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# Executive Summary

## Chapter 1

### 1.1 Introduction

The Government has decided to construct the Central Expressway as the expansion of expressway network to connect the central, Northern and Eastern part of the country to the network. This feasibility report is prepared to check the engineering and economically viability of the project and look for suitable funding for the implementation of the project.

### 1.2 Background

With the realization of uncontrolled traffic increase of the National network and issues in widening the existing network to cater to the demand RDA has recommended the government in development of a high mobility network connecting major development centers. Accordingly several highways have been identified. As per the National Road Master plan about 600 km of high mobility network has been identified. One of the high mobility road identified is the Alternate Colombo Kandy Highway.

The existing Colombo-Kandy Road (Route A1) is one of the major trunk routes radiating from the City of Colombo. This road connects Colombo to Kandy which is the provincial centre of the Central Province and the second largest city of the country. Townships have been developed alongside the road as ribbon development which impedes the flow of traffic. The importance of this road is further enhanced as two important trunk roads, namely Ambepussa-Kurunegala-Trincomalee Road and Peradeniya-Nuwara Eliya-Badulla Chenkaladi Road branch off from this road. As such traffic from Colombo to Kurunegala, Anuradhapura, Jaffna and Trincomalee, Nuwara Eliya, Badulla use the Colombo Kandy Road.

With a view to overcome the serious traffic congestion encountered on this road it has been decided to construct a new access controlled highway from Colombo to Kandy to promote economic development of the Central, North Western and Eastern Provinces of the Country.

With the feasibility carried out in 2000/2001 a road Corridor has been identified for this highway. However with the end of civil disturbance in the year 2009 it was decided to investigate the possibility connecting of North Western, North Central, Eastern and Northern Province along with the Central province connectivity.

Accordingly Central Expressway Project (CEP) trace was identified connecting Outer Circular Highway to Kurunegala, Dambulla and Kandy with a separate link. Government has taken a decision to implement this expressway in stages and first stage is from Outer Circular Highway to Mirigama as the section 1 of the Central Expressway. Full Expressway Map is given in fig 1.1.

### 1.3 Project Description

The CEP section 1 corridor starts from Kadawatha (interchange with OCH) and it will pass close to Ganemulla, Gampaha, Veyangoda, Mirigama

### 1.4 Study Objective

Economic Feasibility study has been carried out for full expressway. Objective of the this study is to check the viability of implementation of Section 1 of Central Expressway Project from Kadawatha .to Mirigama

### 1.5 Study Area

The study are is the area covering Gampaha, Kurunegala, Kandy district and Mainly concentrating to Gampaha district as the both end Kadawatha and Mirigama is in Gampaha district.

### 1.7 Connectivity of National Road Network

When defining the trace of the Expressway, additional measures have been taken to road network of the area specially to National network, as those connection is required to attract traffic in reduction of congestion in expressway network and also for provision of road connectivity to potential land for development

### 1.9 Traffic Estimation

As per the forecasting of traffic using the traffic model forecasted traffic with entire OCH project in operation is given below.

Forecasted Traffic with full construction of expressway

Interchange	Interchange	2021	2026	2036
Kadawatha	Gampaha	12,449	21,629	53,529
Gampaha	Veyangoda	6,817	9,617	23,212
Veyangoda	Mirigama S	6,053	8,624	23,331
Mirigama S	Mirigama N	5,312	7,608	22,883

Traffic of each link of expressway considering the construction of section 1

From Interchange	To Interchange	2021	2026	2036
Kadawatha	Gampaha	9,783	18,255	49,338
Gampaha	Veyangoda	3,852	5,823	16,168
Veyangoda	Mirigama S	2,198	3,295	11,944
Mirigama S	Mirigama N	1,452	2,256	6,917

Accordingly 4 traffic lanes are proposed for the section 1 of the expressway from Kadawatha to Mirigama

## ***1.10 Social Impact and Road Safety***

The social assessment has focused on evaluating the most likely impacts of the Expressway over the socio – economic environment in the local and regional economics. It is contemplated that the expressway would integrate the proposed road network to form a hub of interconnecting roads that are connected to other roads in both local and regional levels. This network will create socially and economically effective connectivity impacts in the area and thereby in the entire country. This would offer direct and indirect benefit for people in these administrative units through multiple roads. Separate Social impact assessment and Resettlement action plan is prepared to mitigate the social impacts due to construction of expressway.

## ***1.11 Evaluation of Alternatives***

The study has evaluated the proposed alternative routes for the Central Expressway in order to select the best possible alignment considering the following factors,

- Highway Engineering
- Transportation
- Hydrological
- Geotechnical
- Environmental and Social.

The expressway was divided into four sections for the purpose of the analysis and alternative traces were evaluated for each section of the expressway. The final expressway alignment would be a combination of the selected traces for each section of the expressway. The alternative traces for each sections were generated from past feasibility studies on Colombo-Kandy Alternative Highway and the Northern Expressway. The selected traces from the alternatives for section 1 based on the multi-criteria analysis is Q-B-H - Kadawatha to Mirigama via Gampaha, Veyangoda.

Comparison criteria and the analysis of alternatives are described in Chapter 4.

## ***1.12 Conceptual Details***

The unique feature of the expressway is that it would be elevated at locations where it is vulnerable to flooding specially in the Attanagalu Basin as any intervention in the vicinity would tend to have repercussions which would be difficult to predict. Further, elevated expressway would be considered depending on the cost element at areas where farm land would be affected.

Damage to the environment and eco systems have been kept to minimum with emphasis on archeological, cultural, religious sites as well.

### **1.13 Environment and Social Assessment**

All the environmental aspects pointed out in the TORs issued by the CEA have been addressed in the Environmental Impact Assessment Report. Necessary precautions and measures specified in the Environmental Action Plan and Resettlement Plan are to be adopted appropriately during the detailed design stage and construction stage in order to eliminate/mitigate negative impacts associated with the project.

### **1.14 Economic Feasibility**

Economic analysis in respect of the Project shows a positive EIRR of 12.99%. This EIRR value is adequate for Government Investment Thresholds (GIT) of 12% for normal projects. As such the project can be considered as a viable project for implementation. Economic indicators at Basic case are given below.

Economic indicator	Value
Net Present Value ( At discount rate of 7%)	Rs. Mn 143,053.72
Economic Internal Rate of Return	12.09
Benefit cost Ratio	2.12

### **1.15 Financial Feasibility**

According to the result of financial analysis the NPV of the project is negative and the value is US\$ 822.14 mn at 2% discount rate.

The negative FNPV indicates that the project is not financially viable. As such private sector investment is not possible.

### **1.16 Conclusion and Recommendation**

According to the Economic Analysis, the project has positive NPV and EIRR more than 12% which is considered as the Government Investment Threshold (GIT) for normal projects. As such the project is viable for the implementation.

Based on the analysis conducted Central Expressway Project section 1 is economically feasible, especially considering the unquantified benefits such as regional development that would result with the improved mobility to the Central, and Northern parts of the country. Accident reduction with use of expressway has not been taken in the analysis and that will be another added benefit.

Results of economic Sensitivity Analysis show that the project is sensitive to cost increase and reduction of benefits.

As such cost control is very important in the implementation of the project.

## Socio - Economic Profile of Country

# Chapter 2

### 2.1 Area and Population

The Democratic Socialist Republic of Sri Lanka is an island republic lying in the Indian Ocean off the South Eastern Tip of the Indian Subcontinent. The Arabian Sea lies to the west, the Bay of Bengal to the Northeast, and the Indian Ocean to the South. Colombo, situated on the Western Coast, is the largest City and the Commercial Capital of Sri Lanka. The Administrative Capital is Sri Jayawardenapura (Kotte), located about 16 km east of Colombo.

#### 2.1.1 Area

The area of Sri Lanka is 65,610 square kilometer. The island stretches over 440 km from north to south and 220 km from east to west. The Central Highlands occupying the Central Province and a part of Uva Province include numerous plateaus, valleys and mountains with altitude culminating at 2524 m above sea level (Pidurutalagala). It forms a natural barrier to cross – country inter-provincial land transportation. Surrounding plains cover the largest part of the Island with elevation not more than 90m above sea level. Numerous national reserves and sanctuaries intended for the protection of flora and fauna cover a total area of about 13 percent of the country's land area.

#### 2.1.2 Population:

The population of Sri Lanka was estimated at 20.3 million as on 2012 census with a density of around 324 persons per square kilometer. The population density is significantly greater in the Western and Southern areas, where the majority of Sri Lankans live. The population grew 8.14% from 2001 to 2012 at an average 0.7% per year.

### 2.2 Population Distribution and Growth

Table 2.1 is shown population distribution in district level.

*Table 2.1 Population and Density during 1981-2012*

District	Population			Population Density (Persons per square kilometer)		
	1981	2001	2012	1981	2001	2012
Colombo	1,699,241	2,234,289	2,315,593	2,605	3,305	3,425
Gampaha	1,390,862	2,066,096	2,300,271	994	1,541	1,715
Kaluthara	829,704	1,060,800	1,220,381	516	673	774
Kandy	1,048,317	1,272,463	1,374,672	554	664	717
Matale	357,354	442,427	484,201	180	227	248
NuwaraEliya	603,577	700,083	709,564	354	410	416
Galle	814,531	990,539	1,061,449	487	613	656

Matara	643,786	761,236	811,884	516	599	639
Hambanthota	424,344	525,370	599,170	164	210	240
Jaffna	738,788	490,621	584,704	795	528	629
Mannar	106,235	151,577	99,528	53	81	53
Vavuniya	95,428	149,835	172,064	36	81	92
Mullathivu	77,189	121,667	92,144	39	50	38
Kilinochchi	91,764	127,263	113,545	80	106	94
Batticaloa	330,333	486,447	526,940	134	186	202
Ampara	388,970	589,344	650,913	86	140	154
Trincomalee	255,948	340,158	379,702	98	135	150
Kurunegala	1,211,801	1,452,369	1,615,554	254	314	349
Puttalam	492,533	705,342	762,764	165	245	265
Anuradhapura	587,929	746,466	859,238	82	112	129
Polonnaruwa	261,563	359,197	404,435	77	117	131
Badulla	640,952	774,555	814,670	227	274	288
Moneragala	273,570	396,173	449,889	49	72	82
Rathnapura	797,087	1,008,164	1,085,754	246	312	336
Kegalle	684,944	779,774	839,014	412	463	498
<b>Sri Lanka</b>	<b>14,846,750</b>	<b>18,732,255</b>	<b>20,328,043</b>	<b>230</b>	<b>299</b>	<b>324</b>

*Source: Economic and Social Statistics of Sri Lanka 2012 – Central Bank of Sri Lanka – 2001 & 2012 figures based on census of Population and Housing – 2001 & 2012. Department of Census and Statistics*

## 2.3 Population Densities

Having about 324 persons per square kilometer in 2012, Sri Lanka is one of the most densely populated countries in the South Asian Region. Data given in the *Table 2.1* shows that the population densities in the country varies from 38 persons per square kilometer in the Mullativu District to 3,425 persons per square kilometer in the Colombo District.

The three districts constituting the Western Province or Colombo Metropolitan Region (CMR) have significantly high population densities. As against 324 persons per square kilometer for the country as a whole, the districts of Colombo had 3,425 persons, Gampaha had 1,715 persons, and Kalutara had 774 persons per square kilometer in 2012. The population density per square kilometer in the Colombo District increased by 120 persons, Gampaha by 174 persons and Kalutara by 101 persons between 2001 and 2012 Censuses as in evident from statistics in *Table 2.1*.

## 2.4 Future Population

Population has been growing at a rate of approximately 1.1% over the years until 2006 and subsequently has started declining. In accordance with Population growth forecasts published by the Registrar General's Department, the anticipated population growth projections are shown in *Table 2.2*.

**Table 2.2 Population Growth Forecasts**

<b>Year</b>	<b>2004</b>	<b>2006</b>	<b>2011</b>	<b>2016</b>	<b>2021</b>
Population (x 1.000)	19,435	19,858	20,869	21,693	22,329
<b>Annual Growth</b>	1.2%	1.1%	1.0%	0.77%	0.58%

*Source: Register General Department*

## **2.5 Economic Growth Patterns and Distribution**

Starting from 1977, the Sri Lankan Government introduced open economic policies centered on reduction of fiscal deficit, liberalized trade, privatization, deregulated foreign investments and export based industrialization. Policy reform program has had its dividends in terms of increased growth rates and reduced unemployment rates in the following decade. Ensued by continuing reform, increased privatization and a stress on export-oriented growth, GDP marked a healthy 7 percent growth in 1993. Economic growth has been uneven in the following years as the economy faced a multitude of global and domestic economic and political challenges. Overall, Average Annual GDP growth was 5.2 percent from 1991 to 2000. In 2001, GDP growth was negative 1.5 percent the first contraction since independence. By this time, the economy had been hit by a series of destructive terrorist attacks, domestic economic problems, political instability as well as external factors such as terrorist attacks in the United States. However, thereafter GDP showed signs of recovery and during the period 2005 to 2010 indicates Annual Average Growth Rate of 6.33.

The GDP growth is given in *Table 2.3*. This growth is visible in all economic sectors, specifically in industries and trading. This growth was commendable as it was achieved in challenging environment marked by high and volatile oil price, natural disasters and renewed of terrorist activities.

**Table 2.3 Sri Lanka GDP, from 2010 – 2015**

<b>Year</b>	<b>2010</b>	<b>2011</b>	<b>2012</b>	<b>2013</b>	<b>2014</b>	<b>2015</b>
GDP at constant prices (Rs. Billion) (2010)	6414	6953	7589	7846	8229	8623
GDP Annual Growth Rate (%)	8	8.4	9.1	3.4	4.9	4.8
GDP Per Capita (US\$ equivalent)	2744	3129	3351	3610	3853	3924

*Source: Economic and Social Statistics of Sri Lanka 2015 – Central Bank of Sri Lanka*

In addition to GDP growth at the country level, it is important to have estimates of the growth rates at the provincial level to be able to predict the Per Capita Domestic Products by Province (PDP) and later by traffic growth rate. The GDP's of nine provinces at 2002 constant prices are shown *Table 2.4*. The growth rates are shown in *Table 2.5* and the percentage contribution of each province in *Figure 2-1*.

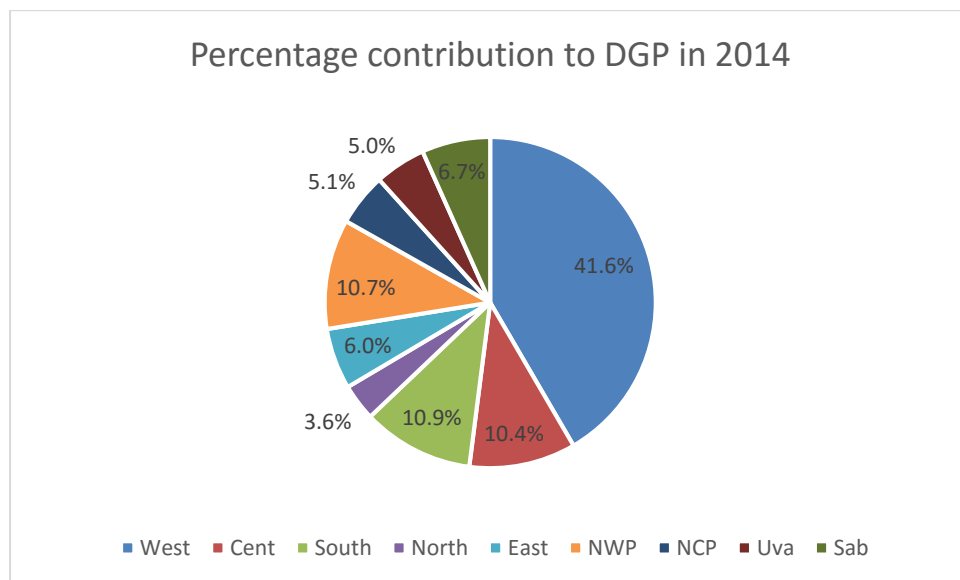
**Table 2.4 Net Provincial Domestic Product (NPDP) in Million Sri Lanka Rupees**

Year	Western	central	Southern	Northern	Eastern	North Western	North Central	Uva	Sabaragamuwa
2010	2512908	562744	598976	189740	333969	534831	266954	253177	350806
2011	2894428	644332	718768	242512	379184	655182	305975	297335	405596
2012	3243854	775580	834287	277828	478104	760148	379243	361975	467238
2013	4078402	1005052	1001254	338799	562099	1006437	480967	471002	648122
2014	4346682	1089048	1136458	374403	622759	1122258	535476	521699	699695

Source : Central Bank Annual Report 2012

**Table 2.5 Provincial GDP Growth Rates (2010– 2014)**

Year	Western	central	Southern	Northern	Eastern	North Western	North Central	Uva	Sabaragamuwa
2011	15%	14%	20%	28%	14%	23%	15%	17%	16%
2012	12%	20%	16%	15%	26%	16%	24%	22%	15%
2013	26%	30%	20%	22%	18%	32%	27%	30%	39%
2014	7%	8%	14%	11%	11%	12%	11%	11%	8%

**Figure 2.1 Percentage GDP Contribution by Each Province**

The Western Province contribution is almost half from the overall economy of Sri Lanka so the growth rate in the Western Provincial GDP greatly influences the overall growth rate of the Sri Lankan economy. It can also be seen that, because of various known reasons, North Western and Central Provinces of Sri Lanka have not been contributing significantly to the overall economy while Uva, Eastern, Northern and North Central contributing marginally. To achieve

the target growth rate in the economy in the future, the contributions and growth rates of the entire country is very important.

## **2.6 Macro Economic Framework**

The Macroeconomic Framework of Sri Lanka 2006-2016 is based on assumptions on the developments in domestic and international economic environment and medium and long term policy measures and directions of the Government.

## **2.7 Assumptions**

### **2.7.1 Global Economic Environment**

- Emerging market economies in the region are expected to grow well above global growth. This regional growth will have positive spillover effects on Sri Lankan economy through higher integration to the region.
- Access to external financing is increasing with more regional countries such as India, China and most East Asian countries are generating surpluses and becoming net lenders from net borrowers in the past.
- Import and export prices are consistent with projections in the World Economic Outlook.

### **2.7.2 Domestic Economic Environment**

- Government has given highest priority to accelerate public investment on infrastructure development.
- Implementation of these development projects will boost economic activities in the Island. Private sector is expected to respond to this demand by increasing their economic activities.
- Completion of these projects would address the infrastructure bottlenecks increasing capacity to grow. This will facilitate private sector to unleash its growth potential in all key sectors.
- Improved aid effectiveness, through better targeting and rationalization of foreign funded development program.
- As a newly emerging middle-income country, cautious management of our access to international capital markets and prudent use of such funds when necessary.
- Continuation of the fiscal consolidation process through revenue enhancement and expenditure rationalization to contain the fiscal deficit.
- Maintenance of prudent monetary policy and the flexible exchange policy supportive of price and financial market stability and balance of payments sustainability.

## **2.8 Strategies**

### **2.8.1 Factors of Growth and Regional Development**

- ***Maintaining a Liberal Economic Regime:*** Export sector will continue to be supported through a conducive tax regime, facilitating more market access via multilateral and bilateral trading arrangements, encouraging more value addition, providing access to duty free inputs and maintaining liberal investment regime. Import tariffs will continue to be simplified providing inputs to domestic industries to maintain their competitiveness.
- ***Capacity Expansion:*** Enhancing production capacity in all sectors of the economy by promoting public, private and foreign investment.
- ***Human Resources Development:*** Strengthening and upgrading primary, secondary and tertiary education institutions by maximizing available opportunities and enhancing the access to education, while improving quality and relevance of education at all levels. Providing high quality, equitable, cost effective, modern and sustainable health care services.
- ***Infrastructure Development:*** Building modern, high quality and efficient infrastructure facilities to expand access to markets. Maintain and rehabilitate existing road network, construction of highways and expressways, increasing the coverage of safe drinking water, upgrading the railway sector, expanding the supply, transmission and distribution of electricity, accelerating ongoing power sector reforms, and developing alternative energy to reduce the cost of power while taking into consideration the social problems and environmental implications and transforming port and airport sectors as an air-sea hub and logistics centre.
- ***Improving Technology and Research and Development:*** Promoting application of modern technology and undertaking research and development activities in the country to enhance competitiveness.

## **2.8.2 Macroeconomic Policies and Strategies**

### **▪ Fiscal Policy**

***Fiscal:*** Turning around revenue deficit to surplus through expanded tax base, higher non tax revenue efforts from state enterprises and cost effective public expenditure management system together with prudent debt policy, increasing public investments largely through financing from concessionary foreign sources and long-term funding services and phasing out budgetary transfers to state enterprises. Public expenditure will be programmed within a medium-term and sector budget framework to improve efficiency and productivity. Tax administration as well as policy environment will be directed to create simple and efficient system of taxation. Overall macro fiscal policy framework will be guided within the Fiscal Responsibility Act of 2002.

***Monetary and Financial:*** Avoiding demand-fuelled inflation, required credit growth for sustained economic activity and strengthening financial sector stability, further strengthening the regulatory framework in the banking, insurance and financial services. Introducing measures to reduce high interest spread, prudent measures of banking & financial institutions, strengthening state banks as strategic state enterprises to improve their financial viability and improve their competitiveness.

## ▪ Policies to Strengthen Structure of the Economy

**Market Development Strategy:** Strengthening both product and factor markets to ensure efficiency and competitiveness of the economy. Major markets requiring improvements are the land, labor and financial markets.

**Infrastructure Development Strategies:** The country requires an efficient and fast growing infrastructure system spread throughout the economy to help in achieving regionally balanced growth. Public sector institutions, which supply vital services such as power, water, transport, and other services, are the important service providing institutions of the government. Most of those institutions are monopolies, yet the quality and adequacy of services and financial positions are very poor. Hence, those institutions are earmarked for strategic reforms.

**Public Service Development Strategies:** The public sector will engage in its critical role as facilitator and pacesetter. The entire perspective of the public service will have to focus on learning to anticipate change, include development and meet the demands of the future in innovative ways.

**Administrative Service Development Strategies:** The institutional strengthening will be implemented to make the government's administrative machinery an efficient, friendly and modern entity through reforms in rationalization of functions of government agencies to ensure that they are focused on functions relevant to current needs with special emphasis on transparency and the use of modern technology.

## **2.9 Liberalized Policy to Enhance Capital Market Development**

The Government will open the Rupee denominated Treasury Bond Market for foreign investors. Treasury Bond is a medium and long-term debt instrument issued by the Government to raise funds from the domestic market to finance the Government budgetary operations. This will be the first instance such a liberalization policy is taken by the Government to open the gilt-edged rupee securities market for foreign investors. This measure will increase the freedom in capital account transactions and thereby enhance the development of the capital market by broadening the investor base and increasing the competition in the bond market.

Foreign investors will be permitted to purchase Treasury Bonds with minimum maturity period of two years and total investment limited to 5% of the value of Treasury Bonds outstanding at any given period of time.

Foreign investors will be able to purchase Treasury Bonds at any time from the secondary market through participatory agents i.e. Licensed Commercial Banks and Primary Dealers. In addition, foreign investors will be permitted to bid at primary auctions of Treasury Bonds through primary dealers.

