Included	Not Included
Road Capacity		10% reduction in the area between CMA and CMC, 30% reduction in CMC area	10% reduction in the area between CMA and CMC, 30% reduction in CMC area	10% reduction in the area between CMA and CMC, 30% reduction in CMC area

Source: CoMTrans Study Team

(5) Master Plan

Several urban transport system development scenarios were prepared to analyse the advantages and disadvantages of each development scenario.

I. Intensive public transport system development scenario (Case C)

II. Mixed public transport and road network development scenario (Case B)

III. Intensive road network development scenario (Case A)

The settings of road service level are listed in Table 4.4.5 and Table 4.4.6

In addition to that, traffic demand management such as Electronic Road Pricing (ERP) to reduce the traffic congestion on the road network was applied for each scenario (named A2, B2, and C2). The total number of links and nodes are 3933 and 2557 respectively.

Table 4.4.5 Case A Case Settings

Case A (Highway Intensive)				
Network	**Classification**	**2020**	**2025**	**2035**
Expressways	Outer Circular Highway	Included	Included	Included
	Colombo- Katunayake Expressway	Included	Included	Included
	Southern Expressway	Included	Included	Included
	Horana Expressway	-	Included	Included
	Port Access	Included	Included	Included
	Northern Expressway	-	-	Included
Road Projects	Base Line Extension	Not developed	Included	Included
	Marine Drive Extension	Included	Included	Included
	Middle Ring Road	Not developed	Included	Included
	Major Arterial Road	Expanded to 4 Lane	Expanded to 4 Lane	Expanded to 4 Lane
	Minor Arterial Road	Included	Included	Included
Road Capacity		10% reduction in the area between CMA and CMC, 30% reduction in CMC area	10% reduction in the area between CMA and CMC, 30% reduction in CMC area	10% reduction in the area between CMA and CMC, 30% reduction in CMC area

Source: CoMTrans Study Team

Table 4.4.6 B and C Case Settings

Case B (Highway and Public Intensive) and Case C (Public Intensive)				
Network	**Classification**	**2020**	**2025**	**2035**
Expressways	Outer Circular Highway	Included	Included	Included
	Colombo- Katunayake Expressway	Included	Included	Included
	Southern Expressway	Included	Included	Included
	Horana Expressway	-	Included	Included
	Port Access	Included	Included	Included
	Northern Expressway	-	-	Included
Road Projects	Base Line Extension	Not developed	Included	Included
	Marine Drive Extension	Included	Included	Included
	Middle Ring Road	Not developed	Included	Included
	Major Arterial Road	Expanded to 2 Lane	Expanded to 2 Lane	Expanded to 2 Lane
	Minor Arterial Road	Included	Included	Included
Road Capacity		10% reduction in the area between CMA and CMC, 30% reduction in CMC area	10% reduction in the area between CMA and CMC, 30% reduction in CMC area	10% reduction in the area between CMA and CMC, 30% reduction in CMC area

Source: CoMTrans Study Team

4.4.2 Assumptions on Public Transport Network and Service Level

Public transport service level projection is done with several assumptions stated under different stages. Each is descriptively stated throughout the section of 4.6.2.

(1) Adjustment Factors

Three main adjustments factors are considered in the transit assignment, time value, walking time and transit speed to change the hypothetical values into real situations. Diverse aspects are considered in setting theses adjustment factors such as differentiating according to the three main income levels and other relevant average factors.

i) Time Value (unit: minutes/currency unit)

Different time values are considered for the three different income groups, Group A, Group B and Group C (see Table 4.4.7). For the combined income level, the public transit assignment also has used different time values prepared based on the HVS survey conducted by the CoMTrans Study Team.

Table 4.4.7 Income Group based Time Values

Income Level	Median Hhd Income (Rs.)	Avg. No. of Workers in Hhd	Monthly Working Hours	Time Value (Rs./h)	Time Value (min./0.1Rs)
Group C	23,297	1.20	176	110.54	**0.054**
Group B	59,999	1.72	176	198.35	**0.030**
Group A	135,050	1.90	176	403.51	**0.015**
All	39,374	1.36	176	164.03	**0.037**

Source: CoMTrans Study Team

ii) Walking Time

In the assignment, the walk time adjustment factor was assumed to be 1.670 for all income groups as well as for the combined transit assignment. The figure was generated with the estimation of real average situational walking link time in the country.

iii) Transit Speed

The link velocity specified in the network data is multiplied by transit speed to obtain the transit speed. The generalised cost which was used to choose the transport mode is calculated by using the slowest link velocity among the following three velocity types.

- Maximum link velocity in the network data file adjusted by transit speed factor
- Scheduled line speed recorded in the line data file
- Link velocity (travel time) recorded in the road assignment results file

In the public transport assignment, 0.800 was considered as the transit speed adjustment factor while different speed values are assigned to different modes and link types in separate input files.

Further, the following assumptions are made on setting speed in the line data file (see Table 4.4.8). Accordingly, it was assumed that the monorail speed will be 30km/h and Bus Rapid Transit (BRT) speed will be 23-25km/h in the line data file.

Table 4.4.8 Speed Setting in TNT & INT

Speed Setting Source in JICA STRADA	Operations		2013	2020	2025	2035
TNT	Rail	Coast Line	30	30		
		KV	23	23		
		Negombo	28	28 / 29		
		Main	25	25 / 30		
		RLS_AMBALU			30	30
		RLS_KCHFOT			30	30
		RL400_SWAV			20	15
		RLE_VYGPND			50	50
		RLE_NGMFOT			50	50
		RL3_GMPMTW			35	35
		RL3_NGMFOT			35	35
		RL100_INTP			50	50
	Mono			30	30	25 / 30
	BRT			23 / 25	23 / 25	23 / 25
INT	Rail			65	65	35 (Ragama to Mt Lavinia)
	Mono Rail			25	25	25
	BRT			25	25	25

Note: KV- Kelani Valley, RLS_AMBALU – Slow Train from Ambepussa to Aluthgama, RLS_KCHFOT - Slow Train from Kochchikade to Fort, RL400_SWAV - Slow Train from Fort to Avissawella, RLE_VYGPND – Expressway Train from Veyangoda to Panadura, RLE_NGMFOT - Expressway Train from Negambo to Fort, RL3_GMPMTW – Slow Train from Gampaha to Moratuwa, RL3_NGMFOT from Negambo to Fort, RL100_INTP – Inter-Provincial Train

(2) Assignment rate (%)

The definition of assignment rates in the public transport assignment is done with the supposition of five incremental rates of 20 % each from first to fifth level which led to total assigning rates adding up to 100%.

(3) Option Parameters

i) Maximum Transfers

This parameter assumes the maximum number of transfers as 3 or 4 in the feasible paths search for each Origin - Destination (OD) pair where the transit assignment rejects those paths that require more transfers than the specified maximum.

ii) Path Rejection Limit (%)

This parameter specifies the upper limit above which alternative paths are rejected as unfeasible. It is expressed in percentage relative to the path of the least generalised cost. In the public transport assignment path, rejection limit is assumed as 130%. Greater reject rates would overtax the Transit Assignment Program.

iii) Maximum Headway

From the results of the assignment, the Transit Assignment Program automatically recalculates the optimum headway for each line. This adjustment parameter specifies the maximum percentage limit of the optimum headway modification relative to the user-specified headway. The adjustment limit of 100% is used in the assignment to modify the optimum headway.

iv) Minimum Trip Load

The minimum loading limit is assumed to be 10 passenger trips for the public transit assignment where if the OD trips are smaller than the user-specified minimum loading limit, the program will load them all at once, regardless of the specified assigning rates.

v) Use of velocities of other Assignment Results

The road assignment results file (.IRE) contains two types of velocities, namely peak velocity and average velocity. Average velocity is assumed to be the most applicable for the public transit assignment.

(4) Mode Classification

The public transport assignment considers seven mode types, namely buses, double track railway, A/C buses, transfer passengers, monorail, BRT, and single track railway (KV Line and Negambo Line). Parameter feed for each mode is done under three main categories, fare, specification and generalised cost coefficient.

1) Fare

Fare calculation is done with the following assumed rates for respective modes with reference to the 2012 fare structure. Fare changing rate is set with consideration of future development plans of the railway such as track enhancement, rail electrification and related expected economic value changes (see Table 4.4.9).

Table 4.4.9 Fare Setting Rates

Year	Bus	Modernised Railway	BRT, Monorail
2020	1.3 times of 2012	1.2 times of railway fare in 2012	1.2 times of railway fare in 2012
2025	1.3 times of 2012	1.5 times of railway fare in 2012	1.3 times of railway fare in 2012
2035	1.3 times of 2012	1.5 times of railway fare in 2012	1.5 times of railway fare in 2012

Source: CoMTrans Study Team

2) Base Fare

Base fare, is the initial fare charged for a minimum distance and is generated based on the existing 2012 fare rates and above explained fare incremental rates for different years (see Table 4.4.10).

Table 4.4.10 Base Fare

Mode	2012	2020	2025	2035
Bus	9.0	11.7	11.7	11.7
Railway	10.0	12.0	15.0	15.0
Monorail	10.0	12.0	13.0	15.0
BRT	10.0	12.0	13.0	15.0
A/C Bus	20.0	20.0	20.0	20.0

Source: CoMTrans Study Team

3) Base Fare Distance (km)

Base fare distance is the distance where the fare is unique from the start of the journey. Existing base fare distance is assumed to be continued in the future for buses and railways where it is 1.5km for buses and 10.0km for railway. Further, it assumes that Monorail and BRT will be operated within the railway settings, where the fare structure will remain the same as the railway, so base fare distance is set as 10km for monorail and BRT (see Table 4.4.11).

Table 4.4.11 Base Fare Distance

Mode	Base Fare Distance (km)
Bus	1.50
Railway	10.00
Monorail	10.00
BRT	10.00
A/C Bus	1.50

Source: CoMTrans Study Team

4) Excess Fare (/km)

Excess fare (per kilometre fare rate after the base fare distance) is calculated with the use of the fare setting rate explained under the fare section. Fare setting rates are assumed to be equally applied for the excess fare setting in the future, so the same rates are used to calculate 2020, 2025 and 2035 excess fares as well (see Table 4.4.11).

Table 4.4.12 Excess Fare Setting

Mode	2013	2020	2025	2035
Bus	1.7	2.21	2.21	2.21
Rail	1.0	1.2	1.5	1.5
Monorail	1.0	1.2	1.3	1.5
BRT	1.0	1.2	1.3	1.5
A/C Bus	3.4	3.4	3.4	3.4

Fare setting in the STRADA is set at 0.1Rs. for each mode in order to be compatible with the time values which are defined as min./0.1Rs. Therefore, base fare and excess fare have to be adjusted on this basis to correspond with the data in the parameter file.

5) Passenger Capacity

Passenger capacity setting is done based on the trip generation ratio of different income groups (see Table 4.4.13). In addition to that, passengers per hour per direction (PPHPD) values for different modes are used for this calculation as indicated in Table 4.4.14. Monorail and BRT are assumed to be equal to railway in setting of PPHPD as well.

Table 4.4.13 Trip Generation Ratio by Income Group

2013 Case DN			2020			2025			2035		
Inter-Zonal Trips (Population in Millions)		%	Inter-Zonal Trips (Population in Millions)		%	Inter-Zonal Trips (Population in Millions)		%	Inter-Zonal Trips (Population in Millions)		%
Group C	4.2	57%	**Group C**	2.6	27%	**Group C**	1.9	18%	**Group C**	1.2	10%
Group B	2.1	29%	**Group B**	3.7	39%	**Group B**	3.7	34%	**Group B**	3.3	25%
Group A	1.0	14%	**Group A**	3.2	34%	**Group A**	5.1	48%	**Group A**	8.2	65%
Total	7.4	100%	**Total**	9.5	100%	**Total**	10.6	100%	**Total**	12.7	100%

Source: CoMTrans Estimates

Note: Group C: monthly income less than Rs. 40,000, Group B: Rs. 40,000 – 79,999, Group A : Rs. 80,000 and more

Table 4.4.14 PPHPD for Different Modes

Mode No.	Mode Name	PPHDP
1	Bus	10,000
2	Railway - Double Track	15,000
3	A/C Bus	10,000
4	Transfer Passengers	1,000
5	Monorail	15,000
6	BRT	15,000
7	Railway - Single Track (KV and Negambo Line)	5,000

Source: CoMTrans Study Team

The setting of the PPHPD values indicated in Table 4.4.14 consider the physical capacity that can be carried by each mode; more precisely, it is not the maximum carrying capacity. PPHDP figure setting considers seating capacity plus comfortable standing capacity, but standing capacity can be increased when the demand is higher.

6) Minimum and Maximum Frequency

Minimum frequency for each mode is assumed be 1 while maximum value differs from mode to mode. Based on the trip generation ratio by income levels, hourly passenger capacity per direction figures are generated and calculated passenger capacities are used for calculating maximum frequency for each mode and income level separately.

7) Passenger Car Unit (PCU) Equivalents

PCU equivalent figures are assumed to be as shown in the Table 4.4.15.

Table 4.4.15 PCU Equivalents

Mode No.	Mode Name	PCU Equivalent
1	Bus	1.8
2	Railway - Double Track	-
3	A/C Bus	1.8
4	Transfer Passengers	-
5	Monorail	-
6	BRT	-
7	Railway - Single Track (KV and Negombo Line)	-

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7) Minimum and Maximum Speed (km/h)

Speed for each mode is defined for minimum and maximum speed separately as shown in the Table 4.4.16.

Table 4.4.16 Minimum & Maximum Speed

Mode No.	Mode Name	Min. Speed	Max. Speed
1	Bus	5.00	30.00
2	Railway - Double Track	10.00	65.00
3	A/C Bus	5.00	30.00
4	Transfer Passengers	1.00	1.00
5	Monorail	10.00	65.00
6	BRT	5.00	40.00
7	Railway - Single Track (KV and Negombo Line)	10.00	65.00

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8) Generalised Cost Coefficient

The generalised cost calculation for the feasible paths search in the Transit Assignment Program uses seven cost components which are entered as coefficients. In other words, the generalised cost is expressed as follows.

$$Cost^m = T^1 * M^{m,1} + T^2 * M^{m,2} + ...+T^7 * M^{m,7}$$

Where, $Cost^m$: generalised cost of mode m

T^i: time value of cost component i

$M^{m,I}$: mode-weighting coefficient of cost component I of mode m

9) Walk Time Cost Coefficient

In the public transport assignment, an assumption has been made that the passenger accessibility does not vary among the public transit modes, and the walking speed need not be changed, so this mode-weighting coefficient is specified as 1 in the parameter file.

10) Wait Time Cost Coefficient

The Transit Assignment Program uses the following formula to approximate the wait time.

$$\text{Wait Time} = \frac{\text{headway}}{2} - \frac{\text{headway}^2}{200}$$

The calculated wait time cost can be changed by this mode-weighting coefficient and assigned values for each mode in the assignment as shown in Table 4.4.17.

Table 4.4.17 Wait Time Cost Coefficient

Mode No.	Mode Name	Wait Time Cost Coefficient
1	Bus	0.990
2	Railway - Double Track	0.940
3	A/C Bus	0.990
4	Transfer Passengers	1.000
5	Monorail	1.010
6	BRT	0.980
7	Railway - Single Track (KV and Negombo Line)	0.970

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11) Boarding/Alighting Coefficient

The boarding/alighting time for the transit assignment is calculated by specifying this mode-weighting coefficient. For the public transit assignment, this coefficient is specified as 1 for all the modes in the parameter file, so the exact calculated figures are used for the assignment.

12) Fare Coefficient

This mode-weighting coefficient is used to modify the time value specification. In the public transit assignment, the fare coefficient is assumed to be 1, similar to the exact fare (fare resistance expressed in minutes) in the General tab without amendments.

13) Travel Time Coefficient

The travel time is obtained by dividing the link distance by the lowest velocity of the three available velocities. The following three types of velocities are available.

- Scheduled line speed recorded in the line data
- Link velocity recorded in the road assignment results (optional)
- Maximum link velocity in the network data adjusted by the transit speed factor

The coefficient applies 1 in the mode-weighting adjustment in public transit assignment with the assumption that travel time is exactly equal to the travel time calculation.

14) Transfer Time Coefficient

The transfer time is basically calculated by the formula used for the wait time. In the public transit assignment, travel time is assumed to be equal to the calculated transfer time by specifying this mode-weighting coefficient as 1 in the parameter file.

15) Discomfort Factor

The cost of congestion (or discomfort from overloading) is calculated by approximation. The congestion ratio of a given transit mode is calculated by dividing the passenger trips by the capacity (a function of the service frequency and the passenger capacity per service). By using this congestion ratio, the Transit Assignment Program automatically calculates the congestion factor. If the congestion ratio is less than 0.8, the congestion factor is zero. If the ratio is 0.8 or more, the congestion factor is calculated by the following formula. In the public transit assignment, this coefficient is set as 1 to adjust the calculated discomfort factor by mode weighting.

Congestion factor = travel time x (congestion ratio x 5 − 4)

16) Free Transfers to Same Mode Line

Currently, the railway gives free transfers to the same mode and it is assumed that monorail and BRT will be operated the same as the railway in offering free transfers to the same mode.

(5) Monorail

i) Route Setting

Basically, four monorail lines are to be operated in the future by 2035 as shown in Figure 4.4.3 and the completion of each line will be done in different stages.

i-1) Line 01

This is referred to as MRT_008 in the transit assignment. It starts from Kaduwela and the ending points are as follows.

2020 - Kotahena

2025 – Kelaniya

2035 – Kelaniya [extend up to MMC1 (Multi Model Centre 01)]

i-2) Line 02

This is referred to as MRT_003 in the transit assignment. It starts from Town hall and ends at Kollupitiya. This line will begin operation from 2020.

i-3) Line 03

This line is to be completed by 2035 and it will be operated on Kelani Valley railway line. This is referred to as MRT_006 in the assignment and it will connect from Borella to Homagama.

i-4) Line 04

This line is referred to as MRT_010 in the transit assignment which will also begin operation by 2035 parallel to the MRT_006 and which will connect from Kirulopone to Wellawatta.

ii) Parameter Setting

These monorail lines are assumed to be operated with the speed of 25 / 30 km/h and frequency of 4 / 6 train sets per hour (see Table 4.4.18).

Table 4.4.18 Monorail Speed and Frequency Setting

Monorail Route ID	Frequency (Bus Units per Hour)	Speed (km/h)
MRT_R03	4	25
MRT_R06	4	28
MRT_R08	6	30
MRT_R10	4	25

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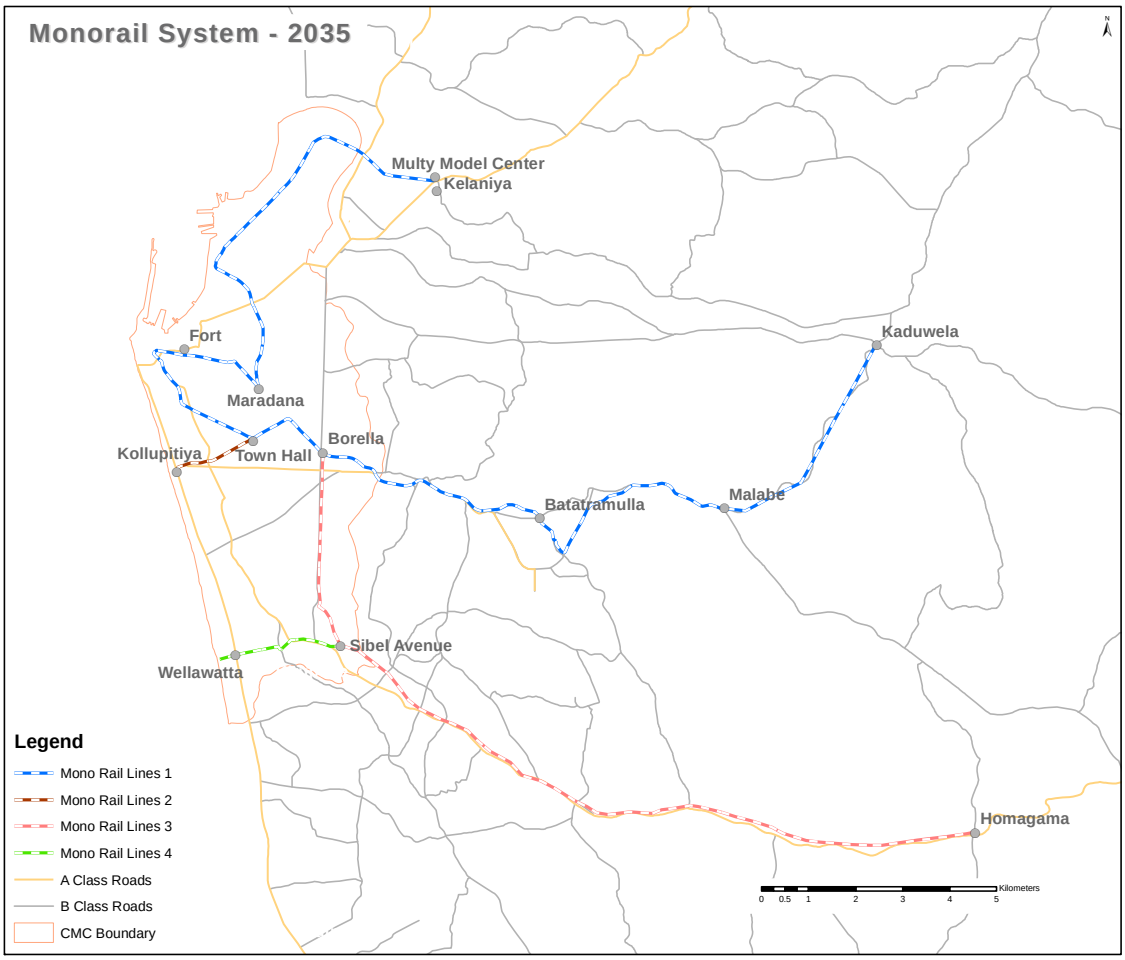


Source: CoMTrans Study Team

Figure 4.4.3 Proposed Monorail Operational Lines

(6) Bus Rapid Transit

i) Route Setting

Bus Rapid Transit operational route setting is scheduled to be executed as follows and Figure 4.4.4 indicates route setting for each line.

i-1) Line 01

This line is referred to as BRT_002 in the transit assignment and will begin operation from 2020. This BRT Route will connect Kelaniya, Fort, Wellawatta, Borella and Kelaniya.

i-2) Line 02

This line is referred to as BRT_003 in the transit assignment and it will begin operation from 2025. This BRT Route will connect Handala to Borupone Junction via Koswaththa.

i-3) Line 03

This line is referred to as BRT_004 in the transit assignment and will also begin operation from 2025. This Route will connect Kelaniya, Borella, Baseline extension and Moratuwa which reaches the Galle road at Rathmalana.

i-4) Line 04

This line is referred to as BRT_008 in the transit assignment and will begin operation from 2020. This Route will connect Kadawatha & Fort.

i-5) Line 05

This line is referred to as BRT_008 in the transit assignment and will begin operation from 2020. This Route will connect Fort and Moratuwa.

ii) Parameter Setting

These BRT lines are assumed to be operated at the speed of 23 - 25 km/h and frequency of 4 / 6 buses per hour (see Table 4.4.19).

Table 4.4.19 BRT Speed and Frequency Setting

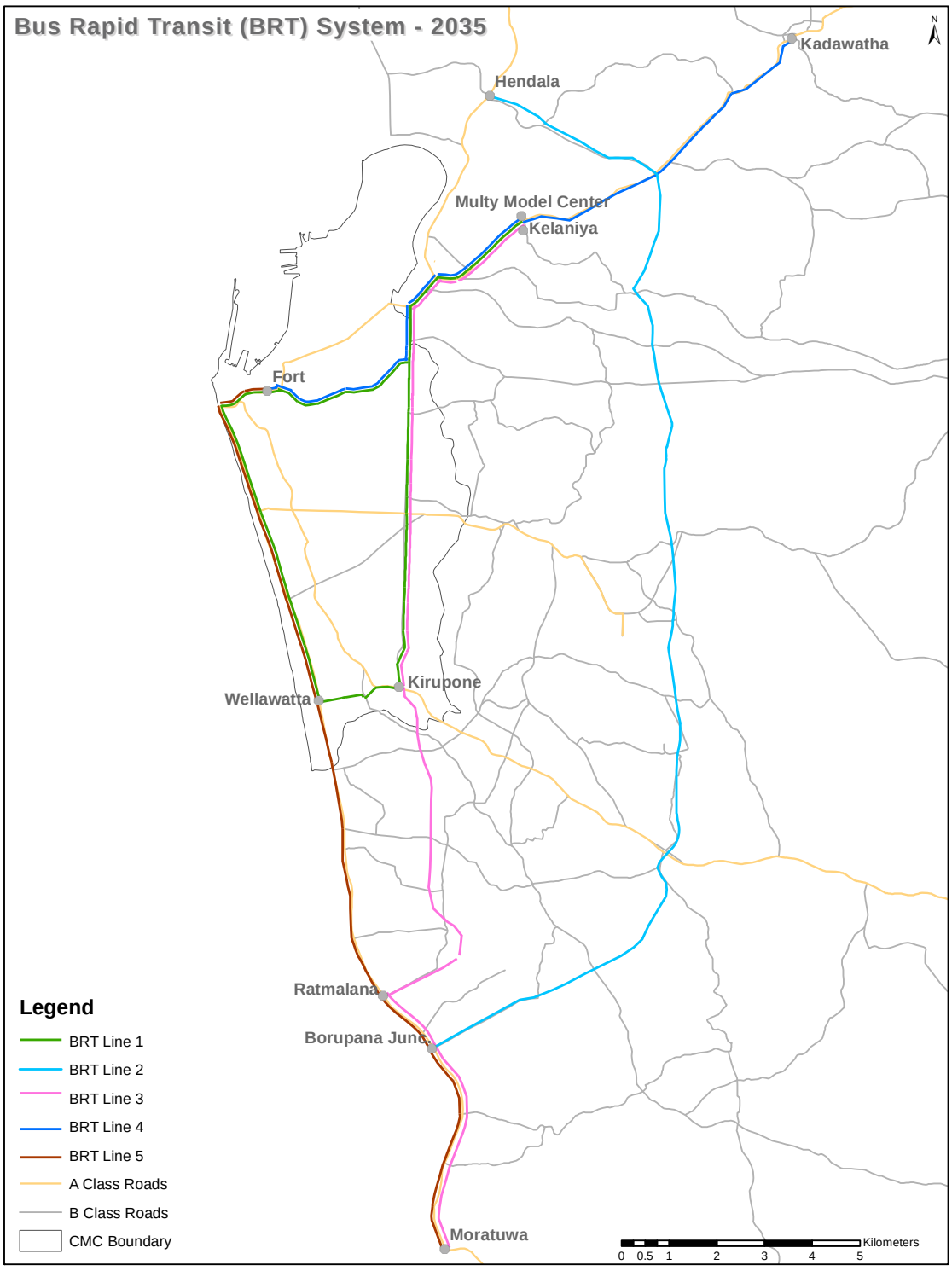
BRT Route ID	Frequency (Bus Units per Hour)	Speed (km/h)
BRT_R02	6	23
BRT_R03	4	25
BRT_R04	6	23
BRT_R08	6	23
BRT_R09	6	23

Source: CoMTrans Study Team

(7) Railway

i) Route Setting

Route setting of the railway for 2020 is precisely the same as the existing railway network. Railway modernization and signal improvement will be executed in 2025 and this will affect the railway route setting in the future due to the speed and frequency improvements. Figure 4.4.5 and Table 4.4.21 indicate the railway route setting due to the railway modernization applied for 2025 & 2035. Figure 4.4.7 and Table 4.4.20 shows the railway network for 2020 which was discussed in section 2.8.1.



Source: CoMTrans Study Team

Figure 4.4.4 Proposed BRT Operational Lines

ii) Parameter Setting

Railway lines in 2020 are assumed to be operated at different speeds and frequencies of 1 - 2 train sets per hour (see Table 4.4.20). Speed setting of the Kelani Valley line considers several factors, as it has experienced several delays, breakdowns and even cancelation of operation recently. Therefore, it uses 15 km/h in the line data file to conform with actual operating speed.

Table 4.4.20 Railway Setting in 2020

Railway Route ID	Route		Frequency	Speed
RL300_SLOW	Coastal Line	Slow Train	1	30
RL300_SHTD		Short Distance Train	2	30
RL300_EXPR		Express Train	1	30
RL400_SWAV	Kelani Valley Line	Slow - Avissawella Train	1	15
RL400_SWPD		Slow - Padukka Train	1	15
RL200_SWKH	Negambo Line	Slow - Kochchikade Train	1	28
RL200_SWNG		Slow - Negambo Train	1	28
RL100_SLOW	Main Line	Slow Train	2	25
RL100_SWVG		Slow - Veyangoda Train	1	25
RL100_EXPR		Express Train	1	25
RL100_INTP		Inter Provincial Express Train	1	25

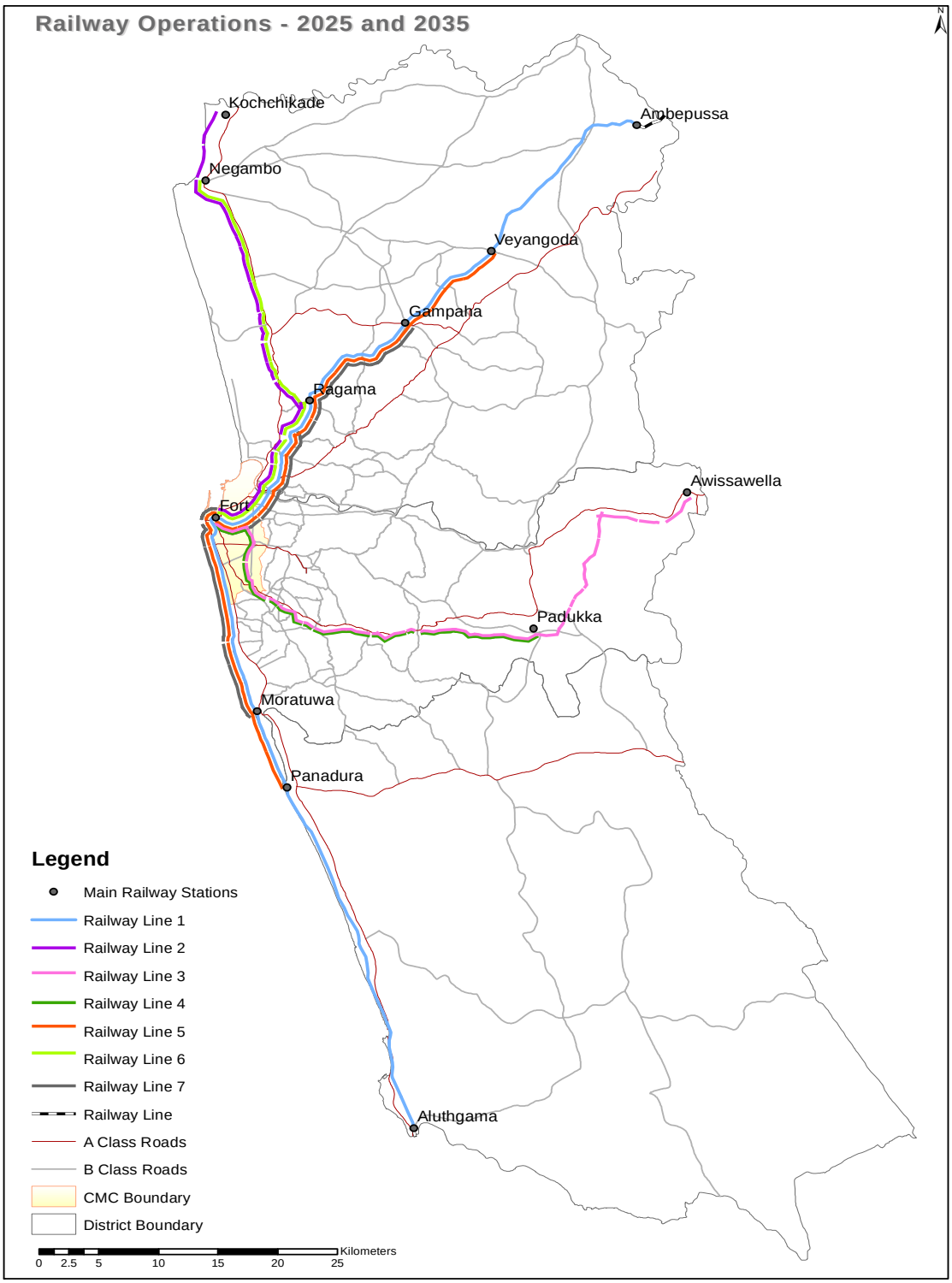
Source: CoMTrans Study Team

Similarly, Railway lines from 2025 are assumed to be operated at different speeds and frequencies of 1 - 6 train sets per hour (see Table 4.4.21).

Table 4.4.21 Railway Setting of 2025 & 2035

Railway Route ID	Line No.	Route	Description	Frequency	Speed
RLS_AMBALU	Line 01	Ambepussa - Aluthgama	Slow Train	1	30
RLS_KCHFOT	Line 02	Kochchikade - Fort	Slow Train	1	30
RLS_AVSFOT	Line 03	Avissawella - Fort	Slow Train	1	15
RL400_SWPD	Line 04	Kelani Valley Line	Slow - Padukka Train	1	15
RLE_VYGPND	Line 05	Veyangoda - Panadura	Express Train	3	40
RLE_NGMFOT	Line 06	Negambo - Fort	Express Train	3	40
RL3_GMPMTW	Line 07	Gampaha - Moratuwa	Express Train	6	35
RL3_NGMFOT	Line 08	Negambo - Fort	Express Train	6	35
RL100_INTP	Line 09	Main Line	Inter Provincial Express Train	2	40

Source: CoMTrans Study Team



Source: CoMTrans Study Team

Figure 4.4.5 Proposed Railway Operational Lines

(8) Bus

i) Route Setting

According to the master plan transport setting, some of the bus routes are altered and a few will stop operating in the future due to the implementation of the Monorail, BRT & modernised railway system. Basically, bus route deletions and alterations will take place for buses operated in Kandy, Negambo and Malabe corridors with the implementation of the above options. This entire bus reroute plan is applied only from 2035 when the entire MRT_008 (Monorail Line 01) is scheduled to be completed up to Kelaniya.

The National Transport Commission has commenced operating luxury buses on the newly opened Colombo-Katunayake Expressway (CKE). These buses are connecting Colombo, Ja-Ela, Katunayake and Negambo.

ii) Parameter Setting

Speed and frequency settings of buses will not be changed in the future, so the settings are as discussed in section 2.8.2.

(9) Multi Model Connectivity

Intermodal connectivity is required to ensure that passengers can easily transfer from one mode to another. The information needed to analyse the intermodal connectivity is the number of transfers that the passengers need to make. Relevant transfer links are provided in the network file and the line data file.

(10) Status Quo

For the public transport assignment, there is no setting difference between the status quo and doing nothing cases. A summary of the settings is indicating in Table 4.4.22.

Table 4.4.22 Status Quo Setting

Mode	Remarks
Monorail	Not available
BRT	Not available
Bus	All bus routes are as in 2013
Railway	Railway modernization has not been implemented

Source: CoMTrans Study Team

(11) Base Case

Base case is considered for 2035 with the selected options as indicated in Table 4.4.23. All the parameter settings and .TNT settings are similar as discussed in the previous section of chapter 5.

Table 4.4.23 Base Case Settings

Mode	Corridor	Options
Monorail	Malabe	MRT_008 (Kaduwela - Kelaniya)
	High Level Rd.	MRT_006 (Borella - Homagama)
	Galle	MRT_003 (Town hall - Kollupitiya)
BRT	Galle	BRT_R08 (Fort - Kadawatha)
	Kandy	BRT_R09 (Moratuwa - Fort)
Bus	Negambo	Bus Priority System (BRT to Negambo and Negambo Road. to Airport)
	Horana	Bus Priority System with Road Widening
	Low Level Road	Bus Priority System with Road Widening
Railway	Galle	Modernised Railway
	Negambo	Modernised Railway
	Kandy	Modernised Railway

Source: CoMTrans Study Team

(12) Master Plan Cases

Master plan cases consider three aspects, highway intensive, public transport intensive and combined (highway and public transport) intensive options. Further, these cases are separately considered based on the TDM option availability where A1, B1, & C1 are the No TDM cases and A2, B2, & C2 are the TDM cases.

Table 4.4.24 Case A (Highway Intensive) Settings

Case A (Highway Intensive)				
Year	**Operational Lines**	**2020**	**2025**	**2035**
BRT	Fort - Moratuwa (BRT_R09)	Included	Included	Included
	Kelaniya – Fort – Wellawatta – Kirillapone – Borella - Kelaniya (BRT_R02)	Included	Included	Included
	Fort – Kelaniya - Kadawatta (BRT_R08)	Included	Included	Included
	Middle Ring Road (BRT03)	Not Developed	Included	Included
	BRT Baseline extension (BRT_R04)	Not Developed	Not Included	Not Included
Monorail	Kelaniya - Kaduwela (MRT_008)	Included (Kotahena - Malabe)	Included (Kelaniya - Kaduwela)	Included (Kelaniya - Kaduwela)
	Town Hall - Kollupitiya (MRT_003)	Included	Included	Included
	Borella - Homagama (MRT_006)	Not Included	Not Included	Not Included
	Wellawatta - Kirulapone (MRT_010)	Not Included	Not Included	Not Included
Railway (Electrification & Signal Improvement is not done)	Costal Line (Speed = 30 km/hr)	Included	Included	Included
	Negambo Line (Speed = 28 km/hr)			
	Main Line (Speed = 25 km/hr)			
	Kelani Valley (Speed = 15 km/hr)			

Table 4.4.24 describes public transport settings for the highway intensive scenario for the modes of BRT, monorail and railway. Bus setting is similar to that described in section 5.5.2. Public transport settings for Case B & C are described in Table 4.4.25.

Table 4.4.25 Case B (Highway and Public Transport Intensive) and Case C (Public Transport Intensive) Settings

Case B (Highway and Public Transport Intensive) and Case C (Public Transport Intensive)				
Year	**Operational**	**2020**	**2025**	**2035**
BRT	Fort - Moratuwa (BRT_R09)	Included	Included	Included
	Kelaniya – Fort – Wellawatta – Kirillapone – Borella – Kelaniya (BRT_R02)	Included	Included	Included
	Fort – Kelaniya - Kadawatta (BRT_R08)	Included	Included	Included
	Middle Ring Road (BRT_R03)	Not developed	Included	Included
	BRT Baseline Extension (BRT_R04)	Not developed	Included	Included
Monorail	Kelaniya - Kaduwela (MRT_008)	Included (Kotahena - Malabe)	Included (Kelaniya - Kaduwela)	Included (Kelaniya - Kaduwela)
	Borella - Homagama (MRT_006)	Not Included	Not Included	Not Included (B1) ; Included (C1)
	Wellawatta - Kirulapone (MRT_010)	Not Included	Not Included	Not Included (B1) ; Included (C1)
Railway (Electrification & Signal Improvement is not done)	Normal Railway Operations	No electrified railway	Included	Included
	Express (Speed = 40 km/hr)			
	Slow (Speed =25 km/hr)			
	Kelani Valley (Speed = 15 km/hr)			

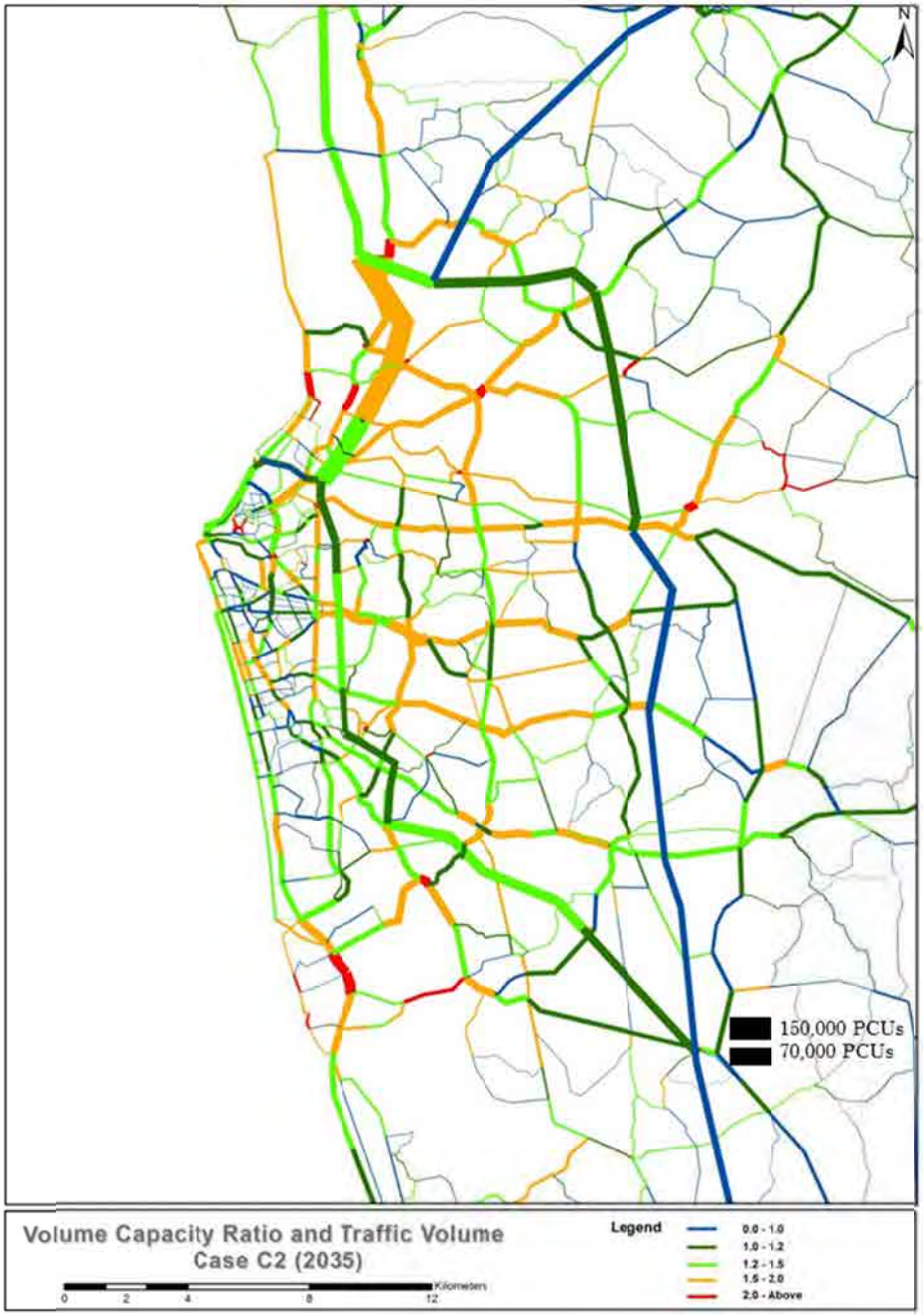
Source: CoMTrans Study Team

4.4.3 Consideration of Transport Demand Management

The objective of the Transport Demand Management (TDM) is to reduce the traffic along the road network and shift passengers from the private mode to public transport. Transport Demand Management tools like capacity increase and electronic road pricing (ERP) have already been applied. Electronic road pricing of Rs. 300 was applied only for the major roads which are going through the CMC boundary.

4.4.4 Estimated Results of Road Transport

Accordingly, six options were considered for the above scenarios. This has further considered 2020, 2025 and 2035 separately. Road sectional volume and volume/capacity maps for the case of C2 for 2035 are included in the section below and other outputs are annexed to the report.

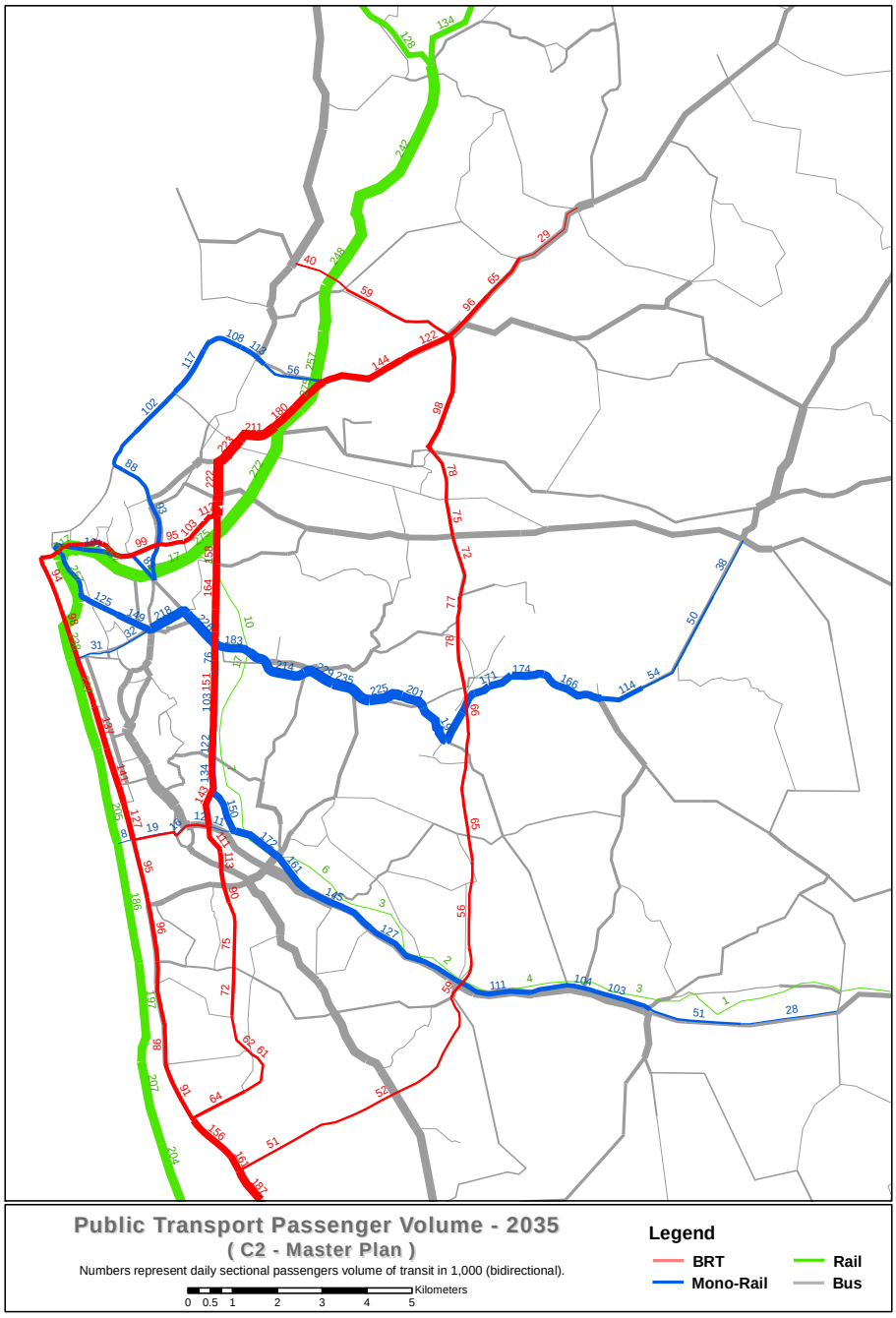


Source: CoMTrans Estimates

Figure 4.4.6 Volume Capacity Ratio and Traffic Volume of C2 Case

4.4.5 Estimated Results of Public Transport

Accordingly, six options were considered for the above scenarios. This has further considered 2020, 2025 and 2035 separately. Public assignment sectional volume maps for the case of C2 for 2035 are included in below section and other outputs are annexed to the report.



Source: CoMTrans Estimates

Figure 4.4.7 Public Transport Sectional Volume Map of 2035

4.5 Estimation of Benefits of the Master Plan

4.5.1 Assumptions for Benefit Estimation

(1) Vehicle Operating Cost (VOC):

The unit vehicle operating cost (VOC) is assumed based on "Assessing Public Investment in the Transport Sector 2001" by the Department of National Planning, Ministry of Finance and Planning. The price was converted to 2013 price based on the Colombo Consumer Price Index (CPI) of the transport sector. Unit vehicle operating cost is estimated by the representative vehicles and operating speed in 2013 prices shown in Table 4.5.1.

Table 4.5.1 Unit Vehicle Operating Cost for Economic Analysis

Velocity (km/h)	Motorcycle	3 Wheeler	Car & Van	Medium & Large Bus	Medium 2-Axle Lorry & Large 2-Axle Lorry	Large 3 or more -Axle Lorry
10	17.24	45.15	64.87	145.25	120.72	175.21
15	15.03	37.19	54.60	110.65	93.30	140.98
20	13.96	33.21	49.63	93.27	79.50	123.79
25	13.40	30.82	46.73	82.84	71.28	113.48
30	13.07	29.27	44.85	75.98	65.85	106.74
35	12.83	28.15	43.55	71.14	62.10	102.01
40	12.65	27.35	42.62	67.64	59.34	98.59
45	12.51	26.70	41.98	65.05	57.33	96.11
50	12.60	26.42	41.77	63.10	55.87	94.33
55	12.65	26.18	41.66	61.65	54.77	93.02
60	12.69	26.04	41.59	60.62	54.05	92.13
65	12.79	25.90	41.57	59.90	53.56	91.61
70	12.83	25.81	41.60	59.46	53.32	91.42
75	12.93	25.76	41.67	59.24	53.28	91.52
80	12.97	25.71	41.79	59.29	53.44	91.89
85	13.07	25.71	41.94	59.57	53.81	92.55
90	13.11	25.71	42.10	60.02	54.35	93.48
95	13.21	25.71	42.29	60.65	55.10	
100	13.30	25.76	42.49	61.54	56.04	

Unit: Rs. / km Note: Prices were adjusted for 2013 economic price. Vehicle categories are summarised.

Source: Based on "Assessing Public Investment in the Transport Sector 2001" by the Ministry of Finance and Planning

(2) Travel Time Cost Estimate:

Hourly travel time values of passengers was estimated by three income groups based on the results of the Home Visit Survey conducted in 2013 for the CoMTrans Project and the Household Income and Expenditure Survey 2012 by the Department of Census and Statistics. Income categories were identified by the Home Visit Survey considering vehicle ownership and mode choice characteristics. The mean household income was estimated by the Household Income and Expenditure Survey 2012. It is assumed that the future value of time by income class is consistent throughout the analysis period. Table 4.5.2 presents the time value of workers average trips for three income categories in 2013 prices.

Table 4.5.2 Hourly Value of Time by Income Group

Income Level	Mean Household Income (Rs.) 1)	Avg. No of Workers in Household 2)	Monthly Working Hours 3)	Social Security & Benefits 4)	Time Value of Work Trip (Rs./h)	Work Trip Ratio 5)	Avg. Time Value (Rs./h) 6)
Group C	24,009	1.20	140	30%	186	15%	81
Group B	56,810	1.72	140	30%	307	16%	136
Group A	186,164	1.90	140	30%	909	23%	462
All	70,366	1.36	140	30%	479	16%	215

Source: CoMTrans Study Team, Avg. Stands for ”average”.

Note: 1) Mean household incomes were estimated from the Household Income and Expenditure Survey 2012 by the Department of Census and Statistics.

2) Average number of workers in a household was estimated from the Home Visit Survey of the CoMTrans Project that was conducted in 2013

3) 20 working days are assumed per month considering public holidays. 7 working hours are assumed excluding rest time during work hours.

4) Including medical and employment insurance payments from employer, benefits, allowances and bonuses

5) According to the Home Visit Survey of the CoMTrans project conducted in 2013

6) Work trips are multiplied by 1.2 considering company overhead. Non-work trips were multiplied by 0.3 referring to the ”Handbook on Economic Analysis of Investment Operations”, The World Bank, 1998

Average time value of freight vehicles are estimated from freight value and interest rate. The estimated time value is shown in Table 4.5.3.

Table 4.5.3 Time Value of Freight Vehicles

Vehicle Type	Truck (10t)	Trailer (25t)
Freight Value (Rs/veh) 1)	4,856,870	12,142,175
Interest Value 10% (Rs/veh) 2)	485,687	1,214,217
Time Value of Goods (Rs/veh-h)	194	486
Time Value of Freight Vehicle (Rs/veh-h)	194	486

Source 1) "Study on the outer circular highway of the city of Colombo, 2000". Adjusted for 2013 economic price
Source 2) "Economic and social statistics of Sri Lanka, 2013"

(3) Estimate of benefit due to the reduction of GHG emission

Environmental improvements due to the decrease of GHG emission are also considered as a benefit of the monorail system. While there are several greenhouse gases, carbon dioxide (CO2) was considered for the analysis due to data availability. Unit emission factors of carbon dioxide by vehicle type are shown in Table 4.5.4.

Table 4.5.4 Carbon Dioxide Emission Factor by Vehicle Type

Vehicle Type	Emission Factor (g/km)
Cars Diesel	275
Cars Petrol	200
Cars Gas	175
Vans Diesel	400
Vans Petrol	285
Motorcycle Petrol	60
Land Vehicle Diesel	113
Taxi(3-Wheeler Petrol)	130
Medium Bus Diesel	788
Bus Diesel	800
Lorry/Truck Diesel	800
Lorry Petrol	285

Source: L. U. Preethika and SamanBandara, Department of Civil Engineering University of Moratuwa

Proceedings of the First National Symposium on Air Resource Management in Sri Lanka - 2004 of the Air MAC - Ministry of Environment & Natural Resources

http://cleanairinitiative.org/portal/sites/default/files/60272_presentation.pdf

The emission of carbon dioxide (CO2) was converted to the price based on the annual average European Union Allowance (EUA) Price. As of 2012 the unit price was 18.8 USD/ton according to “State and Trends of the Carbon Market 2012”, The World Bank, which is available on the internet from the link below.

http://siteresources.worldbank.org/INTCARBONFINANCE/Resources/State_and_Trends_2012_Web_Optimized_19035_Cvr&Txt_LR.pdf

(4) Estimation of Benefit by Reduction of Accident Costs

Accident loss was estimated by the method proposed in "Assessing Public Investment in the Transport Sector 2001" by the Ministry of Finance and Planning. Assumptions on accident loss estimation are shown in Table 4.5.5. Unit accident cost per vehicle-kilometre in 1999 was converted to the 2013 value. It is assumed that traffic accidents will decline 4% every year.

Table 4.5.5 Assumptions regarding Accident Loss

Accident Cost 1)	0.396	Rs./vehicle-km in 1999 values
Accident Cost	1.465	Rs./vehicle-km in 2013 values
Annual decline in accident rate 1)	4%	
Accident rate reduction in '35	41%	'35/'13
Accident Cost in 2035	0.597	Rs./vehicle-km in 2013 values

Source 1): Based on "Assessing Public Investment in the Transport Sector 2001" by Ministry of Finance and Planning

4.5.2 Estimation Results

Key Performance Indicators (KPIs) of the base case, and A, B and C cases are estimated separately under different factors which are summarised in Table 4.5.6.

Table 4.5.6 KPIs of Master Plan Cases

No.	Year	Case Name	Pax-km (bn. pax-kms /year)	Pax-hr (bn. pax-hr /year)	VOT (bn. Rs. /year)	Veh-km (bn. veh.-km /year)	VOC (bn. Rs. /year)	Supply Cost (bn. Rs. /year)	CO2 Emission (mn. ton/year)	CO2 Loss (bn. Rs. /year)	Accident Loss (bn. Rs. /year)
1	2013	DNS	25.8	1.61	359	8.94	357	716	1.87	4.6	5.2
2	2020	DNS	41.2	2.17	581	13.52	583	1,164	2.87	7.1	7.8
3	2020	SQ	41.3	2.11	564	13.65	581	1,145	2.90	7.1	7.9
4	2020	A1	40.5	1.86	494	13.91	563	1,057	2.87	7.1	8.1
5	2020	A2	40.3	1.81	476	13.50	539	1,015	2.80	6.9	7.8
6	2020	B1	40.6	1.94	519	13.81	574	1,094	2.87	7.1	8.0
7	2020	B2	40.5	1.90	502	13.48	554	1,056	2.81	6.9	7.8
8	2020	C1	40.6	1.94	519	13.81	574	1,094	2.87	7.1	8.0
9	2020	C2	40.5	1.90	502	13.48	554	1,056	2.81	6.9	7.8
10	2025	DNS	50.2	3.08	979	16.78	800	1,779	3.69	9.1	9.7
11	2025	SQ	50.2	2.93	930	16.67	780	1,710	3.68	9.1	9.7
12	2025	A1	48.6	2.36	750	17.49	758	1,508	3.70	9.1	10.2
13	2025	A2	48.4	2.29	719	16.95	722	1,441	3.60	8.9	9.9
14	2025	B1	49.0	2.51	803	17.42	783	1,586	3.69	9.1	10.2
15	2025	B2	48.8	2.41	763	16.87	745	1,509	3.60	8.8	9.8
16	2025	C1	49.0	2.51	803	17.42	783	1,586	3.69	9.1	10.2
17	2025	C2	48.8	2.41	764	16.87	745	1,509	3.60	8.8	9.8
18	2035	DNS	64.5	5.11	1,892	21.73	1,161	3,053	4.99	12.3	12.6
19	2035	SQ	63.9	4.66	1,727	20.46	1,063	2,790	4.77	11.7	11.8
20	2035	Base Case	61.7	3.68	1,365	19.41	972	2,337	4.50	11.1	11.2
21	2035	A1	61.5	3.54	1,324	20.81	1,023	2,347	4.66	11.5	12.1
22	2035	A2	61.4	3.46	1,290	20.45	996	2,286	4.59	11.3	11.9
23	2035	B1	61.4	3.52	1,318	20.39	1,010	2,328	4.59	11.3	11.8
24	2035	B2	61.2	3.45	1,290	20.14	989	2,280	4.54	11.2	11.7
25	2035	C1	61.4	3.52	1,321	20.46	1,016	2,337	4.59	11.3	11.9
26	2035	C2	61.1	3.40	1,269	19.88	972	2,242	4.49	11.0	11.5

Source: CoMTrans Estimates

Note : Pax-km – Passenger Kilometres, Pax-hr – Passenger Hours, VOT – Vehicle Operating Time, VOC – Vehicle Operating Cost, CO2 – Carbon Dioxide, DNS – Doing Nothing Scenario, SQ – Status Quo