## **2.10 Trade Policy**

### **2.10.1 Present Status and Challenges**

Sri Lanka depends heavily on imported inputs especially in the key export industry, the apparel sector, and also for a large share of our investment. Most exports of the country are destined to EU and US markets with less movement towards regional markets. The trade policy for market diversification does not explicitly recognize the importance of emerging growth centers in Asia nor does it entail any meaningful programs.

Sri Lanka has rapidly integrated into the world trading system with the trade policy liberalization. Of the total external trade, goods and services trade accounts for 76 percent of GDP, indicating sharp rise in this openness indicator, compared to about 35 percent in the pre-liberalized period. The tariff structure has been simplified, rationalized and lowered over the years and currently it maintains a four-band system. The current account fully liberalized and capital transactions are relatively free.

Sri Lanka has in the recent times strengthened its preferential trade policy regime with a view to promote external trade through rapid integration into regional markets. The Indo-Sri Lanka Free Trade Agreement (ISFTA), Pakistan Sri Lanka Free Trade Agreement (PSFTA) and South Asian Free Trade Agreement (SAFTA) are significant drivers of regional trade. The country has not properly developed a program for promoting trade in service either on regional and extra-regional context.

Over the years Sri Lanka has strengthened the liberal trade and payments policy regime, with no aberration. The country's regulatory system dealing with the external trade has not been upgraded commensurate both with progress made in this respect elsewhere and the country's own trade policy improvements. Many gaps do exist in the laws, institutions and enforcement in regard to trade inspection, certification, standards, facilitation, etc, making domestic manufacturer and the consumer at a disadvantageous position.

- Strategy - The external trade and environment is becoming intensely competitive. The external trade and investment policies will promote both exports and efficient import substitution. With the growing domestic income significant component of domestic demand need to be met out of local production such a policy will also help in the balance of payments adjustment process to further strengthen medium-term debt sustainability. This strategy is built on a framework, ensuring consistent, transparent, predictable and liberal external trade policy regime.
- Market penetration through preferential market access programs. Strengthening existing Regional Integration Arrangements (RIAs) to ensure improved market access in regional economies.
- Negotiations of new RIAs with advanced economies and/or countries whose economies are dissimilar for increased market access. This ensures trade expansion through the process of capturing trade complementarities on preferential basis.
- Development of market penetration schemes for fast growing economies in Asia while devising mechanism to capture available opportunities under the GSP + Scheme, including attraction of foreign investment.

- Diversification of Sri Lanka's export sector with the emphasis on small and medium enterprise sector.
- Development of infrastructure and policy support-based backward integration for high value added thrust export industries-apparel, tea, gem and jewellery, spices, electronic based products.
- Promotion of Trade in services, including IT related and services with higher domestic value addition.
- Creating infrastructure, institutional and regulatory framework for developing Colombo centered South Asian Economic Hub with a focus on free port and inter-port trading, financial environment, sea port facilities.
- Upgrading competitiveness and trade regulatory environment for ensuring level playing field between imported and local products in the domestic market.
- Reorientation of diplomatic services for promoting country's economic interests.

## **2.11 Expected Outcome**

### **2.11.1 Real Sector Developments**

- During 2014 – 2020 GDP is projected to grow at 7.4 –10.9 per cent as per the Megapolis Master plan document. The growth is expected from improvements in all three sectors of agriculture, services and industrial sectors. Investment as a percentage of GDP is expected to increase from 29.7 to 40 per cent over the medium term while inflation will be remain at present level of 5.5 percent. Growth Centers are identified in *Figure 2.2*.
- Further acceleration of the growth is projected with the planned infrastructure investment and sectoral policies.
- A steady increase in domestic savings both by the private and public sectors as well as higher foreign capital flows will support the higher level of investment.
- The Per Capita GDP is projected to increase from US \$ 3930 in 2015 to around US \$ 4,430 by 2020 which will further increase of incomes and the standard of living in Sri Lanka. Moreover, with the more balanced approach to overall economic development, benefits of this growth will be accrued to the entire population.
- From the supply side, the growth will be reflected in all three major sectors – agriculture, industry and services. The agriculture, forestry and fishing sectors are expected to grow over around 5 percent exceeding the average growth rate of around 1.0 percent in the past 10 years. Although, total land extent under tea bearing will increase only marginally over the medium term, the growth in the tea sector is expected mainly from improvements in value addition. Rubber production is expected to increase through expanding tapping areas and good management practices.
- The industrial sector growth is expected to remain in same level at present. The share of industrial sector in GDP will remain at level of around 26.5 per cent as in 2015.
- The services sector in which Sri Lanka has a comparative advantage and also is expected to grow with a further improvement in telecommunications, import and export trade, cargo

handling, financial services as well as many other private services including health and educational areas. The share of services sector in GDP is expected to increase from 56.6 per cent in 2015 to 59-60 percent by 2020.

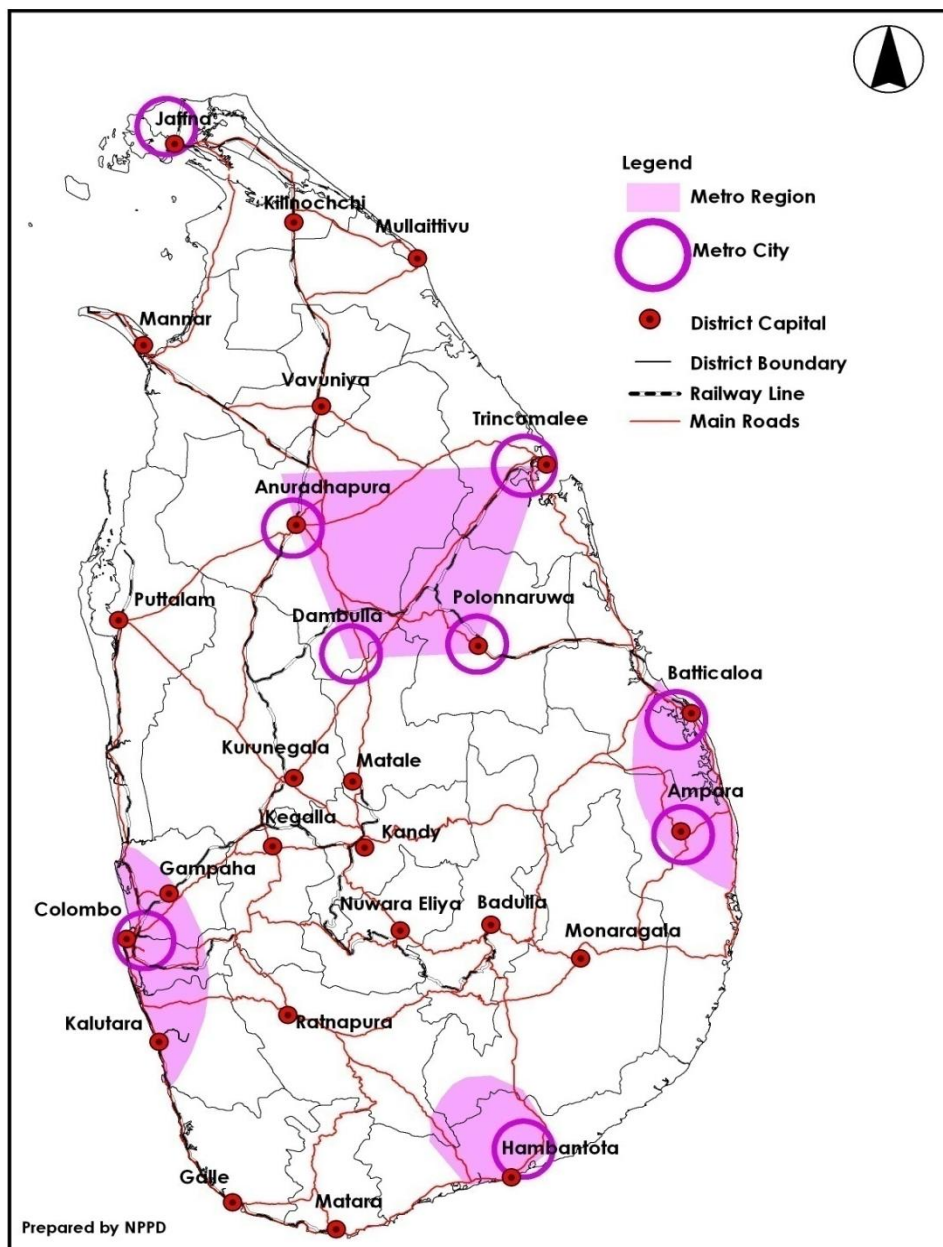


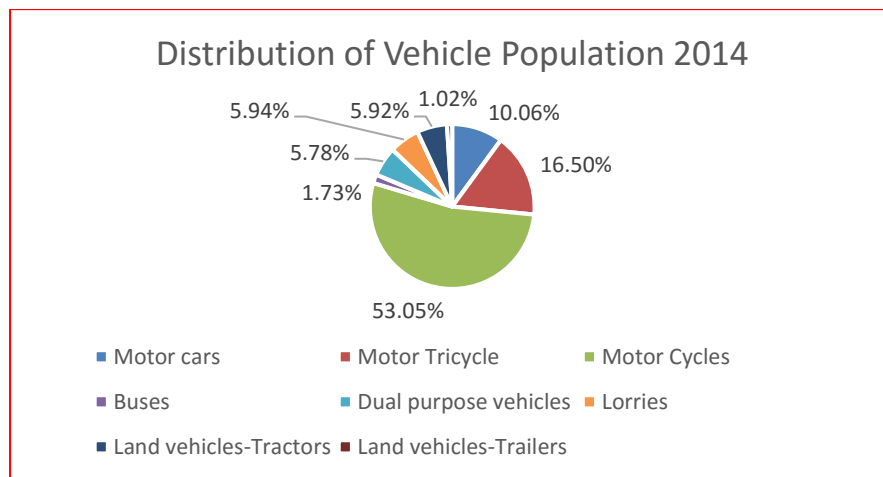
Figure 2.2 – Growth Centers

## 2.12 Vehicle Population Distribution

The all island vehicle registration obtained from the Department of Motor Traffic of country is given in the Table 2.6 for the period 2007 – 2014 and Figure 2.3.

Table 2.6 All Island Vehicle Population

CLASS OF VEHICLE	2007	2008	2009	2010	2011	2012	2013	2014
Motor cars	361,211	381,448	387,210	410,282	468,168	499,714	528,094	566,874
Motor Tricycle	361,727	406,531	443,895	529,543	667,969	766,784	850,457	929,495
Motor Cycles	1,604,648	1,760,600	1,896,021	2,100,832	2,354,163	2,546,447	2,715,727	2,988,612
Buses	79,870	81,050	81,789	84,280	88,528	91,623	93,428	97,279
Dual purpose vehicles	193,380	196,236	197,516	209,228	242,746	280,143	304,746	325,545
Lorries	262,584	276,622	284,847	296,692	311,510	323,776	329,648	334,769
Land vehicles-Tractors	221,326	245,683	259,634	276,997	297,070	315,520	326,292	333,362
Land vehicles-Trailers	41,048	42,823	44,156	46,457	49,578	53,020	55,286	57,298
TOTAL	3,125,794	3,390,993	3,595,068	3,954,311	4,479,732	4,877,027	5,203,678	5,633,234



**Figure 2.3 Vehicle Population of Sri Lanka in Year 2014**

**Table 2.7 Average Vehicle Growth Rates (2007– 2014)**

CLASS OF VEHICLE	Growth Rate %
Motor Car	8.13%
Motor Tricycle	22.42%
Motor Cycle	12.32%
Bus	3.11%
Dual Purpose Vehicle	9.76%
Lorry	3.93%
Land Vehicle-Tractors	7.23%
Land Vehicle-Trailers	5.66%

According to the above statistics it shows the rapid growth in motor cycles and three wheelers since year 2005. The motor cycle fleet in the island is almost half the total vehicles. The average growth rate of the motor cycles is around 11% per annum. The average growth rate is shown in the Table 2.7.

### **3.0 REGIONAL STRUCTURE**

#### **3.1 Terrain and Land use**

The Central expressway is to be developed to serve the Kandy as well as the Kurunegala and Dambulla as a connection to North and East. It is required to consider the present Colombo Kandy road as well as the Ambepussa – Kurunegala Trincomalee road.

The Colombo Kandy road, along the first 50-60 km from Colombo, passes over flat or slightly undulating terrain. Further to the east the road traverses hilly terrain passing Kegalle and Mawanella. East of Mawanella road A1 reaches mountainous terrain, requiring serpentine curves through some passes, until it approaches the vicinity of Kandy at Peradeniya.

The Ambepussa Kurunegala Trincomalee road (A6) road also passes over flat land most of the road sections.

The most economically feasible approach for a new road from the west towards Kandy will be on an alignment north of road A1. The western part of the study area is dominated by paddy with home gardens on flat river valleys; in the middle part by rubber and coconut in hilly, undulating terrain. Areas around Kandy are dominated by home gardens and paddy, with some areas with rubber, some with coconut.

#### **3.2 Socio Economic Characteristics**

The settlement pattern, social conditions and economic activities within the areas of Sri Lanka that will generate the traffic on the new expressway will also determine the number and types of vehicles that will use the new expressway, and it is therefore necessary to describe current socio-economic conditions within this area, as well as make projections for the future.

##### **3.2.1 Socio-economic conditions**

There are a number of traffic generating factors in an area of influence, e.g. the number of inhabitants, settlement pattern, social conditions, levels of income, employment situation, centres of trade and production, social infrastructure like schools and hospitals, etc. All these factors contribute, often in a complex pattern, to the total traffic movements within and between an 'area of influence' and its surroundings. In order to identify these traffic generating factors, the socio-economic conditions in the project area are described.

##### **3.2.2 Demographic data**

The population of the area of influence is around 6.6 million at present (6.3 million in 2012). Two of the districts - Colombo and Gampaha district - form part of the Greater Colombo area, which is characterised by a high degree of urbanisation. The remaining three districts - Kegalle, Kurunegala and Kandy - are more rural in nature.

The population of the project area has been increasing during the last decade more or less as the country as a whole, i.e. with 0.8 - 1.1 % per annum. There are differences between the districts when it comes to, e.g., crude birth and death rates. The more urbanized districts within the project area are growing somewhat faster than the districts with a more rural character, but the difference is relatively small.

Population densities vary considerably, basically reflecting the differences in urbanization, i.e. rural/urban character of the respective five districts. Colombo is the most urbanized, Gampaha

is becoming urbanized, Kegalle is becoming urbanized in a hilly landscape, Kurunegala is rural in an undulating, hilly area under intense cultivation, and Kandy semi urban in a mountainous landscape.

### **3.2.3 Employment and levels of income**

The area of influence encompasses parts of three provinces with different social and economic characteristics. Colombo and Gampaha districts form part of the densely populated Western Province, which is not only the administrative, commercial and political hub of the country but also the most industrialized one.

Kegalle and Kandy districts form part of Sabaragamuwa and Central provinces, respectively, and are predominantly rural in character, as well as Kurunegala, belonging to the Northwestern province.

Colombo and Gampaha districts are located in a province with an economic structure and an employment pattern that differs substantially from the provinces of the other three districts of the project area. Manufacturing and different types of service industries play a much more central role in employment terms in the Western Province than in the other three provinces, where Kurunegala district is in an intermediate position.

The difference in rate of industrialization, the relative importance of the service industry, etc, influence the level of income for both individuals and households. Both income and consumer expenditures are substantially higher in the Greater Colombo parts than in the rest of the area of influence

### **3.2.4 Household consumption**

Differences in income and expenditure levels are also reflected in the availability of household equipment, like telephones and television sets, motorbikes and cars. The difference in relative economic well-being between the Greater Colombo region and the more outlying districts of the area of influence is fairly large.

### **3.2.5 Social services**

The difference in standards between the districts is less pronounced when it comes to access to social services, like health and educational facilities. When it comes to the availability of basic services in these fields, the availability and standards are fairly similar within the districts in the project area. Colombo district is better provided with more qualified education and health services than the rest of the country.

## **3.3 REGIONAL CHARACTERISTICS**

Kandy, Kurunegala and Colombo are larger regions involved in this study. They form the end points of the proposed expressway. In addition to general characteristics for the respective regions, information is given on population, economy, and development trends and opportunities.

### **3.3.1 Colombo**

The following characteristics related to Colombo Metropolitan Region (CMR) are based on information included in the Colombo Metropolitan Regional Structure Plan (CMRSP) from 1998. The Colombo region is the seat of government, and also the largest administrative and functional urban region in Sri Lanka. The population of Colombo district has increased from 1.26 million in 1981 to 1.93 million by the year 2000, at the rate of 4 - 5 % per annum. The Colombo region contributes about 44% of the national economy. In 1996 about 84% of all industrial establishment of Sri Lanka were located in CMR, accounting for 80% of industrial employment. About 33% of the number of tourist beds, and 45% of total foreign guest nights were registered in CMR in 1996. Health institutions play an important role with high shares of staff and facilities. About a quarter of government schools and a majority of private schools are located in CMR. In business Colombo has a corresponding dominant role in the country, with all major banks, insurance companies, and other national offices of all major companies.

### **3.3.2 Gampaha district**

Gampaha is one of the most important centres along road A1 providing a link at Miriswatta junction to the traffic generated from Kotte - Battaramulla, Kaduwela and Biyagama. After the construction of Kaduwela Bridge and the subsequent widening of the road, it now carries a heavy traffic during peak hours. Due to heavily congested traffic on road A1 at Kadawatha, a substantial volume of traffic with destinations to Gampaha and beyond uses this new road.

There is also a flow of traffic to Miriswatta and Yakkala junctions on road A1, which is generated in Negombo, Kandana and Ja-Ela areas. Gampaha is fragmented into several sub-centres due to low-lying marshes and paddy fields. Major centres along road A1 are at Kadawatha, Yakkala and Miriswatta, while Gampaha town proper is centred on Gampaha railway station, where most of the public offices, banks, commercial establishments and schools, are located.

The northern part of the CMRSP, comprising the Negombo sub-sector, is the fastest growing area of the CMR, inter alia, due to the Katunayake IPZ, and several other industrial complexes generating large employment opportunities in the district. Katunayake Export Processing Zone currently has 60,000 jobs, while Biyagama Export Processing Zone has 26,500 jobs. The number of jobs is even higher if Peliyagoda Industrial Project and Ekala Industrial Estate are taken into account. These industries also have created many supporting industries in surrounding areas.

Gampaha district was the fastest growing district of the Colombo Metropolitan Region during the last decade, and this trend is anticipated to continue during the next decade as well.

The tourism sector is significant in terms of traffic generation and has implications on traffic in the corridor. The Negombo sub-sector presently is an important tourist resort area.

### **4.3.2 Kegalle district**

There are three important towns in the Colombo-Kandy corridor in Kegalle district, which will have an impact on traffic generation, viz. Kegalle, Mawanella and Rambukkana towns.

Kegalle Town had an estimated population of more than 19,000 in year 2000. Presently, the town has developed through out road A1 in ribbon form. The town is much congested as the result of commercial activities located on both sides of the road, and by the large number of buses using the bus terminal area.

Mawanella Town had a population estimated at about 22,000 in 2001. The town centre, located along road A1, is congested with a narrow road with roadside parking.

Rambukkana Town has developed based on the railway station. The nearby location of the Elephants' Orphanage and the railway terminus has created a stream of travellers, and a modest growth of commercial facilities. The population of Rambukkana town is estimated at 8,583 in 2001.

#### 4.3.3 Kurunegala

Population growth and economic activities of Kurunegala and other important sub-centres in the district have implications on traffic generation on road A1 up to Warakapola. The Kurunegala D.S. Division had a population of 153,448 in 1994 out of which 26,198 was within the Kurunegala M.C. area. It has an agro-based economy and the development of agro based industries will become important in the future to meet the employment needs of the district. Kurunegala has a rich agricultural hinterland, not yet fully exploited.

#### 4.3.4 Kandy

Kandy city has a special historical and cultural significance. The location of Kandy presents major geographical constraints for its expansion, as it constitutes a small plateau surrounded by hills, forests and the river at an elevation of 500 to 600 metres above msl. Kandy M.C. had an estimated population of 131,000 in 2001. The population of Kandy district increased continuously as given below.

Table 2.8 : Population increase of Kandy District

Year	Population
1996	1,286,336
2001	1,363,516
2012	1,369,900

The population of Kandy is increasing increase as a result of the relative decline of the agricultural and plantation sector, and consequent shift of the rural and estate population to urban areas. Kandy experiences population pressure due to migration from surrounding areas, but the city has no room for expansion. Due to land constraints, the population growth of the city does not show a significant increase, but the surrounding areas show significant increase. Kandy and Nuwara Eliya traditionally have plantation economies based primarily on tea production. Long-term prospects of plantation agriculture in Sri Lanka are not very encouraging; due to soil erosion and silting of riverbeds caused by land clearing; removal of vegetation cover for introduction of vegetable and potato cultivation has resulted in environmental problems. In order to protect the environment in the long term, existing agricultural practices needs to be changed, and employment opportunities be created in the secondary and services sector associated with urban development. An industrial estate has been established at Pallekale, which is not yet fully utilized, having 3,500 employees at present. The tourism sector is well developed in Kandy with international and domestic tourists. A major tourist resort complex is planned at several locations as the demand is increasing.

Kandy is the most developed service centre in the hill country and attracts a substantial population from its hinterland, related to various service activities. It has a highly developed commercial centre with retail and wholesale trade activity. In terms of employment opportunities, the service sector accounts for more than 70 % of total employment in Kandy M.C.

# Sector Information

## Chapter 3

### 3.1 Trends and Patterns in Road Transport

#### 3.1.1 Existing Transportation System

Sri Lanka has a multi-modal transportation system consisting of roads, railways, maritime and aviation. However, road transport is considered as the dominant mode of transportation within the island due to its flexible characteristics over railway. Sri Lanka has a road density of 1.5 km/km<sup>2</sup> which is considered high when compared to other South Asian Countries. More than 116,000 length of road network covers almost every part of the country including very remote areas providing access to all parts for its citizens. The railway network is about 1,640 km. At present the contribution of railway as a transport means is very limited and its services are restricted to few districts and are currently available between Colombo and a few provincial cities.

The Road Development Authority (RDA) which is under the purview of the Ministry of Higher Education and Highways is responsible for the planning, designing, construction, rehabilitation and maintenance of the National Highway Network which is in the highest level of hierarchy of the road network in Sri Lanka. Further, RDA has embarked in developing Expressway Network of approximately 800km for Sri Lanka to augment the national road network and they are at various stages of development. First section of expressway of length 95km from Kottawa to Galle (E-1) came into operation in November 2011.

Public transport accounts for nearly 73% of all motorized passenger transport. Bus services provided by the state and private operator command 68% of the market. Rail transport accounts for only 5% of the country's passenger travel. Despite its dominance, the quality and services of public passenger transport are seen to be far from satisfactory at present. For freight carriage, nearly 99% of cargo movements are by road resulting in heavy burden on road pavement and aggravating congestion. The share of the rail in freight transport has reduced to 1% in recent years.