APPENDIX

Technical Report No. 5, Transport Demand Forecast

1. Maps of Road Traffic Assignment Results

2. List of Rerouted Bus Routes

3. Maps of Public Transport Assignment Results

1 Maps of Road Traffic Assignment Results

1.1 Road Assignment – Year 2020

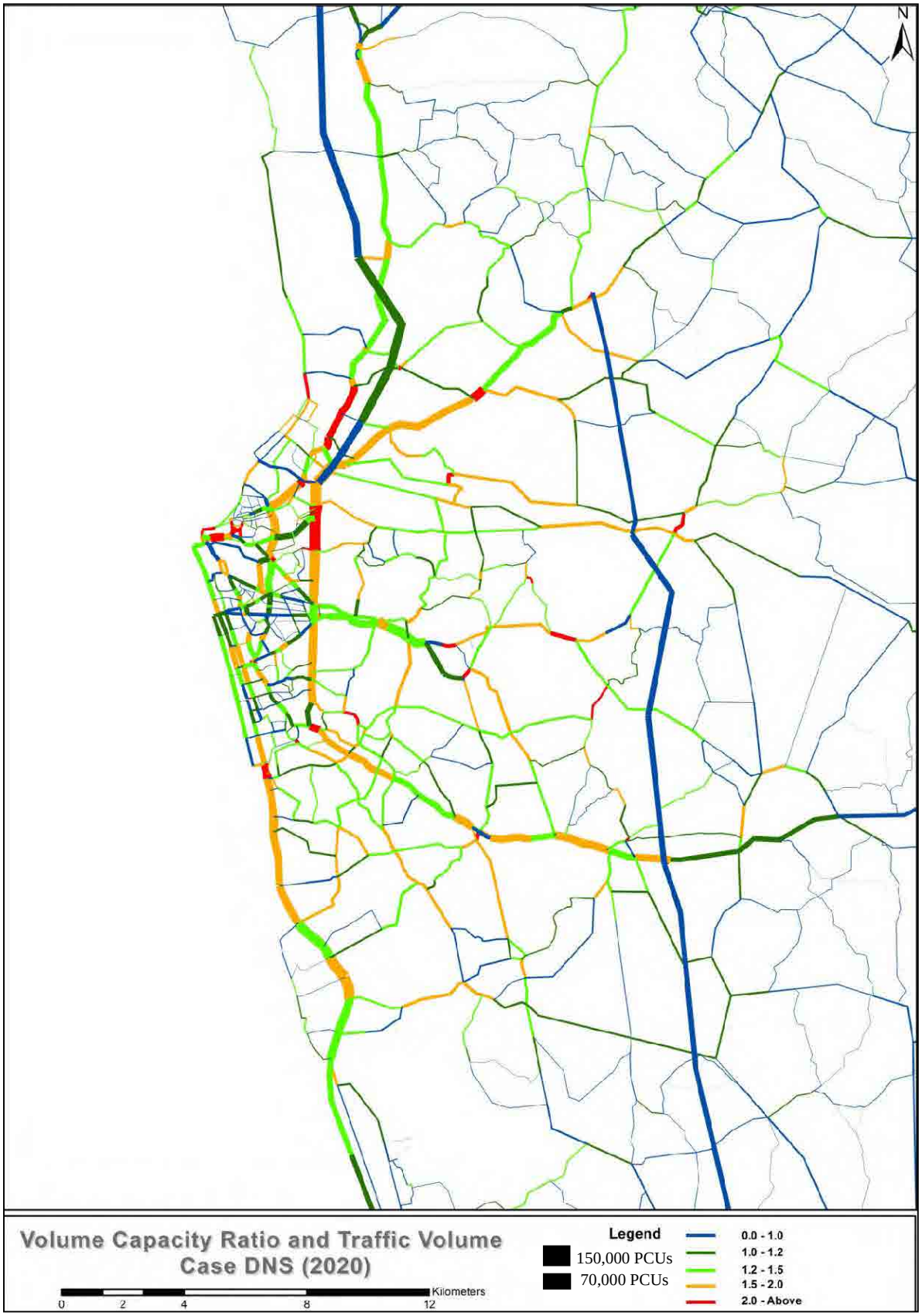


Figure 1 Volume Capacity Ratio and Traffic Volume Maps Do Nothing in 2020

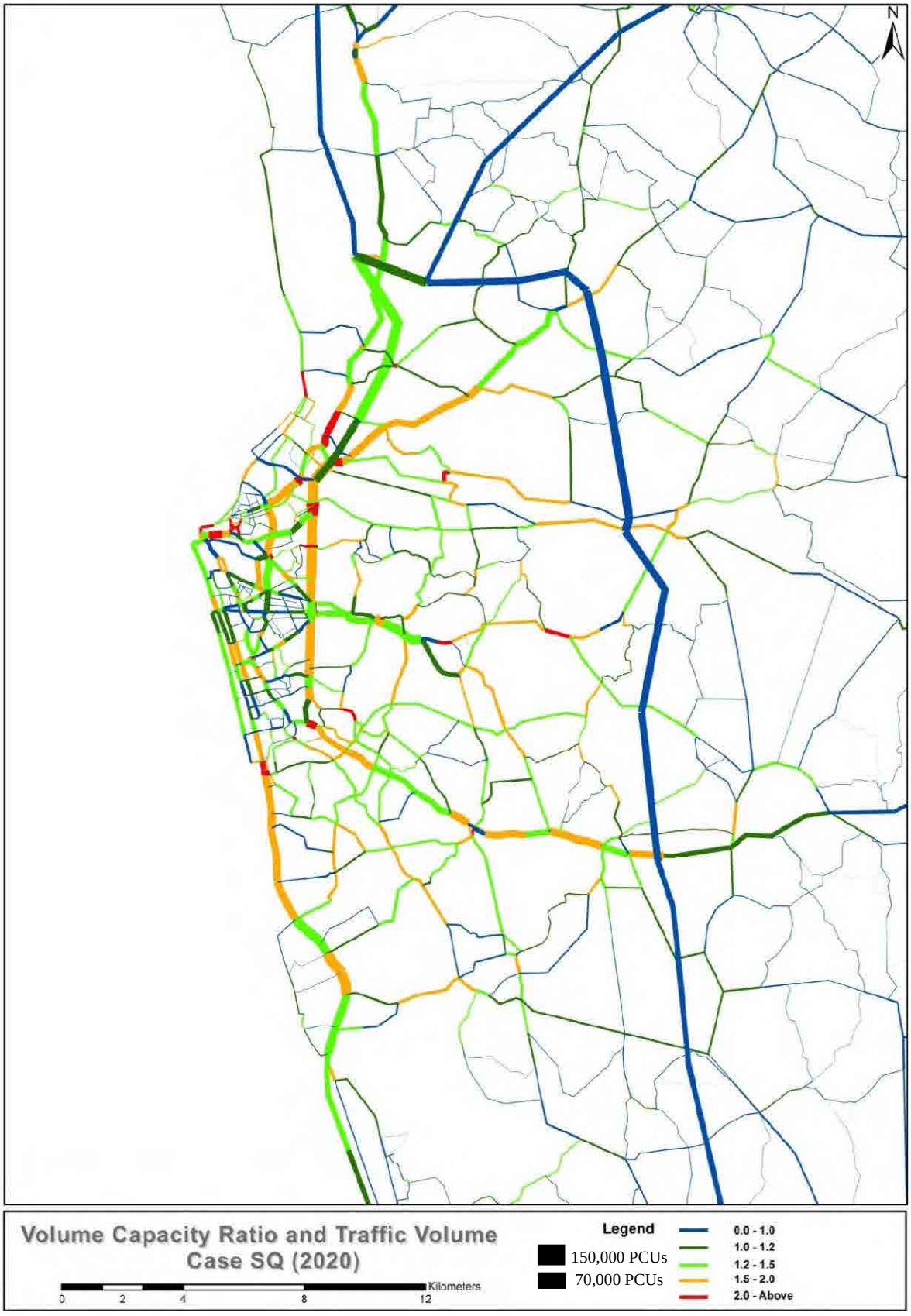


Figure 2 Volume Capacity Ratio and Traffic Volume Maps Status Quo in 2020

Figure 3 Volume Capacity Ratio and Traffic Volume Maps Case A1 in 2020

Figure 4 Volume Capacity Ratio and Traffic Volume Maps Case A2 in 2020

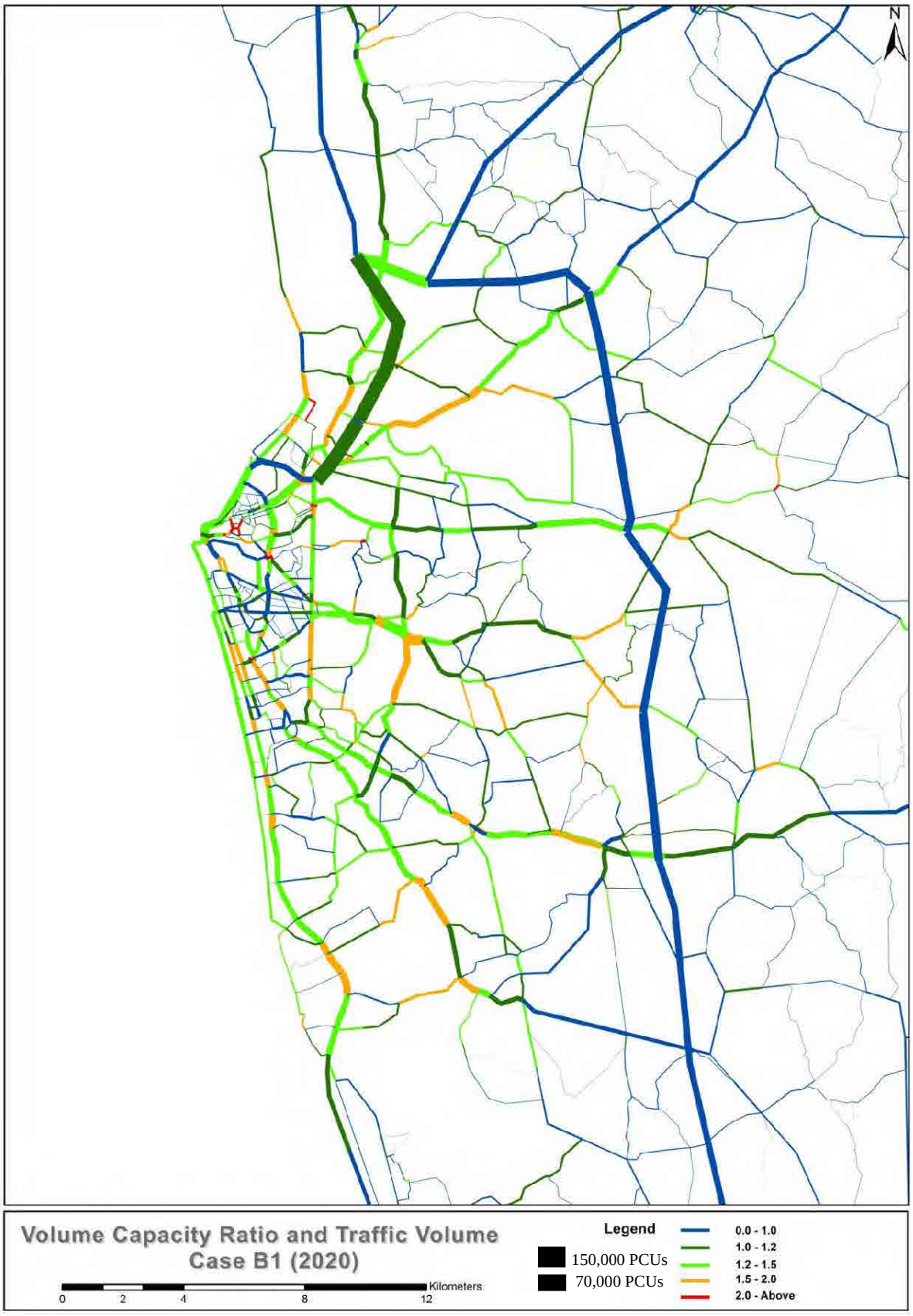


Figure 5 Volume Capacity Ratio and Traffic Volume Maps Case B1 in 2020

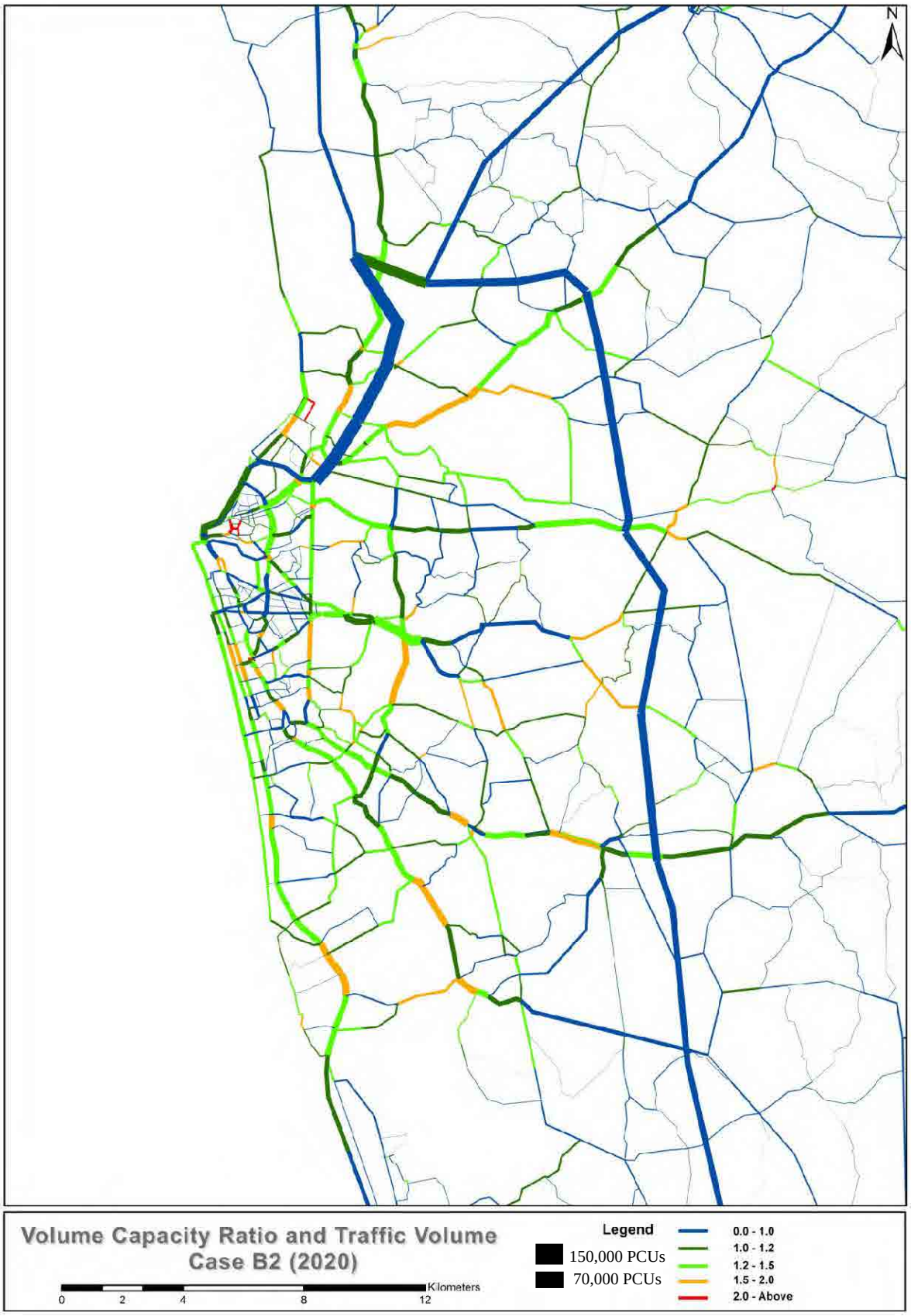


Figure 6 Volume Capacity Ratio and Traffic Volume Maps Case B2 in 2020

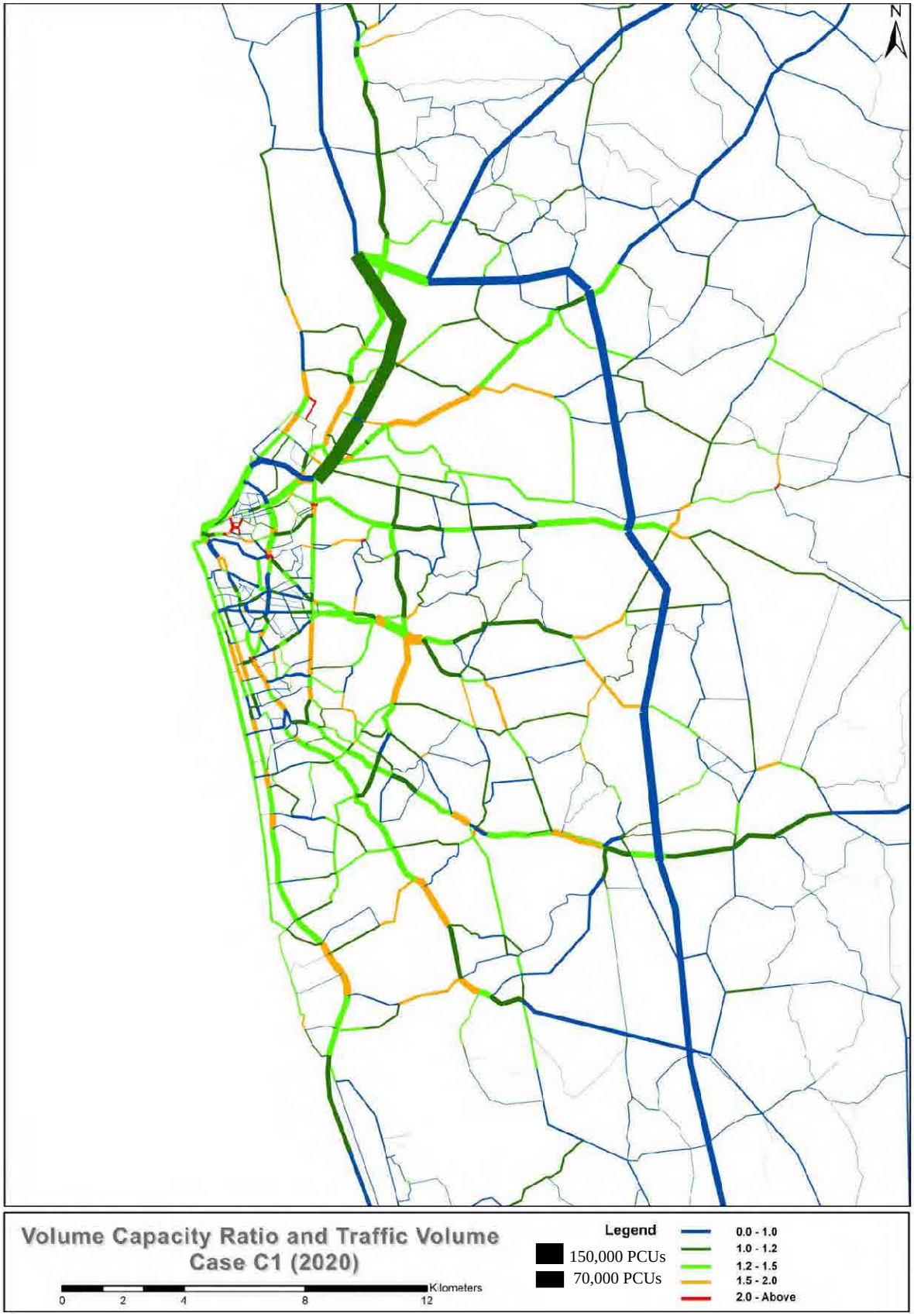


Figure 7 Volume Capacity Ratio and Traffic Volume Maps Case C1 in 2020

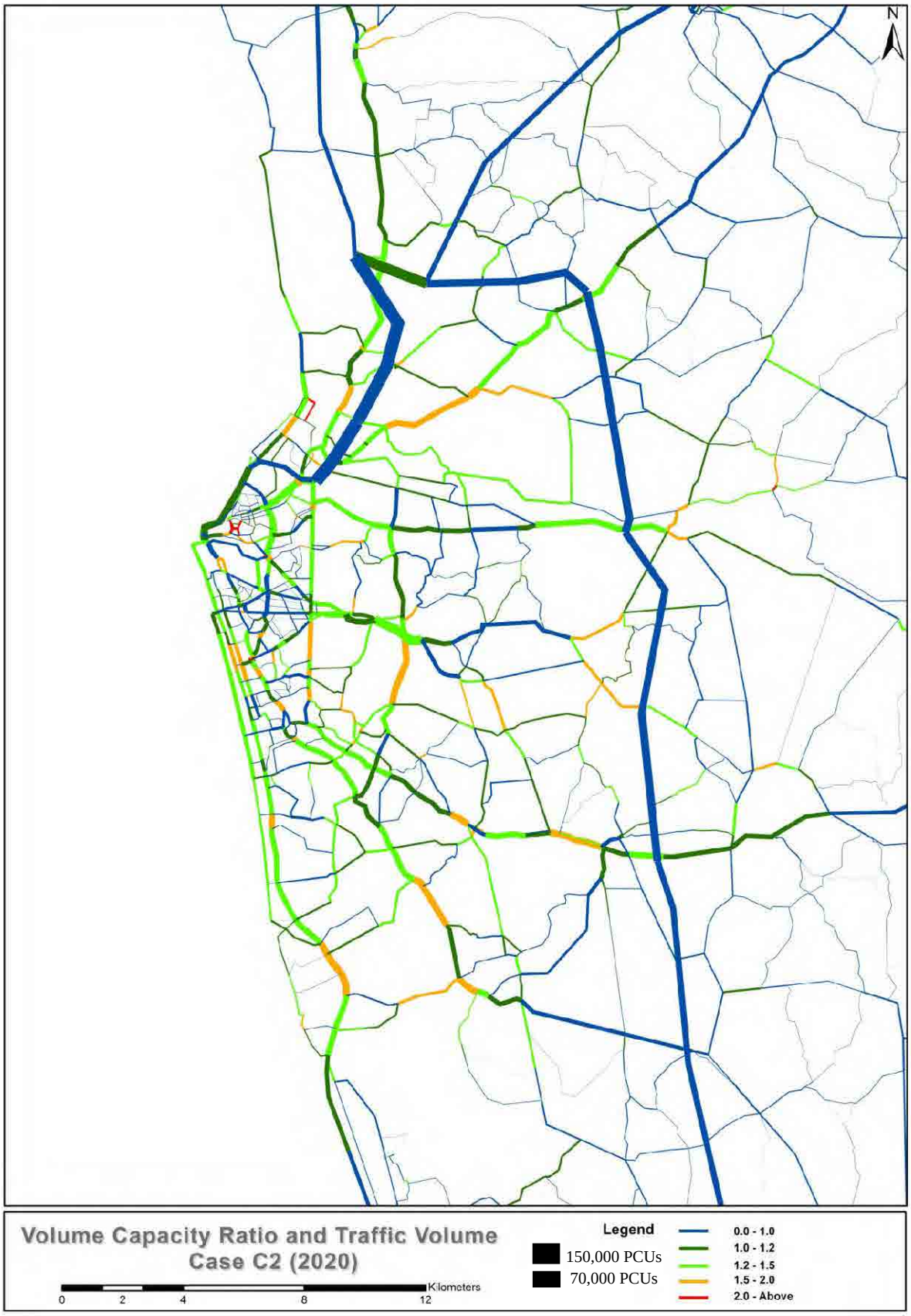


Figure 8 Volume Capacity Ratio and Traffic Volume Maps Case C2 in 2020

1.2 Road Assignment – Year 2025

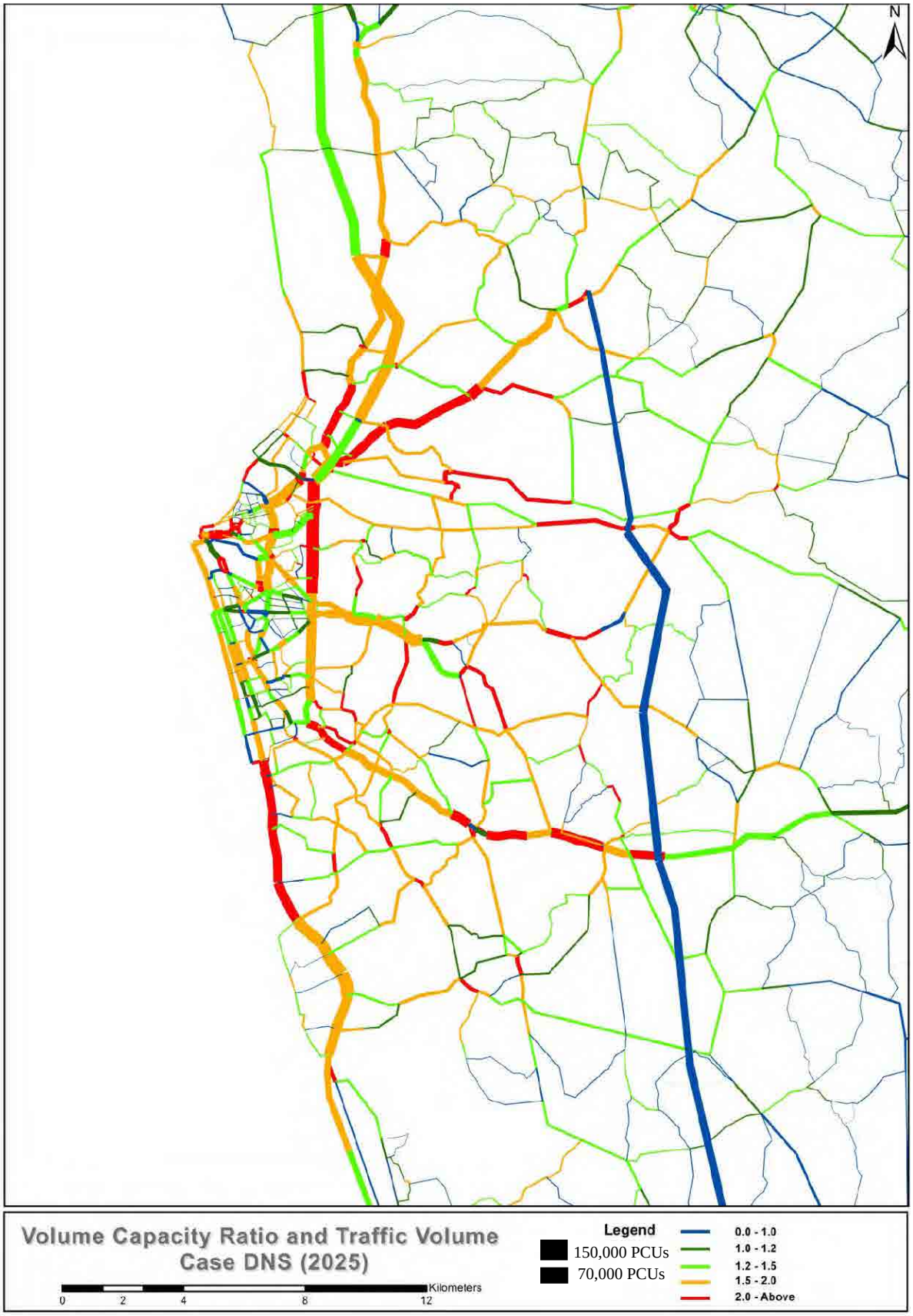


Figure 9 Volume Capacity Ratio and Traffic Volume Maps Case Do Nothing in 2025

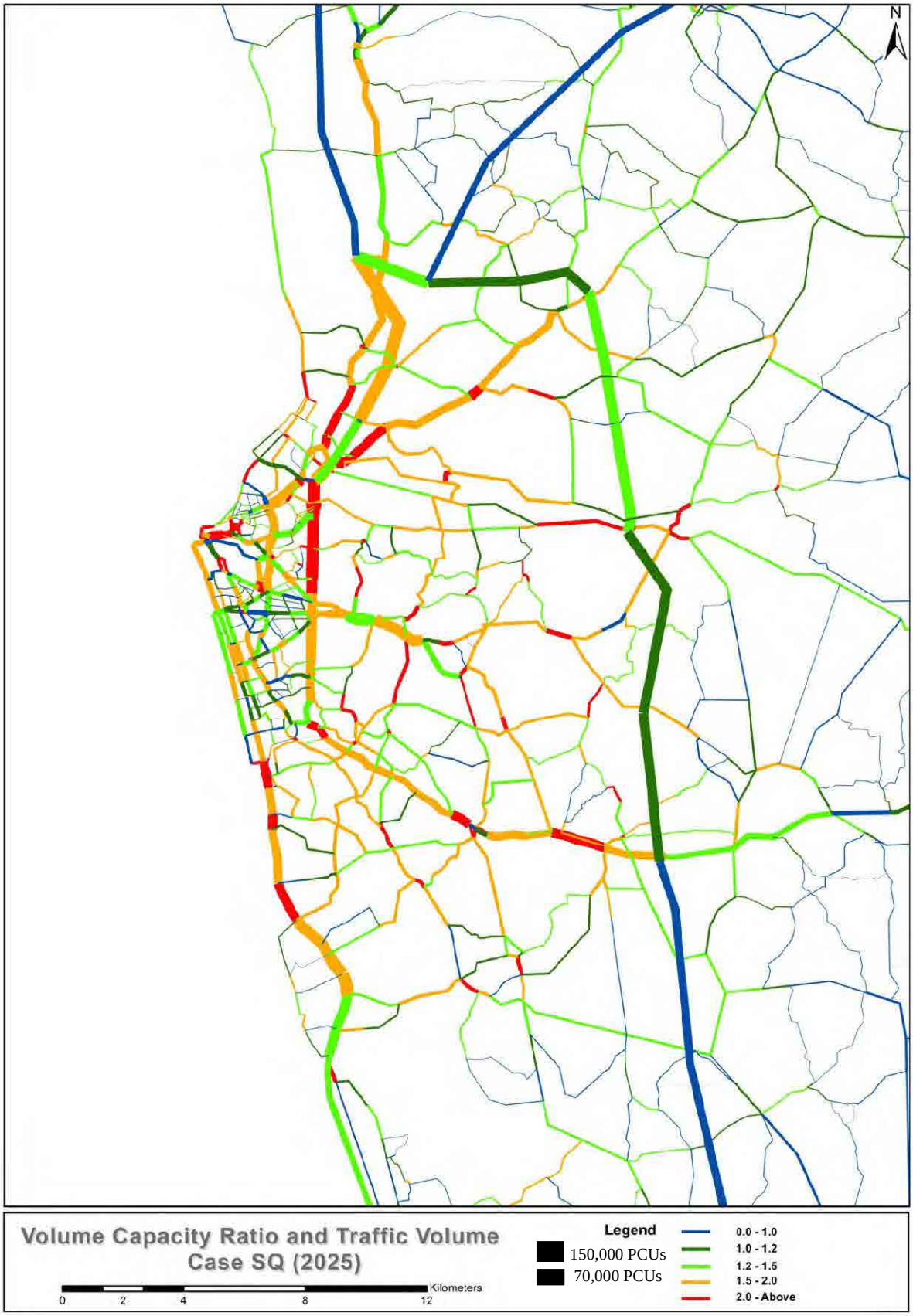


Figure 10 Volume Capacity Ratio and Traffic Volume Maps Case Status Quo in 2025

Figure 11 Volume Capacity Ratio and Traffic Volume Maps Case A1 in 2025

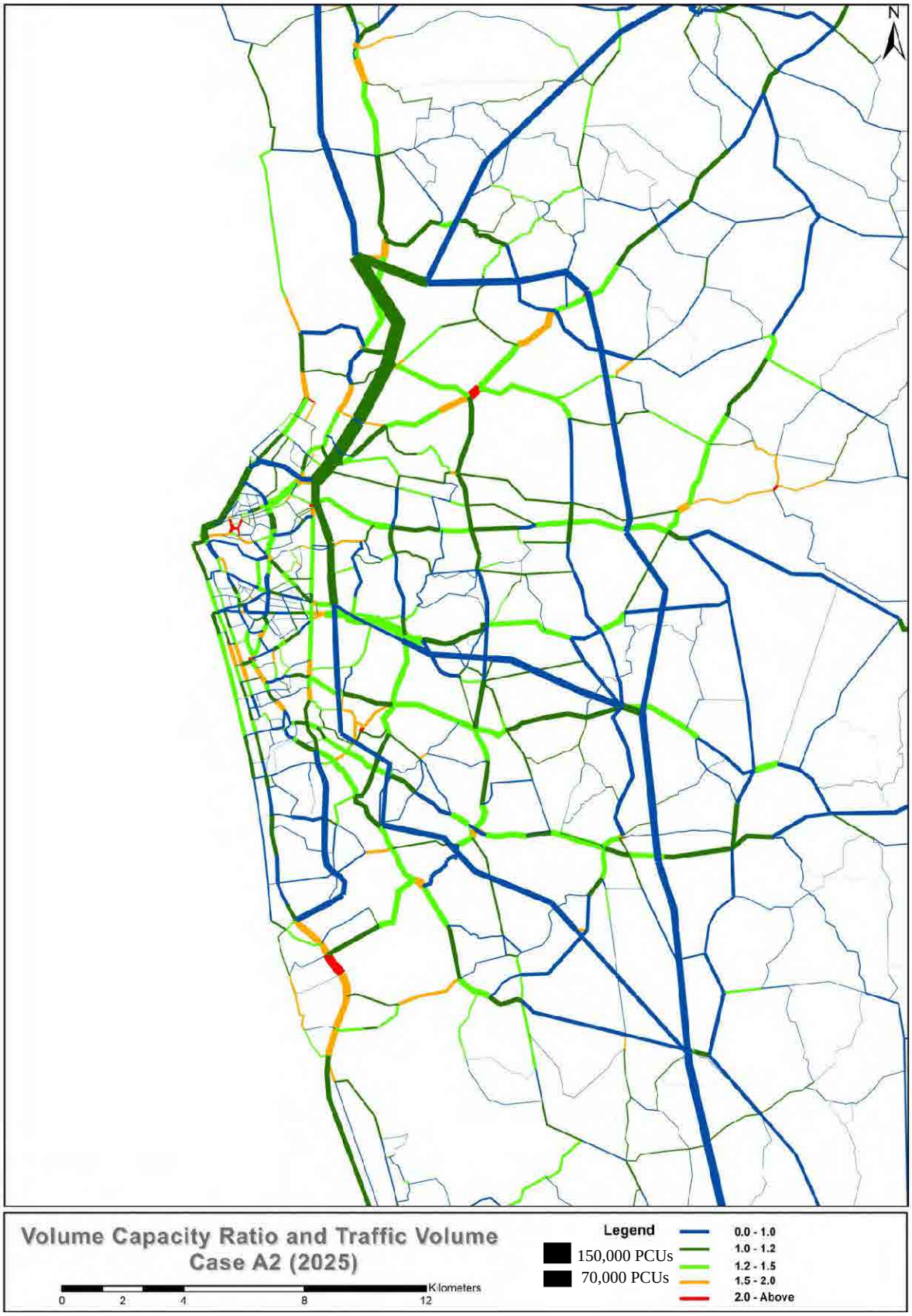


Figure 12 Volume Capacity Ratio and Traffic Volume Maps Case A2 in 2025

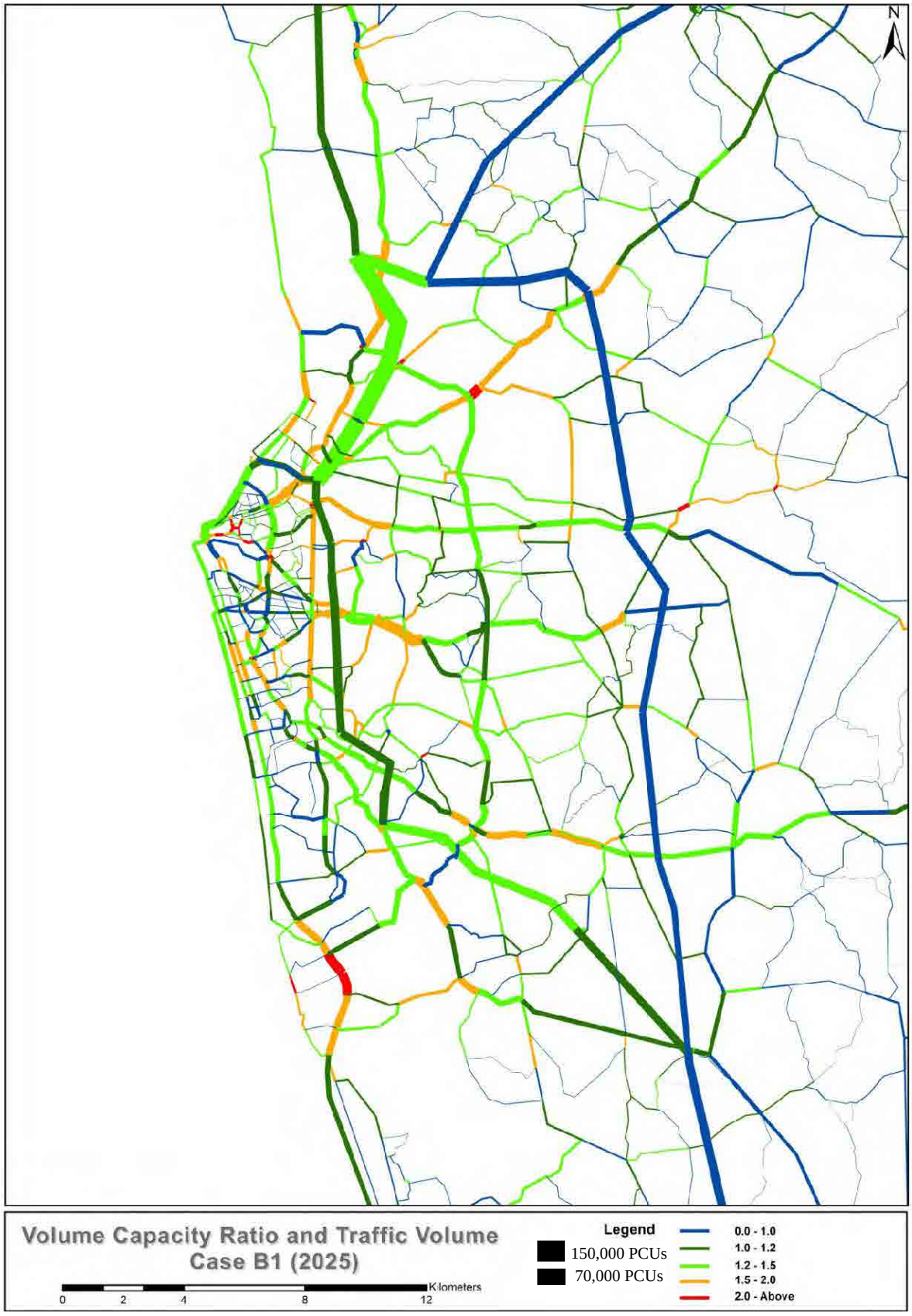


Figure 13 Volume Capacity Ratio and Traffic Volume Maps Case B1 in 2025

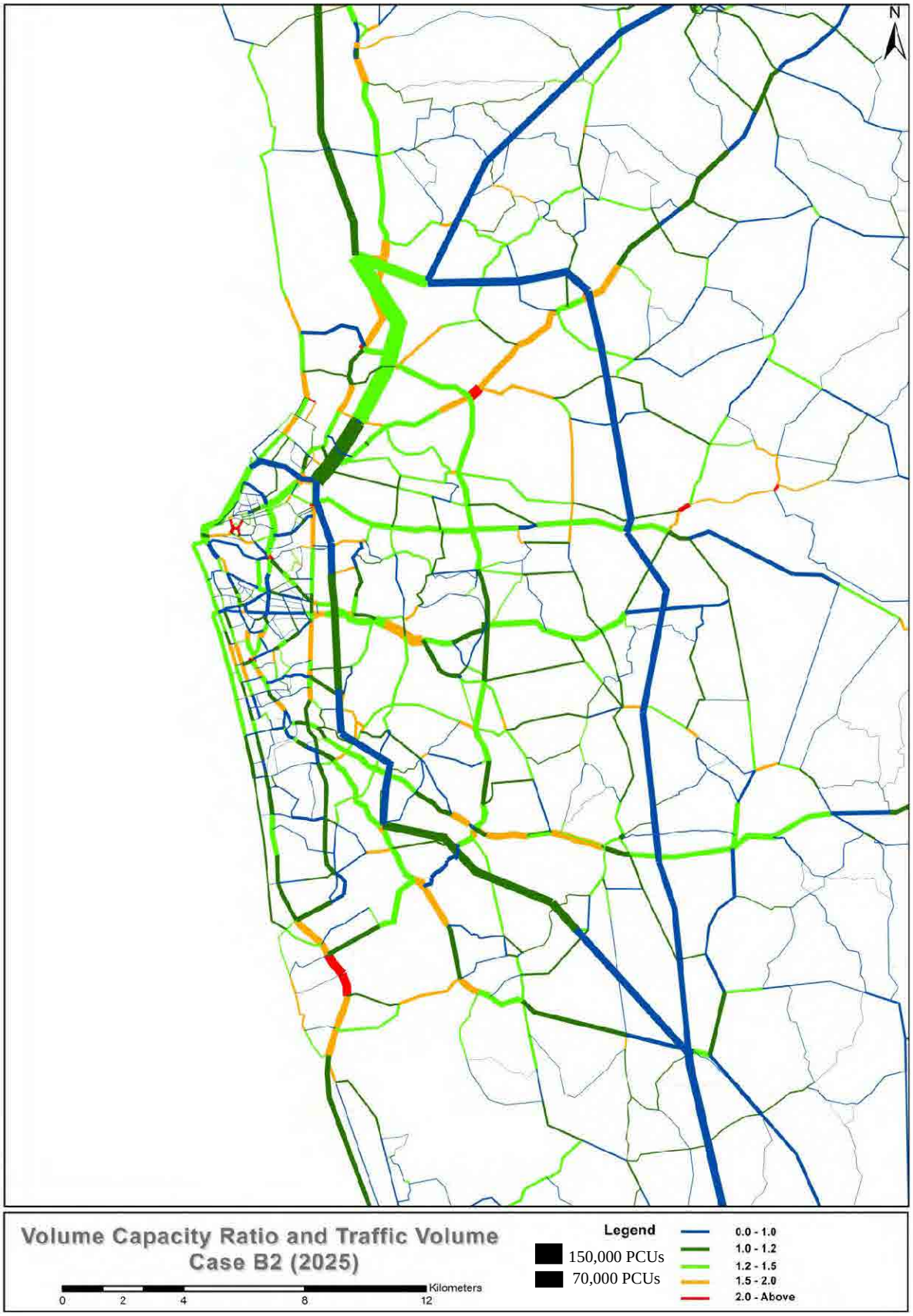


Figure 14 Volume Capacity Ratio and Traffic Volume Maps Case B2 in 2025

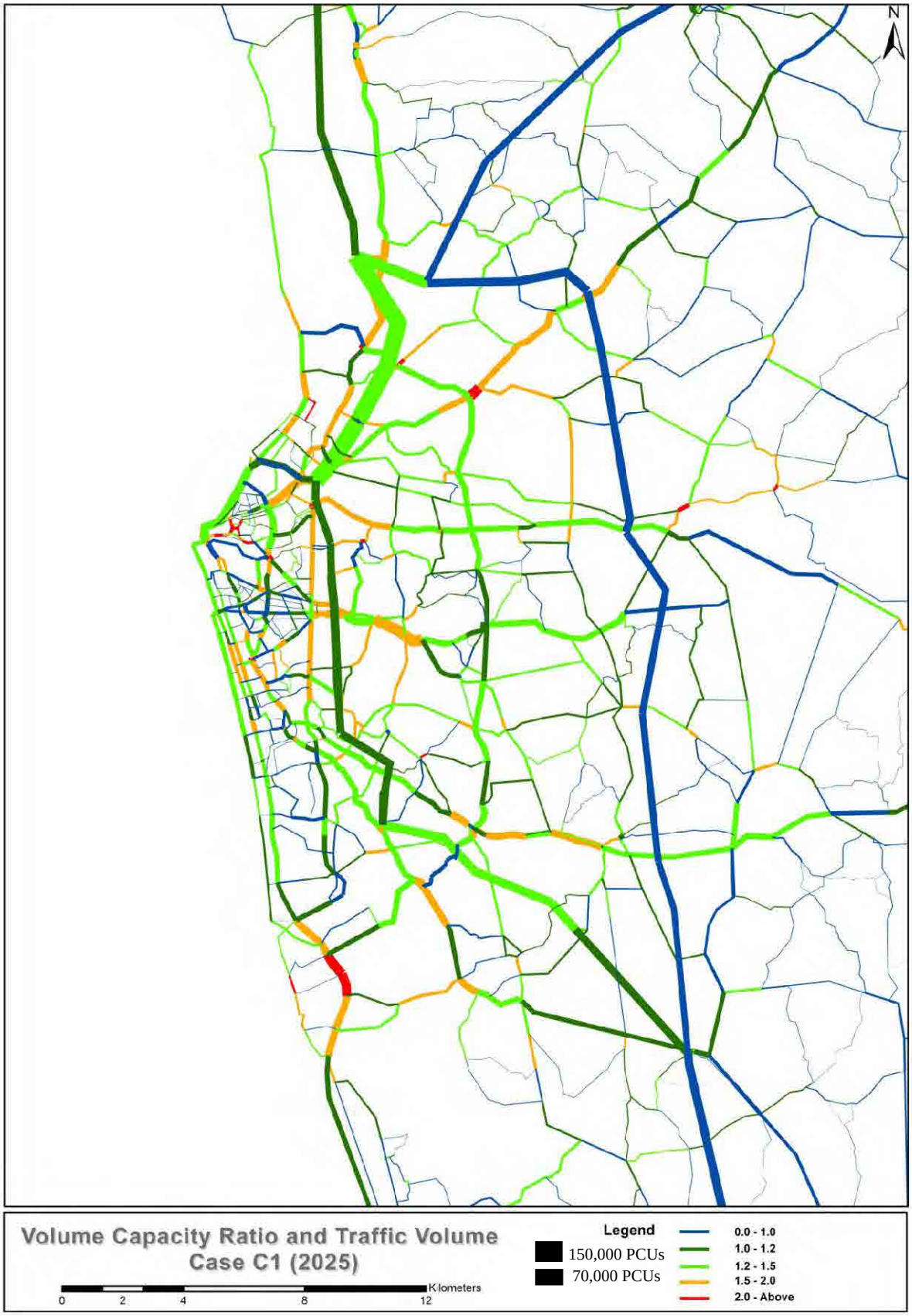


Figure 15 Volume Capacity Ratio and Traffic Volume Maps Case C1 in 2025

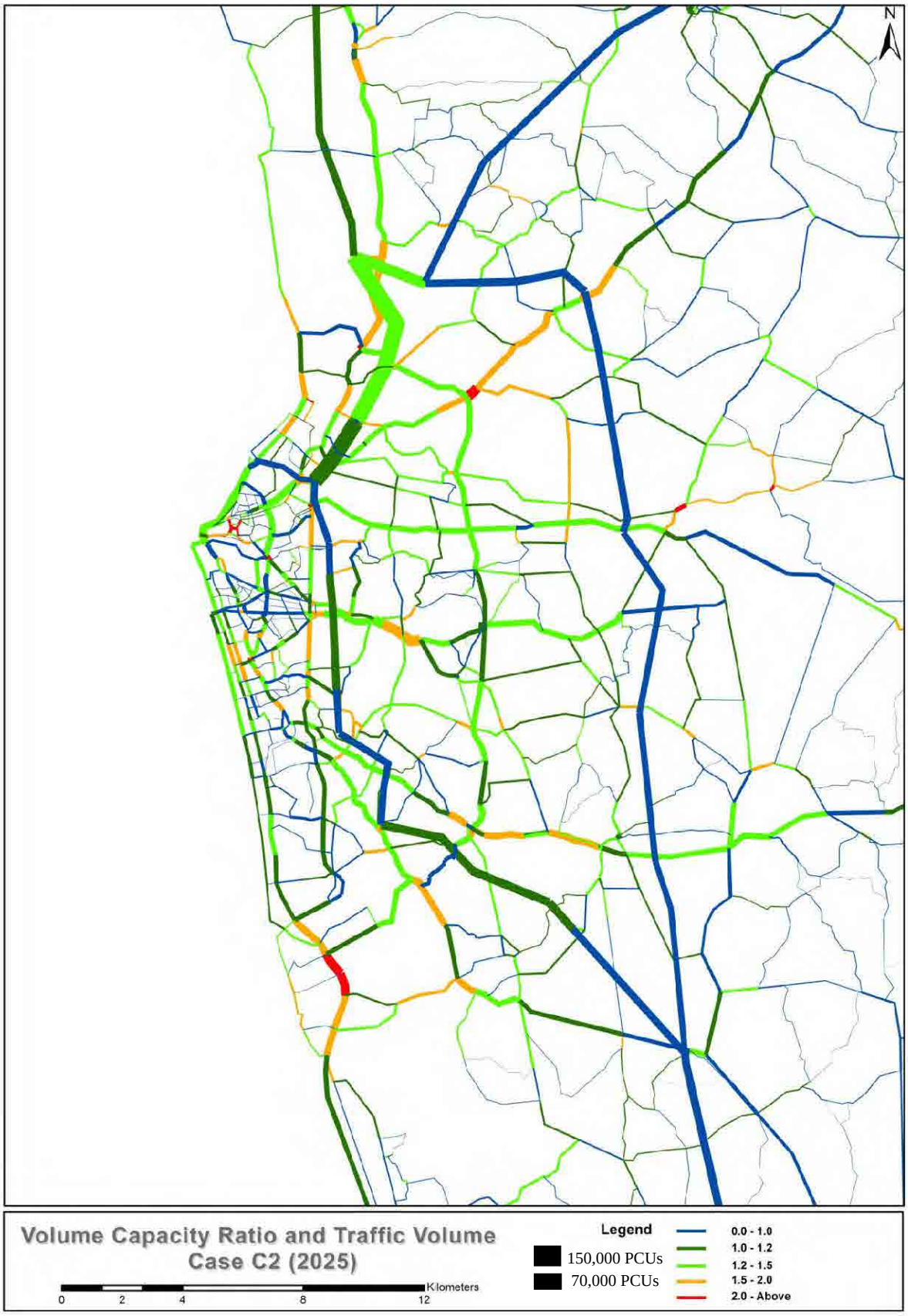


Figure 16 Volume Capacity Ratio and Traffic Volume Maps Case C2 in 2025

1.3 Road Assignment – Year 2035

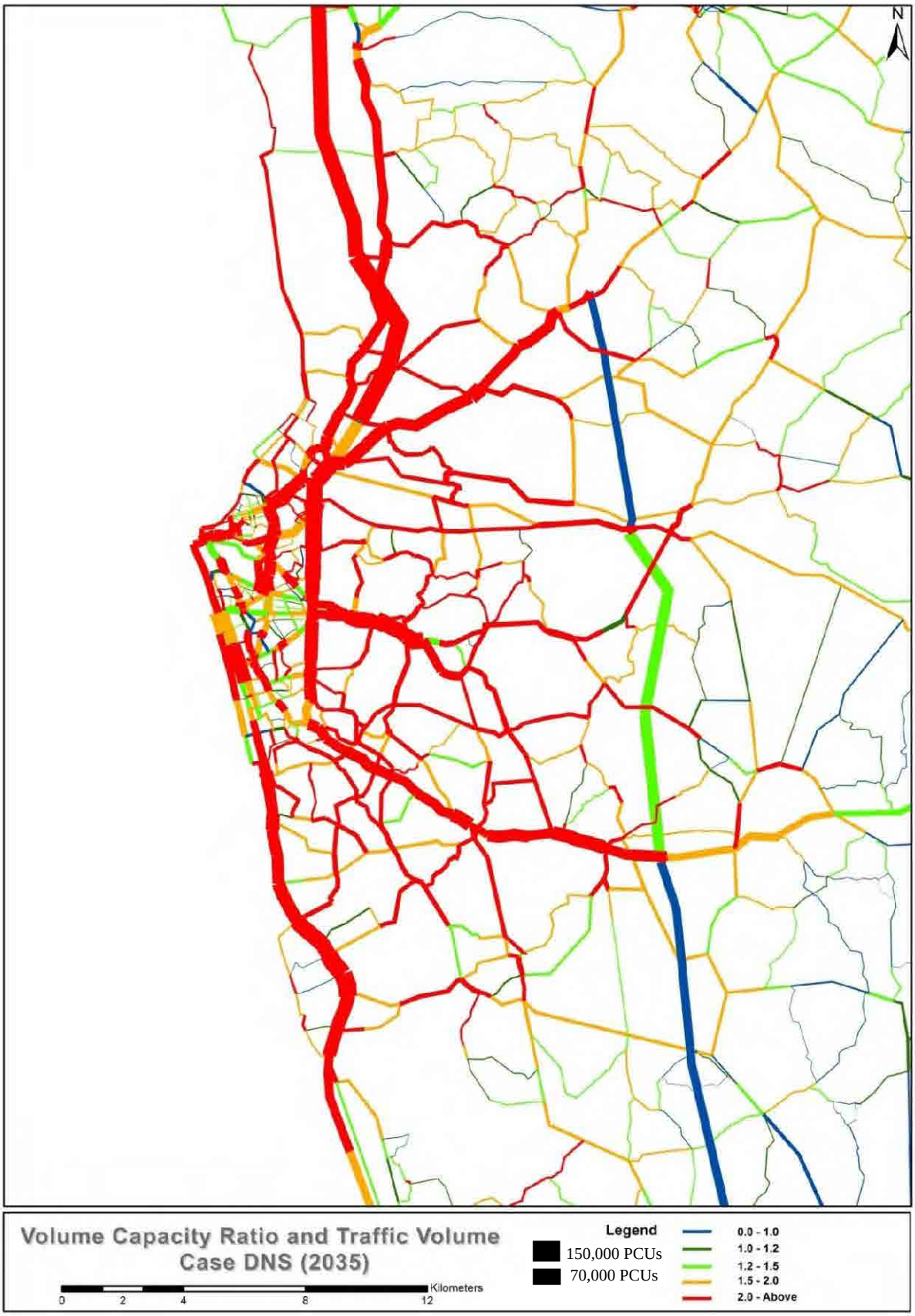


Figure 17 Volume Capacity Ratio and Traffic Volume Maps Do Nothing in 2035

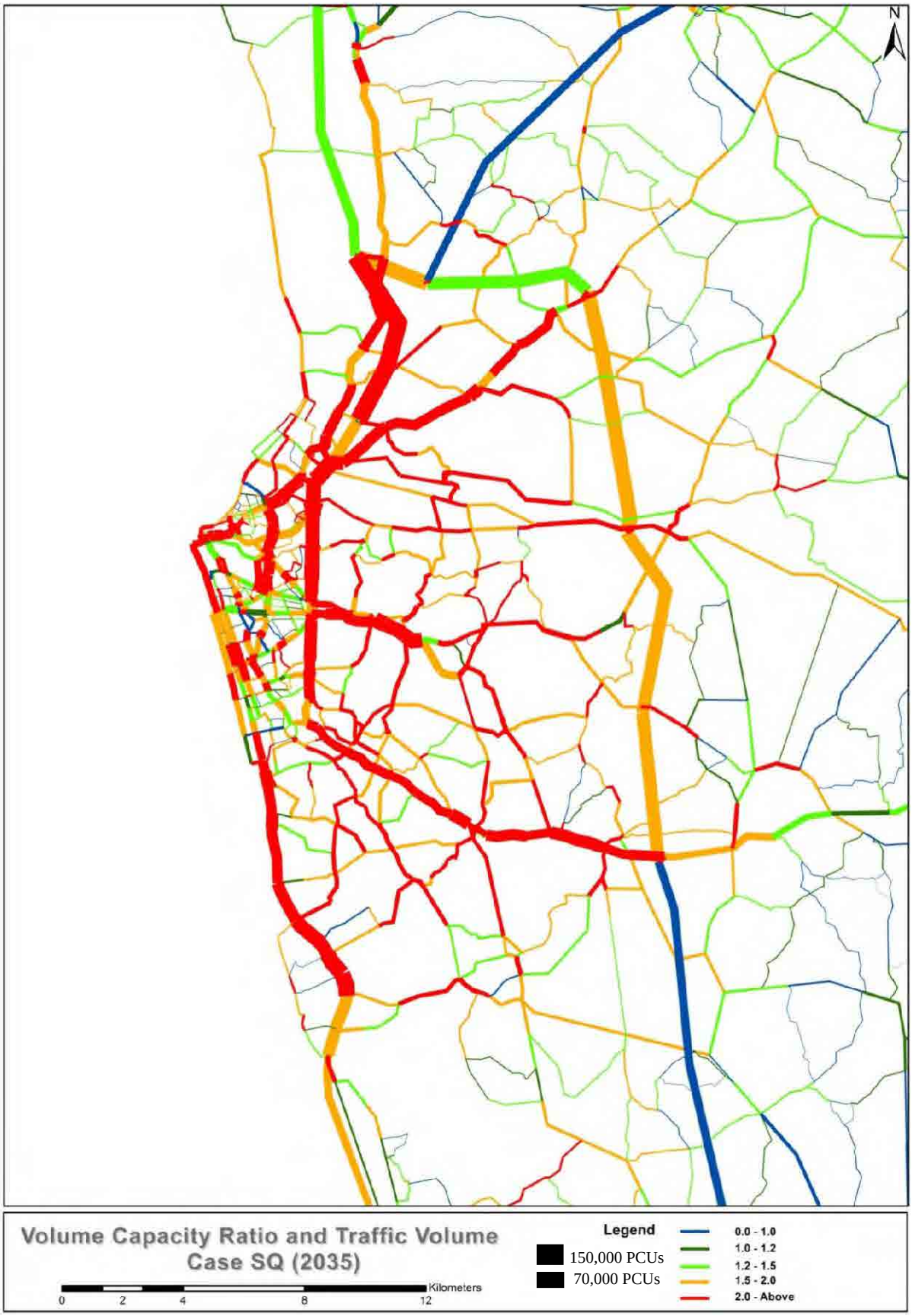


Figure 18 Volume Capacity Ratio and Traffic Volume Maps of Case Status Quo in 2035

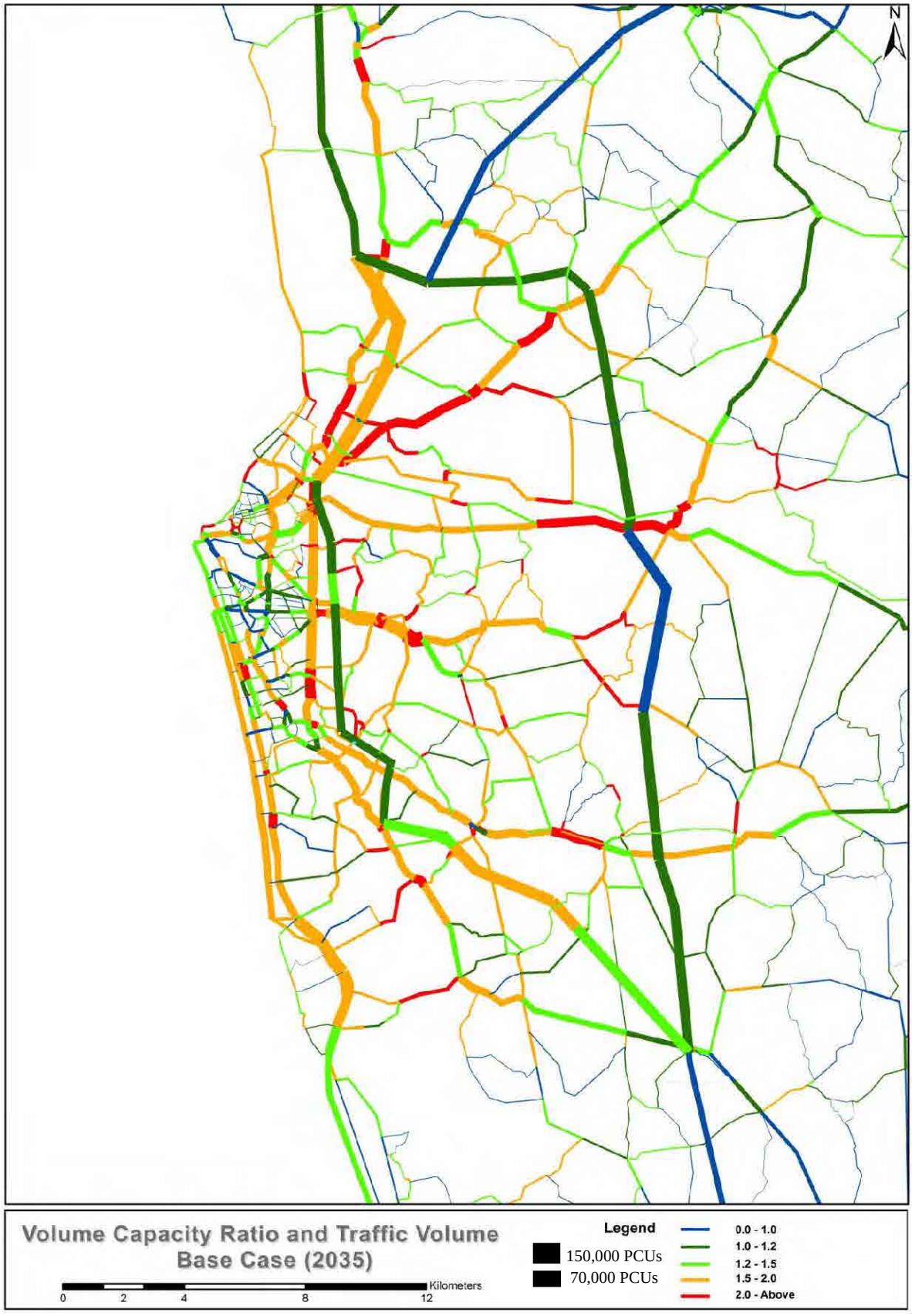


Figure 19 Volume Capacity Ratio and Traffic Volume Maps of Base Case in 2035

Figure 20 Volume Capacity Ratio and Traffic Volume Maps of Case A1 in 2035

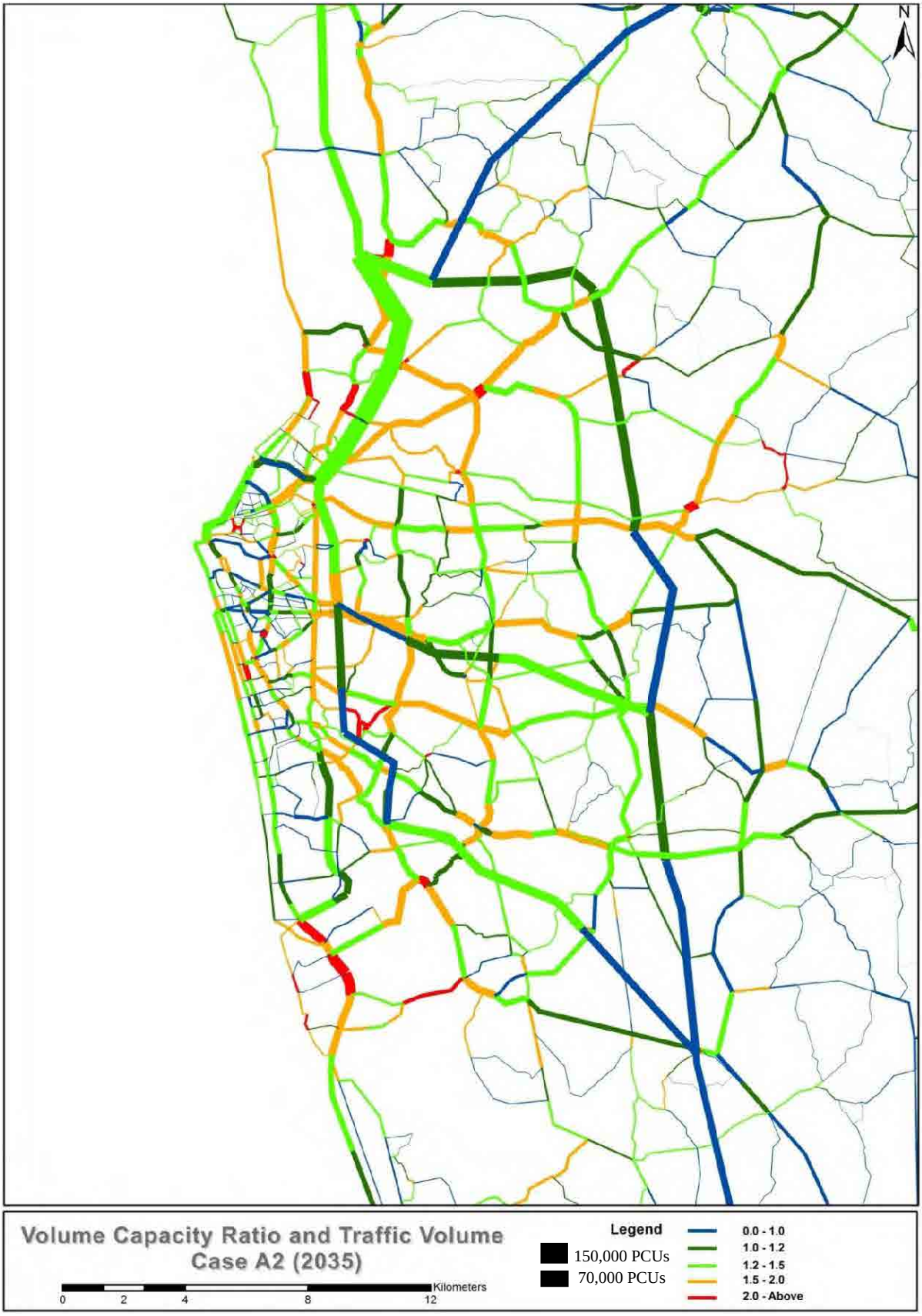


Figure 21 Volume Capacity Ratio and Traffic Volume Maps of Case A2 in 2035

Figure 22 Volume Capacity Ratio and Traffic Volume Maps of Case B1 in 2035

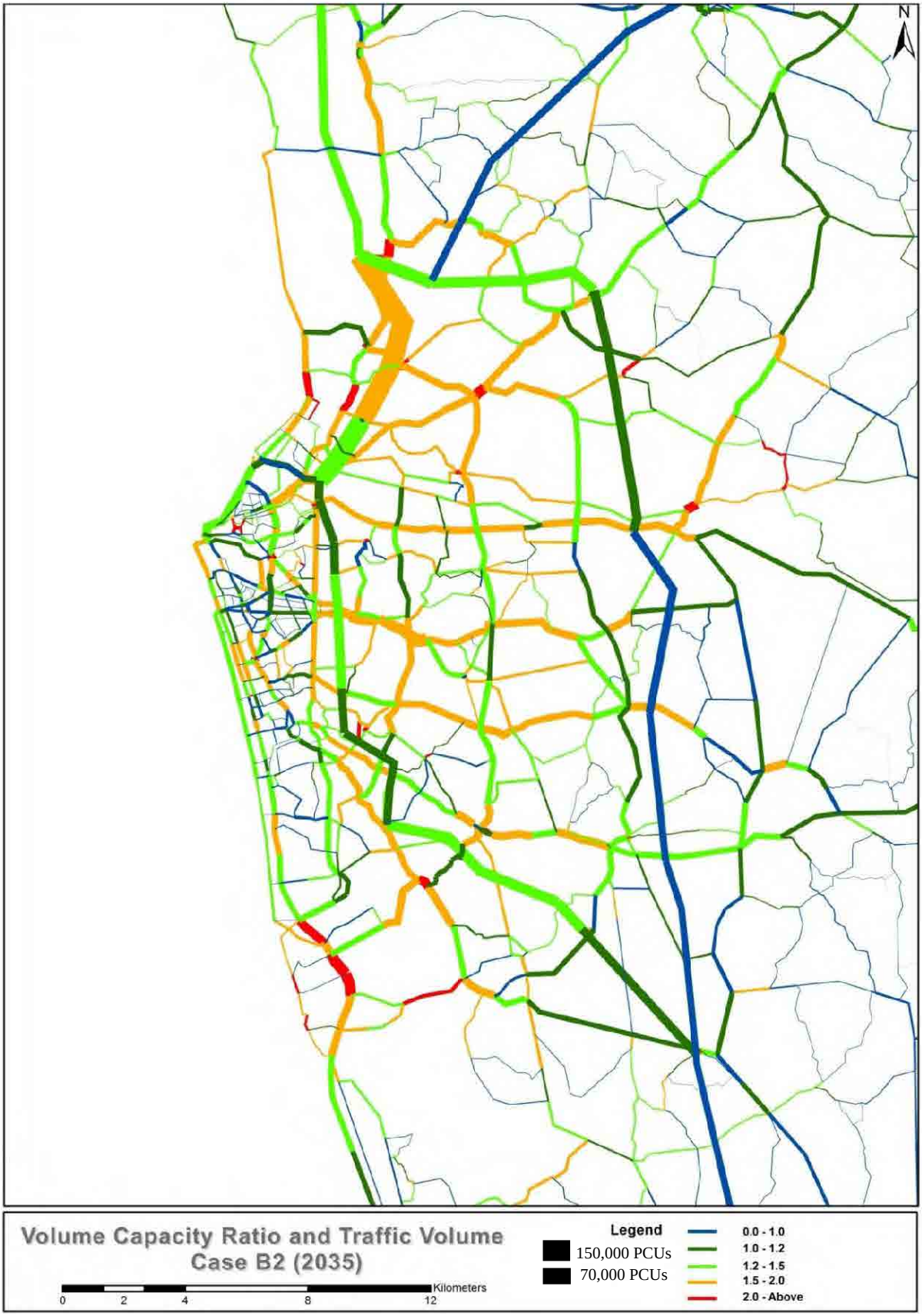


Figure 23 Volume Capacity Ratio and Traffic Volume Maps of Case B2 in 2035

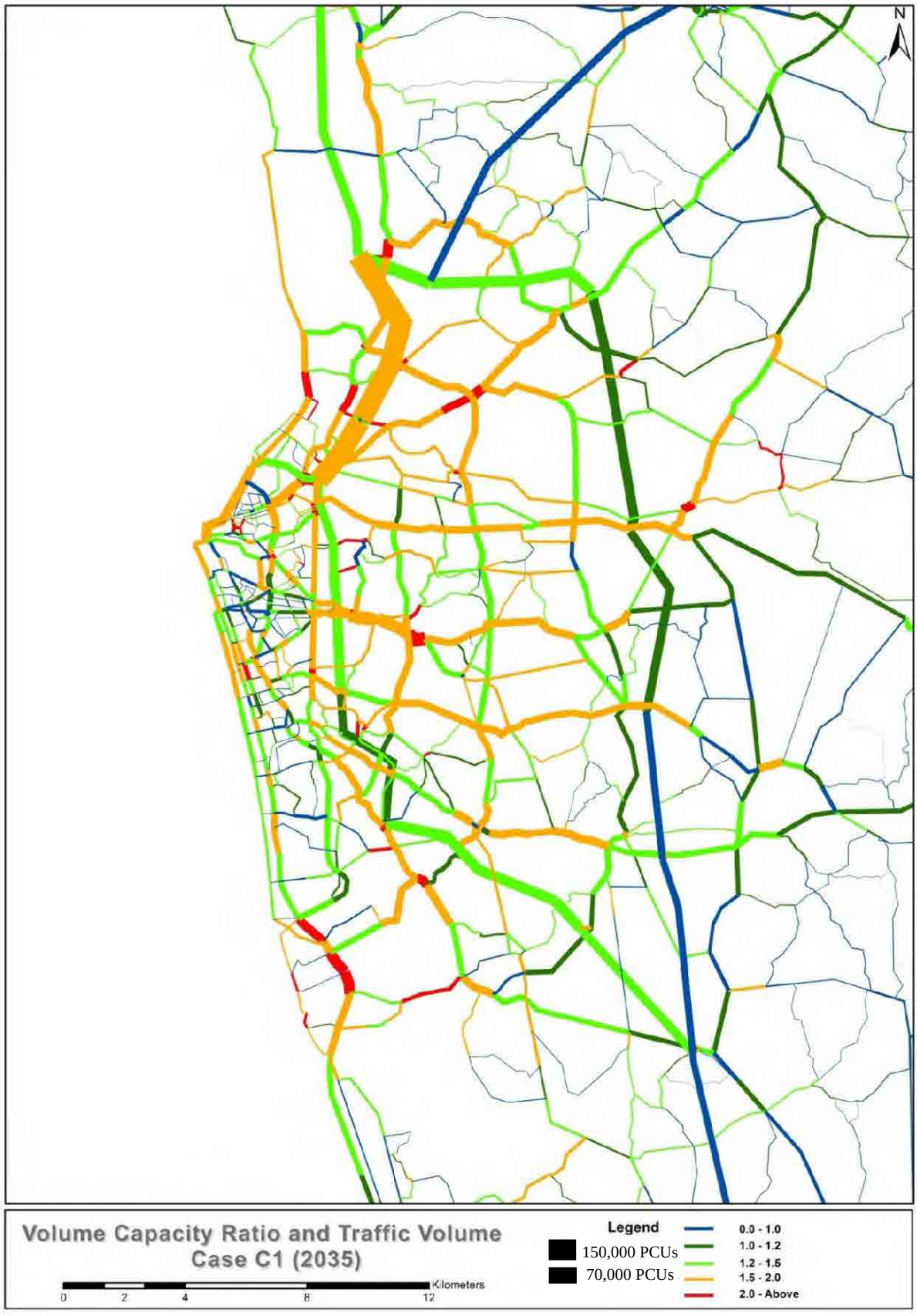


Figure 24 Volume Capacity Ratio and Traffic Volume Maps of Case C1 in 2035

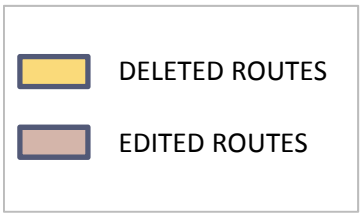
Figure 25 Volume Capacity Ratio and Traffic Volume Maps of Case C2 in 2035