*Table 3.1 Spread of Sri Lanka's Road Network (km) by Type and by Province*

Province	National Roads				Provincial Roads	Local Authority	Other Agencies
	A Class	B Class	Expressways	Total			
Western	374.48	1224.00	98.34	1696.82	15,532	84,380	4000
Central	408.57	1338.41		1746.98			
Southern	346.88	1154.36	71.47	1572.71			
Northern	734.49	524.97		1259.46			
Eastern	619.55	551.13		1170.68			
North Western	352.43	1002.75		1355.18			
North Central	492.04	701.74		1193.78			
Uva	471.04	693.19		1164.23			
Sabaragamuwa	415.57	804.18		1219.75			
<b>Total</b>	<b>4215.05</b>	<b>7994.73</b>		<b>12379.62</b>	<b>15,532</b>	<b>84,380</b>	<b>4000</b>

Source: Planning Division RDA – 2015

As presented in *Table 3.1* Sri Lanka's road network is divided into three categories as described below.

Out of around 116,000 kilometers of entire road network of the country, 12,209.78 km (A and B class roads) and 169.84 km of Expressways are National Roads serving inter-provincial and long-distance transport. The Road Development Authority manages these roads under the purview of Central Government. The National Road Network is shown in the *Fig. 3.1*

15,532 kilometers are secondary roads (C and D class roads) managed by the Provincial Councils and serving for intra-provincial traffic.

Around 84,380 kilometers minor roads are managed by Pradeshiya Sabah/Local Government

Around 4000 kilometers of roads are managed by other sectors mainly Irrigation Department, Mahaweli Authority and Estates sector all over the island producing export crops such as tea, rubber etc.

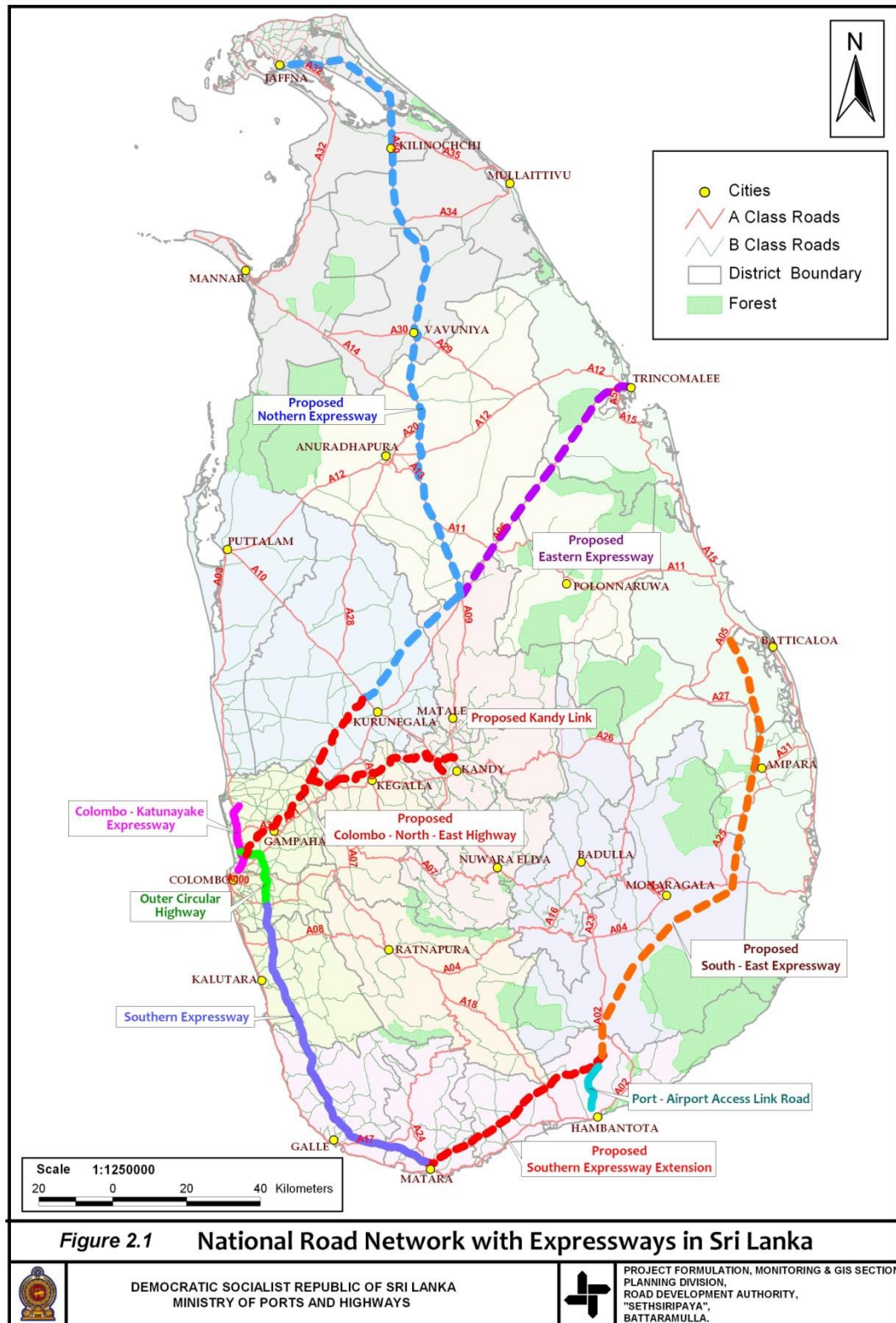


Fig. 3.1 National Road Network with Expressways in Sri Lanka

### **3.1.2 Trends and Patterns in Travel**

A rapid increase in travel demand in Sri Lanka is noted recently. This increase is characterized by growth in automobile transport and increases in vehicle fleet and distance traveled, increased mobility of females and increase in single occupancy vehicles used for trips to work and poor condition of public transport have influenced this situation.

The on-going trend was attributable to economic and social impact of liberalization that started in the late 1980s and lack of growth in the railway sub sector. As a result of shifting job market to the suburbs, a significant increase in travel between rural and urban areas and within urban areas could also be observed. Emerging trends in travel patterns have resulted in a rapid increase in vehicle population and motorized trips over the last decades.

The number of vehicles registered has been steadily increasing annually. However, during 2011 there was a rapid increase in the vehicle fleet as 525,421 new vehicles were registered. This includes 4,248 buses which is significant when compared with 2,491 buses registered in 2010 and 14,818 goods transport vehicles including trucks. The trend continued in the recent years also with lower than the in the year 2011. A significant development has been noted in the taxi industry with the introduction of low priced cars adding to the system, while fair percentage of three wheelers now responding with metered hires. However, there was a significant increase in the importation of three wheelers during the year 2011 numbering 138,426. There was a drastic increase in the registration of motor cars recording 57,886 against 23,072 registrations in 2010 as a result of issuing reduced tax importation permits for the government and semi government sector officers.

## **3.2 Major Problems in the Road Sector**

Compared to many other developing countries, the road density and the road coverage are relatively better in Sri Lanka. However, the road transportation is overwhelmed by many problems as follows:

1. Traffic levels exceed the design capacity of many roads.
2. Uncontrolled roadside development has reduced the road network's capacity and efficiency.
3. The emerging situation has caused increasing road-user costs, making road transport unsafe and lowering the quality and frequency of transport services.
4. Unequal distribution of transport infrastructure is another major problem. The Western Province has a road density of 3.14 km/square.km compared with 1.5 for the country as a whole. Similarly, Southern Province has a road density of 1.62 compared to 0.88 in the Uva Province. In the Western Province, the Colombo City has the most extensive and developed road infrastructure.
5. Road network development is constrained by low purchasing power of the people to support road development, difficulties in land acquisition and slow progress in land use and planned city development programmers.

Even though major part of the road network has been rehabilitated in the recent past there are bridges on the road network which are designed and constructed to cater for the requirements

of traffic volumes, traffic loading and limited land use perceived at that time. With the rapid expansion of development activities since 1980's the traffic volumes have increased on an unprecedented scale. Further, the intensity of traffic loading has increased substantially with the use of heavy container vehicles and with relatively high use of other heavier vehicles with improvement of roads. This overall increase in the traffic as well as loading has caused the deterioration of roads and bridges and early rehabilitation will be required to mitigate the situation.

### **3.2.1 Problems with Urban Transportation**

The Colombo City functions as the hub of the country's transportation system with its connections to almost all provincial capitals and major cities via rail and major road corridors. The major city centers have the most intensive and developed network of roads, but suffer from lack of routine and periodic maintenance and management of traffic to ensure maximum capacity utilization. Some parts of the network are not prepared for the rapid growth of motorization and due to these reasons the capacity of the existing road network is low. Most inner urban areas suffer from lack of developed road infrastructure. For instance, only 30 percent of low-income settlements in the Colombo Metropolitan Region (CMR) have paved inner access roads with proper drainage and about 27 percent of settlements do not have proper access roads. Most highways in urban areas like CMR operate at or near maximum capacity, especially during peak periods. The major problems of road transportation in CMR and most of the provincial capitals are congestion, low mobility, high incidence of accidents and air and noise pollution.

### **3.2.2 Problems with Rural Transportation**

Except in the Colombo District, the great majorities of people in the rest of the districts live in rural areas. Tertiary system of roads comprising over 88,380 km of local or unclassified roads are mainly located in rural areas and serve rural population to access essential services like the health care facilities, schools, banks, markets etc. The local government authorities like the Pradeshiya Sabhas (PSs) are entrusted with construction, rehabilitation and maintenance of local roads.

Rural transport infrastructure, has largely been neglected for many years. Shortfall occurs in rehabilitation and maintenance of local roads due to lack of sufficient funds to local authorities, institutional limitations like the long-practiced work patterns of Government institutions and poor planning. There is little participation of communities in the plans too.

## **3.3 Traffic Accidents**

Rising vehicle population, narrow roads, lack of discipline amongst the drivers and loopholes in the law enforcement system have meant increasing accident rates over the past few years. In the year 2000, one in sixty deaths was due to traffic accidents whilst the corresponding ratio about twenty-five years ago was 1:127. In 2012, 42,088 accidents have occurred, 2425 persons were killed whilst the number of fatal accidents was 2,300. Sri Lanka's traffic system risk

(number of fatalities per 10,000 vehicles) is 11.1 compared to 7 in Malaysia and 1.2 in Norway of fatal accidents, more than 27.7 percent of the deaths involve pedestrians and 8.5 percent involve pedal cyclists. In other words, nearly 40 percent of the deaths involve non-motorized road users. It is believed that all accidents are not recorded and practices of certain insurance companies pre-empt recording of accidents.

Though accident rates in rural areas are increasing, the majority of reported accidents have taken place in urban areas especially in Colombo District. Accident occurred within the Colombo Metropolitan Region in the year 2011 is given in *Table 3.2*.

**Table 3.2- Accident in Colombo Metropolitan Region -2011**

<b>Class of Road</b>	<b>Fatal</b>	<b>Grievous</b>
National Road - Class A	374	982
National Road - Class B	260	864
Municipal Road - Class M	43	167
Provincial Roads - Class C	86	244
Unidentified Roads	72	25
<b>Total</b>	<b>835</b>	<b>2282</b>

**Table 3.3 Accident Severity – Colombo District (2008 – 2011)**

<b>Year</b>	<b>Fatal</b>	<b>Grievous</b>	<b>Non-grievous</b>	<b>Damage only</b>	<b>Total</b>
2008	266	933	2169	5502	8870
2009	269	973	2016	6774	10032
2010	329	1170	2346	8128	11973
2011	309	1234	2328	8289	12160

For instance, 40,258 road accidents were reported in 2011 and of this 12,160 took place in the Colombo City. This includes 309 fatal accidents and 1234 grievous accidents and out of the deaths more than 53% were pedestrians.

### **3.4 Importance of the Sector to the Economy**

The transport system of Sri Lanka consists of about 116,000 km of roads, 1,640 km of railways, three major ports and two international airports. The air and sea transport is mainly for import and export of goods and international passenger transport.

Coastal shipping is used to transport goods to the Northern, Eastern and the Southern parts of the country. The road and rail are the main modes of domestic transport.

The road transport is important due to the following reasons.

- The railway network is confined to limited areas and is in poor operating conditions.
- Road network penetrates to all parts of the country.
- Geography of the country
- The structure of the economy.
- This is the only mode of transport available to certain areas.

The rapid growth experienced in the transport sector has been due to the expansion of the economy in recent years. In addition to that under the regional and rural development programs that have been launched to develop the backward areas in the past, industries are also being presently located in these areas to improve the economy of these areas. The volume of traffic on the road system has increased substantially in many parts of the country as a result of these developments. The railway, on the other hand, is unable to make the necessary improvements and divert traffic off the road on account of large investment involved in the rehabilitation of the track and the purchase of locomotives and rolling stock.

The contribution of the road sub-sector to the transport sector has been increasing sharply since the 1980's. The road sector which accounted for 80 percent of the passenger transport demand and 92 percent of the freight transport demand in the early 1980's now accounts for about 92 percent of passenger transport demand and 99 percent of freight transport demand.

### ***3.5 Authorities Responsible for the Sector***

The Road Development Authority (RDA) which is under the purview of the Ministry of Higher Education and Highways is responsible for the planning, designing, construction, rehabilitation and maintenance of the National Highway Network (NHN) which is the highest level of hierarchy of the road network under the purview of Central Government. Next level in hierarchy of the roads are C and D class roads and are under the responsibility of provincial councils. The 3<sup>rd</sup> level and below are the responsibility of Local Government and other government and private organizations.

### ***3.6 Demand of the Sector and the Extent to which the Demand is satisfied***

As a result of the rapid economic development which has taken place with the introduction of open economy and the deterioration of public transport system, volume of traffic of the road network has increased tremendously. The implementation of large-scale development projects in various parts of the country necessitated the movement of heavy vehicles in all parts of the country. The government policy, under the liberalized economic programme, is to provide infrastructure facilities to satisfy the needs of investors.

In view of that rehabilitation and proper maintenance of roads has been given high priority. The Government as a policy has taken following activities to enhance the capacity of the network.

1. Planning of Expressways/ High Mobility New Highways to supplement the trunk road system, to cater to future needs, as a long-term solution.
2. Improvement/rehabilitation of the existing road NHN with minimum social and environmental damages in order to provide proper 6-lane, 4-lane and 2-lane facility.
3. Major improvements to critical intersections of NHN, through processes of Roundabout Constructions, Signalization and also with Grade Separation and Flyovers.
4. Construction of a system of Ring Roads/ Major By Passes to Cities, Major Towns and other important urban centers.

## 5. Improvement of weak and narrow bridges

National Road Master Plan (NRPM) was developed covering 10 years from 2007 to 2017 to address these strategies.

The government has obtained financial and technical assistance from Asian Development Bank (ADB), the World Bank (WB), Kuwait Fund, Funding from China and Japan Bank of International Corporation (JBIC) to develop the road sector and several rehabilitation programs have been completed and several rehabilitation programs are in progress at present funding from China headed by the EXIM Bank has been playing a predominant role in the implementation of these sectoral development programme.

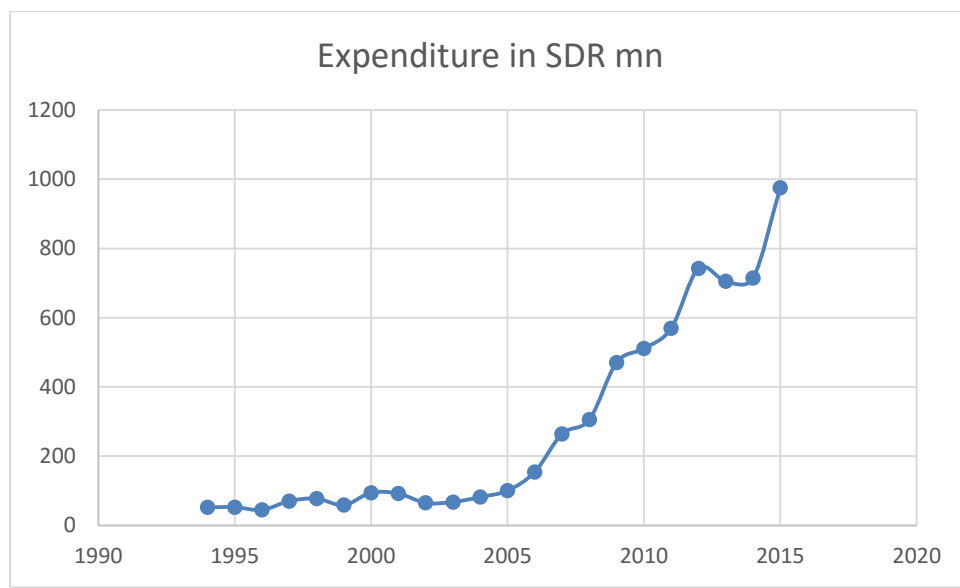
### 3.7 Budgeting and Expenditure

The government allocates substantial amount of resources for the development of the road network. About 17% of the budget is allocated for transport sector and nearly 60% of that is allocated to road sector. It is seen from the past statistics of expenditure that there is a significant growth in the amount of funds provided for national roads.

*Table 3.4 Growth of Expenditure*

Year	Expenditure Rs Millions	Expenditure SDR Millions
1994	3,682.97	52.059
1995	4,108.43	52.846
1996	3,593.51	44.792
1997	5,716.12	70.422
1998	6,786.68	77.418
1999	5,647.23	58.671
2000	9,429.44	94.389
2001	10,456.17	91.922
2002	8,065.62	65.080
2003	9,138.99	67.582
2004	12,279.01	81.926
2005	14,934.04	100.599
2006	23,645.00	154.543
2007	44,824.00	264.651
2008	52,018.00	305.533
2009	82,875.00	470.348
2010	84,689.00	510.830
2011	101,162.07	569.20
2012	131,969.76	742.54
2013	125,318.69	705.12
2014	126,997.07	714.56
2015	173,373.62	975.50

*Source: RDA Planning Division*



*Figure 3.2 Graphical Illustration of Growth of Expenditure (1994 -2015)*

The Government allocates substantial amount of resources for the development of the road network.

The average annual growth of expenditure has gone up from 5.4 percent in 1980-84 to 23.7 percent in 1990-94. Growth of expenditure is shown in *Table 3.3*.

### **3.8 Master Plan Out Comes**

National Road Master Plan (NRMP) prepared by the Road Development Authority in 2007 has identified 594 km comprising 5 expressways to be constructed during the period. Out of these the Southern Expressway, Outer Circular Highway Part 1 and Part 2 and Katunayake Expressway has been completed to a total length completed of approximately 169 km. Construction of Southern Expressway extension from Matara to Hambantota including expressway link to Mattala and Outer Circular Highway part 3 is in progress at present.

Major Part of National Roads under central Government which is maintained by Road Development Authority has been either rehabilitated or improved with funding assistance from domestic fund as well as donor funds. Map showing the present status of road improvement is given in Fig. 3.3 and the development of expressway network is given in fig 3.4

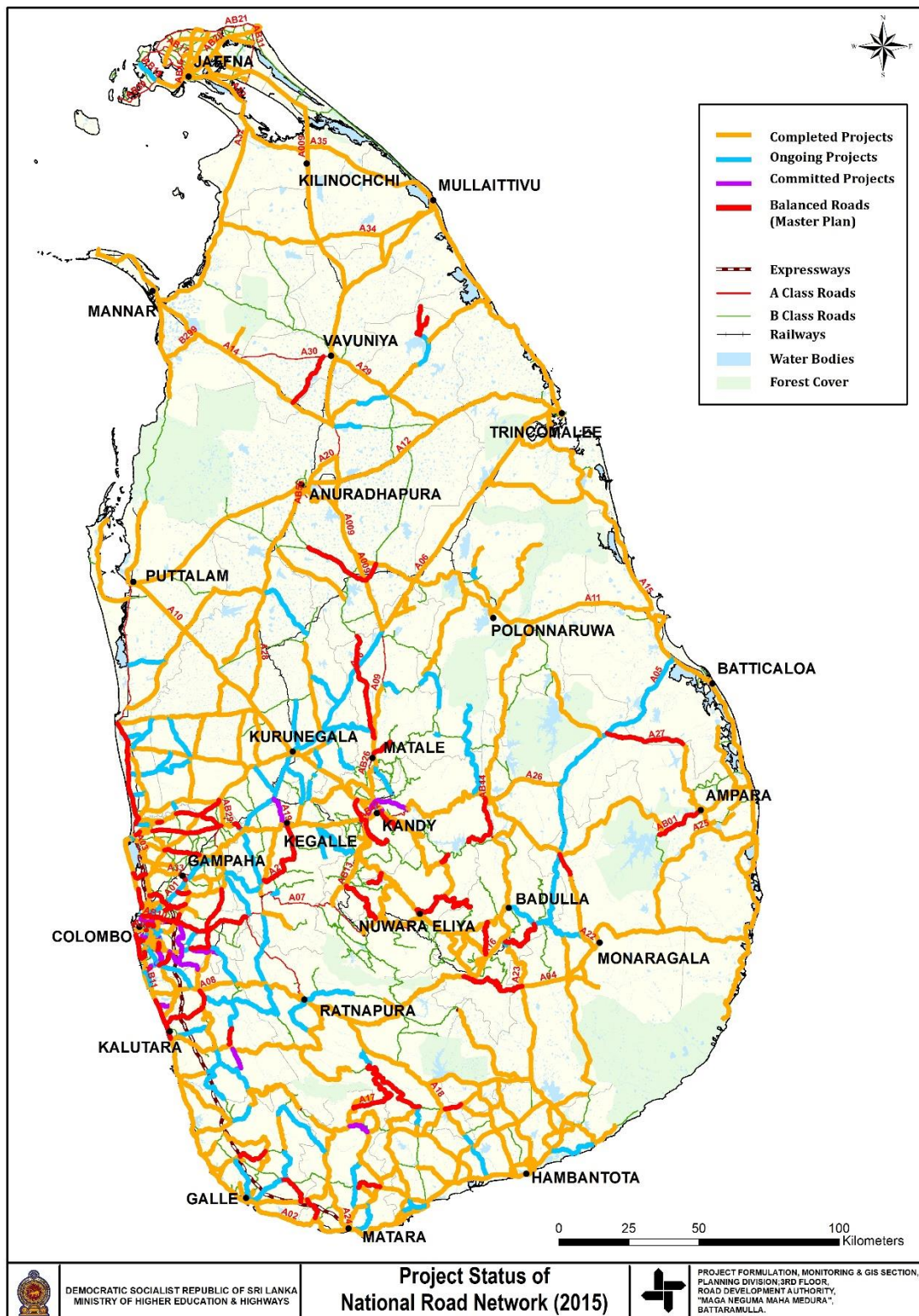


Fig 3.3 Present status of National Road Network.