2 List of Rerouted Bus Routes

Bus Reroute – Referred to 5.5.2

Corridor Information		Bus Route	Origin	Destination	New Destination
Kandy & Negambo Corridors	Negambo Road at CMA	CG187	Airport	Fort	JFB
		CG187_AC	Airport	Fort	JFB
		CG240_AC	Negombo	Colombo	JFB
		GJL188	Raddoluwa	Fort	JFB
	Negambo Road at JFB	CG187	Airport	Fort	JFB
		CG187_AC	Airport	Fort	JFB
		CG240_AC	Negambo	Colombo	JFB
		CG265_AC	Minuwangoda	Colombo	JFB
		CWP187_2	Ekala	Fort	JFB
		CWP187_2R	Ekala	Fort	JFB
		CWP187_3	Ranpokunugama	Fort	JFB
		GDP265	Minuwangoda	Colombo	JFB
		GJL104_1	Wattala	Bambalapitiya	JFB
		GJL187_1	Ja-Ela	Fort	JFB
		GJL188	Raddoluwa	Fort	JFB
		GKD261	Mahara	Pettah	JFB
		GWS107	Elakanda	Fort	JFB
		GWS260	Hendala	Colombo	JFB
		GWS262	Ragama	Colombo	JFB
	Kandy Road at CMA	CG180_AC	Nittabuwa	Pettah	Kelaniya MMC1
		GNT180	Nittabuwa	Petath	Kelaniya MMC1
	Kandy Road at Kelaniya	CG180_AC	Nittabuwa	Pettah	Kelaniya MMC1
		CRL154			
		CRL154_R			
		CWP356	Karabugashandiya	Fort	Kelaniya MMC1
		GGM200	Gampaha	Pettah	Kelaniya MMC1
		GKD138	Kadawatha	Fort	Kelaniya MMC1
		GKD138_1	Kiriilawala	Fort	Kelaniya MMC1
		GKD154	Angulana	Kiribathgoda	
		GKD154R	Angulana	Kiribathgoda	
		GKD193	Kadawatha	Town Hall	Kelaniya MMC1
		GKD234	Delgoda	Pettah	Kelaniya MMC1
		GKD356	Karabugashandiya	Fort	Kelaniya MMC1
		GKD514	Weliweriya	Fort	Kelaniya MMC1
		GKD738	Kossinna	Fort	Kelaniya MMC1
		GNT180	Nittambuwa	Pettah	Kelaniya MMC1

Corridor Information	Bus Route	Origin	Destination	New Destination
Malabe Corridor	CWP144	Rajagiriya	Fort	
	CWP171	Battaramulla	Fort	
	CC177_AC	Kaduwela	Kollupitiya	Malabe
	CTL177	Kaduwela	Kollupitiya	Malabe
	CTL170	Athurugiriya	Fort	Malabe
	CTL170R	Athurugiriya	Fort	Malabe
	CTL190	Meegoda	Fort	Malabe
	CTL190R	Meegoda	Fort	Malabe
	CTL174	Kottawa	Borella	Malabe
	CTL186	Jayawadana	Borella	Malabe
	CUM153	Borella	Hospita	Malabe
	CAG150	Kelaniya	Seemamalakaya	Malabe
	CAG175	Kollupitiya	Kohilawatta	Malabe
	CAG175R	Kollupitiya	Kohilawatta	Malabe
	CAG175_1	Kollupitiya	IDH Jun	Malabe
	CAG175_1R	Kollupitiya	IDH Jun	Malabe
	CUM176	Dehiwala	Hettiyawatta	Malabe
	CUM176_1	Dehiwala	Hettiyawatta	Malabe
	CUM176_1R	Dehiwala	Hettiyawatta	Malabe
	CUM176_2	Dehiwala	Hettiyawatta	Malabe
	CUM176_2R	Dehiwala	Hettiyawatta	Malabe
	CUM168	Nugegoda	Kotahena	Malabe
	CUM168R	Kelaniya	Seemamalake	Malabe