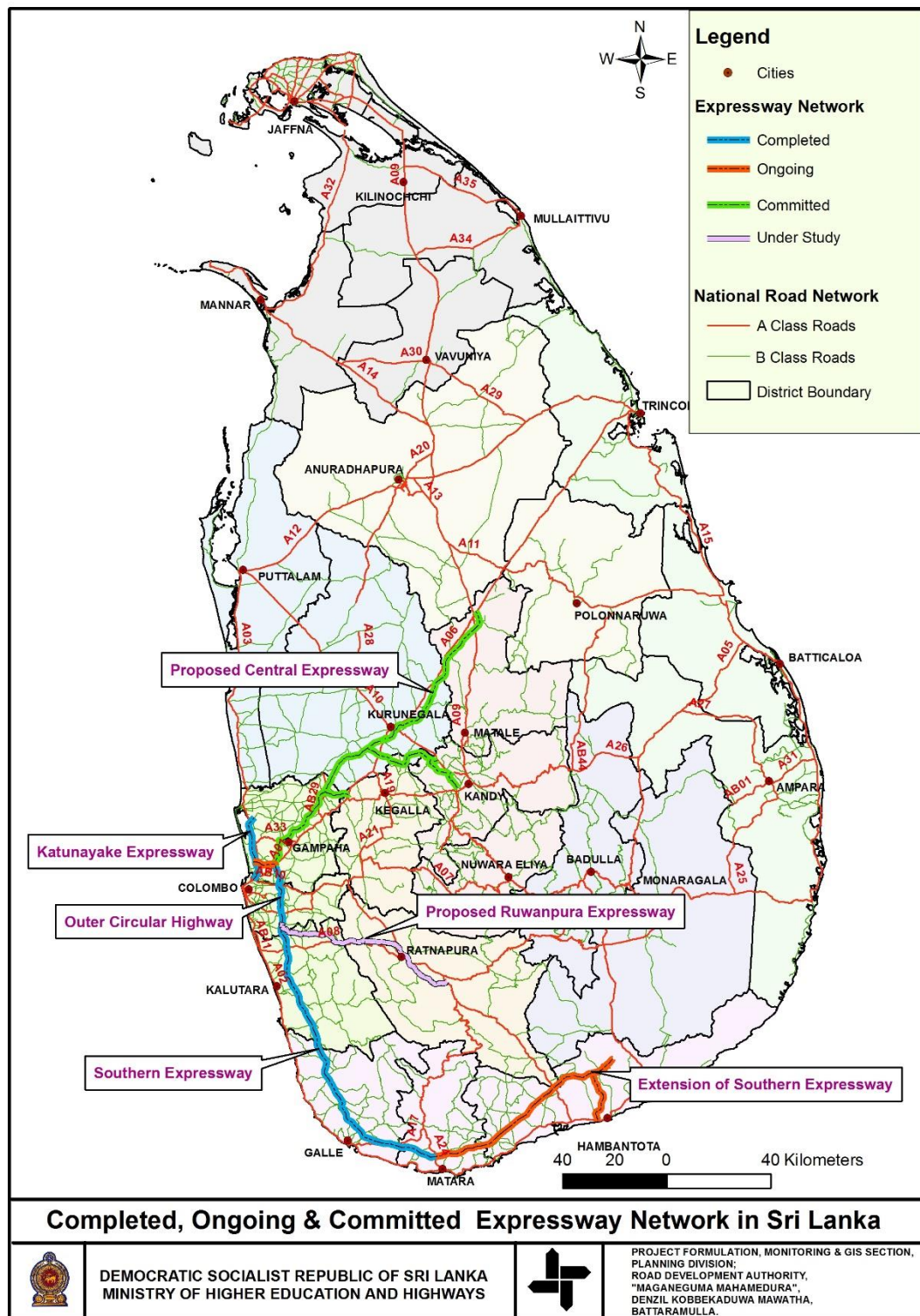


Fig.3.4 Expressway network Development

## Evaluation of Alternative Traces

# Chapter 4

### 4.1. INTRODUCTION

The objective of this chapter is to evaluate the alternatives identified in the selection of the final alignment of the proposed Central Expressway Project (CEP).

#### 4.1.1 Description of the Proposed Central Expressway Project

The expressway is proposed to start from the Outer Circular Highway and extend up to Dambulla, a link to Kandy from the main Colombo-Dambulla link is also envisaged. It is designed as a four lane expressway with operating speeds of 100km/h on the Colombo-Dambulla link and 80 km/h on the Kandy link.

#### 4.1.2 Study Methodology

The alternative analysis based on information available in existing studies done for the same corridor. Alternative traces selected for this study are based on the alternative traces proposed in the past feasibility studies on Colombo Kandy Alternative Highway and the Northern Expressway. The expressway alternative analysis was carried out based on the information available after reviewing the following feasibility study reports.

1. Colombo - Kandy Alternative Highway Feasibility Study - December 2001, Resource Development Consultants Pvt. Ltd.
2. Northern Expressway Feasibility Study - November 2013, SMEC International Pvt. Ltd.
3. Northern Expressway Project Report - February 2015, Road Development Authority.

In addition to this the observations made during the reconnaissance surveys carried out along the trace by the consultants was also incorporated in the evaluation.

### 4.2. ALTERNATIVE ANALYSIS FOR CENTRAL EXPRESSWAY PROJECT

Construction of expressway from Colombo to Dambulla with a link to Kandy will be necessary to cater to the existing and projected traffic demand from Colombo to Kandy, Kurunegala, Dambulla, Northern and Eastern regions of the Country. In this section possible alternatives to the proposed project are discussed.

#### **4.2.1 No Project Alternative**

Sri Lankan economy is growing rapidly after the thirty years of civil war. The Northern and Eastern regions which were the regions primarily affected by the war are the main beneficiaries of those development projects and it will contribute significantly to the GDP. Under the proposed development projects of the Western Region Megapolis, the cities around Katunayake, Mirigama, Colombo, Homagama, Horana and other main cities will be developed thus adding unprecedented amount of traffic to the existing road network of the country. In order to sustain the socio-economic development, it is apparent that the Northern, Central and Eastern provinces should be connected to Western region of the country through an “efficient” land based transportation system.

The existing transportation system is mainly through Colombo – Kandy (A001), Ambepussa – Kurunegala – Trincomalee (A006), Kandy – Jaffna (A009), Maradankadawala – Habarana – Tirikkondiadimadu (A011) Highways, Southern Expressway (E01) Colombo Katunayake Expressway (E03) and Outer Circular Highway (E02). At present it takes more than 12 hours to travel a distance of approximately 400km between Colombo and Jaffna in the Northern Province or Colombo and Trincomalee and Batticaloa (nearly 300km) in the Eastern Province. Although rehabilitation and resurfacing works have been done in the recent past, these roads are mostly of two lanes with exceptions near few town areas where there are four lane facilities. It should also be noted that even with the improved road surfaces the maximum operational speeds on these roads are limited to below 40kmph within town areas and around 60kmph outside town area.

Projected socio-economic growth in the North and Eastern regions and other key cities connected by above roads will exert an increased demand on the existing traffic flow along these roads. Such a situation will further increase the travel time between Colombo and key cities like Kurunegala, Dambulla, Jaffna, Trincomalee and Kandy. Already the sections of A001 Highway between Colombo and Ambepussa and Ambepussa to Kurunegala section of A006 Highway are highly congested with traffic. Increased travel time will lead to an increase in vehicle operational costs. Further the existing road surface will deteriorate at a much faster rate leading to more frequent recurrent maintenance work.

Given the existing conditions, the option of not proceeding with the CEP is not considered to be acceptable. While the “no project” scenario would have no involuntary resettlement impacts and would not impact on the natural ecosystems which would not be disturbed, the avoidance of these impacts is not considered to outweigh the negative impact that the restriction of economic growth potential would bring. As a result, the option of not proceeding with the project is not considered acceptable and is therefore not examined further.

#### **4.2.2 Improvement and Widening of A001, A006, A009 and A011 Highways**

Many sections of the A001, A006, A009 and A011 highways have been improved in the recent past and where possible widened to have four traffic lanes and some sections are already in the process of being upgraded to four lanes, the Colombo – Ambepussa section of A001 highway and Ambepussa – Kurunegala section of A006 highway could be considered equivalent to Section 1, 2 of the proposed CEP. At present these two highway sections have far exceeded their capacity. In order to sustain future traffic demand, the Colombo – Ambepussa section of A001 highway would need to be widened to 6 lanes. Such a move would have an enormous amount of land acquisition and resettlement impacts given the dense land uses immediately adjacent to the road corridor. Furthermore, even if this section of highway is upgraded to 6 lanes, given the maximum speed limits imposed on 'A-class highways and the road side activities, it would not allow for a significant gain in travel time. Additionally, there would be an increased risk of accidents for both vehicles and pedestrians.

As a result of above factors, it is considered that the improvement and widening of the key highways which represent the existing link between Colombo and the Northern and Eastern Provinces is not an acceptable option. Therefore the alternative analysis is confined to selection of most viable alignment for the construction of the Central Expressway.

#### **4.3. ALTERNATIVE ROUTES ANALYSIS FOR PROPOSED CENTRAL EXPRESSWAY**

The sections that were identified in the proposed Central Expressway Project for the alternative analysis are as follows:

- Section I – Colombo to Meerigama
- Section II – Meerigama to Kurunegala
- Section III – An expressway Link to Kandy
- Section IV – Kurunegala and Dambulla

Evaluation of alternative routes for each section was done considering multi-criteria analysis which included the highway engineering, transport, hydraulic, geotechnical and environmental aspects. A quantitative multi-criteria analysis based on ratings assigned under weighted criteria under each of the above factors is conducted to Section 1 as the report is confined to the section. However, for the subsequent sections the selection of the alternative can be justified satisfactorily based on qualitative multi criteria evaluation.

##### **4.3.1 Section 1 (Colombo to Meerigama)**

Four corridors were examined for Section 1; Two of them are starting from Enderamulla; one with an additional spur towards Ambepussa to allow traffic to access and egress the A1 (A-B-H), one following the A-B-H corridor from Enderamulla to Gampaha and then deviating to the west before falling back in to the A-B-N corridor at Meerigama (A-C-H), the other two are starting from a new interchange and Kadawata interchange in OCH trace; one to the east of the existing A1 (D) starting from an interchange between Enderamulla and Kadawata, and the other starting from Kadawatha via CKAH (Q) trace upto Gampaha and follows the A-B-H corridor at the end. Figure 4-1 shows the alternatives traces considered for Section 1.

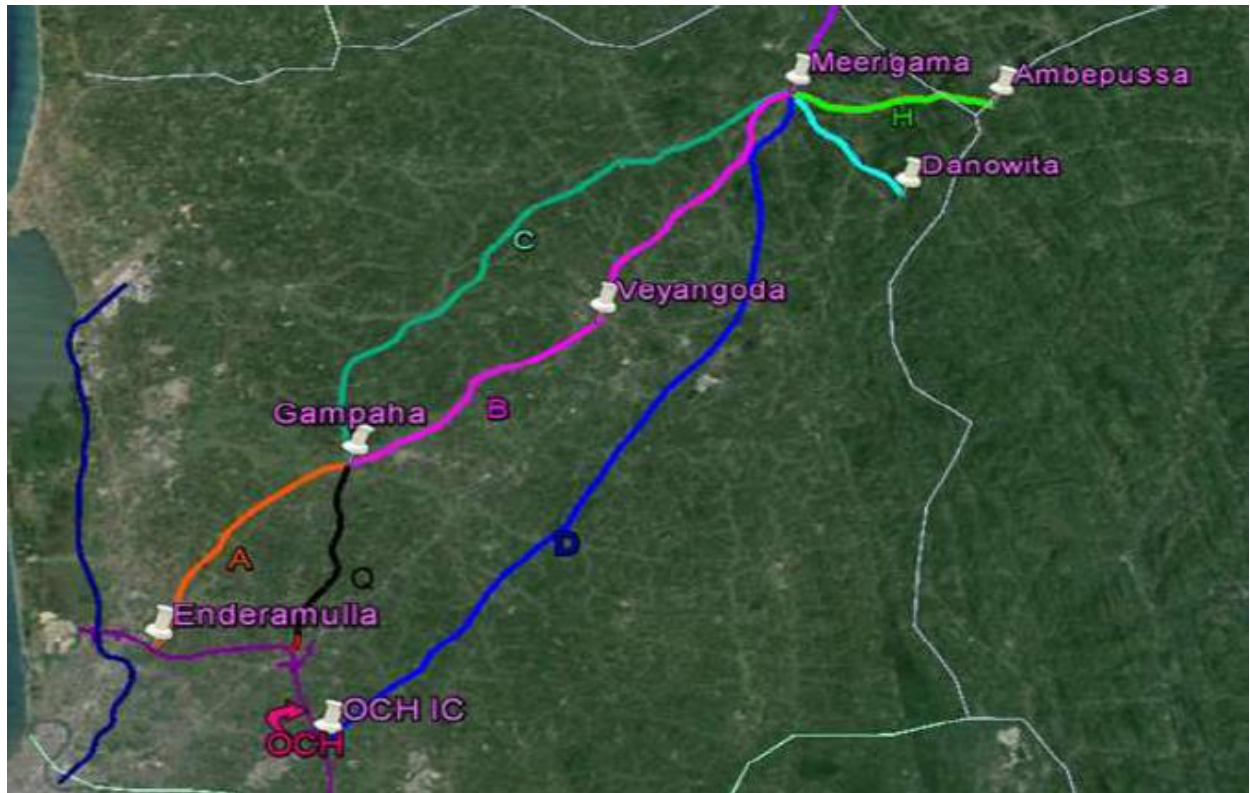


Fig 4.1 Alternative Traces for section 1 of Central Expressway

#### 4.3.1.1 Engineering and Transport Aspects

Initial comparisons of the selected alternatives are indicated in Table 4-1. These costings, along with an assessment of the relative benefits and drawbacks associated with the options, are included in Table 4-1.

Table 4.1

<b>Alternative Corridors</b>	<b>Length km</b>	<b>Probable Construction Cost Rs. bn</b>	<b>Relative Benefit</b>	<b>Relative Drawbacks</b>
1. A-B-H	45	129	<ul style="list-style-type: none"> <li>• Runs close to the railway corridor thereby minimizing resettlement and social impacts.</li> <li>• Affects least number of properties (791)</li> </ul>	<ul style="list-style-type: none"> <li>• High construction cost.</li> </ul>
2.A-C-H	46	113	Provides easy access to Bandaranayake International Airport.	<ul style="list-style-type: none"> <li>• Affects highest number of properties (916).</li> <li>• Perceived high social impact.</li> <li>• High construction cost</li> </ul>
3.D	42	96	<ul style="list-style-type: none"> <li>• Would alleviate traffic Issues at New Kelani Bridge and OCH/CKE junction.</li> </ul>	<ul style="list-style-type: none"> <li>• Affects high number of properties (900)</li> <li>• Does not provide direct link to port.</li> <li>• Perceived high social impact.</li> <li>• Difficult to incorporate new interchange on OCH.</li> </ul>
4. Q-B-H	36.5	128	<ul style="list-style-type: none"> <li>• Would alleviate traffic issues at New Kelani Bridge and OCH/CKE junction</li> <li>• Runs close to the railway corridor thereby minimizing resettlement and social impacts</li> <li>• Shortest distance to OCH and southern Expressway</li> </ul>	<ul style="list-style-type: none"> <li>• Does not provide direct link to port.</li> <li>• Affects moderate number of properties (800)</li> <li>• High construction cost</li> </ul>

The costs given in Table 4.1 are based on assumption of per km basis of previous construction expressways for purposes of comparison between different routes and should not be assumed to be detailed cost estimates. In conclusion, route via CKAH was chosen for further study although it was assessed as one of the highest construction cost options, its reduced impact on social and resettlement issues resulted in it emerging as the preferred option. In addition, it was assessed that land costs would be lower than for the other options due to the lower number of residential properties impacted and this would at least partially offset the highest construction cost. Route via CKAH has the shortest distance to the OCH. South bound traffic can by- pass the busy interchanges in city center. Upon additional study, the link

to Danowita is discarded in preference to extending Section 1 from Meerigama to Ambepussa (H) to connect to the A6.

The main benefit of this alignment is that it allowed traffic on the A6 to easily access the expressway without having to travel along the already highly congested A1 between Ambepussa and Danowita. The alternative distances are measured from the start of the new expressways from OCH. The alternative Q-B-H has the shortest distance out of all alternatives hence has the highest travel time savings. It is followed by alternative D which has almost equal distance. The alternatives A-B-H and A-C-H follow as alternatives with least travel time savings. The accessibility can be evaluated as the location of the connection to the OCH and the key local cities that the alternatives pass through. The connection point to the OCH has three attributes; the accessibility to the city centre (port), Accessibility to the airport, Accessibility to the Southern traffic. It could be considered that majority of the traffic would enter towards the south from existing Southern and OCH expressways. Therefore, the connection being more southwards has a benefit of shorter distance and better accessibility for the travellers. While Alternative D has the south most connection to OCH, the trace passes through few urban centres thereby having less accessibility. Alternative Section C also has less urban centres connected while Section B has the highest and best connectivity to the urban centres with connection to locations like Gampaha, Veyangoda and also running parallel to the existing railways as well. Therefore, Section Q-B-H can be selected as the best trace in terms of transport considering travel time savings and accessibility.

#### **4.3.1.2 Hydrological Considerations**

Routes A and B are runs on low lying areas where floods are very frequent. These are hydrologically very sensitive areas where the existing drainage system can be adversely affected by the proposed road. Further, the northern end of the route Q, and some parts of the route H are also on areas with frequent floods. In flood areas, the adverse impacts caused by the road embankment on the drainage pattern is very difficult to be completely mitigated. Further, the road embankment reduces the flood retention areas in route A and B which can raise the flood levels.

In contrast, the routes D and C are mainly on highlands where the adverse impacts on the existing drainage pattern are not significant and any localized impacts can be easily mitigated by design. Whenever, the proposed road goes across a stream or a low lying area, by providing bridges or culverts with adequate sizes and levels, the existing drainage patterns can be maintained undisturbed.

Therefore, the Alternative 3 with route D is the best alternative as it does not go through any major flood plains. The route C is also on high grounds and therefore the route A-C-H or Alternative 2 is the second best. The route B is mainly on the Attanagalu Oya and Diyaella Oya flood plains making the Alternatives with route B, less preferred in hydrological view point. Alternative 4 is however better than alternative 1 as the route Q (in Alternative 4) is less vulnerable to floods compared to the route A (in Alternative 1).

#### **4.3.1.3 Environmental Issues**

Out of the four alternatives that are being considered, A-B-H and Q-B-H would have the least impact on properties. The other two alternatives (A-C-H and D) would affect at least 100

properties more. Out of A-B-H and Q-B-H, the latter can be considered to be the better option because the length of the trace is 8.5 km shorter. Q-B-H can therefore be considered as the option that would have the least perceived social impacts due to resettlement and acquisition of private property.

All the four alternatives generally traverse mostly parallel to railway lines, and through paddy, marshy and uncultivated areas. In certain sections, the traces have been aligned so as to minimize the impact on existing settlements. The impacts on the existing land use are comparatively the same for all the four alternatives.

All the four traces fall within the same catchment areas of Attanagalu Oya and Diyaella Oya. Therefore, the impacts on quantity and quality of surface water would be almost the same for all the four traces. The impact on surface water bodies, such as irrigation tanks and reservoirs are not significant, other than the impacts on Kapu wewa (which falls on A-B-H) near Ragama. By selecting the Q-B-H as the preferred trace such impacts can be avoided. Impacts on water quality, air quality are almost the same for all the four traces. Impacts due to noise and vibration during construction and during operations are again comparatively the same for all the four traces, due to similar land use and habitation characteristics.

Ambient water quality, air quality, noise and vibration levels do not show any significant variations among selected locations of similar character along the four traces.

#### **4.3.1.4 Social Issues**

##### **Introduction**

As describe early the Stage 1 starts at Kadawatha (00+000 km) and ends at Meerigama (37.9 km). It mainly traverses through home gardens, paddy fields and coconut fields. In addition, there are many natural water bodies and local roads crosses by the proposed road.

##### **Impact on Lands**

As identified in the social assessment and resettlement action plan the total number of all affected plots of private lands in Stage 1 is 2,288 belonging to 2,175 Project Affected Household Heads (PAHHs). Total extent of these private lands is 172,618.20 perches (1,079 acres). Among these total extent of private lands 124,666 perches (779 acres) are affected by the project (95.8 %). In addition, there are 275 plots of lands under government or community organizations and the total number of affected land extent is 5,500 perches (34 acres).

##### **Impact on Private Lands and Use**

The highest impact of land acquisition in CEP Stage 1 is on private lands (124,666 perches) and it represents 95.8 % of the total lands to be acquired. The rest 4.2 % is government land and common/public lands. The private lands identified in the survey can be classified into four major categories as shown in Table 04. According to the Table 73 % (52.9 % of PAHHs) are agricultural lands while 20.9 % (37.2 % of PAHHs) represents residential lands. About 3.6 % of the plots of lands are not used for either agricultural or other purposes (barren lands). The least category is commercial lands 2.5 % used for different trade and business purposes.

**Table 4.2: Private Lands Affected as per the Type of Lands**

Type of Land	No. of PAHHs	%	Total Area (Perch)	%	Affected Area (Perch)
Residential	810	37.2	36,020.61	20.9	25,632
Trade/Business	59	2.7	4,238.58	2.5	1,876
Non-Agricultural	155	7.1	6,283.76	3.6	4,228
Agricultural	1151	52.9	126,075.25	73.0	92,930
Total	2175	100	172,618.20	100	124,666

Source: CEP/Stage 1/RDA/Census Data

The total number of land plots is higher than the total number of PAHHs indicating a high tendency of land ownership. Especially, there are many paddy land owners who are having more than one plot of paddy land. All these figures clearly imply that the ROW crosses rural areas of affected districts.

The all lands affected in Stage 1 are belongs to Gampaha district. Stage 1 is distinct from other stages of CEP due to the level of population density and the type of land use. Highest affected private lands are situated in peri-urban areas (1,623 PAHHs). Majority of these lands are coconut and paddy fields. Second highest is located in rural areas that mostly located in Meerigama, Attanagalla, Minuwangoda, and Diwulapitiya DSDs (408 PAHHs). In addition, there are some lands located in urban areas such as Kadawatha, Gampaha and Veyangoda townships (144 PAHHs). Table 4.3 illustrates more details on the basis of types of land.

**Table 4.3: PAHHs as per the Location of Private Land in Stage 1**

Types of Land	Number of PAHHs			Total
	Urban	Peri-urban	Rural	
Residential	52	621	137	810
Trade/Business	10	46	3	59
Non-Agricultural	7	130	18	155
Agricultural	75	826	250	1151
Total	144	1623	408	2175

Source: CEP/Stage 1/RDA/Census Data

With view of identification of mitigatory measures for the environmental and social issues separate environmental assessment and social assessments are carried out necessary approval need to be obtained.

#### 4.3.1.4 Geotechnical Engineering Aspects

The alternatives have been plotted on the general soil map, elevation and geomorphology maps of Sri Lanka as given in Figure 4.2. All these traces indicate quite similar geological and topographical conditions in Section 1.

However, it has to be noted that a serious input is needed for ground improvements as most of these traces lie on very low grounds such as paddy fields. Detailed investigations are necessary for any ground improvement methodology to be adopted. All the traces have similar weightings in geological and topographical aspects.



Fig. 4.2 Alternate traces on general soil map

#### 4.3.1.5 Multi-criteria analysis for Evaluation of Alternatives for Section 1

Due to the complexities of selecting the most suitable trace for Section 1, a weighted rating was calculated for each alternative under identified set of criteria. Each criteria was given a weightage by the consultant team to reflect the relative importance of the particular criteria. Each consultant assigned a rating (a score from 1-5) under each category in his area of expertise for each alternative. The weighted rating was then calculated and the alternative trace with the highest weighted rating was deemed the most suitable one for the section. The results of the analysis is given in Table 4.2.