3 Maps of Public Transport Assignment Results

3.1 Public Transit Assignment - 2020

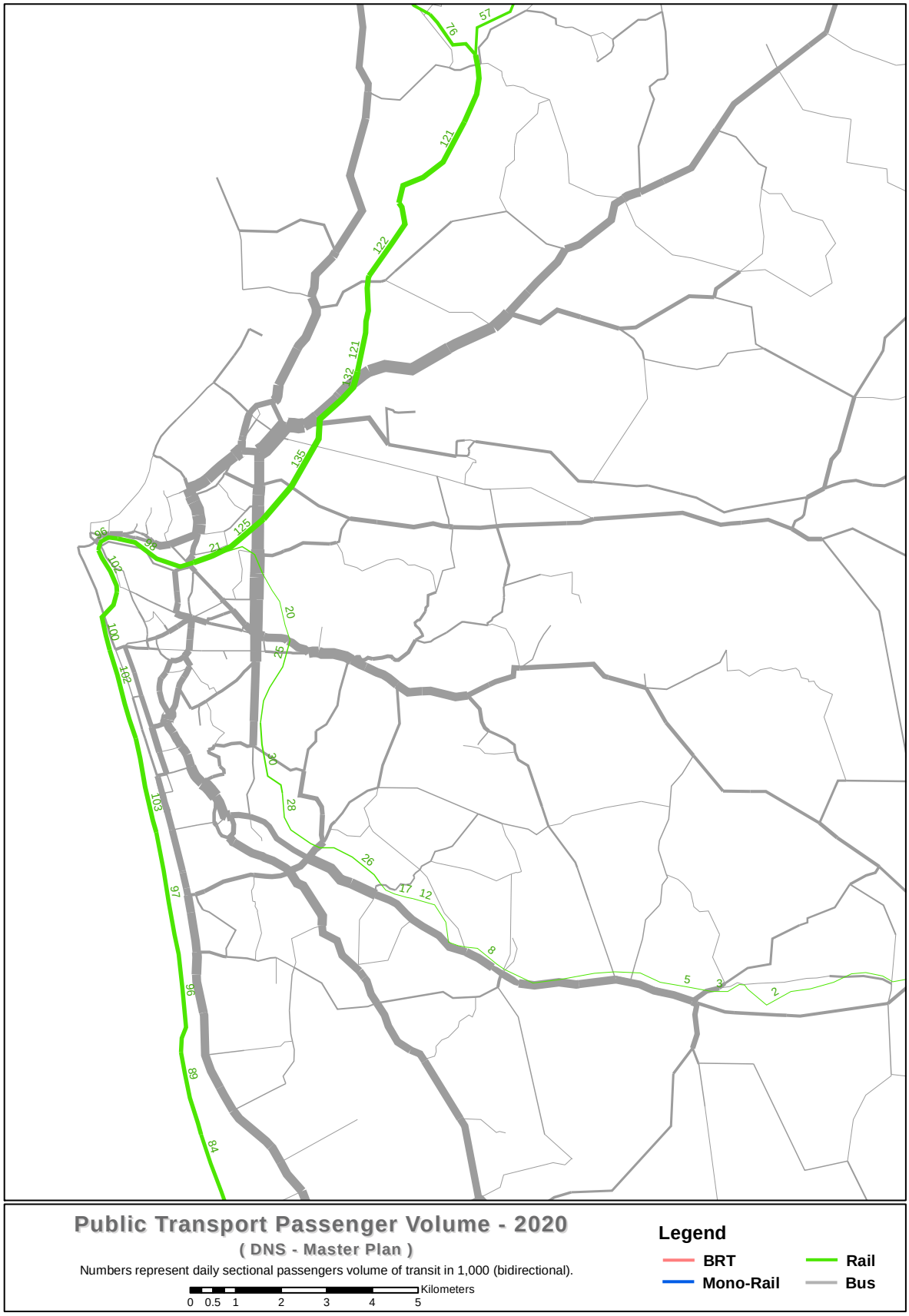


Figure 26 Sectional Volume Map of Master Plan Do Nothing in 2020

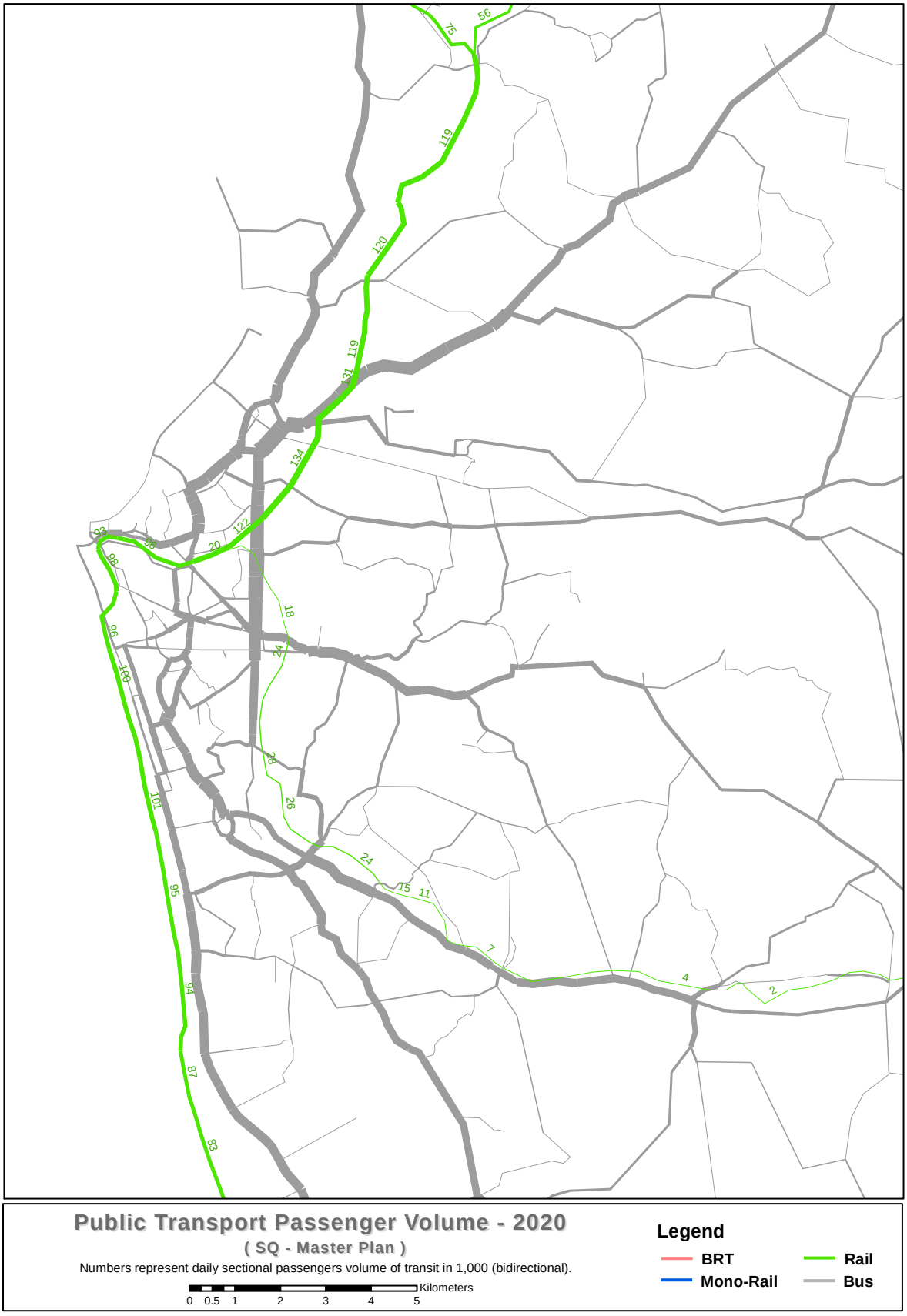


Figure 27 Sectional Volume Map of Master Plan Status Quo in 2020

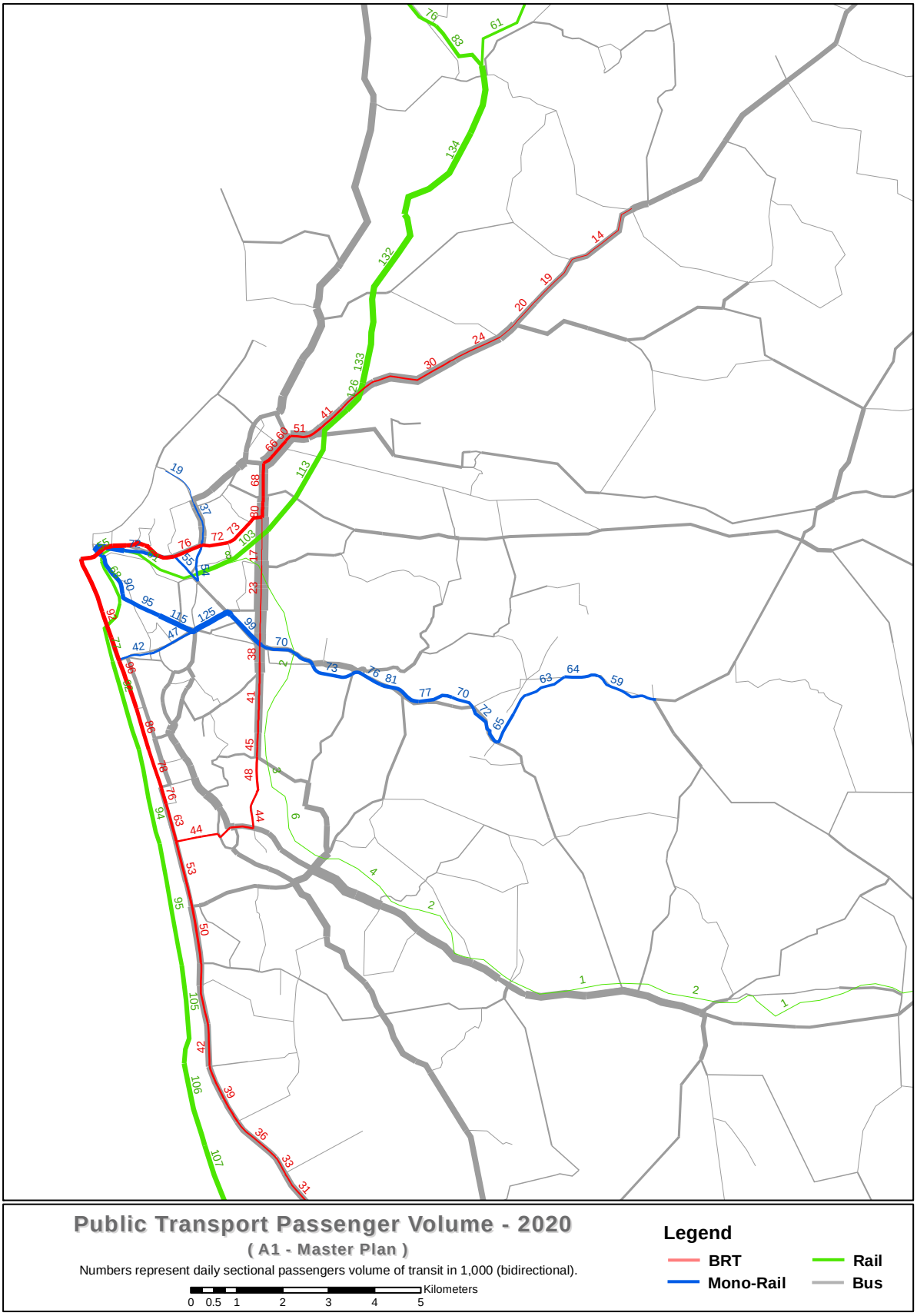


Figure 28 Sectional Volume Map of Master Plan Case A1 in 2020

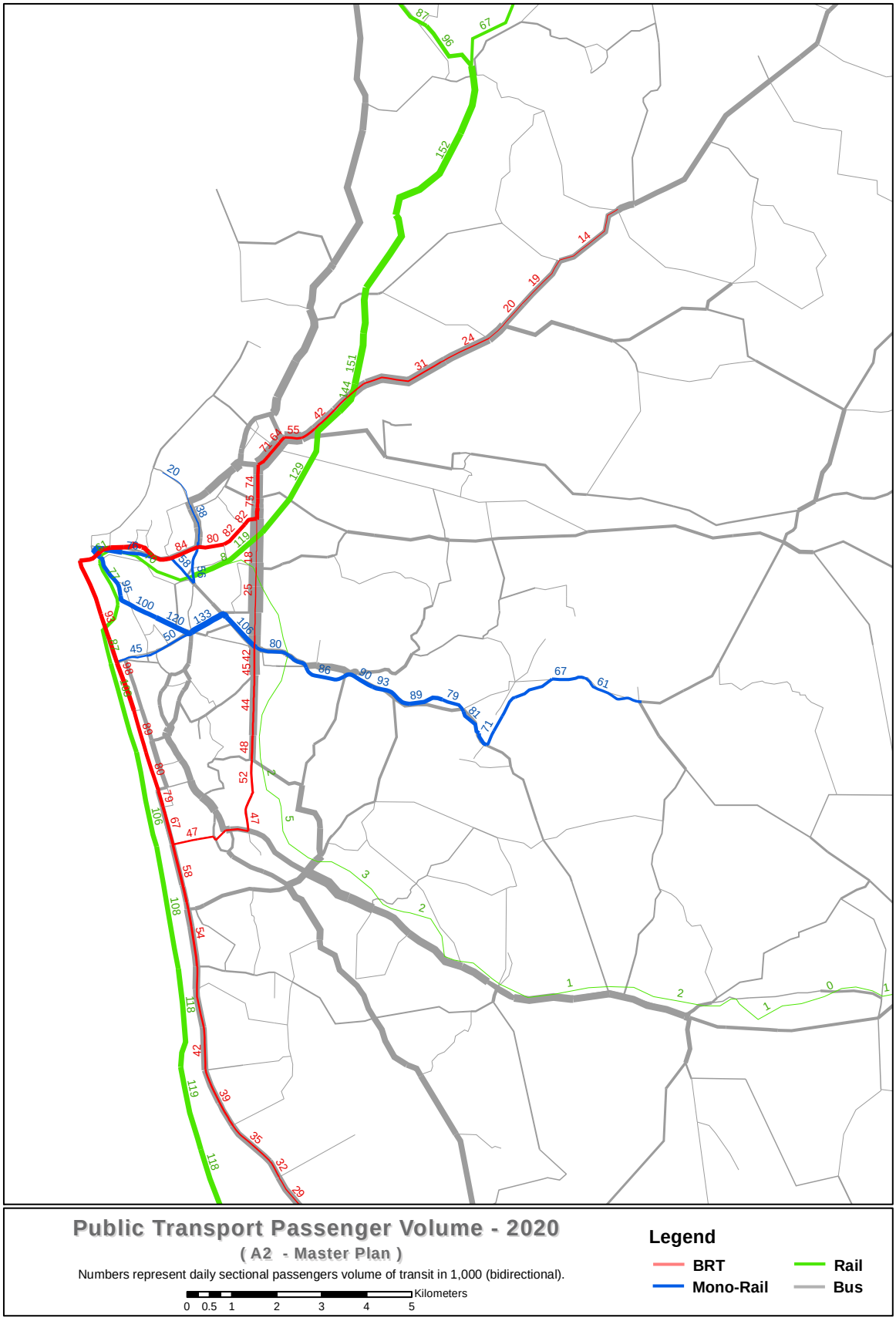


Figure 29 Sectional Volume Map of Master Plan Case A2 in 2020

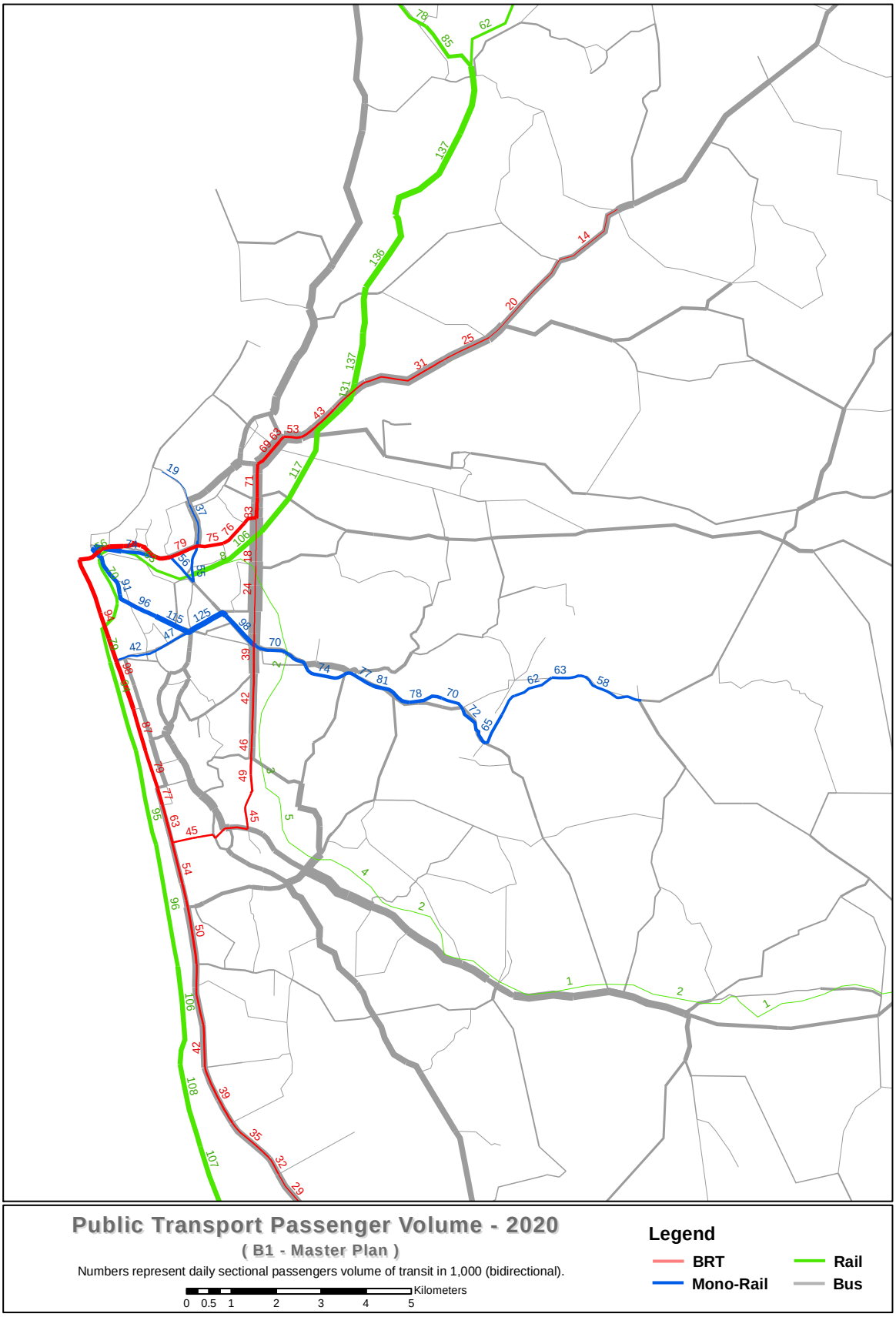


Figure 30 Sectional Volume Map of Master Plan Case B1 in 2020

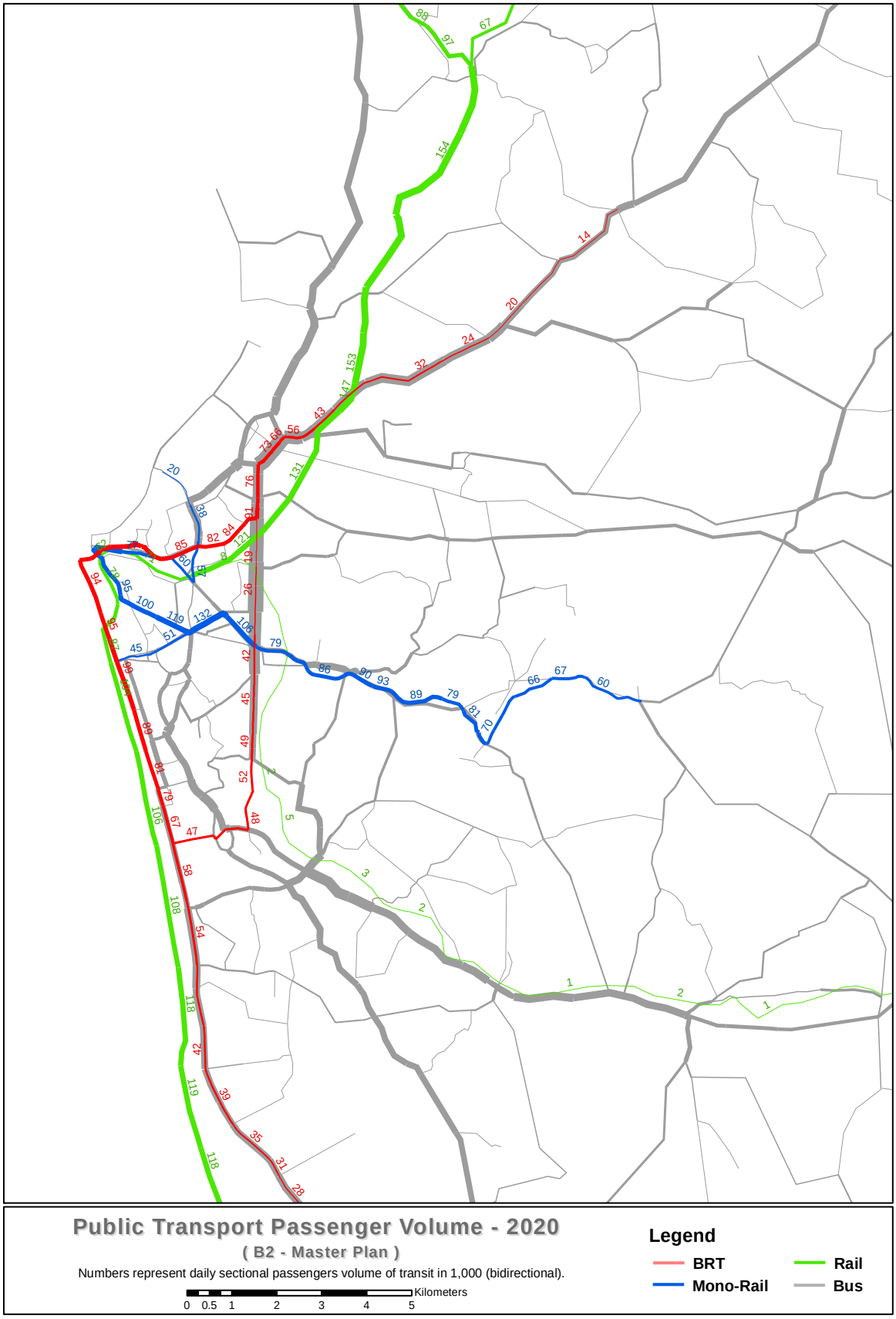


Figure 31 Sectional Volume Map of Master Plan Case B2 in 2020

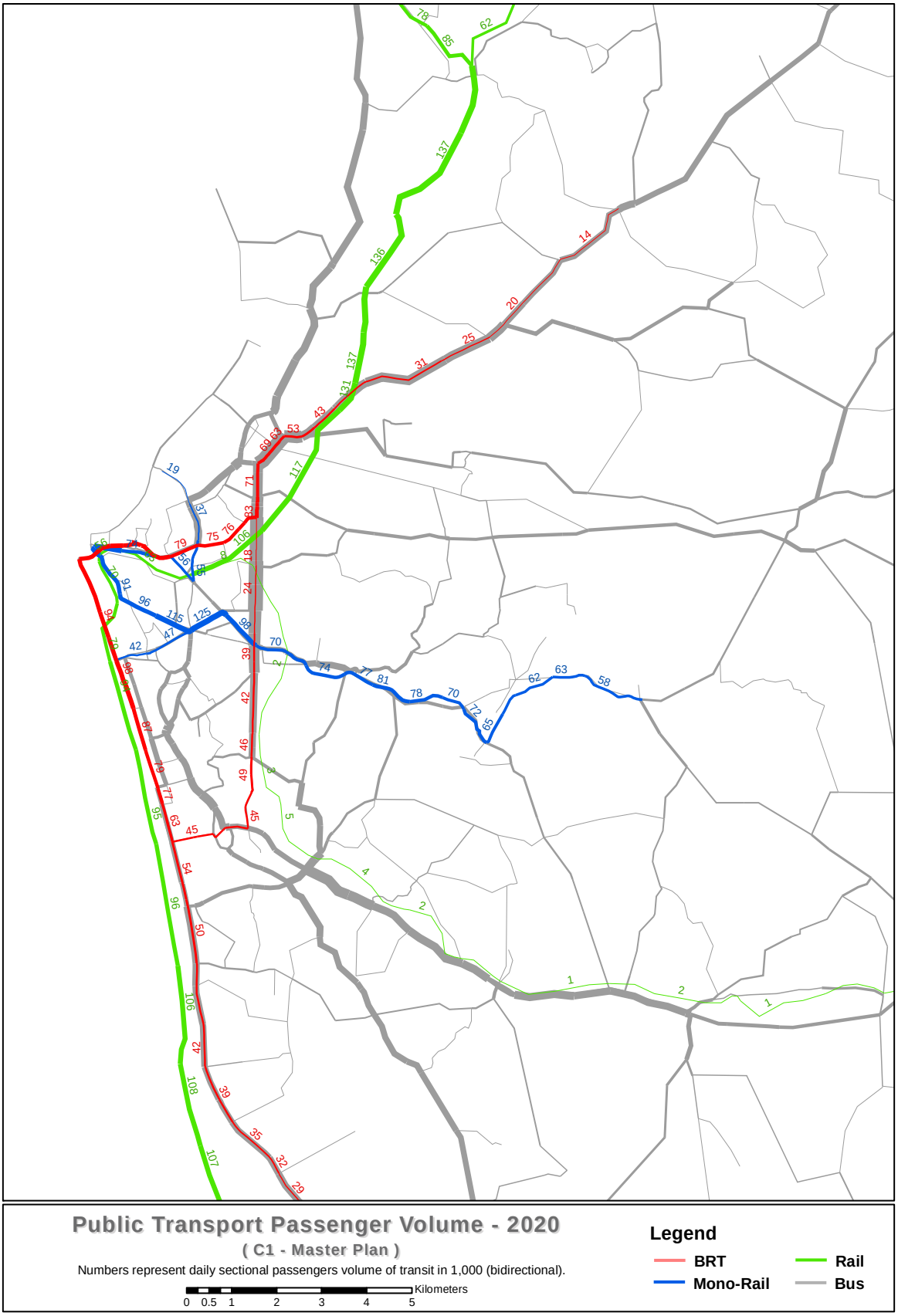


Figure 32 Sectional Volume Map of Master Plan Case C1 in 2020

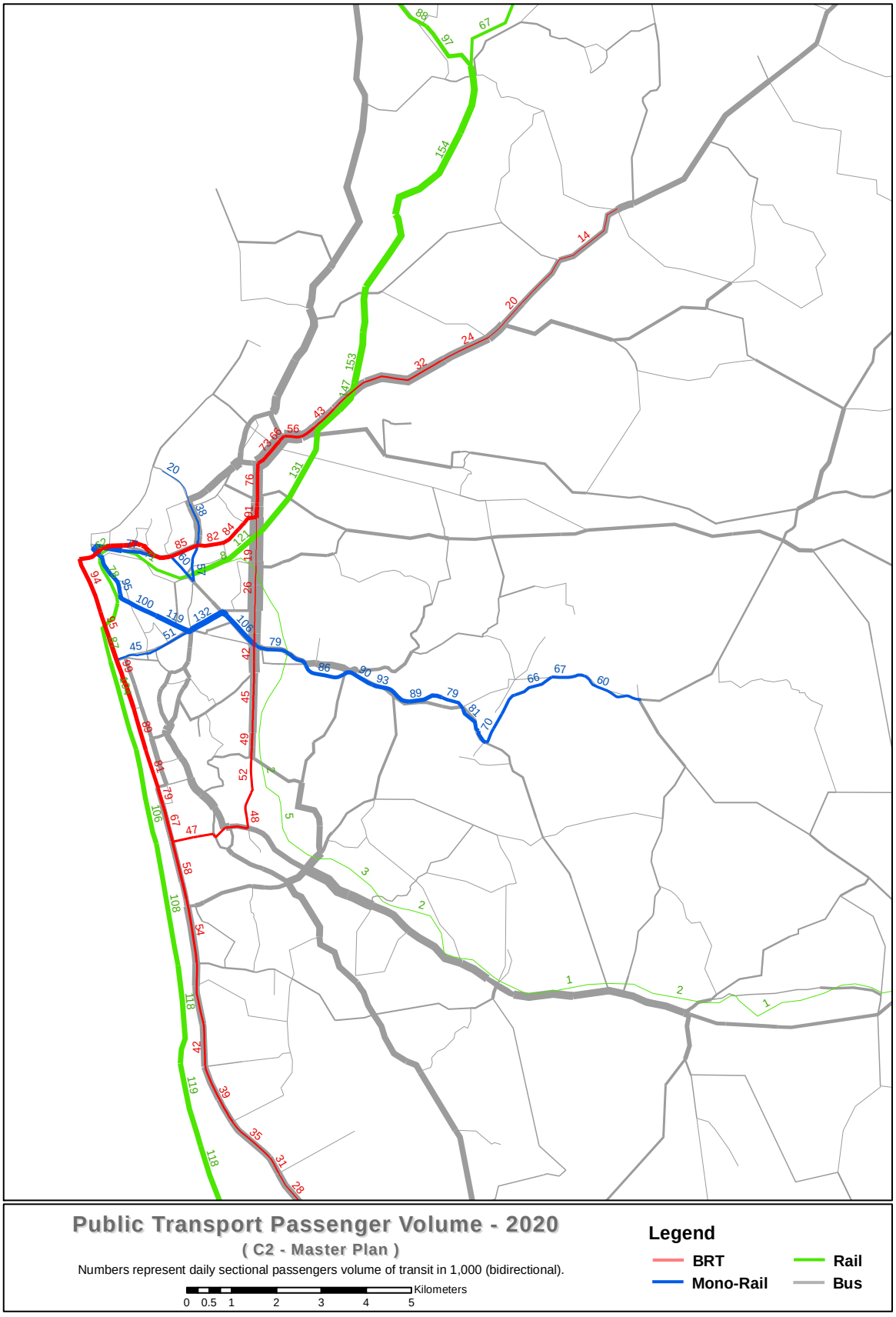


Figure 33 Sectional Volume Map of Master Plan Case C2 in 2020

3.2 Public Transit Assignment – 2025

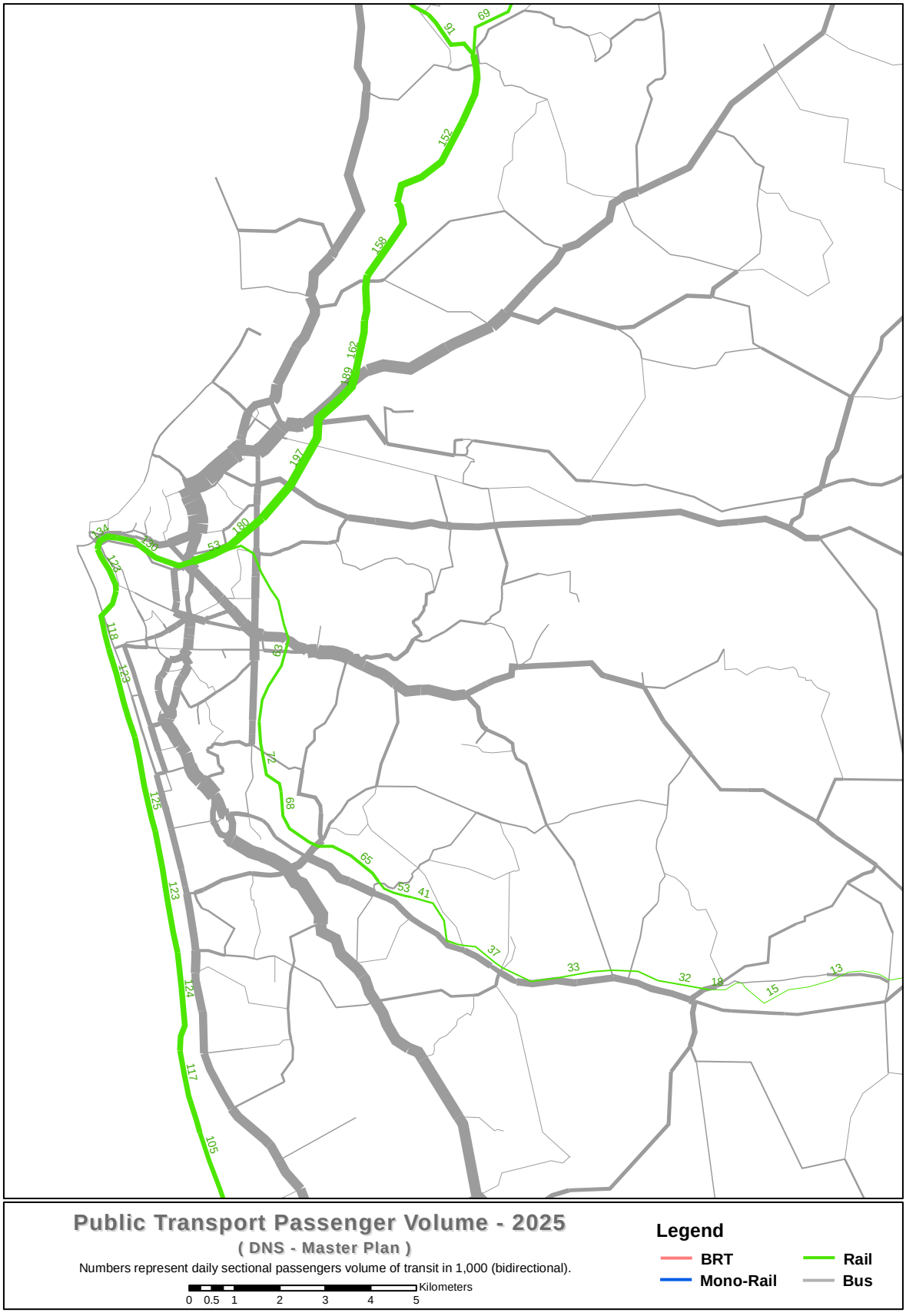


Figure 34 Sectional Volume Map of Master Plan DNS in 2025

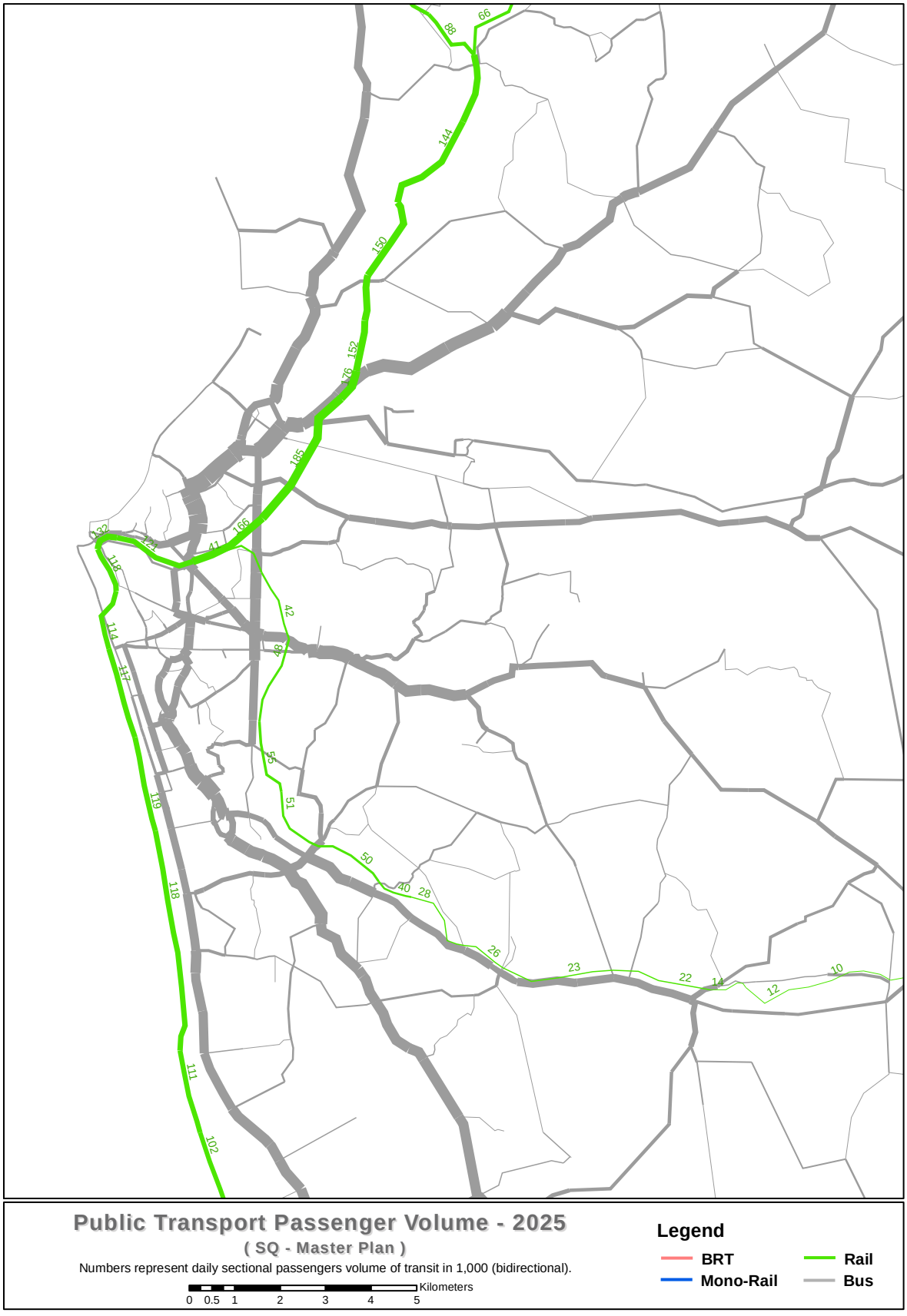


Figure 35 Sectional Volume Map of Master Plan SQ in 2025

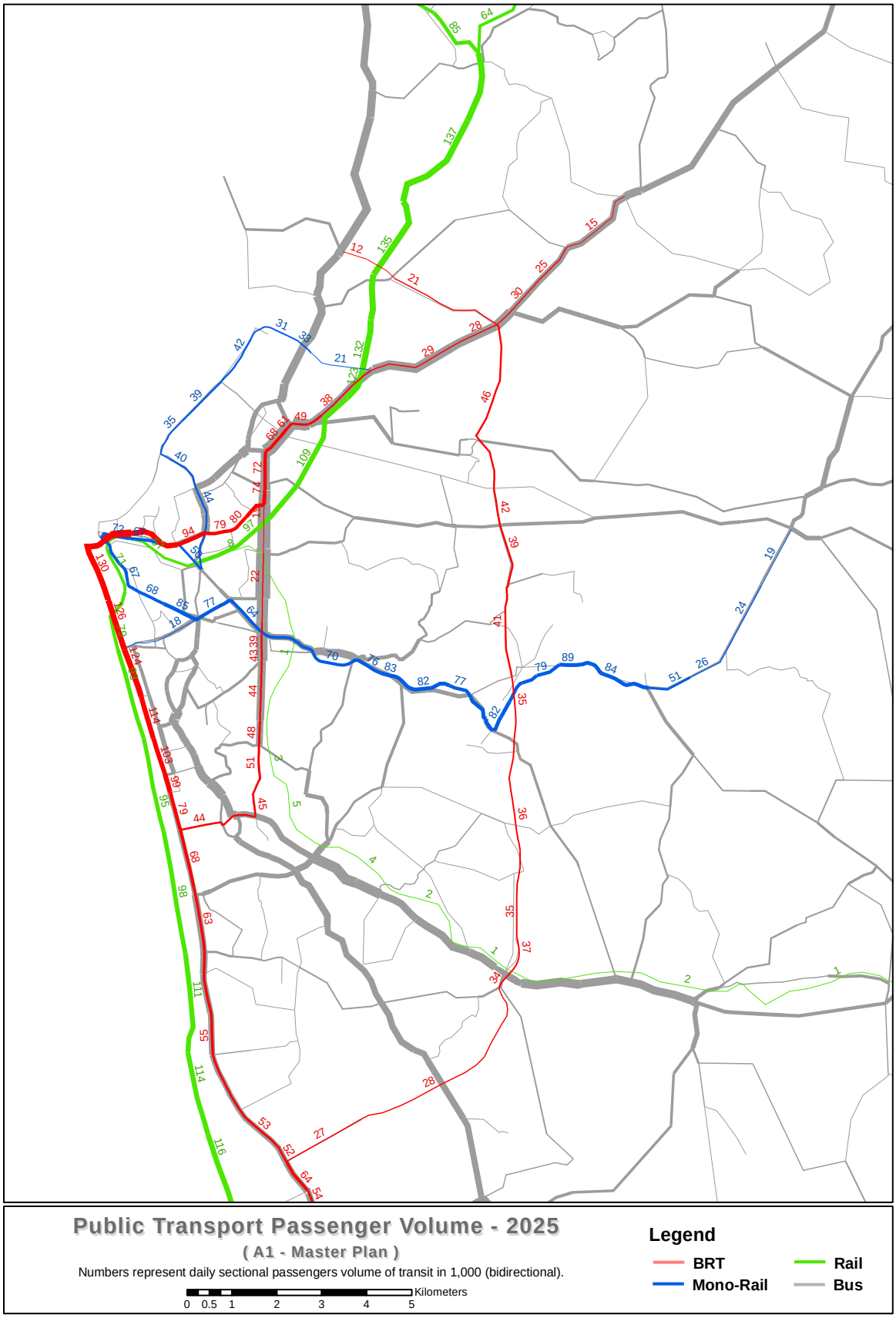


Figure 36 Sectional Volume Map of Master Plan Case A1 in 2025

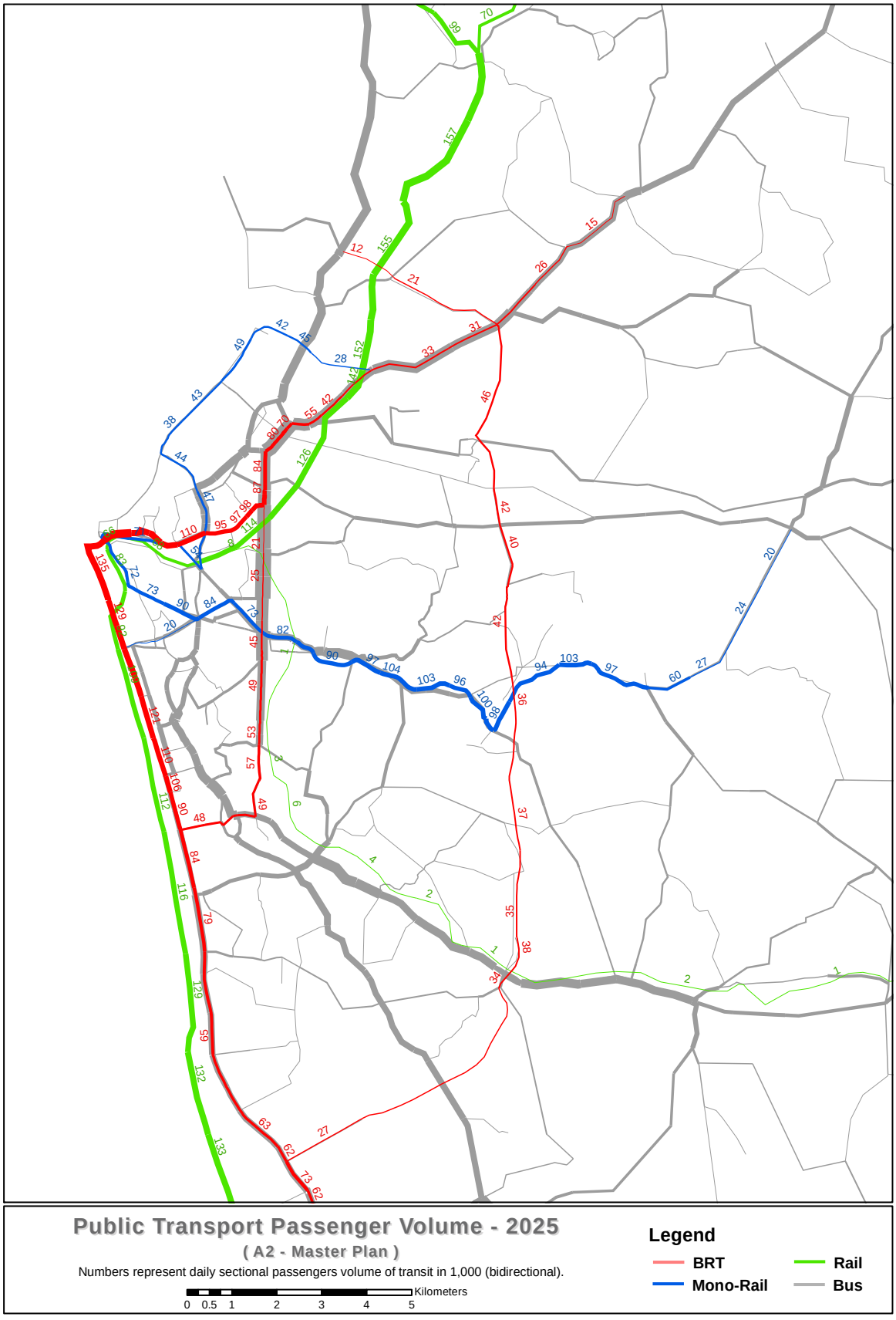


Figure 37 Sectional Volume Map of Master Plan Case A2 in 2025

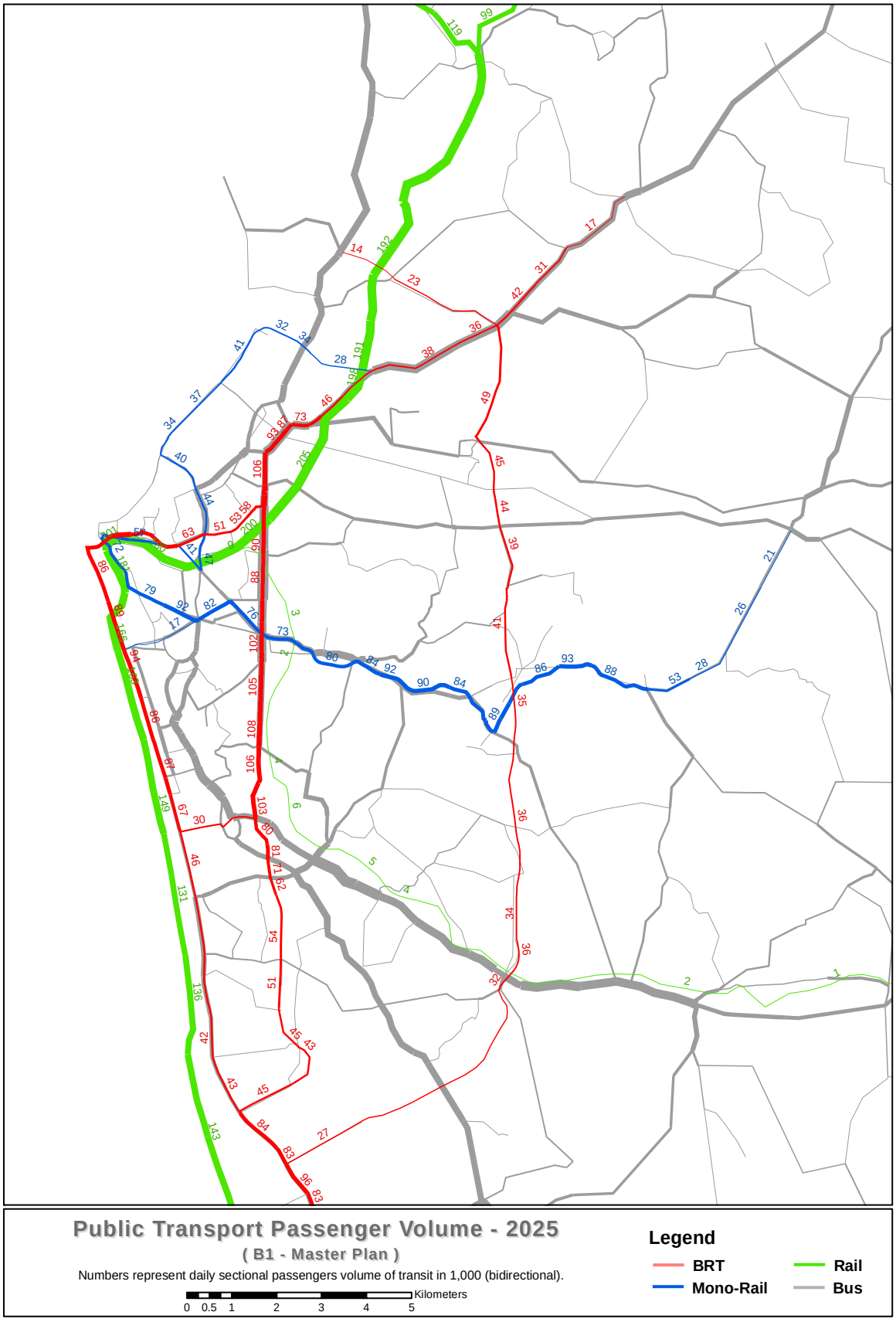


Figure 38 Sectional Volume Map of Master Plan Case B1 in 2025

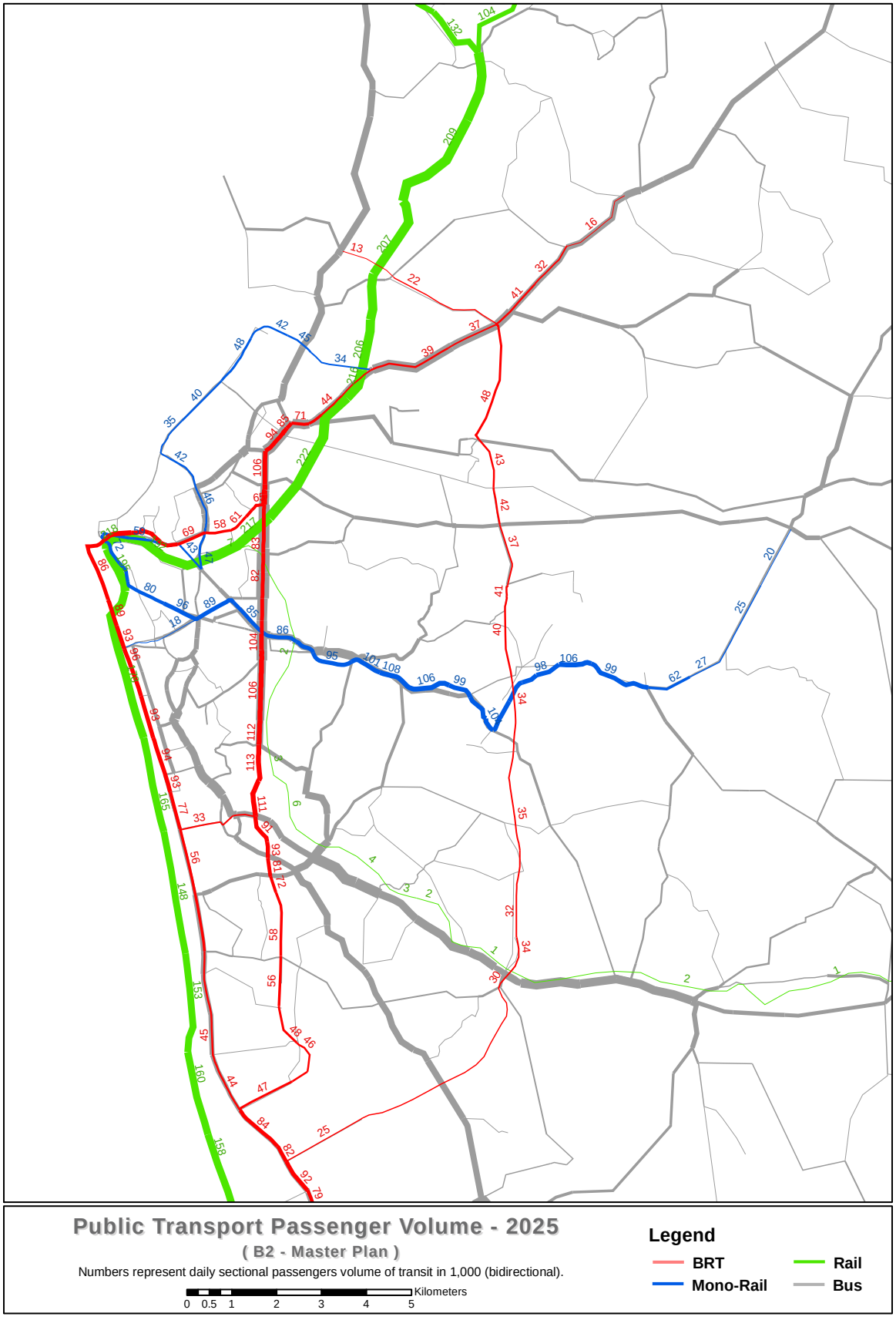