Table 4.2 – Multi -criteria Analysis for Section 1 from Kadawatha to Mirigama alternatives

					Alternative 1		Alternative 2		Alternative 3		Alternative 4	
Category	Total Weightage	Impact factor		Weightage	Rating	Weighted score	Rating	Weighted score	Rating	Weighted score	Rating	Weighted score
Highway Engineering	15	Availability of local resources		3	2	6	2	6	2	6	2	6
		Constructability issues		3	2.5	7.5	2	6	2	6	2.5	7.5
		Cost		9	2.5	22.5	3	27	3	27	2.5	22.5
Transport	15	Travel time savings		8	3.5	28	3	24	4	32	5	40
		Accessibility		7	4	28	3.5	24.5	3	21	5	35
Hydrological	25	Hydrological sensitive area		10	1	10	2	20	2	20	2	20
		Impact to drainage system		15	1	15	2	30	2	30	1	15
Environmental and social	30	Effect to natural resources		3	2	6	2	6	2	6	2	6
		Ecological impacts		3		0		0		0		0
		Pollution	Emission	5	2	10	2	10	2	10	2	10
			Noise	8	1	8	1	8	1	8	1	8
			Water	3	3	9	3	9	3	9	3	9
		Impact from land use change		8	1	8	1	8	1	8	2	16
Geotechnical	15	Geological Sensitive areas		8	2	16	2	16	2	16	2	16
		Topography		7	4	28	4	28	4	28	4	28
Total weighted rating						202		222.5		227		239
Rank						4		3		2		1

## **4.4. CONCLUSION**

The study has evaluated the proposed alternative routes for the Central Expressway in order to select the best possible alignment considering the following factors,

- Highway Engineering
- Transportation
- Hydrological
- Geotechnical
- Environmental and Social.

The expressway was divided into four sections for the purpose of the analysis and alternative traces were evaluated for each section of the expressway. The final expressway alignment would be a combination of the selected traces for each section of the expressway. The alternative traces for each sections were generated from past feasibility studies on Colombo-Kandy Alternative Highway and the Northern Expressway. The selected traces from the alternatives for section 1 based on the multi-criteria analysis is

Q-B-H - Kadawatha to Mirigama via Gampaha, Veyangoda.

## Geotechnical Investigations

# Chapter 5

### 5.1 Introduction

The proposed final trace runs through and crosses, flood plains, flat terrain and relative high grounds. When the topography of Sri Lanka is considered as a whole, it consists of three Pene-plains, a plain produced by long periods of weathering and erosion. The project area lies within the lowest Pene-plain which surrounds the central hill country on all sides and is generally flat, sometimes gently undulating plain stretching down to the coast.

### 5.2 Objectives of the Geotechnical Studies

The studies are carried out aiming to find the solutions for following:

- i) Solutions for the following geotechnical/geological problems:
  - Embankment construction on soft grounds;
  - Foundations for bridges and other structures;
  - Stability of slopes and earth retaining structures; and
  - Disposal of the construction waste.
- ii) Availability of construction materials such as: fill material; sand and aggregate (metal) in terms of both quality and quantity; and
- iii) Other concerns during construction stage such as: ground vibration due to rock blasting, ground vibration due to construction activities, soil erosion etc.

### 5.3 Data Collection

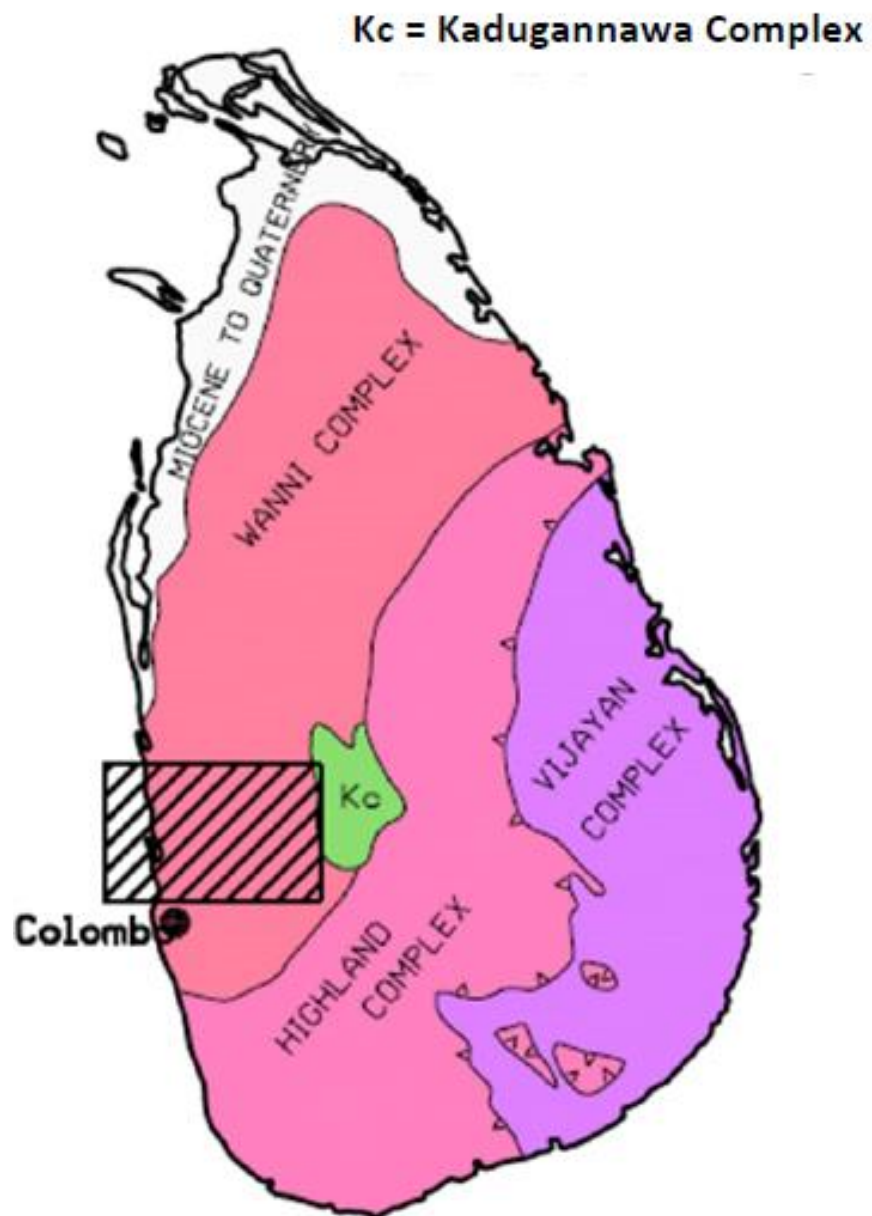
A Geotechnical desk top study has been undertaken which comprises identification and review of currently available historical geotechnical data relevant to the study area. List of general desktop data that has been obtained for review has been summarized below for reference:

- Geomorphological Map of Sri Lanka 1:1,000,000 scale
- Soil Map of Sri Lanka 1, 1,000,000 scale
- Geology Map of Sri Lanka 1:1,000,000 scale
- Regional Geological Maps at 1:100,000 scale (Sheets 14,13 10 and 16)
- Inferred Map of Landslide Hazard Zones for Kandy and Kegalle districts (NBRO)
- Location maps of currently held mining licenses (GSMB)
- An Introduction to the Geology of Sri Lanka (Ceylon) - Text by PG Cooray

#### 5.4 Geological Setting

Around 90% of Sri Lanka is underlain by Precambrian aged, high grade metamorphic rocks from the Indian Shield, which are divided into four lithological complexes, as follows:

- ☐ Central Highland Complex
- ☐ Wannai Complex
- ☐ Vijayan Complex
- ☐ Kadugannawa Complex.



### Fig 5.1 Distribution of Rock complexes with in Sri Lanka

The proposed trace is anticipated to traverse the Wannu, Kadugannawa and Highland Complexes.

Key geological aspects of these units are summarised below for reference. The fold belt of the Highland Complex geographically occupies the Sri Lankan Central Hill country and part of the northern plain, extending from the south west to north east of the island.

Highland series rocks generally comprise interbanded and metamorphosed sediments and charnockitic gneisses. The subordinate Kadugannawa Complex occupies the area in the vicinity of the Kandy arena. Deformed into distinctive NNW- SSE trending boat shaped doubly plunging systems, this highly folded complex forming the Kandy arena is anticipated to typically comprise hornblende-biotite gneisses. Quartzite, quartz schist and migmatite bands are anticipated to be present also.

The Wannu Complex (WC) is located to the west of the Highland Complex, and typically comprises granitoid gneiss, charnockitic gneiss, granite and metasediments. The Vijayan Complex is located to the east of the central Highland Complex and typically comprises biotite-hornblende gneiss and bands of metasediments and charnockite gneisses.

## **5.5 Material Availability**

Availability of good quality construction material particularly rock and gravel fill materials in appropriate quantities in the vicinity of the project area is a very important factor for economic feasibility of a project of this magnitude. Therefore, a survey of the metal quarries and gravel borrow areas was carried out to prepare a list of metal and gravel quarries within the project area and the vicinity.

A desktop study of current mining and mineral deposits has been undertaken. Sri Lanka's GSMB has provided a list and location plan of currently held category A and B Industrial and Artisanal mining licenses for the area in vicinity of the Stage 1 and 2 alignments

Large quantities of soil and rock will be required to be obtained to facilitate the construction of the works. Earthworks materials will be available from site via cuttings, or alternatively obtained from local borrow pits or quarries. To minimize construction cost and environmental footprint, use of site own cut materials will be preferred to importation of materials from borrows or quarries. A review of currently used materials and sources is presented below

### **5.5.1 Hard rock**

Charnokitic orthogneiss is understood to be preferred as a pavement material due to its hardness, toughness, abrasion resistance and interlocking texture. From desktop review, this material dominates the subsurface geology along Stage 1 and 2 traces, from Veyangoda through to Kurunegala.

An abundance of hard, sound, durable rock quarries are present around Meerigama and beyond, with a full range of quarried aggregates and larger dimension stone readily available and used for concrete, road, port and building construction. Rough dimension rock for use on the CKE project is understood to be currently sourced from Diwulapittiya and Pannala areas, which are located 8-10 km west of the section 1.

This rough dimension rock is transported and crushed at the expressway sites crushing plant, where aggregate material is produced for concrete and road construction materials for the project.



Fig : Hard rock crushing plant close to section 1 trace

### 5.5.2 Laterite

Lateritic soils are potentially considered an excellent material for the construction of dams, levees and road embankments due to their good compatibility, low permeability when compacted and hardening upon exposure to air. Laterite gravel has been extensively used in Sri Lanka and elsewhere around the world within tropical environments for road base and wearing course. Ferricrete has historically been used for building stone, base course for pavements and airstrips.

### 5.5.3 Soil and weathered rock

Soil and weathered rock borrow areas were observed at various locations along the section 1 trace, typically comprising clay/sand/gravel mixtures derived from either laterite or weathered quartz dominant ridges. It is understood that this material is widely used as general filling material for road works and general civil works. See Plate 2-3 and Plate 2-4 for examples of disused borrow pits located in the vicinity of the Stage 1 trace and Stage 2 alignment respectively.

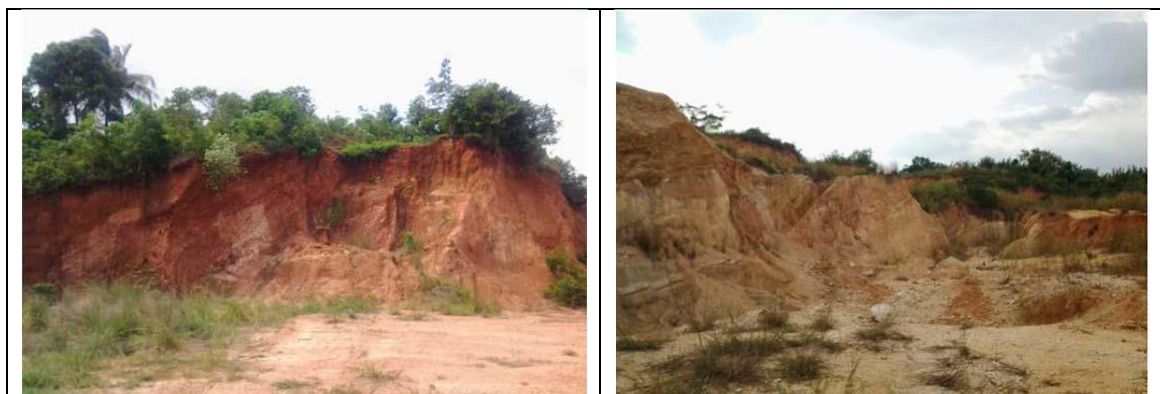


Fig 5.2: Abandoned Borrow - section 1 trace Ch 38+500

#### **5.5.4 Dredged sand**

Sand dredged from offshore areas west of Negombo has been successfully used as embankment fill material for the CKE project. Additionally, this material has been screened, processed and utilized as sand in concrete production.

## ***Hydrological Study***

### *Chapter*

# 6

#### **6.1 Introduction**

Sri Lanka is mainly divided in to two hydrological zones namely Wet Zone and Dry Zone. The Proposed Expressway (CEP) trace falls in Wet Zone. Also the trace passes through two hydrologically sensitive areas and several other streams. Two main sensitive areas are Attanagalu oya Flood Plain and Deella Flood Plain.

In addition, the trace crosses several irrigation canals in the area.

#### **6.2 Main Objectives**

Main objective of this chapter is to highlight main findings carried out under the separate hydrology study along the road corridor within the area that are affected by the construction of the Proposed Expressway (CEP). The study also includes the collection of data on relevant streams, flood plains, lowland areas, catchment areas relevant to different streams, rainfall variations, variation of flood flows and flood levels in streams, inundation of land during floods etc.

#### **6.3 Existing Geological Features**

##### **6.3.1 Location Map for Section 1 of Central Expressway**

The project area lies mainly Kalu Oya and Attanagalu Oya Basins. Figure 6-1 shows the Section 1 of the proposed Central Expressway.

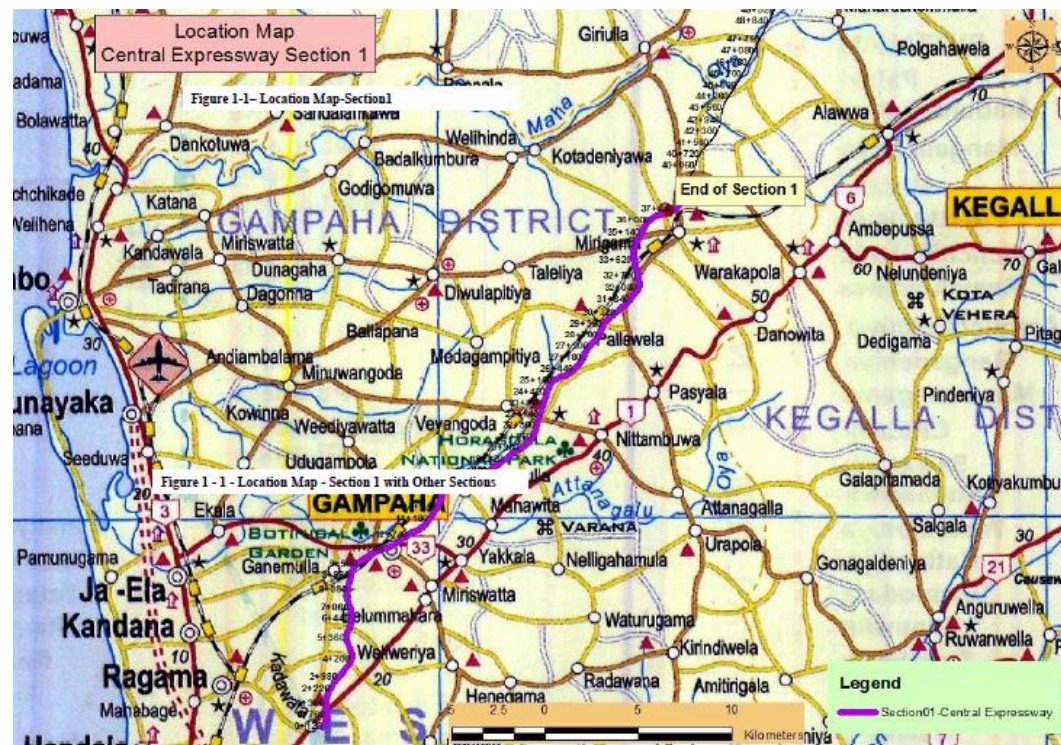


Fig 6.1 Location map of Section 1 with road network

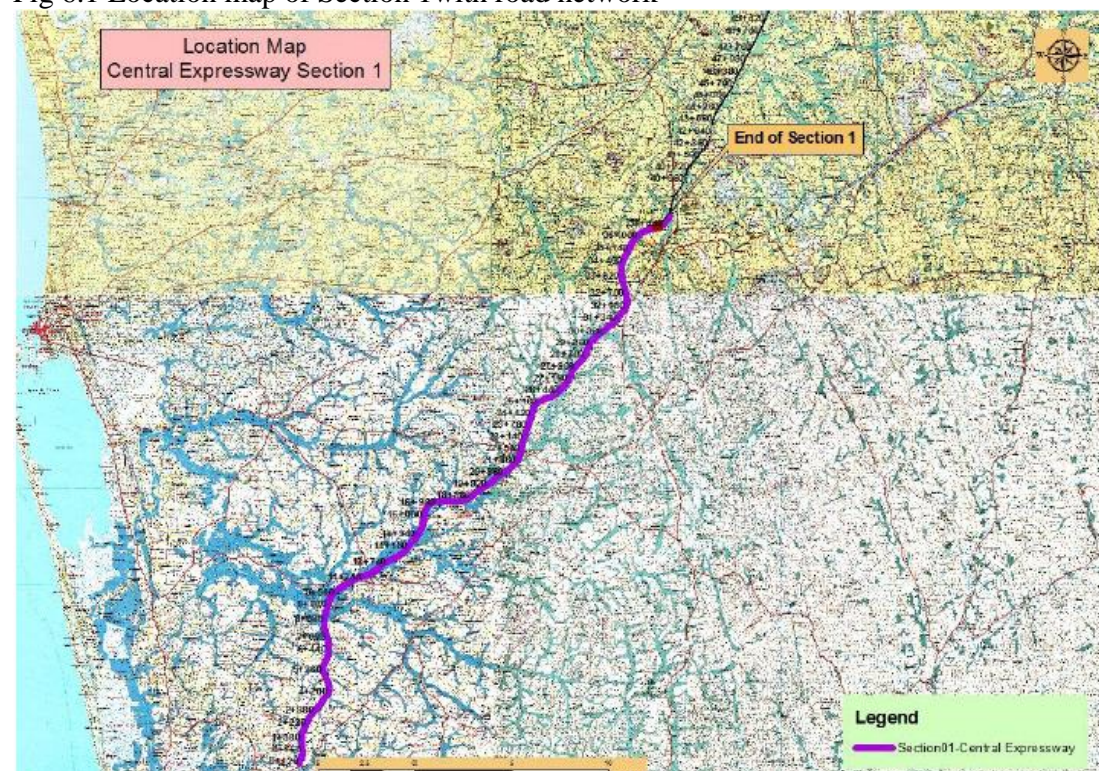


Fig 6.2 Location Map showing streams and water bodies

Proposed road trace in Section 1 entirely runs through low-lying areas mainly paddy fields, abandoned paddy fields, marshes and wetlands which are vulnerable to floods. Flood plains of Attanagalu Oya and its tributaries dominate the list of low-lying areas in this stretch. Categorization of streams are done according to their discharge capacities. Streams and creeks where there is a minor discharge requiring only a culvert are classified as minor streams and

the streams and rivers with higher discharges are categorized as major streams where bridges or via ducts are proposed. As the streams are shallow, catchment areas are high and the flood plains are vast streams alone will not become important entities where sheet flow dominates.

## 6.4 Major Streams

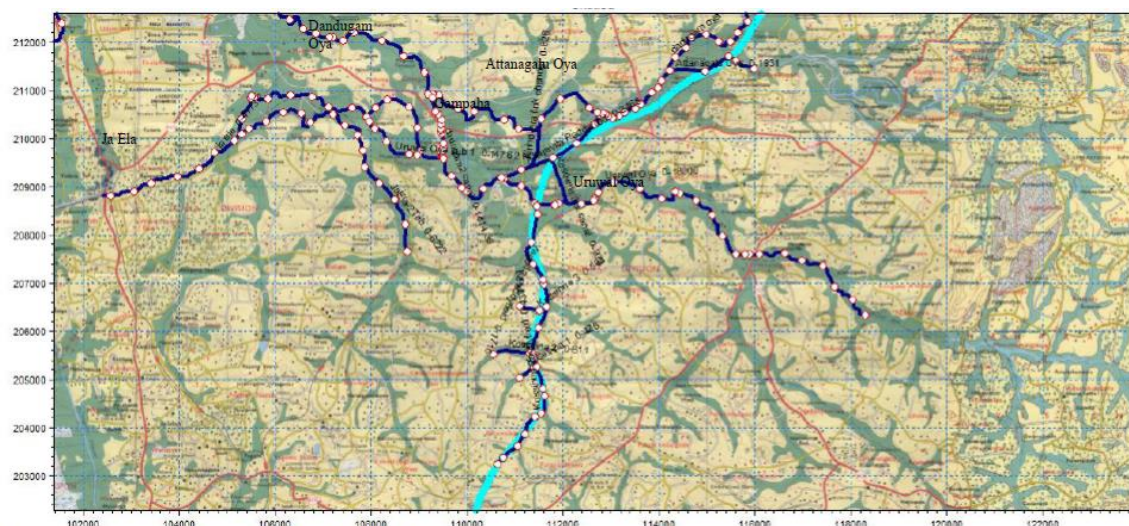
There are some streams and streamlets which cross the proposed expressway and most of the low lying areas are paddy areas which serve as flood plains. Major streams that drain across the expressway trace are given in Table 6.1.

**Table 6.1 -Major streams that drain across the expressway trace**

Chanage	Stream Name	Remarks
8+700, 8+440	Uruwal oya	There are multiple crossings
13+700, 18+900	Attanagalu Oya	
20+920, 22+540, 25+840, 26+440, 27+300, 29+840, 32+540, 33+860	De Eli Oya	

## 6.5 Minor Streams

There are many streams, creeks and irrigation canals identified using 1: 50,000/1: 10,000, topographic maps, topographic surveys satellite images and GPS information collected during site reconnaissance. Culverts are proposed at all those locations so that the storm water will cross the expressway with no disruption. However, there can be few additional locations where additional culverts may be necessary which can be identified only when a detailed topographic survey is done.



**(a) Stream network from 2+500 to 14+000 km**

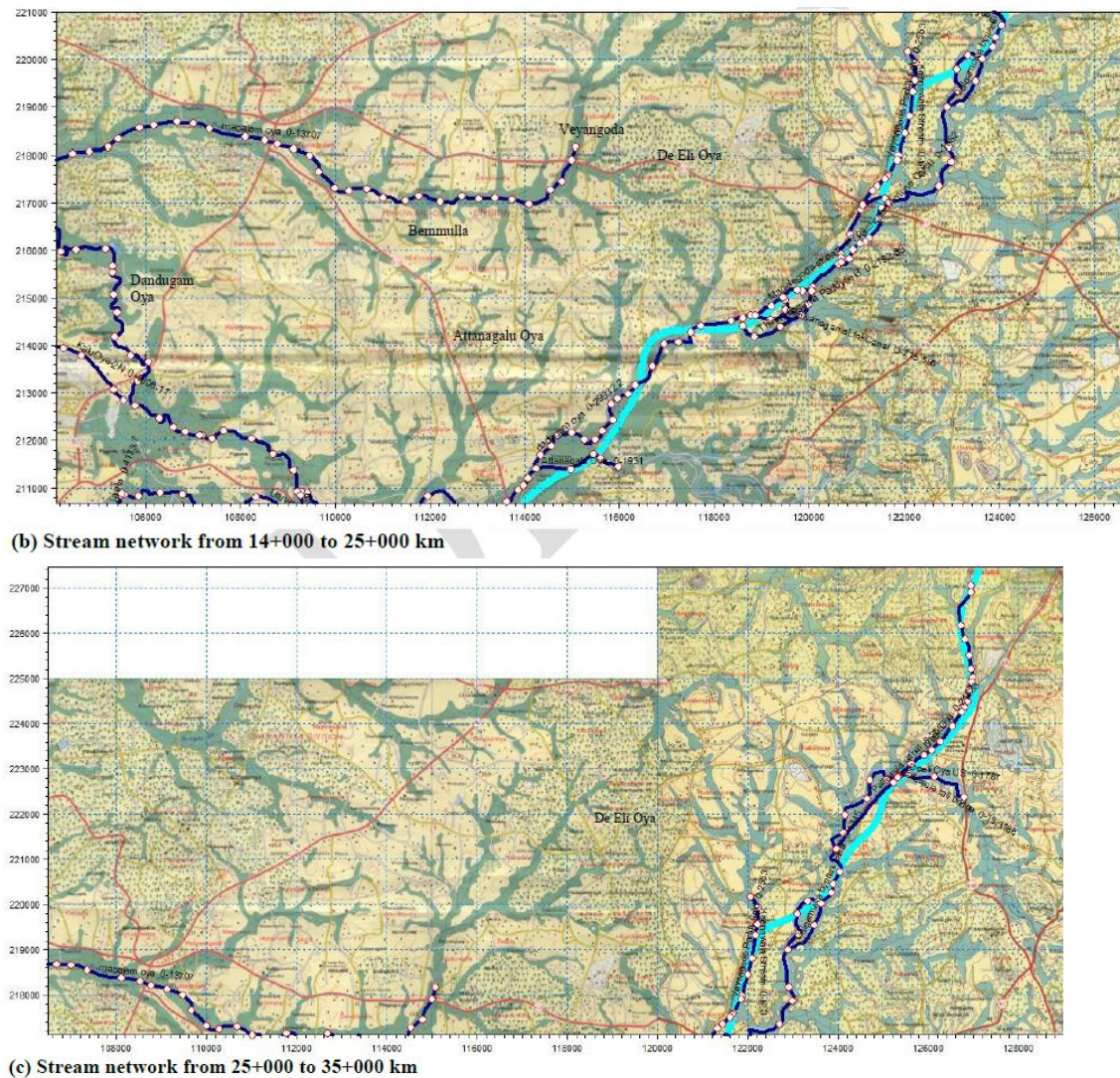


Fig 6.3 Stream network used in the Hydraulic model

## 6.6 Locations and details of Irrigation Anicuts

There are many irrigation anicuts in Attanagalu Oya basin and some of them are located in Di Eli Oya which is flowing close to the expressway. The expressway traverses very close to some of these anicuts in DeEli Oya. These anicuts consist of a weir sill and gates on them. During the flood time these anicut gates will be opened by the Irrigation Department operators. Many other anicuts are located in Attanagalu Oya upstream and downstream of the expressway. Function of most of these anicuts affect the flood situation in Attanagalu Oya basin. Hence it was necessary to represent these anicut as “hydraulic structures” in the flood model formulated for this section. Details of these anicuts were obtained from Irrigation Department. The anicut locations, gate sizes, number of gates, sill levels and the distance of longitudinal bund built up was obtained through site reconnaissance, topographic surveys, and irrigation scheme maps prepared by the Irrigation Department



Irrigation structures in Attanagala flood plain

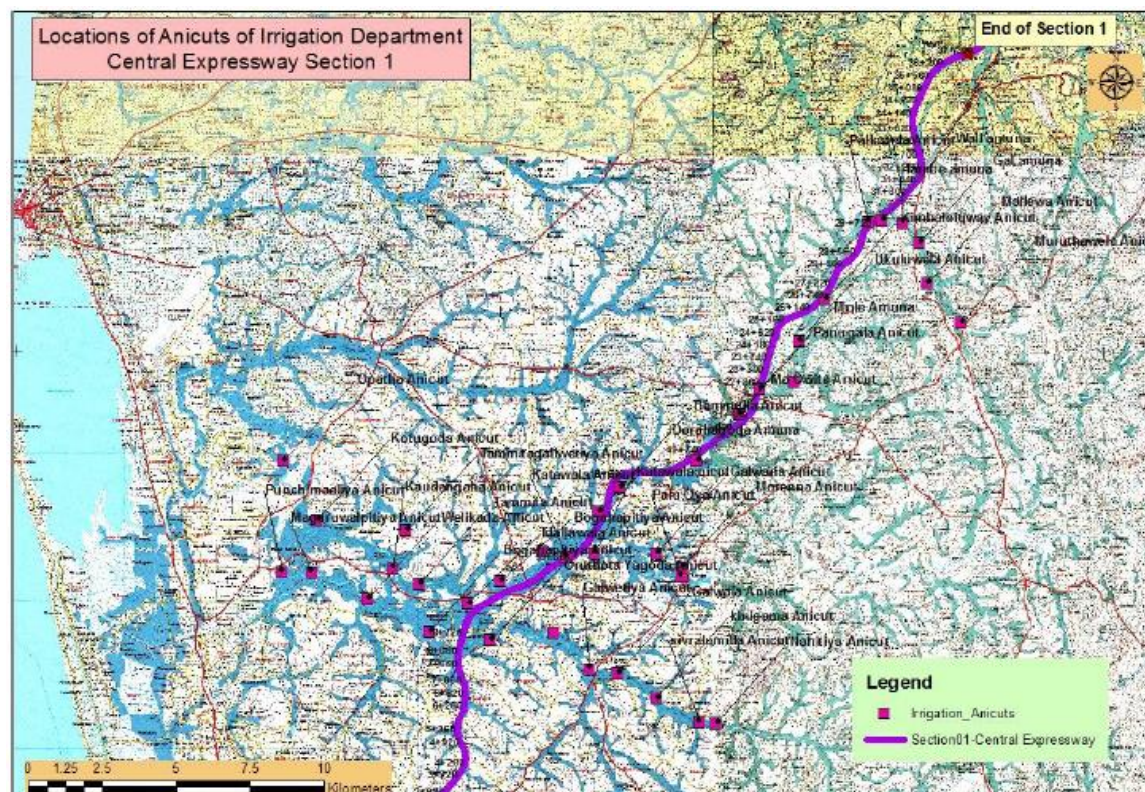


Fig 6.4 Location map of Irrigation Anicuts

## 6.6 Recommendation of Hydraulic study

- (1) Approximately, 30 km of proposed expressway in stage 1 run through low lying areas and 25 km of those are vulnerable to floods.
- (2) It was possible to minimize the impact of backwater inducement of floods by readjusting the positions and lengths of via ducts in the analysis using the hydraulic model. The status quo about floods will mostly remain unchanged.
- (3) Approximately 9.58km long via ducts, 22 numbers (5.6km) of bridges and 61 number of box culverts have to be proposed to minimize the backwater created by the expressway.

- (4) Some of the box culverts above serve as irrigation and access cum drainage structures.
- (5) Via duct positions are based on the model analysis to convey the flood without obstructions, to suite the local topographic conditions and also to accommodate the requests of local residents.
- (6) Some of the bridges and culverts will serve triple purposes i.e. drainage, irrigation and access.
- (7) Total length of the flood paths needed (green strips) is about 5 km.

## **7.0 Traffic Studies and Traffic Forecasting**

The traffic demand analysis for the Central Expressway Project, (CEP) was conducted using the Northern Expressway Strategic Traffic Model (NESTM) that was developed by M/S SMEC International (Pvt) Ltd, Australia as part of the Northern Expressway Project Feasibility Study.

The data collected by the study for the development and calibration of the traffic forecasting model is summarized below.

### **7.1 TRAFFIC SURVEYS AND ANALYSES**

#### **7.1.1 Traffic flow data**

In the NEP study the consultant use the traffic data collected by Road Development Authority and University of Moratuwa in the country especially the project area. Road Development Authority (RDA) has since 1985 carried out extensive traffic volume counts on A- and B-class roads.

In this NEP study, manual counts have been carried to supplement the data gaps identified in the study. Map showing the locations are given below.

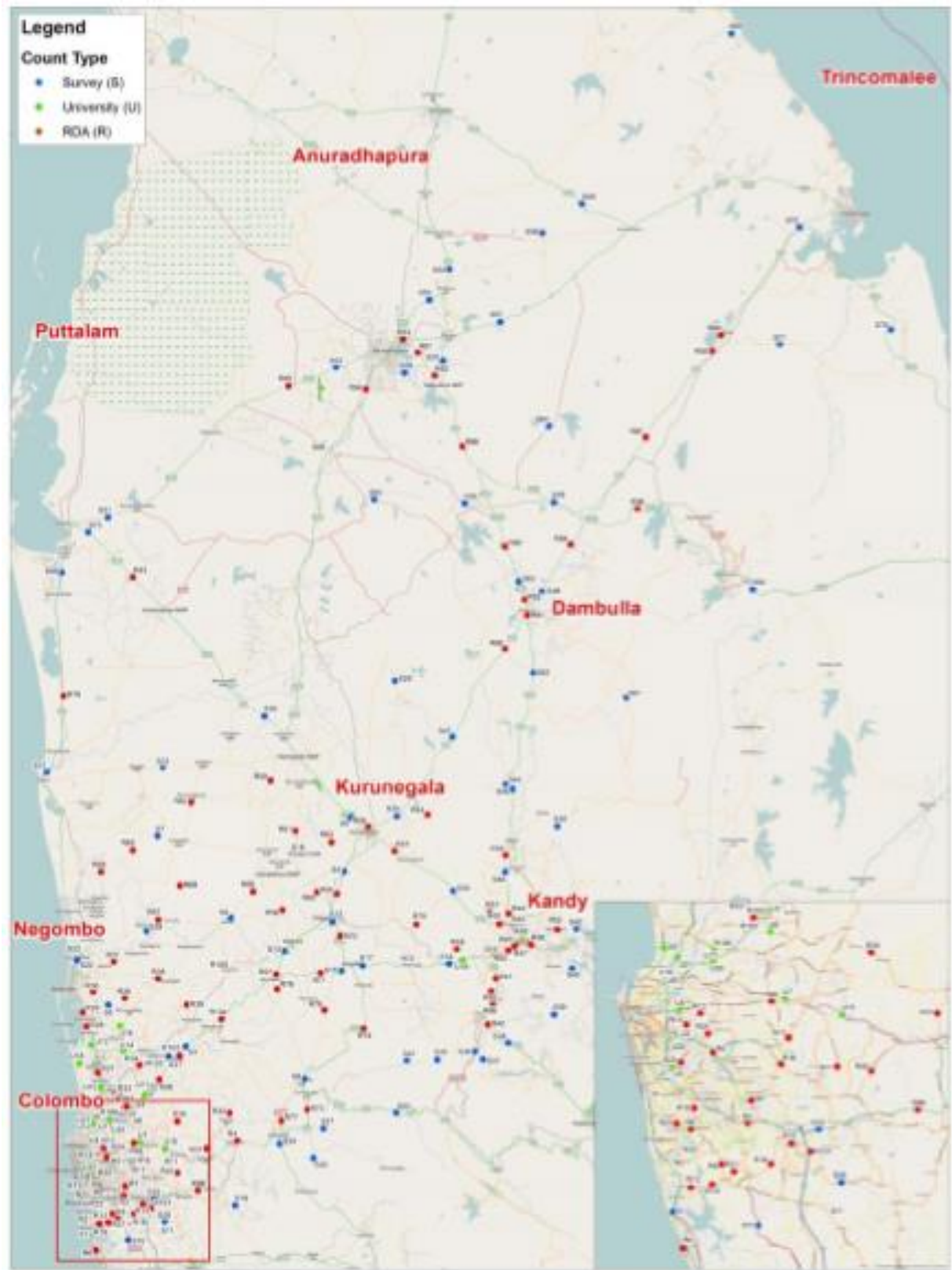


Fig 7.1 Location map of all counts

### 7.1.2 Origin-destination (OD) surveys

The purpose of the Origin and Destination surveys was to collect data on peoples travel patterns to help calibrate the model. The undertaking of traffic counts at this location formed a dual purpose. It allowed us to identify the proportion of survey vehicles in the OD survey and provided data on all traffic movements at that point over 16 hours. Again crucial data for model calibration.

The origin and destination surveys were undertaken in the form of road side interviews that sought to obtain a representative sample of vehicles excluding motorbikes, three-wheelers and buses. The surveys were two-way in direction and 12hr in duration (6am to 6pm). Surveys were undertaken between Monday to Friday but where possible focused on Tuesday to Thursday to provide a weekday average.

Sites were identified to perform the following roles.

**Cordon.** Sites were located along key roads that bisected the study area boundary. These

'Gate' sites were used to identify movements in and out of the study area.

**Internal movements.** These sites identified internal movements along the key highways and in particular inter-urban trips within the study area. It was felt that a high number of trips were of a relatively short duration along the highways between urban centers and as such it was important to capture these.

### 7.1.2 Road traffic growth

RDA has made repeated counts during ten years on several locations, thus providing growth trends. The annual growth on road A1 and road A6 is on average 6.6%. To understand the trend of traffic growth these growth rate were used.

#### 7.1.3 Speed-delay surveys

Travel time surveys allowed us to identify average travel times between designated points along key roads in the study area. The data was used to aid in the calibration of the model and along with the traffic count data were the two main sources of data available for validating the Project Model.

The travel time surveys were undertaken in the following manner. A standard road vehicle is driven along a defined start and end point of a road. Using a GPS logger the time taken and the speed of the vehicle is recorded. A number of surveys at differing times of the day and in the week will provide data on travel time and potential pinch points along the route for input into the traffic model.

Surveys were undertaken along various sections of roads given in the Table-7.1 below and roads are shown in the map given in Fig. 7.2

Table 7.1 – Road sections Traffic flow speed survey

Road	From	To
A1	Colombo	Kandy (inclusive of segments of Colombo – Nittambuwa and Kandy - Ambepussa
A4	Southern Expressway (Niyandagala Rd)	Avissawella (CRWB Hway/Avissawella By Pass Road Intersection)
A7	Avissawella	Karawanella
A21	Karawanella	Kegalle
A19	Kegalle - Kandy Road (A1)	Polgahawela (A6)
A6	Ambepussa (A1)	Kurunegala (Kurunegala Junction)
A10	Kandy (Gannoruwa Rd)	Kurunegala (Kurunegala Junction)
A3	Colombo (Nawaloka Roundabout)	Katunayake (Airport, Canada Friendship Rd)
A3	Katunayake (Airport, Canada Friendship Rd))	Negombo (Negombo - Giriulla Rd)
A3	Negombo (Negombo - Giriulla Rd)	Chilaw (Chilaw-Warlyapola Rd)
A33	Kanuwana - A3	Gampaha - A1
A003	Chilaw – intersection with B079	Puttalam intersection with A10
A10	Puttalam intersection with A3	Kurunegala – intersection with B247
A6	Kurunegala - intersection with B082	Dambulla – intersection with A009
A9	Dambulla - - intersection with A6	Matale - intersection with B194
A6	Dambulla - - intersection with A9	Trincomalee - intersection with B140
A9	Dambulla - - intersection with A6	Rambewa - intersection with A20
A12	Puttalam intersection with A10	Anuradhapura - intersection with A20

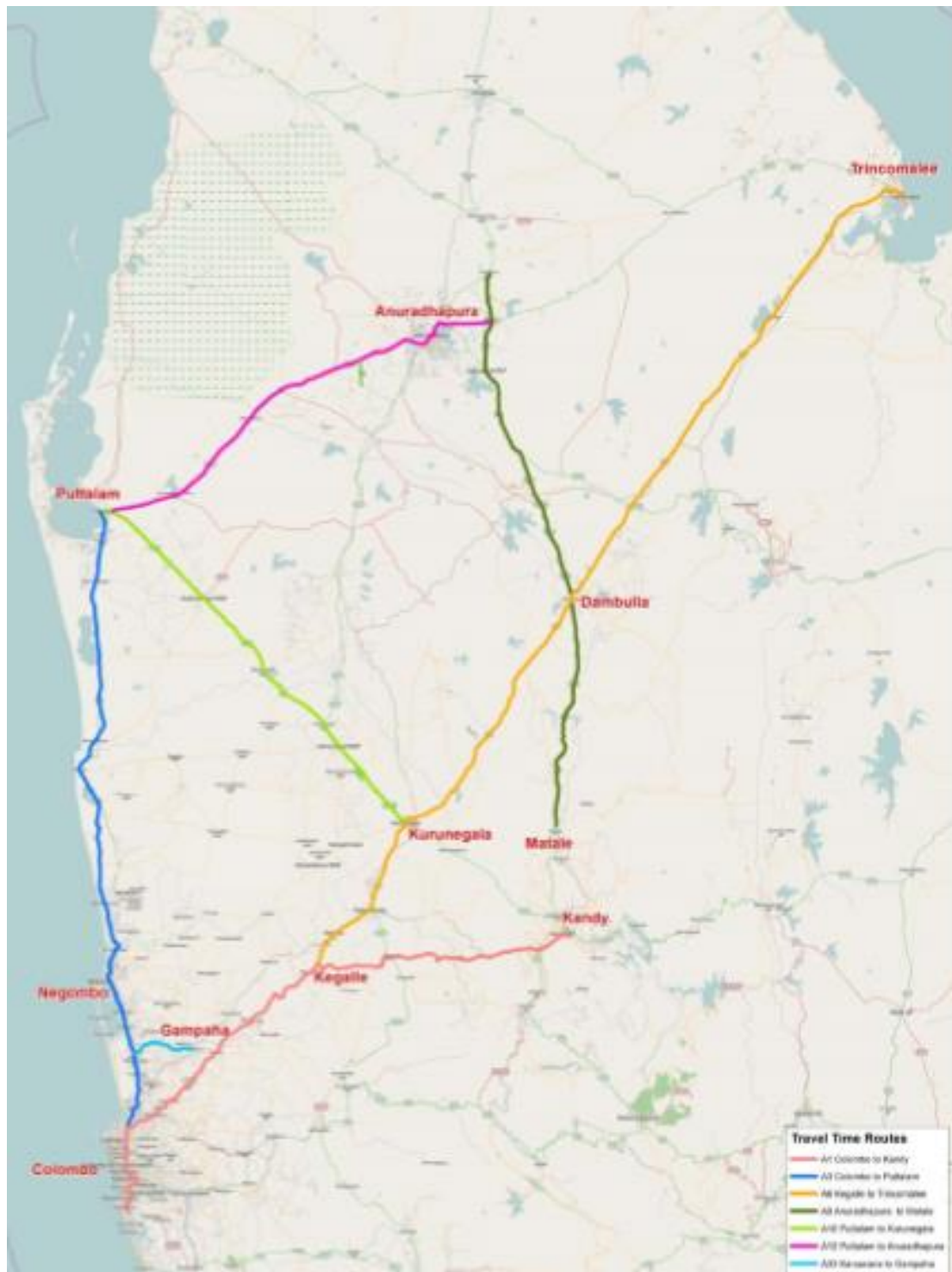


Fig 7.2 – Road sections of travel time survey

## **7.2 TRAFFIC DEMAND ANALYSIS**

### **7.2.1 TRAFFIC FORECASTING MODEL**

The traffic demand analysis for the Central Expressway Project, (CEP) was conducted using the Northern Expressway Strategic Traffic Model (NESTM) that was developed by M/S SMEC International (Pvt) Ltd, Australia as part of the Northern Expressway Project Feasibility Study. The above study is named as NEP hereafter in the report. The NESTM is a project specific traffic model developed using the Cube Voyager Software, which provides forecasted traffic volumes in terms of average weekday daily traffic (AWDT) for private cars travel for business and private purposes and commercial vehicles under three categories along expressway and along A and B class road within the study area. A range of other model outputs including Vehicle Kilometres Travelled (VKT) and Vehicle Hours Travelled (VHT) are generated that has enabled the economic analysis to be completed. The NEP has conducted an extensive study of the project by collecting base year data for 2012 and developing the NESTM which has been calibrated and validated. The information in this report is predominantly taken from the NEP study and extracted from Economic and Financial Report on the Northern Expressway, Affordability and Delivery Models, Appendix A – Traffic and Tolling Analysis Report, unless otherwise stated. The modelling work in the current exercise was done using the NESTM developed by M/S SMEC with necessary network and parameter modification specified in this report. The Model development process and the calibration process adopted are explained in the report by M/S SMEC and is extracted and included in a separated annex (Annex 1) to this report.

### **7.2.2 Study Area**

The study area for the NESTM was based around achieving a balance between using too small a study area where there is a danger that not all of the relevant data will be captured against using too large an area which can result in wasted time collecting data that is not relevant.

The study area used here defines the extent of the detailed assessment and collection of data on transport infrastructure, travel patterns and demographic data. It is based on incorporating an area where existing and likely future travel patterns will influence and be influenced by the development of the expressway. Therefore, key destinations such as Colombo metropolitan urban area, Gampaha, Kandy, Kurunegala, Trincomalee and Anuradhapura are included along with major roads such as the A1, A6, A9 and A10.



Fig 7.3 NESTM Coverage Area with Transport Analysis Zones - DSD by Districts

Integral to identifying the study area is the need to establish a traffic analysis zone (TAZ) system. A zone is a spatial area from which demographic and land use data is represented. The zone acts a generator of trips (origin) and a place where trips of attracted to (destination).

The study area boundary and traffic zoning system within the study area needed to reflect an administrative boundary which defines a data source. There are four levels of government administration that data is generally reported upon, Provincial (9), District (25), Divisional Secretary's Divisions (DSD) and Grama Niladharis (GN). The DSD has been identified as being the most appropriate in terms of size and availability of data and was used as the basis for the traffic zones within the study area.

NESTM includes 187 internal and 29 external traffic analysis zones (TAZ) in the study area. The coverage and zone system of the traffic model are shown in Figure 7.3. It should be noted that some of the DSDs have been divided to form multiple TAZ so that better geographical representation is made. The TAZs adopted by NEP was considered sufficient and adopted in the current study.

### **7.2.3 Base Year Network**

The 2012 Base year network was refined to include detailed representation of the road network which include the link type, speeds, capacities based on the road classes, number of lanes, districts and observed travel speeds. The model network and associated network parameters are shown in Figure 7.4, Figure 7.5 and Table 7.1.