Figure 39 Sectional Volume Map of Master Plan Case B2 in 2025

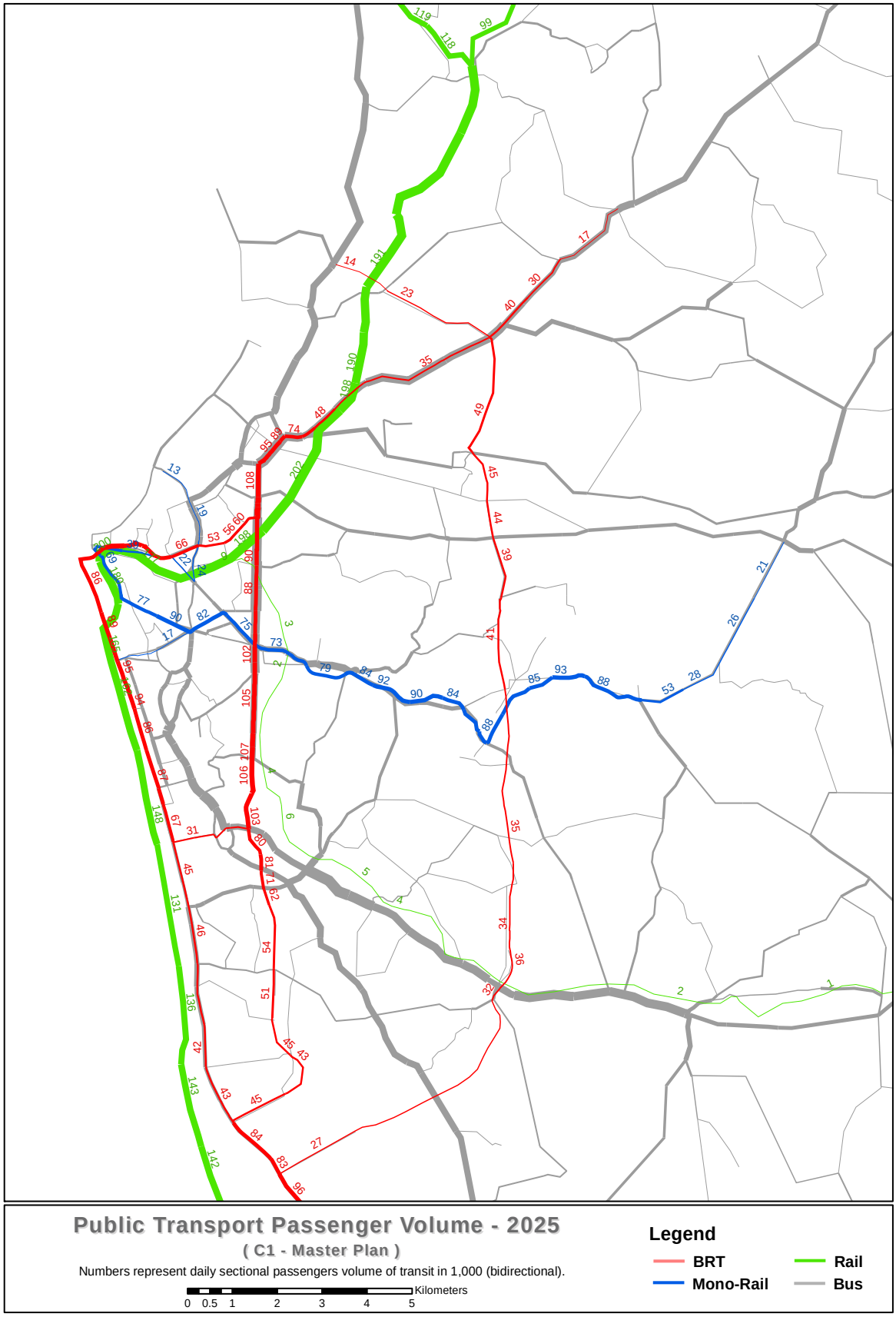


Figure 40 Sectional Volume Map of Master Plan Case C1 in 2025

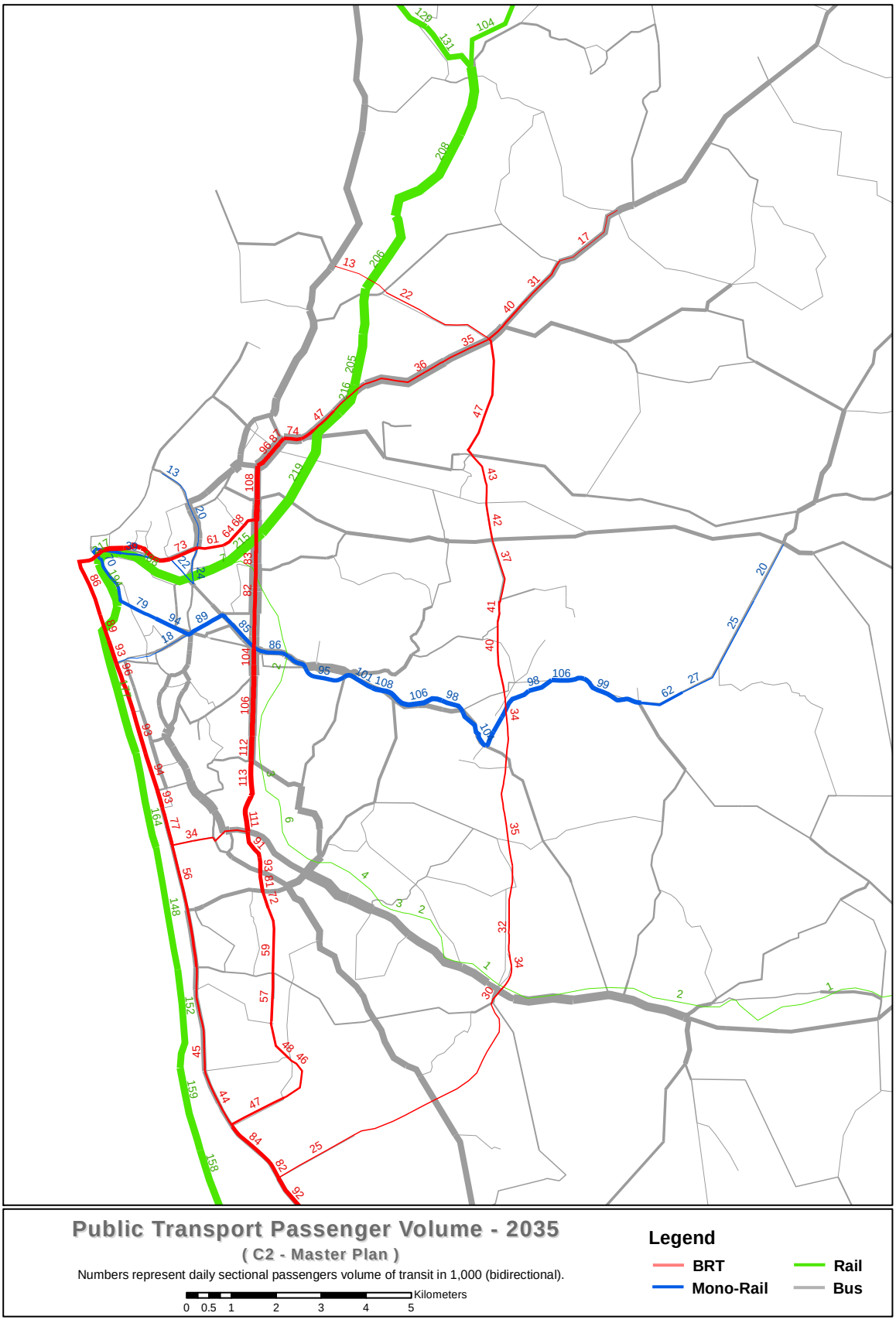


Figure 41 Sectional Volume Map of Master Plan Case C2 in 2025

3.3 Public Transit Assignment – 2035

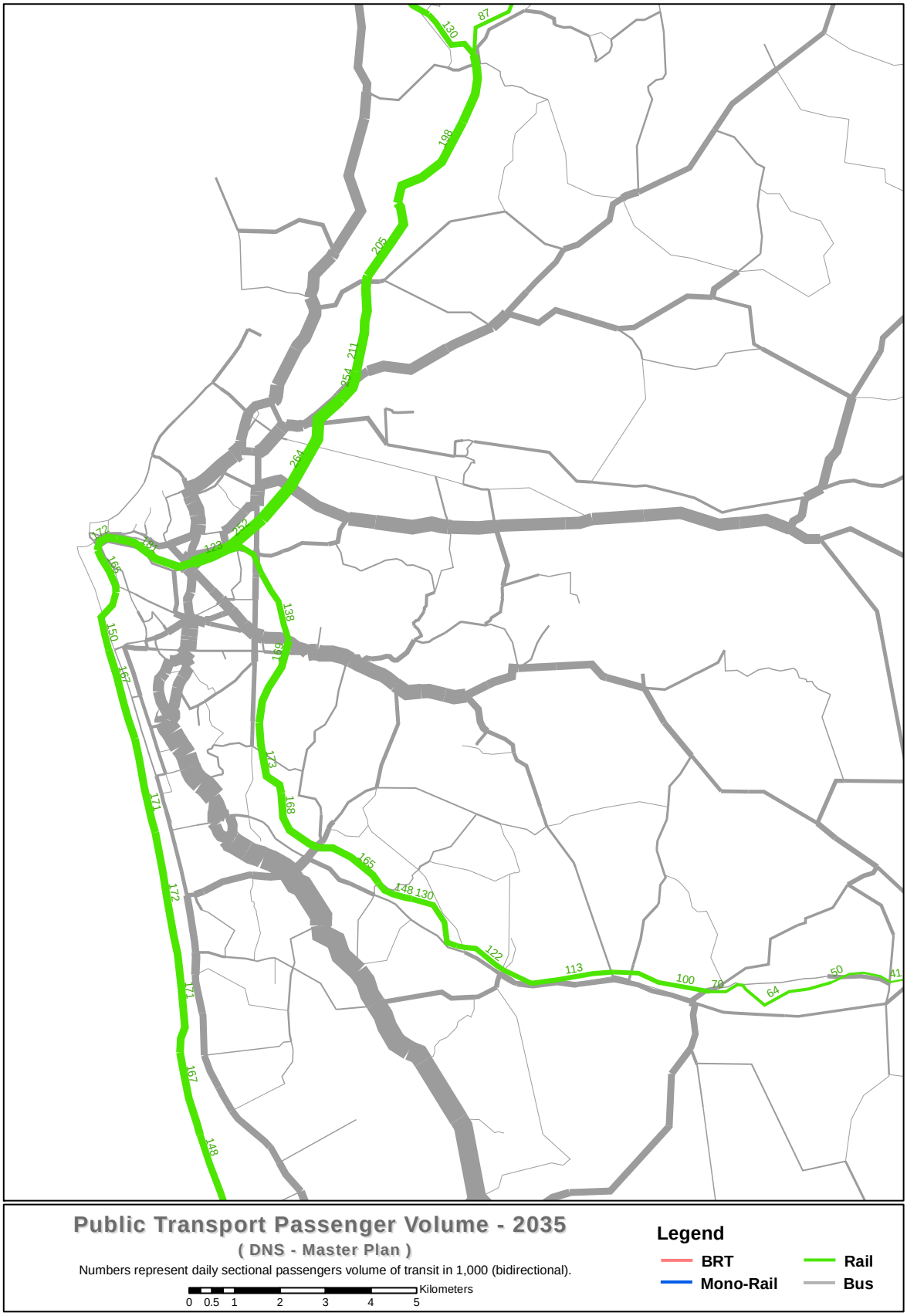


Figure 42 Sectional Volume Map of Master Plan DNS in 2035

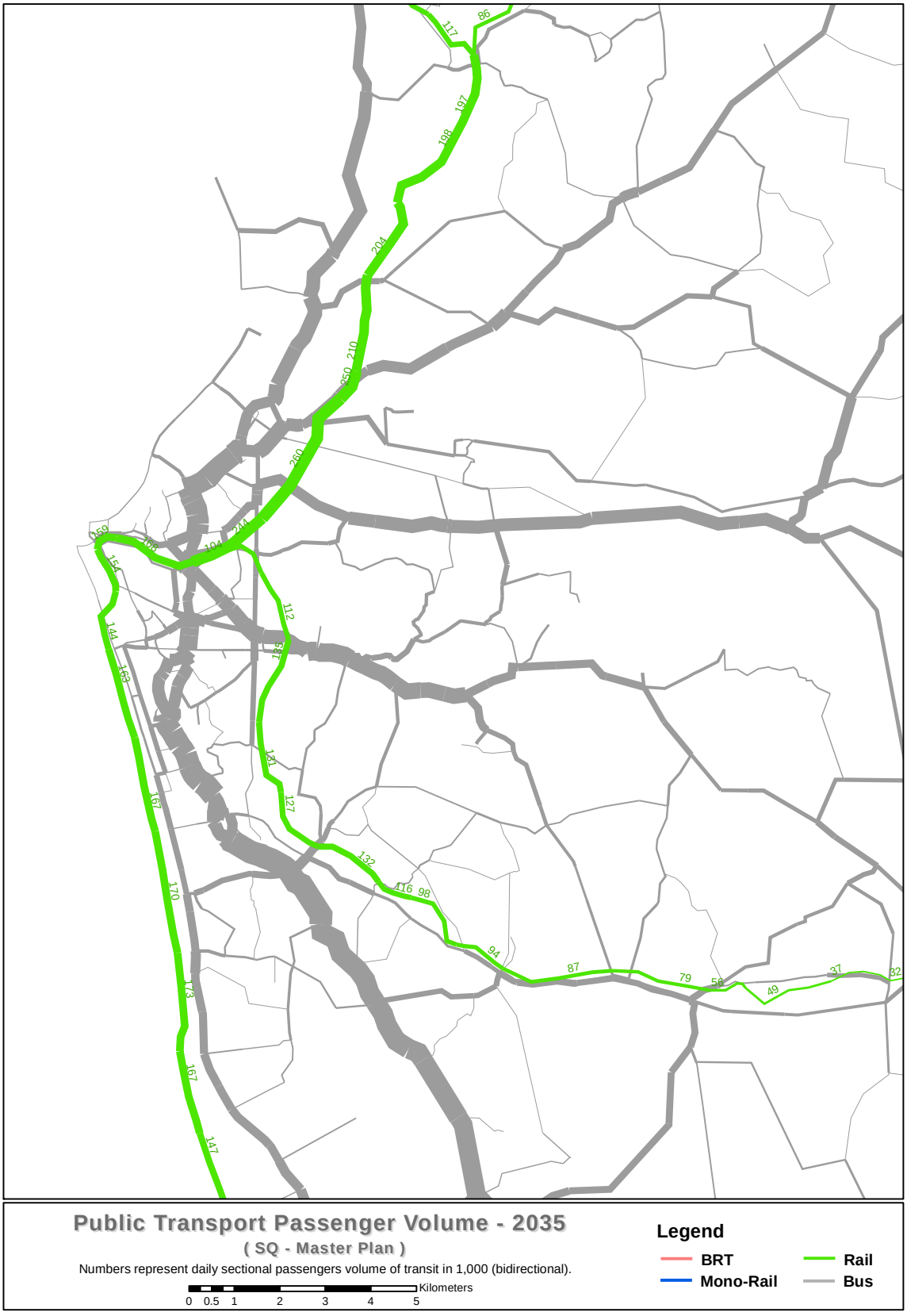


Figure 43 Sectional Volume Map of Master Plan SQ in 2035

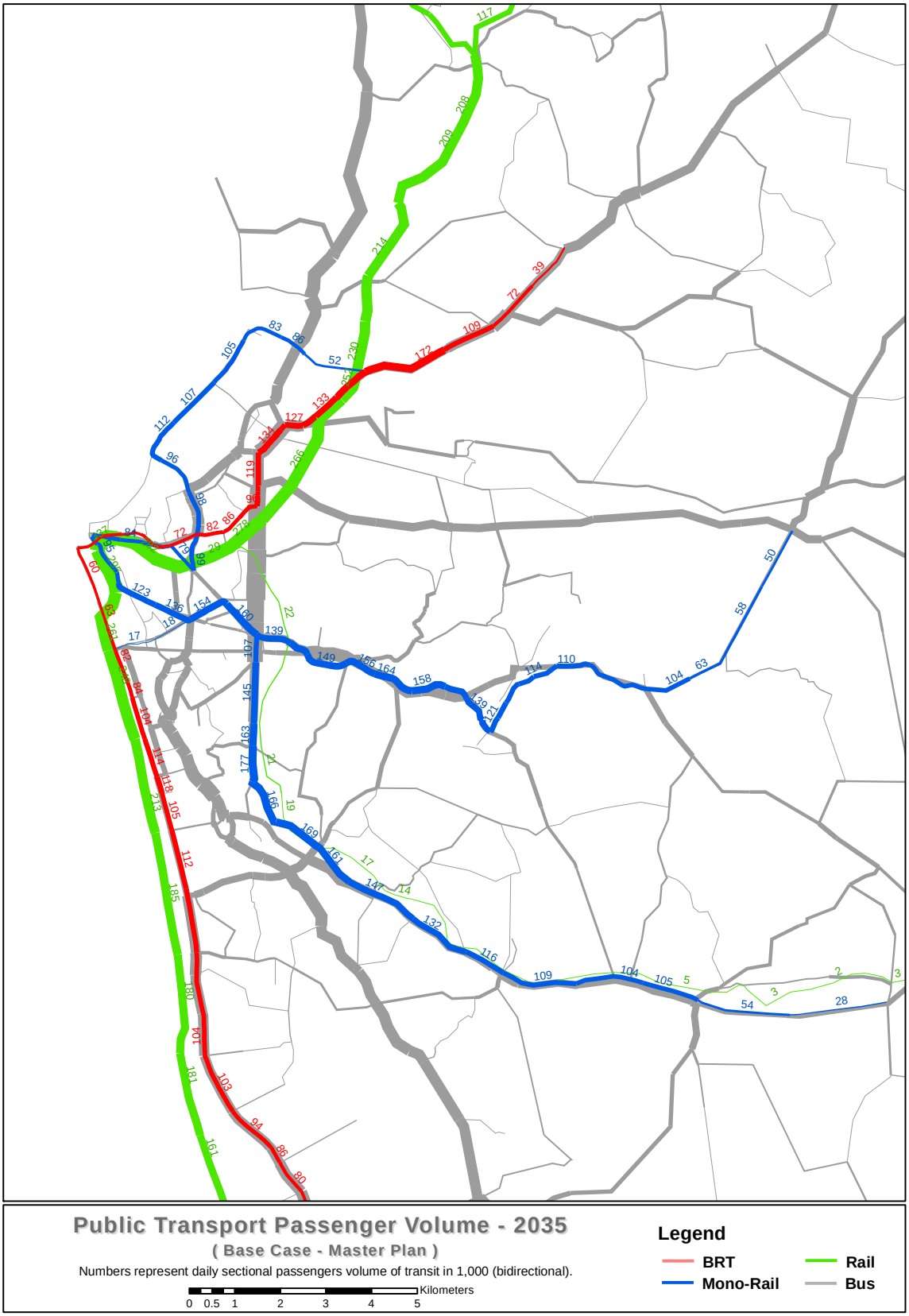


Figure 44 Sectional Volume Map of Master Plan Base Case in 2035

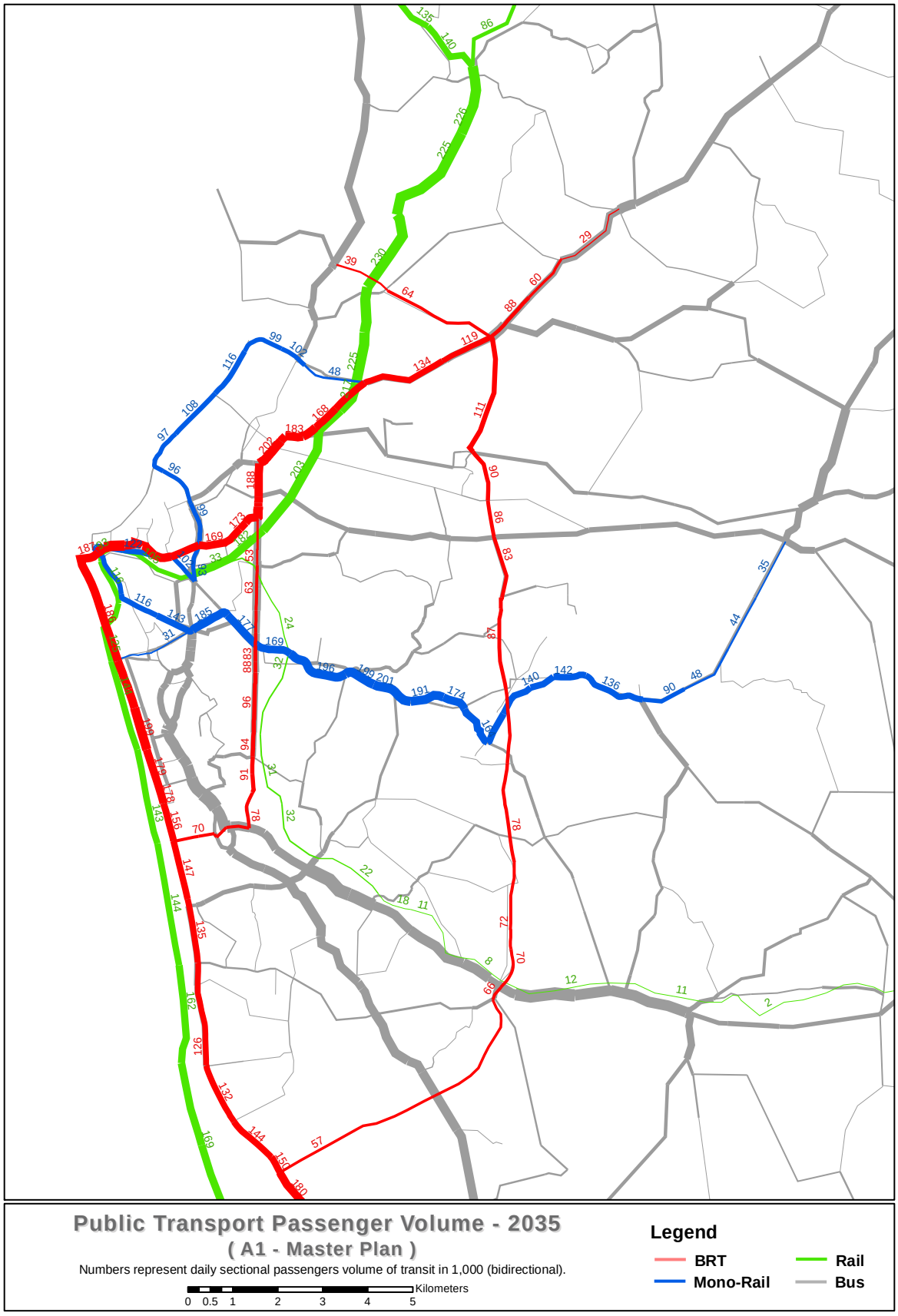


Figure 45 Sectional Volume Map of Master Plan Case A1 in 2035

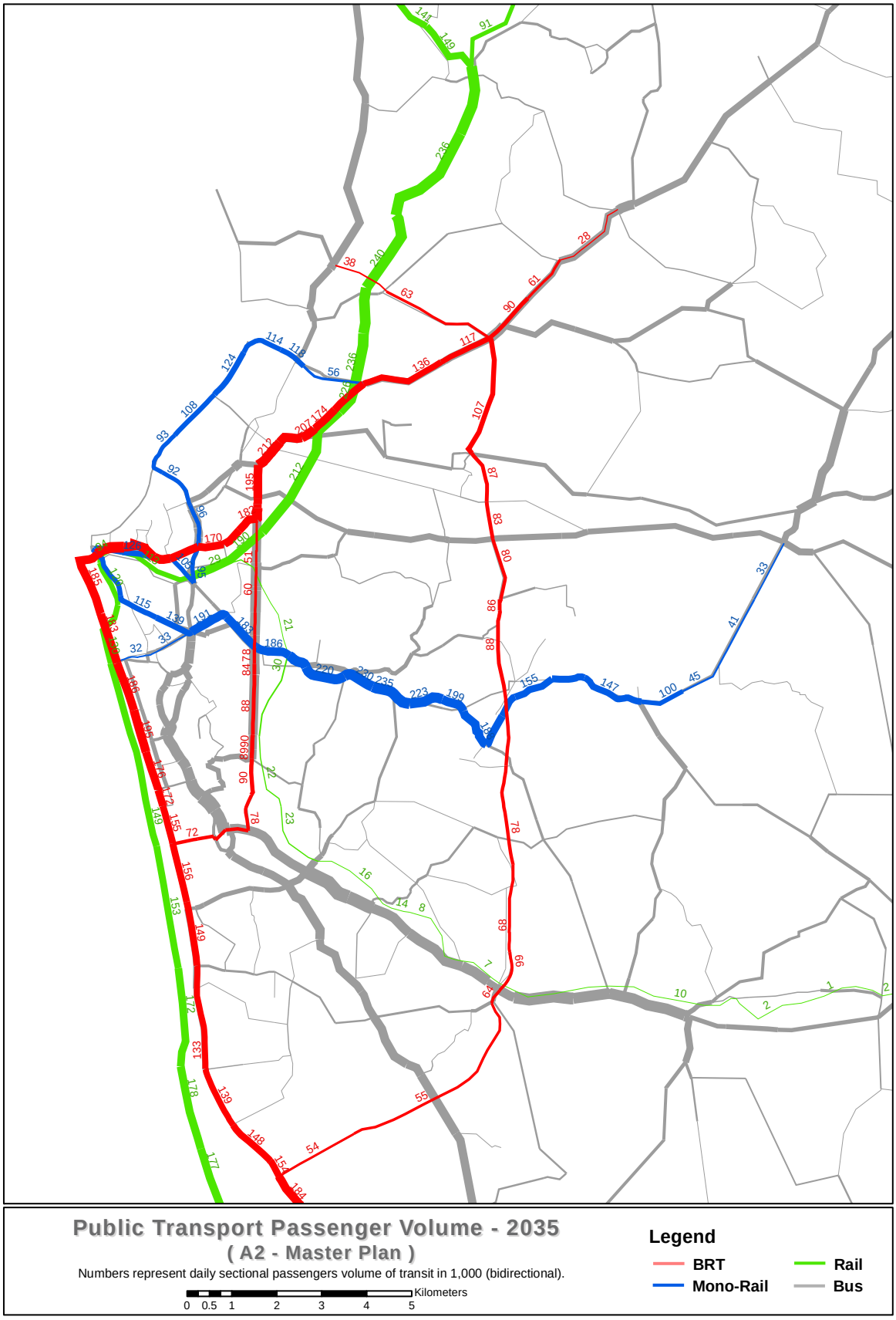


Figure 46 Sectional Volume Map of Master Plan Case A2 in 2035

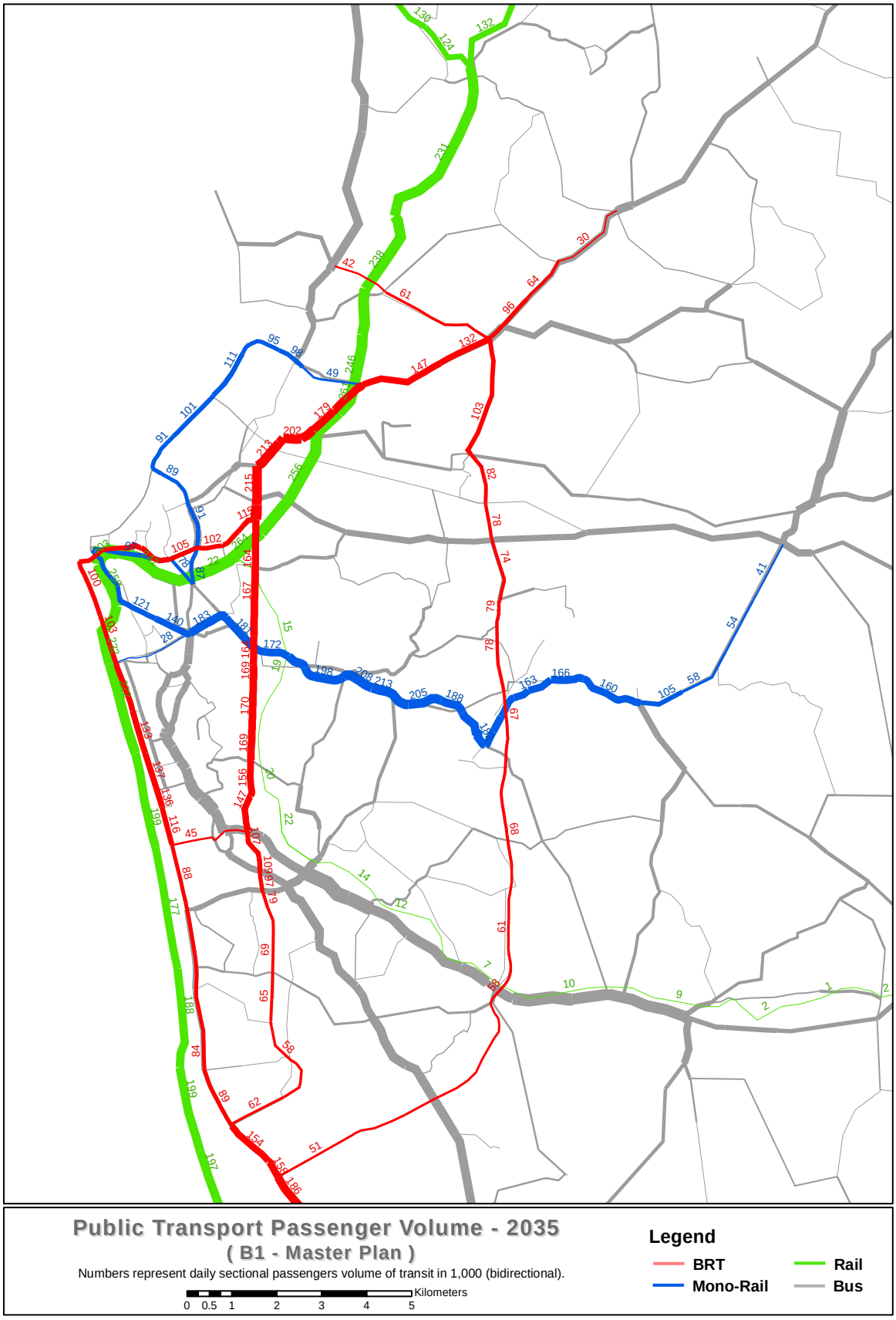


Figure 47 Sectional Volume Map of Master Plan Case B1 in 2035

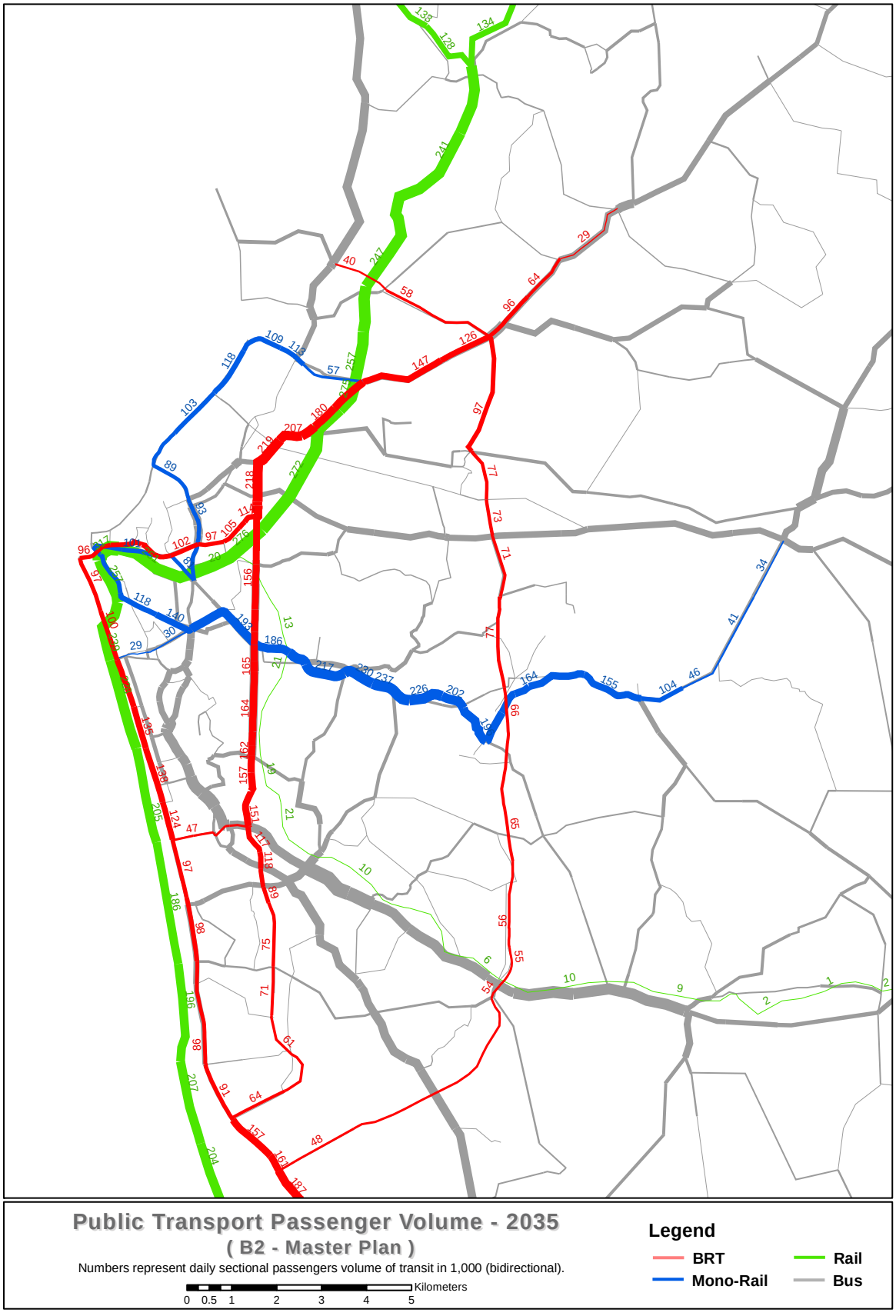


Figure 48 Sectional Volume Map of Master Plan Case B2 in 2035

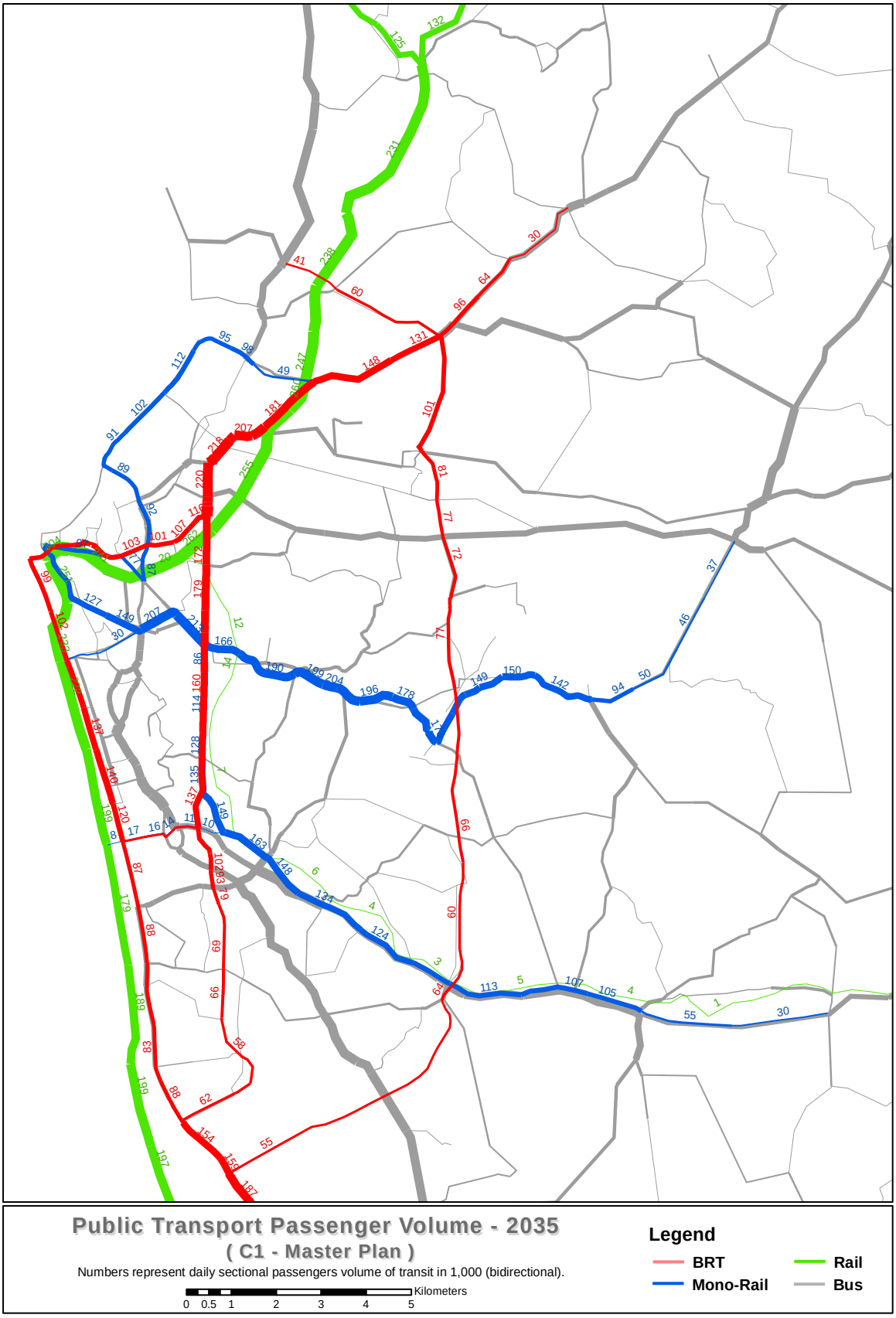


Figure 49 Sectional Volume Map of Master Plan Case C1 in 2035

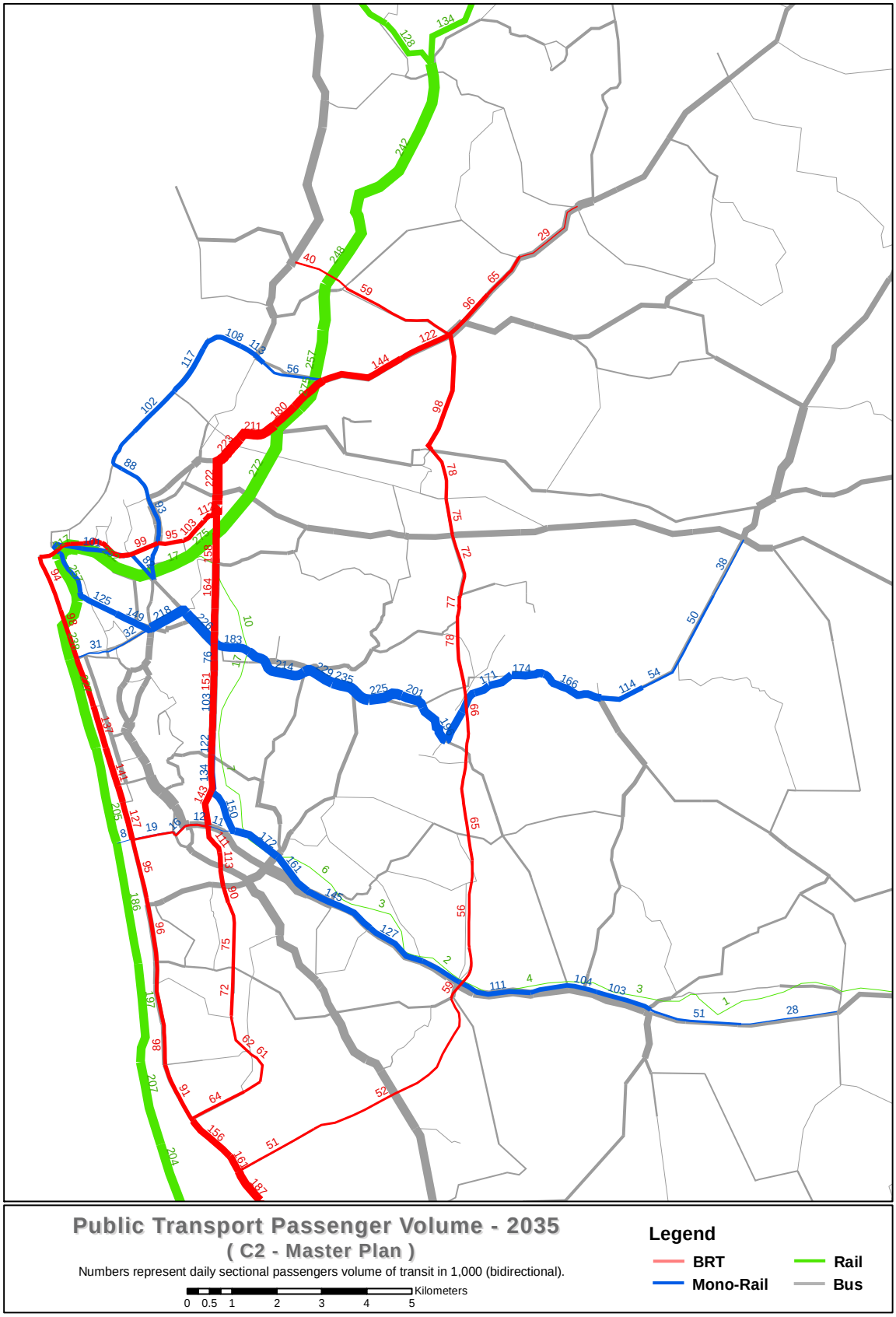


Figure 50 Sectional Volume Map of Master Plan Case C2 in 2035

DEMOCRATIC SOCIALIST REPUBLIC OF SRI LANKA
MINISTRY OF TRANSPORT

URBAN TRANSPORT SYSTEM DEVELOPMENT PROJECT FOR COLOMBO METROPOLITAN REGION AND SUBURBS

Technical Report No. 6

Urban Transport Master Plan

AUGUST 2014

JAPAN INTERNATIONAL COOPERATION AGENCY (JICA)

ORIENTAL CONSULTANTS CO., LTD.