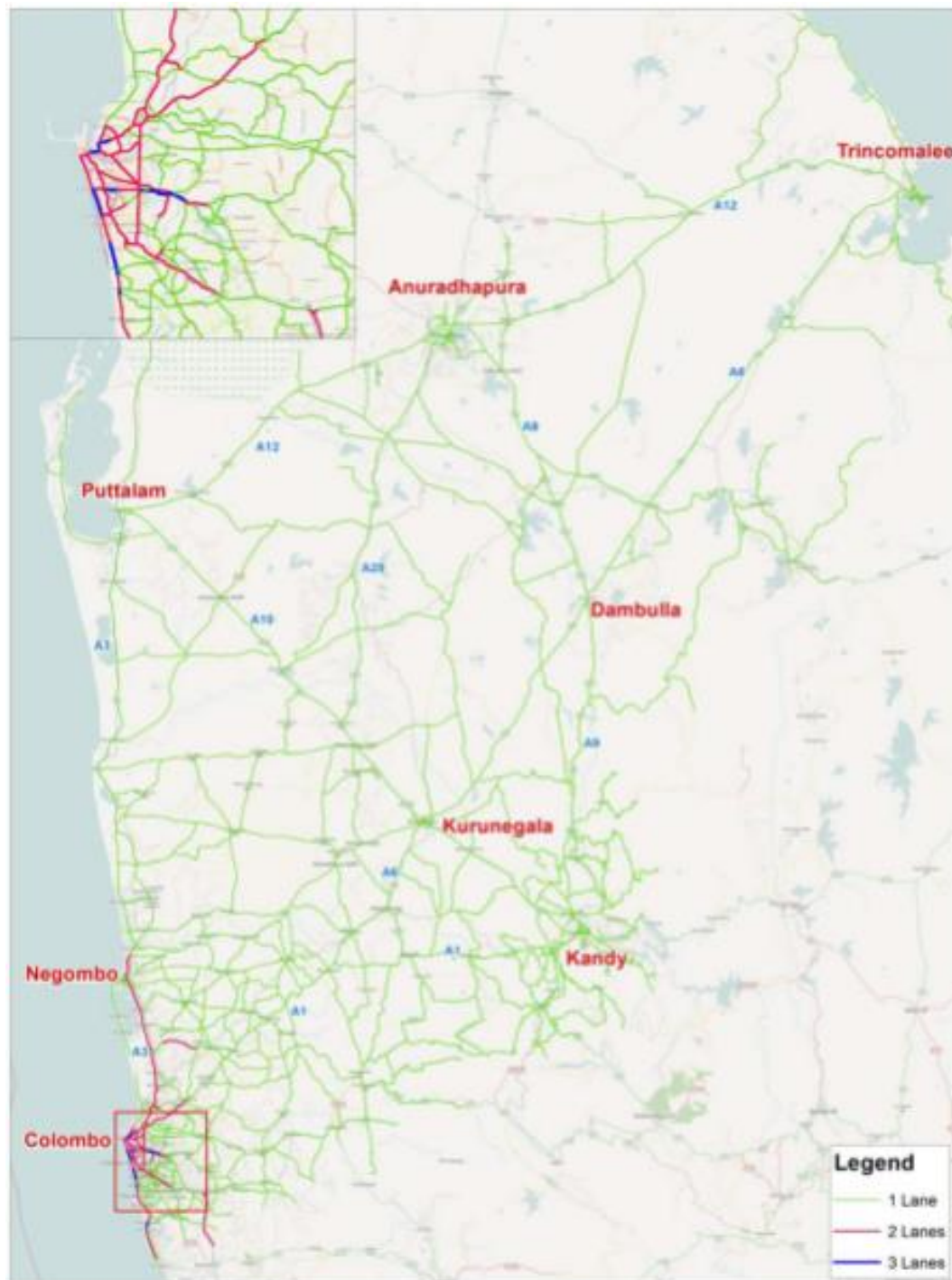


Fig. 7.4 Road network of the model with Lane numbers



Fig 7.5 NESTM Model Free Flow Speed for 2012 Base year Network  
Source: NEP report

Table 7.2 NESTM Network Parameters

Road Type	District	No. of Lanes	Link Type	Free flow speed (km/hr)	Daily capacity (pcu per day)
Class A	Colombo	3	11	40	36,000
	Non - Colombo	3	21	50	36,000
Class A	Colombo	2	12	35	27,000
	Non-Colombo	2	22	45	27,000
Class A	Colombo	1	13	30	15,000
	Non-Colombo	1	23	40	15,000
Class B	Colombo	2	14	35	23,400
	Non-Colombo	2	24	40	23,400
Class B	Colombo	1	15	30	13,000
	Non-Colombo	1	25	30	13,000
Expressway	All		6	80	18,000 per lane
Expressway Ramp	All		7	60	18,000 per lane
Local Road	Colombo		18	30	8000 per lane
Local Road	Non-Colombo		28	30	8000 per lane
Centroid Connector	All		99	40	1,000,000

Source: NEP study report

#### 7.2.4 Future Year Network

NESTM future year national road expansions were based on Road Development Authority (RDA) National Road Master Plan 2007 – 2017.

In the NEP analysis the Central expressway was considered from 2016 in the future network.

However considering the current situation the Central Expressway scenarios has been considered from the year 2021 onwards and the model results have been considered for 2021, 2026 and 2036.

The trace for the Central Expressway shown in Figure 7.3 and Figure 7.6 was considered as the option Stage 3C under the NEP report.

The trace considered in the current study has following changes made to the network.

- The CEP connects to the Outer Circular Highway (OCH) at Kadawatha instead of Enderamulla.
- The Kandy Link connects the Central Expressway at Potuhera through a system interchange travel via Polgahawela, Rambukkana to Galagedera.
- New interchange at Polgahawela and Rambukkana on the Kandy Link.
- New Interchanges at Mirigama North, Rideegama and Galewala.
- The Ambepussa link connects to the CE at Mirigama North Interchange is a standard 2 lane highway instead of an expressway link.
- The local road widening & improvement in Kandy area as identified by the RDA as per National Road Master Plan.
- The port access elevated road has been extended up to Galle face as per the updated plan.

- The OCH connection at Kerawalapitiya with access to A3 road via Gunasekara Mawatha.
- New Interchanges at Athurugiriya, Kadawatha and Kothalawalapura has been included to the OCH

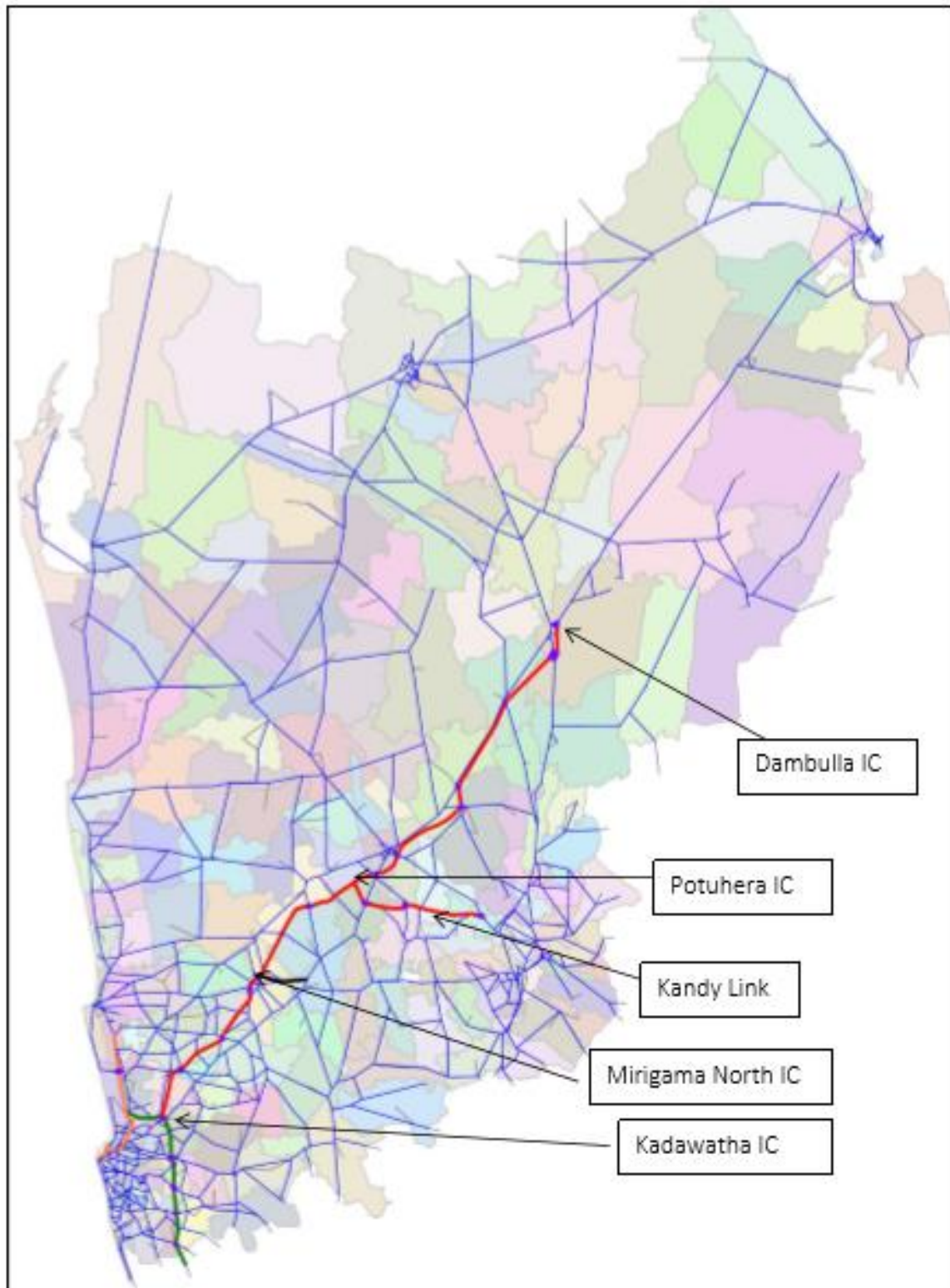


Figure 7.6 CEP Trace

### 7.2.5 Assignment

Trip assignment method used here is equilibrium assignment with the generalized cost function as follows.

$$GC = Time + Distance \times VOC \times \frac{1}{VOT} \times 60 + Toll \times \frac{1}{VOT} \times 60$$

Where

Time = Travel Time (minutes)

Distance = Travel Distance (km)

VOC = Perceived vehicle operating cost (Rs/km)

VOT = Perceived value of time (Rs/hr)

Toll = Toll cost (Rs)

A 24 hour multi class assignment model, where the vehicle demands are segmented and different choice parameters are applied to the each class was adopted. The vehicle class segments in Table 7.3 are used in the model.

Table 7.3- User classes assigned to the network

User Class	Description
PV NB	Private Vehicle Non-Business Car Trip
PV 0B	Private Vehicle Business Car Trip
LCV	Light Commercial Vehicle Trip
MCV	Medium Commercial Vehicle Trip
HCV	Heavy Commercial Vehicle Trip

The Vehicle operating cost (VOC) and Value of Time (VOT) that was used in the NESTM in NEP was considered as need of a revision and therefore was updated in the current study. The updated VOC and VOT in Table 8 were based on the values given in the report, “Assessing Public Investment in the Transport Sector, 2000, Department of National Planning”. The VOT is estimated considering the intercity travel scenario while the VOC is estimated assuming IRR of 6 and speed of 30km/h

Table 7.4: Network Routing Parameters (2012 Rs Values)

Vehicle Type	VOT (Rs./hr)	VOC (Rs./km)
Private Vehicle Non Business Car Trip (PV NB)	407	28.77
Private Vehicle Business Car Trip (PV B)	597	28.77
Light Commercial Vehicle Trip (LCV)	517	28.77
Medium Commercial Vehicle Trip (MCV)	850	47.10
Heavy Commercial Vehicle Trip (HCV)	1,250	68.37

The delay function is used to calculate the congested travel time on each link of the road network in equilibrium assignment. The standard Bureau of Public Roads (BPR) formula was used in the traffic model:

$$Time = T_0 \times \left( 1 + TC_{coeff} \times \left( \frac{V}{C} \right)^{TC_{exp}} \right)$$

Where

*Time* = Travel Time (minutes)

$T_0$  = Free Flow Time (minutes)

TCOEFF = Travel time function coefficient

TCEXP = Travel time function exponent term

The NESTM uses a coefficient of 2 and exponential of 4. The form of the function for a free flow speed of 30 km/h is shown in Figure 7.7

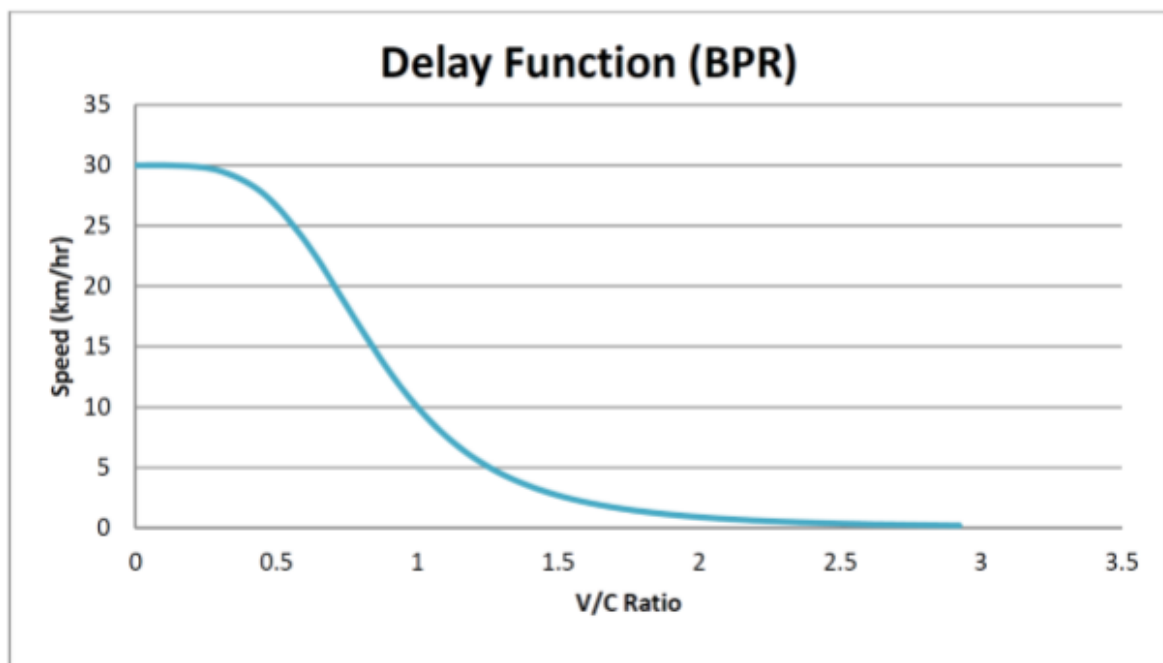


Figure: 7.7 -Form of the BPR Function

### 7.2.6 Central Expressway Toll Strategy

The NEP considered a range of toll strategies and recommended a distance based slab toll system that was not consistent with the current tolling strategy used by the RDA. A regression analysis was done to estimate the toll based on a fixed cost component and variable cost component based on the distance between interchange using the current tolling rates of RDA on Southern Expressway and OCH. The findings are shown in Table 7.5. This reflects that there is a fixed cost component each time a vehicle enters through an interchange and the variable cost accounts for the distance travelled on the expressway. The fix cost component is not accounted when a vehicle pass through a system interchange such as Kadawatha System Interchange.

Table 7.5: Current Tolling Strategy by RDA

Vehicle Category	Fixed cost (Rs.)	Variable Cost (Rs/km)	R <sup>2</sup> of the Estimate
Category 1 (Car, Van, LCV)	76.47	3.64	0.9613
Category 3 (MCV)	76.32	11.85	0.9974
Category 4 (HCV)	93.77	15.53	0.9891

The IC to IC tolls for CE was derived from the above equation based on the distance between ICs. The discounted rate was considered with only distance based variable cost been applied when travel originating from a IC from either Southern expressway or OCH (including at the Kadawatha SI), since a fixed cost is already applied at the entry to either SE or OCH. Same tolling strategy is used in the analysis also.

### 7.2.7 FORECASTED TRAFFIC ON THE CENTRAL EXPRESSWAY

The NEP by SMEC evaluated 5 scenarios:

1. Conservative
2. Improved Connections
3. Mid- way
4. GDP linked CV growth – toll on NE
  - 4A GDP linked CV growth – No toll on NE
5. Ultimate Development

The **Conservative** scenario represents a situation where current travel behaviour and economic activity does not significantly change.

**Improved Connection** reports on the benefits that improved access onto the NE, in particular a direct connection to the Kelani bridge area and in to the port.

**Mid- Way** introduces the effects of changes to travel behaviour that occur through increases in Value of Time where the needs of a road user in reaching a destination quicker is perceived to be higher and as such they are willing to pay a toll to achieve this time saving.

**GDP linked CV growth** – toll identifies further changes in travel behaviour and economic activity with a higher a growth in the number of commercial vehicles as it is linked to a projected annual national GDP rather than the lower growth value of employment. The 4A no- toll subset provides a sensitivity test on the effect of a no toll expressway.

**The Ultimate Development** scenario represents a future year case where travel behaviour and economic activity have significantly altered due to much increased economic activity across all variables and a low toll rate on the NE. The GDP linked CV growth scenario was selected by the NEP as the most suitable scenario to evaluate the feasibility.

The growth rates estimated in the NEP by SMEC is shown in **Table 7.6**.

Table 7.6 Trip growth rates in NEP Estimations

Vehicle type	Base Year 2012 Trips	NEP 2036 Trips	NEP CAGR
PV_ NB	611,339	854,331	1.40%
PV_ B	102,895	146,007	1.47%
LCV	58,970	199,436	5.21%
MCV	222,564	753,206	5.21%
HCV	11,878	40,086	5.20%

While noting that this scenario resembles the most probable scenario, a revision was warranted based on two reasons and following changes were made.

1. The growth rate of 1.40% - 1.47% per annum for Private vehicle was underestimating the growth of private vehicles. The motor car registration growth in Sri Lanka is around 6.65% for cars and even higher for motor cycles at 9.55% and three wheelers at 15% from years 2011- 2014. Therefore the GDP based growth factor for private vehicles were updated to be 5% based on annual growth values on existing road network as shown in Table 7.7.
2. Commercial Vehicle (CV) growth factor of 5.21% across all CV types was considered too high. The highest annual growth in the national highway network is around 4% for LCV while MCV and HCV are 3.5% and 2.5% respectively. Therefore the GDP based CV growth rates were adjusted for commercial vehicles as shown in Table 7.7.

**Table 7.7 Trip growth rates in CEP Estimations**

Vehicle type	CEP CAGR
PV_NB	5.0%
PV_B	5.0%
LCV	4.0%
MCV	3.5%
HCV	2.5%

### 7.2.8 Base Case.

The base case is defined as the ‘do minimum’ scenario where the expressway is not built, but the identified future year national road network improvements is completed as per National Road Master Plan. The model runs were completed for ‘do minimum’ scenarios for year 2021, 2026 and 2036.

### 7.2.9 Project Case

The project case selected for further analysis is similar to GDP linked CV growth as selected in NEP, but with adjusted future year growth rates for private vehicles and commercial vehicles and updated network parameters as discussed previously. The growth rates for future year forecasts are based on Compound Annual Growth Rate (CAGR) as shown in Table 7.8. The CAGR is higher in earlier years and then reduces towards 2036 as shown in parenthesis. The total vehicle trips based on the selected scenario with updated growth values were assigned to the network for the years 2021, 2026 and 2036 for future forecast.

Table 7.8: Vehicle trips by Forecasted Year with CAGR

Vehicle Category	AWDT across the study area / (CAGR)					CAGR (2012-2036)
	2012	2016	2021	2026	2036	
PV_NB	611,545	759,049	980,400	1,250,425	1,974,656	5.01%
		(5.55%)	(5.25%)	(4.99%)	(4.68%)	
PV_B	103,074	128,139	166,055	212,590	335,907	5.05%
		(5.59%)	(5.32%)	(5.07%)	(4.68%)	
LCV	58,974	70,265	86,686	105,524	150,987	3.99%
		(4.48%)	(4.29%)	(4.01%)	(3.65%)	
MCV	222,560	254,872	299,109	346,462	451,932	3.00%
		(3.45%)	(3.25%)	(2.98%)	(2.69%)	
HCV	11,853	13,191	15,083	17,148	21,545	2.52%
		(2.71%)	(2.72%)	(2.60%)	(2.31%)	

The stage wise analysis was conducted to estimate the volumes on expressway and the VHT, VKT required for Engineering analysis and economic analysis to be considered for stage wise development of the expressway based on the following sections.

Section 1: Kadawatha to Mirigama (North)

Section 2: Mirigama (North) to Kurunegala with Ambepussa Link

Section 3: Pothuhara – Galagedera

Section 4: Kurunegala - Dambulla

Five scenarios can be considered for stage wise analysis with combination of different sections as detailed in Table 7.9.

Table 7.9: Alternatives scenarios and sections considered

Scenario	Section Abbreviation	Sections Included
Scenario 1	Section 1	1
Scenario 2	Section 12	1,2
Scenario 3	Section 123	1,2,3
Scenario 4	Section 124	1,2,4
Scenario 5	Section 1234 (complete trace)	1,2,3,4

In this study only Scenario 1 and Scenario 5 was considered and it will be use as given below.