URBAN TRANSPORT SYSTEM
DEVELOPMENT PROJECT
FOR
COLOMBO METROPOLITAN
REGION AND SUBURBS

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CHAPTER 1 Introduction

1.1 Procedure to Establish CoMTrans Urban Transport Master Plan

The process of preparing the master plan is shown in Figure 1.1.1

(1) Present Urban Transport Problems in Colombo Metropolitan Area

Present urban transport problems have been identified by transport subsector and summarised in Chapter 3. In the process of formulating the urban transport master plan, countermeasures for the identified transport problems should be incorporated.

(2) Future Perspective of Colombo Metropolitan Area (see Sub-section 5.2)

Future perspective of the Colombo Metropolitan Area has been discussed in Chapter 4. It sets out the socio-economic framework of the Colombo Metropolitan Area. This framework indicates the future population, employed population and the number of pupils/students. It also estimates growth of household income in the future. Transport demand is projected based on the socio-economic framework.

Although the structure plan for the Colombo Metropolitan Area is not included in the scope of the Study, the future urban structure is studied from the viewpoint of integration between the transport system and urban structure. An urban structure with sub-centre development is proposed to reduce excessive concentration of traffic flows in the city centre of Colombo. Compared to the present urban structure of mono-polar concentration in Colombo, it is proposed to decentralise business and commercial functions to sub-centres.

(3) Planning Issues for Urban Transport Systems in CMA (see Sub-section 5.3)

Based on the analysis of present urban transport problems and understanding of the future perspective of the Colombo Metropolitan Area, planning issues have been identified. The planning issues include not merely the present transport problems to be dealt with but also anticipated problems which can be considered based on the understanding of the future perspective. For instance, based on the growth of population and suburbanisation, and increase in real household income, it is anticipated to see problems such as increase of car ownership and modal shift to private modes of transport.

(4) Objectives for Urban Transport System Development (see Sub-section 5.4)

The present problems and planning issues in urban transport suggest the fields in which improvements are required to close the gap between the present situation and an ideal state. Consolidations of the problems and issues have led to identify four major objectives for urban transport system development.

The objectives include 1) Equity in transport for all the members of society, 2) Efficiency in transport systems to support economic activities, 3) Environmental improvement and health promotion related to transport and 4) Traffic safety and security in transport.

(5) Urban Transport Policy (see Sub-section 5.5)

In order to achieve the four objectives of urban transport system development, four urban transport policies have been selected. The urban transport policies are composed of urban transport system development programs and those programs include a variety of projects. Four urban transport policies include 1) Promotion of public transport use, 2) Alleviation of traffic congestion, 3) Reduction of air pollutants/traffic noise and promotion of health and 4) Reduction of transport accidents and improvement of security.

(6) Policy Measures for Respective Urban Transport Policies (see Sub-section 5.6)

Based on the analysis of the present transport condition and anticipated perspectives of the Colombo metropolitan area, general policy measures have been listed by policy.

(7) Major Transport Corridor Analysis (see Sub-section 5.7)

Prior to formulating urban transport system development scenarios, transport demands on the major corridors were projected and candidate modes of transport were selected by a screening process. Then the most appropriate modes of transport by corridor are selected through evaluation from various aspects. The evaluation results were utilised as a Base Case to formulate urban transport system development scenarios for the metropolitan area.

(8) Phasing of Urban Transport Projects (see Sub-section 5.8)

The policy measures can be regarded as a long list of projects to improve the transport situation. Among the policy measures, sequential order can be put in general with various factors. Sub-section 5.8 explains the points which are taken into account for prioritizing projects.

(9) Urban Transport System Development Scenarios (see Sub-section 5.9)

Urban transport systems which cover the whole metropolitan area were prepared based on the evaluation results in the corridor analysis, review of the existing development plans and new project ideas from the Study team. In order to examine the direction of transport system development for the Colombo Metropolitan area, three development scenarios were formulated for comparison with the Base Case scenario; those are 1) Intensive public transport system development scenario, 2) Mixed development of public transport system and road network scenario and 3) Intensive road network development scenario.

First of all, the selected mode and routes in the corridor analysis are regarded as a core transport system, in particular for the public transport. In addition several public transport systems and road network are added to the transport network. The intensive public transport system development scenario includes more public transport systems; on the other hand the intensive road network development scenario obviously includes more highway network expansion.

(10) Evaluation of Development Scenario Alternatives (see Sub-section 5.10)

The evaluation has been examined from various aspects such as travel speed of vehicles, accessibility to public transport, traffic safety and air pollutant and CO2 emission.

(11) Selected Major Projects by Urban Transport Policy (see Sub-section 5.13)

Major projects of the CoMTrans master plan have been identified. General description of the selected projects is provided to explain what kinds of projects shall be executed.

(12) CoMTrans Urban Transport Master Plan (see Sub-section 5.14)

The urban transport master plan is divided into stages. The projects are allocated into short-term, intermediate term and long term development plans, considering a logical sequence among projects.

(13) Strategies for Urban Transport System Development (see Sub-section 5.11)

Strategy for urban transport system development can be divided into two groups. One is strategy in planning stage and the other is that for implementation.

(14) Intercity Transport Systems (see Sub-section 5.12)

Intercity transport systems and urban transport systems should be separated since characteristics of intercity travel and travel in urban areas are different. However if these systems are not integrated, it causes inconvenience for the users. In establishing the urban transport master plan, taking the future intercity transport system into consideration, connection between the two systems should be incorporated. In particular the role and function of the intercity terminal should be studied carefully.

People coming to the Colombo metropolitan area first arrive at major railway stations and intercity bus terminals and go further to their final destinations. Urban transport systems should be developed to support such travel needs from these railway stations and intercity bus terminals to the final destinations within the urban area

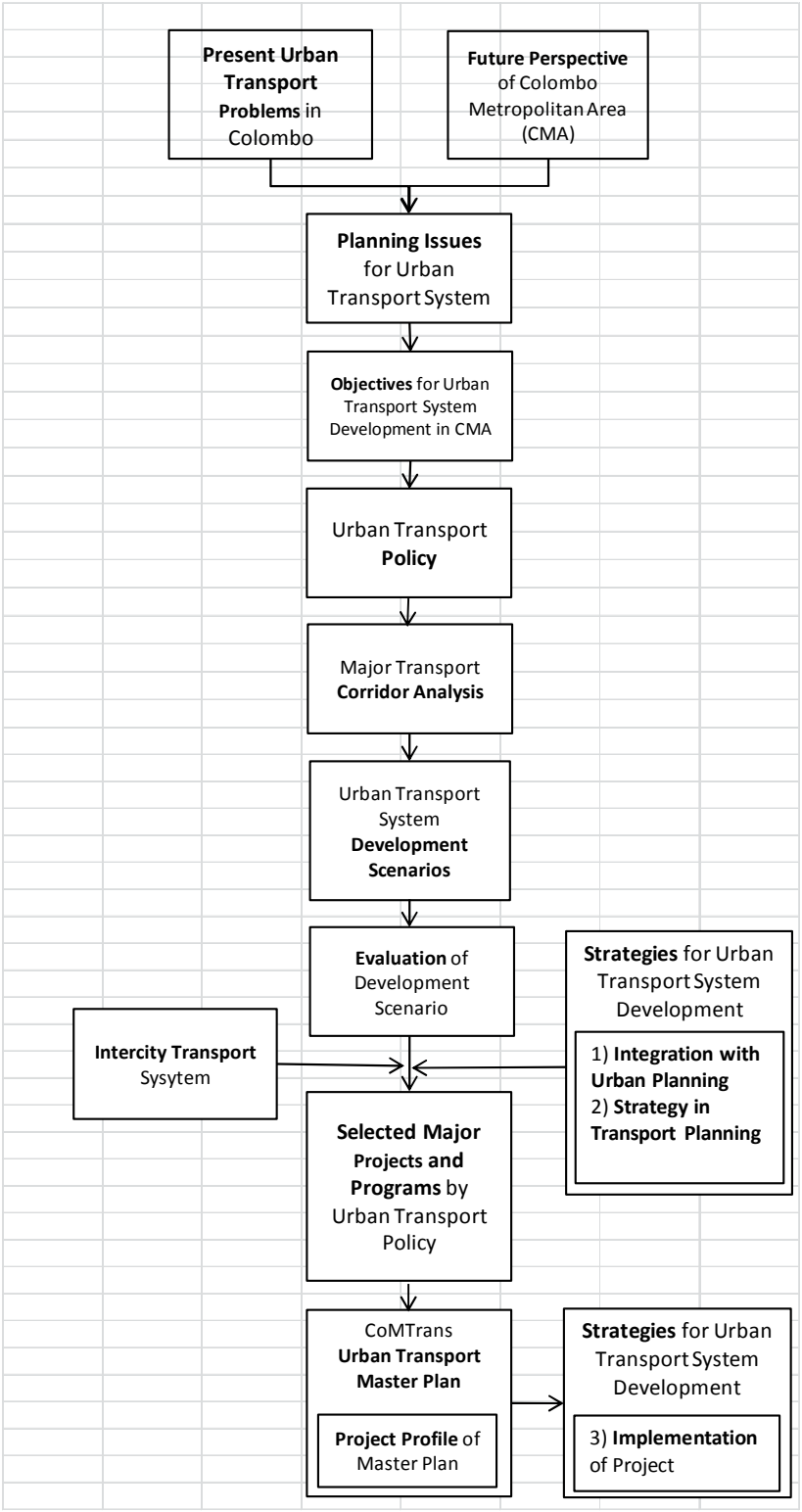


Figure 1.1.1 Flowchart of Establishing Integrated Urban Transport Master Plan

CHAPTER 2 Future Perspective and Planning Issues

2.1 Future Perspective of Colombo Metropolitan Area

2.1.1 Perspective of Socio-Economic Aspect and Urban Structure

(1) Population Growth and Suburbanisation

Population will grow in Western Province. It is projected to increase from 5.8 million people in 2012 to 7.9 million in the target year of 2035 as shown in Sub Section 4.2.1(5) Projected Population to 2035. Population of the Colombo metropolitan area will increase more rapidly since the metropolitan area is the main urban area of the province. Recently the population in CMC has been decreasing, while the population in the suburbs has been increasing rapidly. This suburbanization continues and expands the urbanised area outward from the city centre.

(2) Urban Development in the City Centre

Urban development projects are planned mainly in the city centre and job opportunities will increase in the central area. Since the residential area will disperse and the urban area will be expanded to the suburbs, it implies that commuter trips to the city centre will increase and travel distance of commuters will be longer due to dispersion of the residences of the population.

(3) Increase in Real Household Income

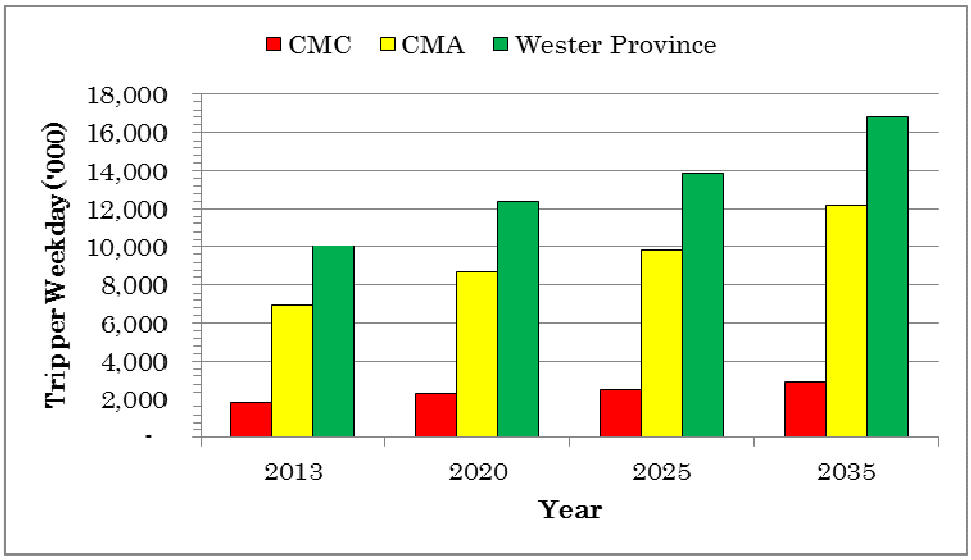
As high economic growth is expected in the nation, real term household income would increase. In accordance with GRDP growth, real household income would also increase proportionally. As shown in 4.2.5 Forecast of Population by Income group, it is estimated that the composition of Group C households, of which monthly income is lower than Rs 40,000, would decrease from 67.8 % in 2012 to 12.5 % in 2035. In contrast the composition of Group A (monthly income: Rs. 80,000 and more) households would increase from 7.6% in 2012 to 56.3% in 2035.

(4) Increase in Ownership of Private Modes of Transport

The increase of household income would bring about an increase in ownership of private passenger cars and motorcycles. The increase in private modes of transport naturally increases traffic demand on the roads and would cause serious traffic congestion without development of public transport systems and intervention by the government through countermeasures for transport demand management.

2.1.2 Projected Transport Demand

In 2035 the total person trip production in the Colombo Metropolitan Area would increase to almost 12.2 million person trips per day and this is 1.75 times the present person trip demand of 6.9 million person trips per day as indicated in Figure 2.1.1.

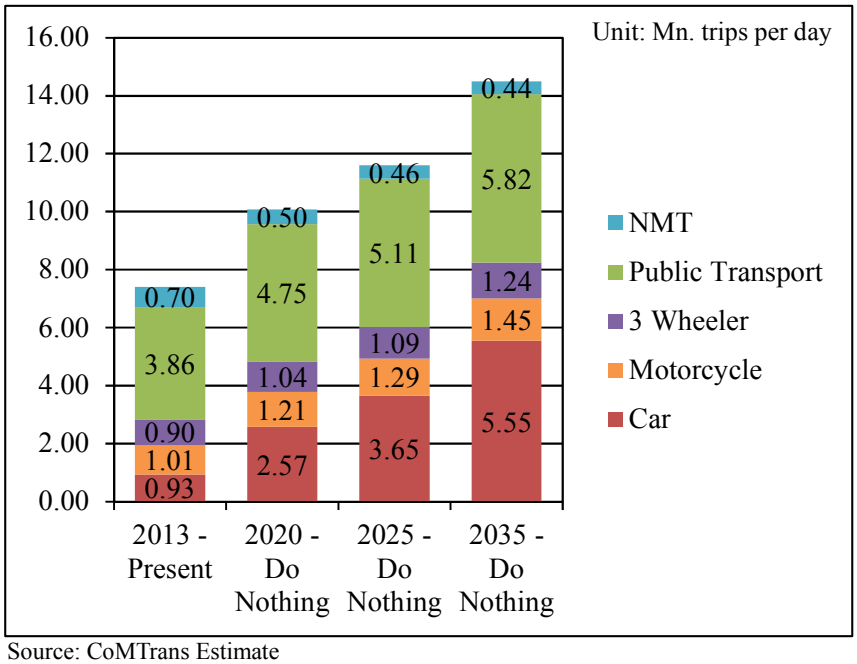


Source: CoMTrans Estimate

Figure 2.1.1 Increase of Person Trip Demand by Region: 2013 – 2035

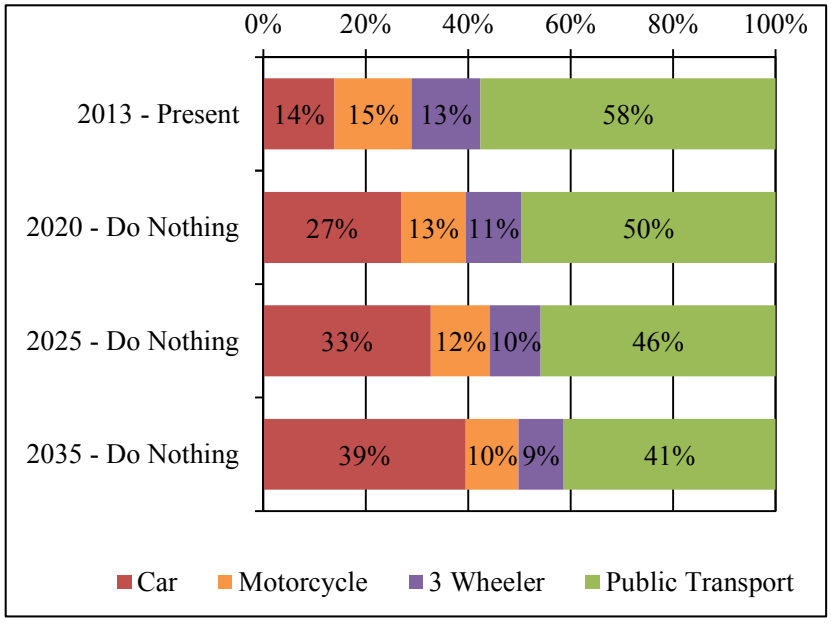
Total person trip demand would increase by 1.75 times from 2013 to 2035 however it should be noted that the trips made by private cars would increase from 0.93 million trips in 2013 to 5.55 million trips in 2035, which implies that the number of trips by cars will grow to almost six times the starting value during the period as illustrated in Figure 2.1.2.

In 2013 the share of public transport in the Western Province was 58 percent of total transport; however, the share of public transport would fall to 41 percent in 2035 if no improvement of public transport was undertaken as shown in Figure 2.1.3.



Source: CoMTrans Estimate

Figure 2.1.2 Increase of Person Trips by Mode of Transport: 2013 - 2035



Source: CoMTrans Estimate

Figure 2.1.3 Change of Modal Share for Do Nothing Case: 2013 -2035

2.2 Planning Issues for Urban Transport System Development

Person trip demand would increase significantly as described above. Shift to private modes of transport is expected due to the increasing ownership of passenger cars, three wheelers and motorcycles. It is anticipated that traffic congestion will continue getting worse and worse without efforts on improvement of public transport systems and the restriction of private modes of transport by the government. Planning issues in urban transport system development are identifies as follows;

2.2.1 Dealing with Peak Transport Demand and Concentration of Traffic in the City Centre

Traffic congestion is brought about by peak traffic demand in time and spatial concentration of vehicular traffic in the city centre as analysed in Subsection 3.1.9 Hourly Fluctuation of Trips Generated and Attracted. To tackle the traffic congestion problem, one way is to flatten the peak demand by a staggered working hour system.

Another countermeasure is to distribute traffic concentration in the city centre to sub centres. This would be achieved by developing urban centres in suburban areas where a sufficient number of job opportunities should be provided. By distributing job opportunities in sub centres, these sub centres would attract employed population from the surrounding areas and could reduce traffic concentration in the city centre.

2.2.2 Shifting from Private Modes of Transport to Public Transport

To deal with the traffic congestion problem in the city, reduction of traffic demand is the main issue to pursue. Since total travel demand in Colombo metropolitan area would increase in the planning period, a shift to public transport from private modes of transport is a challenging task for the government. As traffic demand increases, traffic congestion on the road network would be worse and travel speed would be reduced in the future. Operation speed of ordinary buses will be lower due to traffic congestion.

Public transport systems generally provide less convenient and longer travel time compared to private modes of transport, which can provide door-to-door service. Consequently, the public transport network to be introduced should be at a high level of service and congestion free by providing dedicated transport space in order to compete with private modes of transport.

In this regard, a heavy rail system, medium-size transit system and bus rapid transit system can be regarded as public transport systems with a high level of service in terms of operational speed and punctuality. It is therefore recommended to formulate the public transport systems for the Colombo metropolitan area with these congestion free systems and cover the public transport service area as widely as possible.

2.2.3 Affordability of Public Modes of Transport

A rail-based transport system is better than bus rapid transit and other types of public transport systems since rail-based transport in general has larger passenger transport capacity than ordinary bus transport. Usually rail-based transport has a grade separated structure and will not be disturbed by other modes of transport; consequently, it runs faster than BRT since BRT usually must stop at intersections. However, it requires a huge amount of investment as well as having a higher operation cost. This implies that the system needs to charge the passengers a higher transport fare. According to the Home Visit Survey, the Group C household with monthly income less than Rs 40,000 pays about Rs 4,000 for transport. This implies that about 10 % of household income is consumed for transport. According to worldwide household expenditure statistics, average transport expense is usually around 10 % of household income and if it exceeds the 10 %, households must sacrifice some other expense[1]. Most households therefore, cannot afford to pay more for transport than the present level. If the fare of a new or improved public transport system is much higher than the presently prevailing fare level, the majority of residents will not be willing to pay the higher transport fare. Until their household income increases to a certain level, the government should provide financial support for developing the new transport systems and probably for operation cost in the beginning. This issue will be studied in depth in the next stage of the Study by conducting a Stated Preference Survey.

[1] Source: Jarvi Kauppila, Administrator TEN STYLISED FACTS ABOUT HOUSEHOLD SPENDING ON TRANSPORT 1 Joint Transport Research Centre of the OECD and the International Transport Forum No. 1/2011

CHAPTER 3 Objectives of Urban Transport System Development and Urban Transport Policy

3.1 Objectives for Urban Transport System Development

The analysis of the present urban transport problems and the planning issues in the Colombo metropolitan area have resulted in the identification of four major objectives which the urban transport system development needs to pursue as shown in Figure 3.1.1.

3.1.1 Equity in Transport for All the Members of Society

A minimum level of transport service should be provided to all members of society. In the Colombo metropolitan area, the mobility of Group C (monthly income: less than Rs. 40,000) is limited due to their insufficient income. The role of public transport is thus of great importance in providing affordable means of transport for the lower income people to access urban services.

At the same time, it is necessary to develop transport facilities for the physically challenged. Such facilities are seldom seen in the Colombo metropolitan area at the present time and a gradual improvement of the transport facilities is needed.

3.1.2 Efficiency in Transport Systems to Support Economic Activities

Traffic congestion has resulted in a considerable amount of economic loss to society because of longer travel times, lack of punctuality and the deterioration of the environment. Efficiency in transport can be achieved by balancing transport demand and transport network capacity. Alleviation of traffic congestion can be dealt with in the following three ways: 1) by increasing road capacity through the development and improvement of the road network; 2) by optimizing utilization of the existing road capacity by using a traffic control system and providing traffic information; and 3) by decreasing excessive vehicular traffic demand through transport demand management and diverting private mode users to public modes of transport.

At the same time, the promotion of public transport usage would also contribute toward economic efficiency by reducing vehicular traffic demand on the congested urban road network. Mass transit systems have an advantage over private modes of transport in terms of travel costs and lower consumption of space in the context of an urban area. The combination of all the approaches mentioned above will create an efficient transport system.

3.1.3 Environmental Improvement and Health Promotion related to Transport

Air pollution caused by motorised vehicles should be minimised through emission controls for automobiles, and promotion of public transport and traffic demand control, especially in the congested areas. Countermeasures to reduce PM10 should be the main focus, particularly in the

Colombo Metropolitan area. In addition, aesthetics should also be considered for developing urban transport systems.

3.1.4 Traffic Safety and Security in Transport

Since lives are invaluable and death and injury due to traffic accidents will bring great grief to family members and friends, traffic safety should be enhanced and the number of accident victims should be minimised through the enforcement of laws and regulations, intensive public campaigns, and training and education for drivers as well as the general public. Improvement of traffic facilities through engineering design would contribute to the reduction of traffic accidents. Furthermore, the security of children and women in public transport should be improved and it would partly contribute to increase the use of public transport.

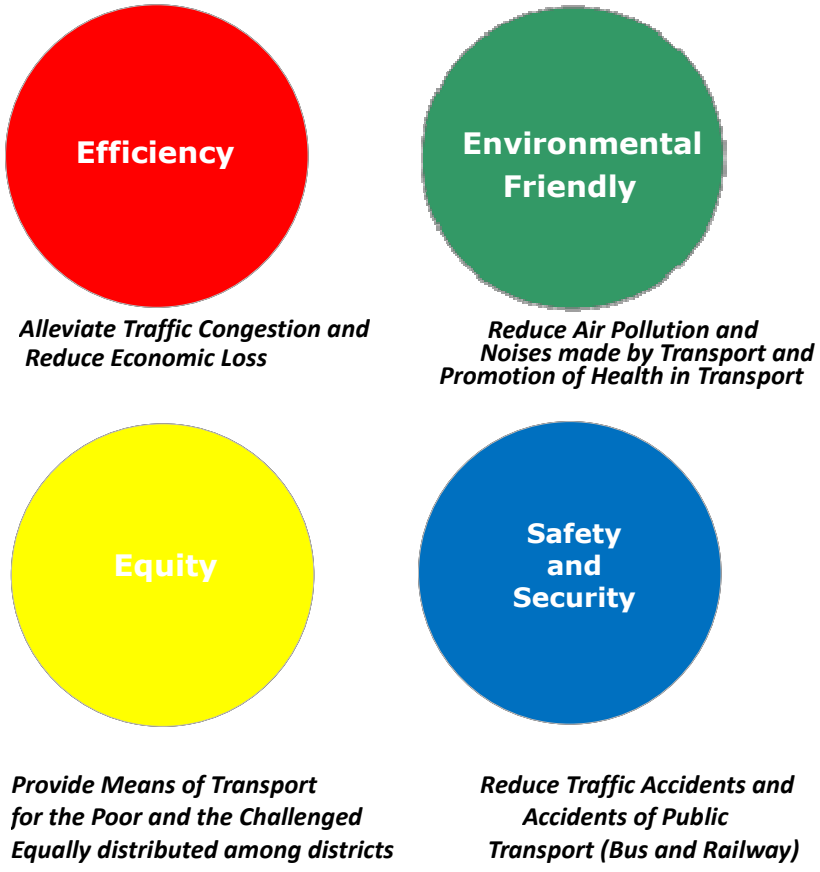


Figure 3.1.1 Objectives for Urban Transport System Development

3.2 Urban Transport Policy

To achieve the four different goals for transport system development, the following transport policies are essential for the Colombo metropolitan area;

1) Promotion of Public Transport Use

2) Alleviation of Traffic Congestion

3) Reduction of Air Pollutants/Traffic Noise and Promotion of Health

4) Reduction of Transport Accidents and Improvement of Security

These four transport policies are inter-related as illustrated in Figure 3.2.1. Promotion of public transport is a principal measure to reduce dependence on private modes of transport. Mere improvement of public transport services, however, would not entice people who are accustomed to using private modes of transport to shift to public modes.

Traffic restraint policy measures would enhance the increase in public transport use if a sufficient level of public transport services is provided.

Reduction of private vehicle use would also lead to reduction of air pollution and traffic noise caused by cars and motorcycles.

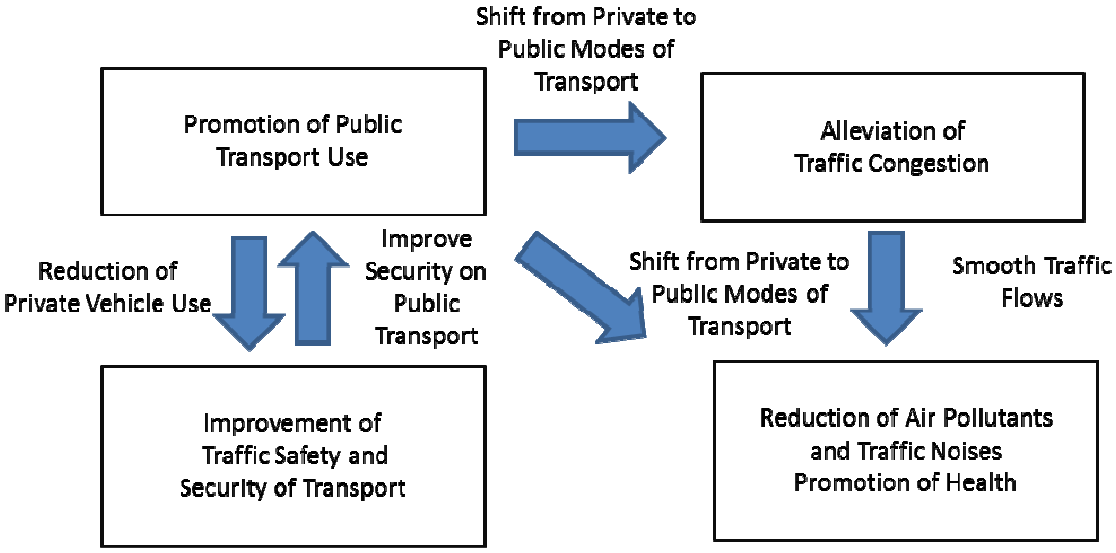


Figure 3.2.1 Relationship between Urban Transport Policies

3.3 Policy Measures for Respective Urban Transport Policy

Based on the analysis of the present transport condition and anticipated perspectives of the Colombo metropolitan area, countermeasures have been listed below;

3.3.1 Policy Measures for Public Transportation Promotion

- Extensive Development of Quality Public Transport Networks (Sri Lanka Railway, New Transit System and BRT)
- Enhancement of Intermodality (Development of Multi-modal Transport Hubs, Multi Modal Centres and Park and Ride Facilities)
- Modernisation of Sri Lanka Railway Main Line, Coast Line and Puttam Line (Electrification, Direct Operation, Improvement of Existing Railway Facilities)
- Development of New Transit Systems
- Introducing a Bus Rapid Transit (BRT) System
- Transit Oriented Development(TOD) in the Areas Surrounding Railway Stations[2]
- Construction of Arterial Roads to accommodate BRT
- Reformation of the Bus Operation Regime
- Improvement of Management of Railway Operation

3.3.2 Policy Measures for Traffic Congestion Alleviation

- Road Widening to Increase Road Traffic Capacity
- Construction of Flyovers and Underpasses at Bottleneck Intersections
- Arterial Road Development in Suburban Areas
- Urban Expressway Network Development
- Transport Demand Management (TDM)
- Traffic Control Improvement
- Secure Lands for Road Development (Road Network Master Plan)
- Separation of Heavy Vehicles from General Traffic (Port Access Road)

3.3.3 Policy Measures for Air Pollution and Traffic Noise Reduction and Promotion of Health in Transport

- Establishment of Environmental Management Scheme
- Establishment and Enhancement of Air Pollutant/Noise Emission Standards

[2] Please refer to 5.11.1 about TOD

- Enhancement of Vehicle Inspection and Maintenance Programs
- Low Sulphur Diesel Program
- Promotion of Hybrid Cars and Electric Vehicles
- Promotion of Natural Gas Vehicles
- Promotion of Walking and Bicycles for Health

3.3.4 Policy Measures for Traffic Safety and Security Improvement:

- Education on Traffic Safety
- Rehabilitation and Installation of Traffic Signals
- Rehabilitation of Railway Signal System
- Analysis on Causes of Traffic Accidents
- Provision of Sidewalks and Pedestrian Crossings
- Establishment of Urban Road Design Standard including Sidewalks
- Improvement of the Security of Women and Children in Public Transport