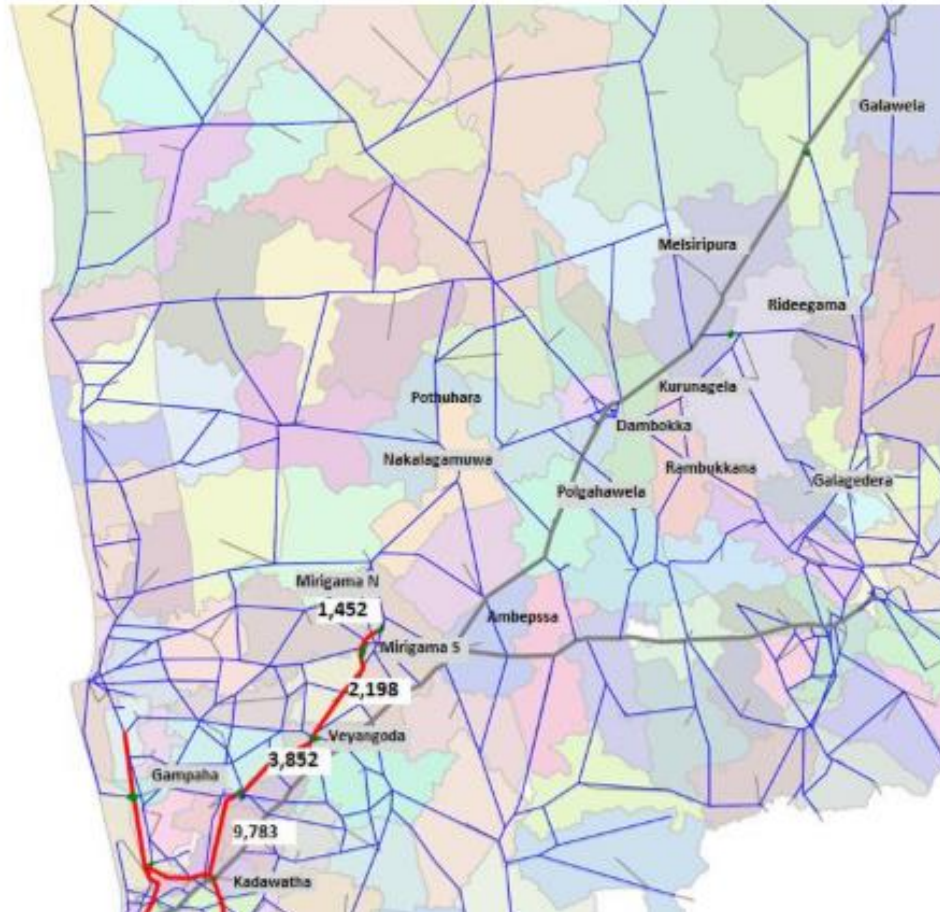
- For engineering analysis of the highway and taking the decision on the cross section pavement design traffic forecasted at the scenario 5 ( Fully complete Highway) will be used.
- For Economic and Financial analysis traffic forecasted at Scenario 1 will be used along with the cost of implementation of section 1 ( Kadawatha to Mirigama)

### Scenario 1: Section1 (Kadawatha to Mirigama)

The forecasted vehicle volumes on the Central Expressway between interchanges for scenario 1 with only section 1 are shown in Table 7.9. These are illustrated for forecasted years 2021, 2026 and 2036 in Figure 7.8, Figure 7.9 and Figure 7.10. This traffic volume will be used for the economic evaluation as it will be the lowest volume of traffic in expressway even other sections

**Table 7.9 : Central Expressway Vehicle Volumes Between IC by Year for Scenario 1 (Veh/day)**

From Interchange	To Interchange	2021	2026	2036
Kadawatha	Gampaha	9,783	18,255	49,338
Gampaha	Veyangoda	3,852	5,823	16,168
Veyangoda	Mirigama S	2,198	3,295	11,944
Mirigama S	Mirigama N	1,452	2,256	6,917



**Fig 7.8 : Daily Vehicle Volumes between IC on Central Expressway -2021 for Scenario 1**



Figure 7.9 : Daily Vehicle Volumes between IC on Central Expressway -2026 for Scenario 1

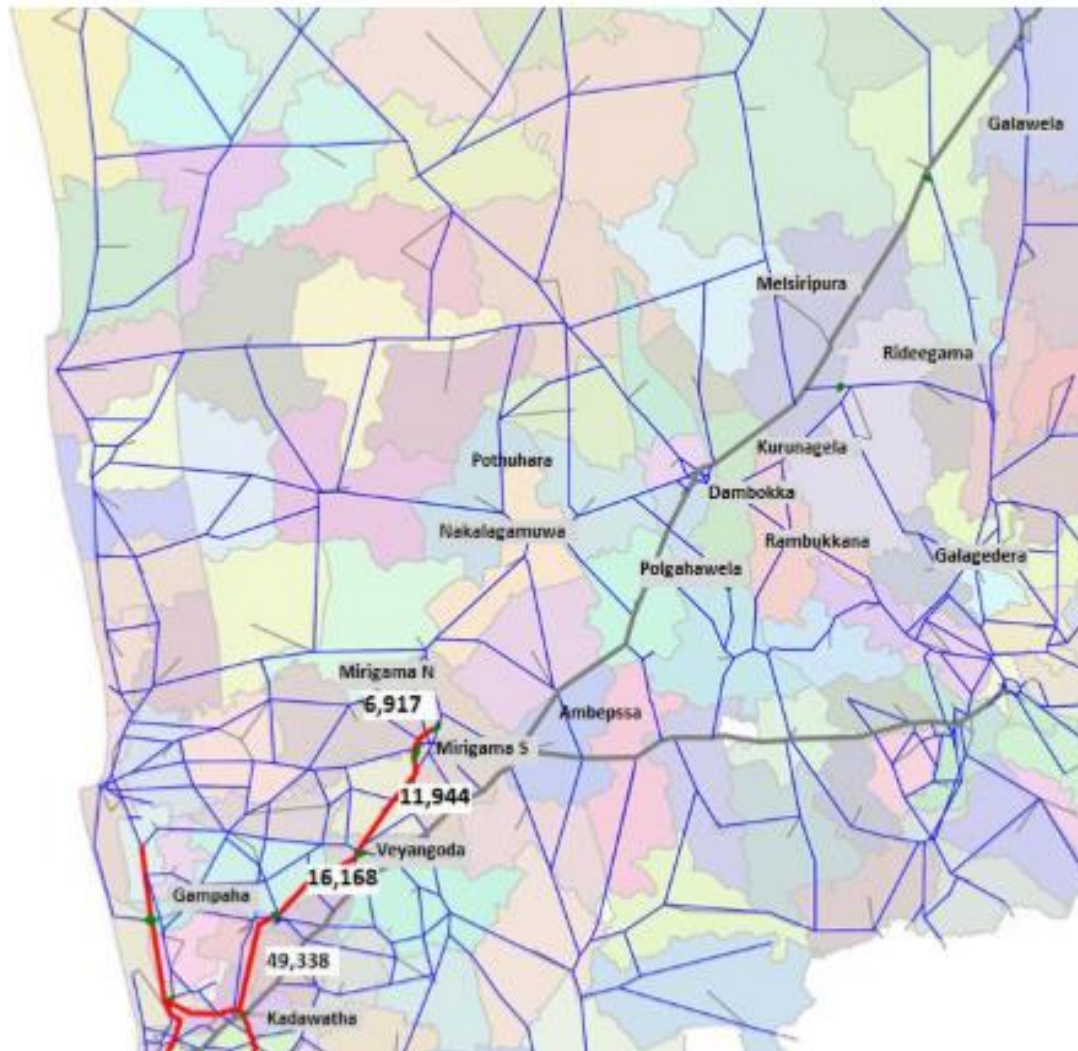


Figure 7.10: Daily Vehicle Volumes between IC on Central Expressway -2036 for Scenario 1

#### Scenario 5: Section1234 (Complete CE Trace)

The forecasted vehicle volumes on the Central Expressway between interchanges are shown in Table 7.10. These are illustrated for forecasted years 2021, 2026 and 2036 in Figure 7.11, Figure 7.12 and Figure 7.13.

Table 7.10: Central Expressway Vehicle Volumes between IC by Year (Veh/day) for Scenario 5

Interchange	Interchange	2021	2026	2036
Kadawatha	Gampaha	12,449	21,629	53,529
Gampaha	Veyangoda	6,817	9,617	23,212
Veyangoda	Mirigama S	6,053	8,624	23,331
Mirigama S	Mirigama N	5,312	7,608	22,883
Mirigama N	Nakulugamuwa	7,003	10,230	28,952
Nakulugamuwa	Pothuhera	6,989	10,306	25,669
Pothuhera	Dambokka	4,569	6,671	18,110
Dambokka	Kurunegala	4,941	7,172	18,540
Kurunegala	Rideegama	5,399	7,535	17,766
Rideegama	Melsiripura	5,769	8,222	18,580
Melsiripura	Galewela	4,806	7,035	16,596
Galewela	Dambulla (A-9)IC	3,889	5,732	14,036
Dambulla (A-9)IC	Dambulla	2,415	3,626	9,680
Mirigama N	Ambepussa	5,661	7,051	11,911
Pothuhera	Polgahawela	2,420	3,435	7,558
Polgahawela	Rambukkana	3,627	5,145	10,786
Rambukkana	Galagedara	3,621	5,182	10,907



Figure 7.11: Daily Vehicle Volumes between IC on Central Expressway -2021 for Scenario 5



Figure 7.12: Daily Vehicle Volumes between IC on Central Expressway -2026 for Scenario 5



Figure 7.13 Daily Vehicle Volumes between IC on Central Expressway -2036 for Scenario 5

### 7.3 Calculation of Capacity requirement for Expressway

Estimated values of capacity and service volumes for two lane and multilane road, in relation to the forecasted traffic demand, could significantly affect the “When and How” for the proposed project.

The term ‘Level of Service’ originates in the US Highway Capacity Manual (HCM) which also referred to in RDA’s Geometric Design Standard of Road (1998). It define 6 level of services with different level of riding quality.

HCM describes methods for estimating the capacity and Level of Service for existing roads as well as recommendations for road design in order to achieve a desired level of service. Accordingly the capacity of new four lane motorway would be the order of 1,500 vehicles per hour per lane, corresponding to about 60,000 vehicles per day at level of service B.

The expressway to be design to operate at Level of Service of “B” at the design year and the lane width of 3.6 m. The capacity requirement for each forecasted year at 2 scenarios are given below.

**Scenario 1 – Construction of expressway up to Mirigama**

Table 7.11 – Traffic of each link of expressway

From Interchange	To Interchange	2021	2026	2036
Kadawatha	Gampaha	9,783	18,255	49,338
Gampaha	Veyangoda	3,852	5,823	16,168
Veyangoda	Mirigama S	2,198	3,295	11,944
Mirigama S	Mirigama N	1,452	2,256	6,917

Table 7.12 – Numbers of lane requirement

From Interchange	To Interchange	2021	2026	2036
Kadawatha	Gampaha	2	2	4
Gampaha	Veyangoda	2	2	2
Veyangoda	Mirigama S	2	2	2
Mirigama S	Mirigama N	2	2	2

**Scenario 2 – Full construction of expressway up to Dambula with link to Kandy**

Forecasted Traffic for the scenario 5 is given in Table 7.13

Table 7.13 – Forecasted Traffic with full construction of expressway

Interchange	Interchange	2021	2026	2036
Kadawatha	Gampaha	12,449	21,629	53,529
Gampaha	Veyangoda	6,817	9,617	23,212
Veyangoda	Mirigama S	6,053	8,624	23,331
Mirigama S	Mirigama N	5,312	7,608	22,883

Numbers of lane required for each year is given in Table 7.14

Table 7.14 Numbers of lane required for section 1 to cater full operation

Interchange	Interchange	2021	2026	2036
Kadawatha	Gampaha	2	2	4
Gampaha	Veyangoda	2	2	2
Veyangoda	Mirigama S	2	2	2
Mirigama S	Mirigama N	2	2	2

The capacity of Section 1 from Kadawatha to Mirigama should be able to accommodate the traffic level forecasted for full construction of expressway. It is required to provide at least 2 lanes at each direction to accommodate overtaking of vehicles. As such numbers lane proposed for the expressway is given in the table 7.15

Table 7.14 Numbers of lane proposed for section 1 to cater full operation

Interchange	Interchange	2021	2026	2036
Kadawatha	Gampaha	4	4	4
Gampaha	Veyangoda	4	4	4
Veyangoda	Mirigama S	4	4	4
Mirigama S	Mirigama N	4	4	4

## **8.0 Highway Engineering**

### **8.1 Introduction**

In design of highways or expressways, it is a common thing that various geographical features are come across such as: mountains, valleys, streams, irrigation canals, flood plains and so on. In searching whether such a project is feasible with respect to the economic, environmental, social and other factors, it is necessary to carry out necessary survey and investigations; and study all matters relevant to the project.

### **8.2 Investigation Procedures**

In general, once the project objectives are established for an expressway, it is necessary to select an economically, socially and environmentally feasible trace. In order to select the most appropriate trace, it is required to carry out sufficient studies at different stages.

#### **8.2.1 Desk Study**

The first thing is to study the available maps (1:10,000 maps and satellite images), previous study reports and any other records relevant to the area such as rainfall data, flood levels, vegetation patterns, human settlements etc. With the above data, mainly, three alternative traces were selected. Thereafter, further investigations were carried out along these traces through site inspections and surveys. It is important to collect every possible detail including the availability of necessary quality construction materials for the construction work.

In order to take a proper decision on the most suitable trace, necessary detail investigations as follows were carried out.

#### **8.2.2 Carrying Out the Topographical Survey**

This will help to study properly the geometrical features of the ground, especially the vertical profile of the ground and the exact locations of the buildings, plants and other objects with respect to the selected trace / traces. The topographical survey was carried out using the Total Station Instrument with respect to the National Grid (NG) and the ground levels were referred to the Mean Sea Level (MSL).

The width of the corridor for surveying was decided based on the project objectives. Considering the typical cross sectional details and the finer adjustments to be made to the trace, following survey corridor width of 80 m were selected from Kadawatha to Mirigama.

### **8.2.3 Carrying Out Hydrological Study of the Area**

This study gives the details of streams and their flow patterns; rain fall data and their variations; flood levels and their variations; and details of effective catchment area and its ground roughness values. With this data, the maximum volumes of water flows in streams could be calculated and the maximum flood levels with respect to the return period considered, either manually or by using computer software packages. In the case of culverts and minor bridges, calculation could be done manually to get the details at the particular location of construction. In construction of major bridges, it may be necessary to understand the variation of maximum flow volumes and maximum flood levels within the catchment area to carry out an economical design of the bridges. For this, it is required to do a computer model and do the analysis using the computer software like MIC –II.

The return period for rain fall data or flood levels to be considered depends on the design period of the structure. Normally, the design period taken for culverts and minor bridges is between 15 and 20 years, whereas the design period taken for major bridges is 100 years.

Where there are critical areas with respect to the hydrology of the area such as flood plains, it is necessary to study and analyze variation of different factors through suitable computer modeling. Results of the Hydrology Study can be used for the design of the drainage system including the opening sizes of the highway structures and the irrigation structures. They are also used to decide the economical formation level of the expressway mitigating environmental, social and other damages.

### **8.2.4 Carrying Out Geotechnical Investigation of the Area**

The road pavements, road embankment and all the structures necessary to be constructed for the Expressway (CEP) are to be built on the existing ground and hence, it is necessary to study the behavior and the variations of the ground condition along the trace to a sufficient depth of the ground. Geotechnical Investigations are carried out to study the subsurface soil conditions, possible underground rock formations and their qualities and existence of underground water and their qualities. These details are helpful to determine the properties of soils and rocks (Soil Parameters), bearing pressures and frictional capacities.

To determine the necessary soil and rock properties, it is required to obtain necessary samples of soil and rock through different tests. As it is required to have continuous information along the trace, the suitable method is to carry out borehole investigation at suitable spacing which is decided based on the initial studies carried out. With these details, any further investigations could be carried out, if necessary. In the case of structures (such as viaducts, bridges, underpasses and overpasses) borehole testing should be carried out to suit the particular structure considering the pier and abutment locations etc. Further, if the rock formation is encountered at a reasonable depth, it is necessary to do the borehole to a depth of at least 3.0 m in to the rock to take a decision on the type of rock formation.

These details could be used to design the foundation of the structures and other geotechnical engineering designs along the trace.

### **8.2.5 Material Surveys**

Material survey should be carried to find the availability of construction materials and find the suitable dumping areas. This survey should include the suitability of the material and the possible quantities that can be harvested from each location. At the same time these material should be available at a feasible distance from the selected final trace.

### **8.2.6 Environmental and Social Studies**

Environmental and social studies should be carried out to identify necessary precautions and measures, which are to be adopted in order to eliminate / mitigate negative impacts associated with the project. These are to be considered and adopted appropriately during the detailed design stages.

## **8.3 Design Criteria and Technical Standards**

In carrying out geometric designs of this Expressway (CEP), the possibility of use of various International Technical Standards available for expressway designs was studied. Various Technical Standards being used by other Expressway projects in Sri Lanka were also scrutinized. Out of such standards currently available for the expressway designs, AASHTO (US) and AustRoads (Australia) will be mainly considered for the Basic Geometric Designs and Detailed Engineering Designs. In addition, any other Technical Standards necessary for the study such as Japanese Standards and the Geometric Design Standards of Roads Published by RDA will be considered where ever suitable.

## **8.4 Design Speed**

The design speed of the Expressway (CEP) is selected considering several factors.

- One is the selected design speed should be consistent with the design speed of the other expressway, especially with that of the Outer Circular Highway.
- Design speed should cut down the travel time, which is a main objective of the project

Even when the basic design vehicle for road alignment is the car, all the designs should be checked to see whether the design is satisfactory for the trucks and the designer should consider the decrease in speed between successive geometric elements. However on high speed roads, truck speed can be taken to be the same as that of cars and truck speed will closely match car speed on flat terrain provided sufficient length of acceleration is available.

The Expressway (CEP) is intended to provide a high quality of service for high traffic volumes and they are characterized by having full control of access, median divided multi-lane carriageways, grade separations and interchanges. Vertical grades tend to have flatter grades in order to minimize the difference in speed between cars and trucks.

Considering all these facts, Road Development Authority has decided to maintain an operating speed between 80 – 100km/h and hence it is suitable to take the design speed as 110km/h (Austroads Part 3 – Table 3.1). At the same time different design speeds will be selected for various components of the Expressway (CEP) such as ramps, main roads, interchanges etc. (See the *Table 8.2 for standards*)

**Table 8.2 – Design Speeds**

Expressway Component	Design Speed	Reference
Freeway	110 km/h	Austroads Part 3 Table 3.1
Main Roads (A & B Roads)	70-80 km/h	
Ramps	60 km/h	
Service Interchange -		Austroads Part 4C Table 6.1
Direct	85 km/h-100 km/h	
Semi-Direct	85 km/h-90 km/h	
Outer	85 km/h-90 km/h	
Loop	50 km/h-55 km/h	

Following were selected for the design of the expressway.

For system interchange: 40 - 80 km/h

For Service Interchange: >40 km/h

## 8.5 Design Vehicle

The physical and operating characteristics of vehicles using the road control specific elements in the geometric design. The design vehicle is a hypothetical vehicle whose dimensions and operating characteristics are typically used to established traffic lane widths, intersection lay out and road geometry.

This is selected considering the existing mix of vehicles and the vehicles that will use the Expressway (CEP) in future.

This Expressway (CEP) is designed taking the design vehicle as 16.5 m Semi-Trailer (WB 15 AASHTO).

## 8.6 Lane Width and Number of Lanes

The width of the traffic lanes are selected considering the freeway standards and maintaining the consistency of the Expressway Elements as given in the *Table 8.3*

**Table 8.3 – Lane Widths**

Expressway Component	Pavement Widths	Reference
Freeway	3.6 m	AASHTO Chapter 8
Main Roads (A & B Roads)	3.5 m	Austroads Part 3 Table 4.3 Table 4.4
Ramps		Austroads Part 4C Table 5.1
1-Lane Ramps	4.0m	
2-Lane Ramps	3.50m	

See the Typical Cross sections in *Figure 8.1, 8.2 and 8.3 (Detail typical cross sections are given in Annex 2)*

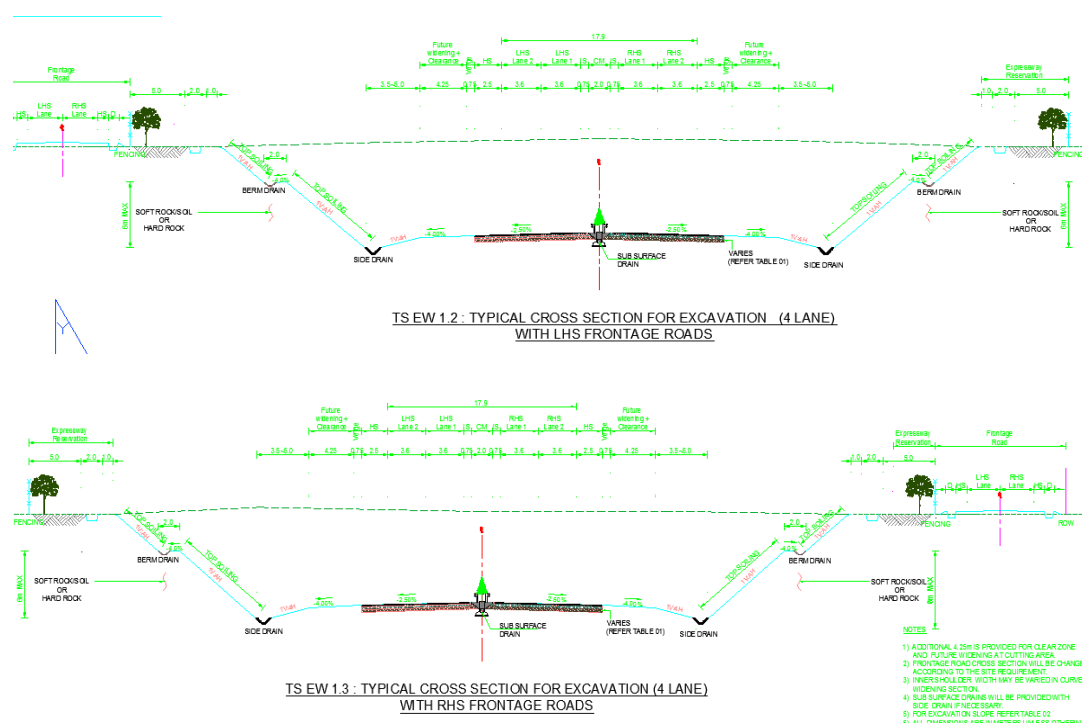
After a proper traffic study and analysis, existing traffic volumes, diverted traffic and the projected traffic volumes for the different design periods are calculated. Using this information, number of lanes and the carriageway widths are decided. In deciding the carriageway width, it should be consistent with the other expressways especially with the Outer Circular Highway.

As per the traffic analysis as shown in Table 7.14, two lane expressway is sufficient up to the year 2036 to cater to a Level of Service (LOS) of category B accept Kadawatha Gampaha section. However, considering the requirements for traffic safety and uninterrupted overtaking facility throughout the entire expressway, it is required to provide four lane facility for all sections at the initial stage. The above requirement is in par with the policy of the RDA in determining the requirement of number of lanes to comply with existing Expressway and the ones presently under construction.

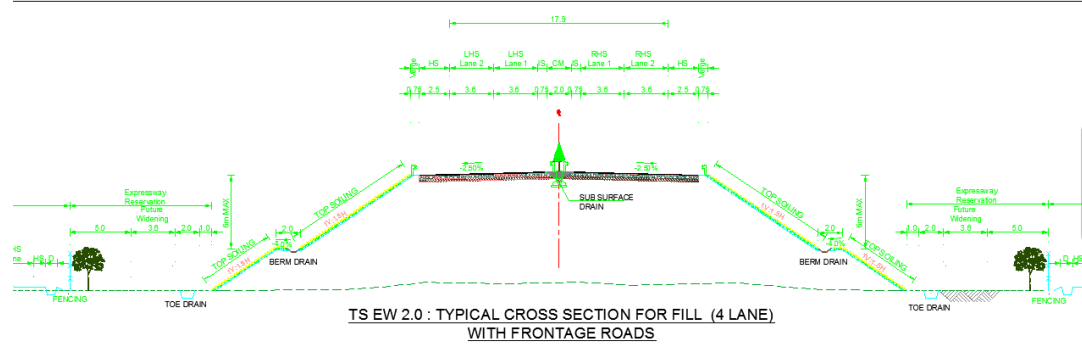
Accordingly, in this Expressway (CEP), a typical cross section of carriage way is as follow:

- Section from Kadawatha to Mirigama

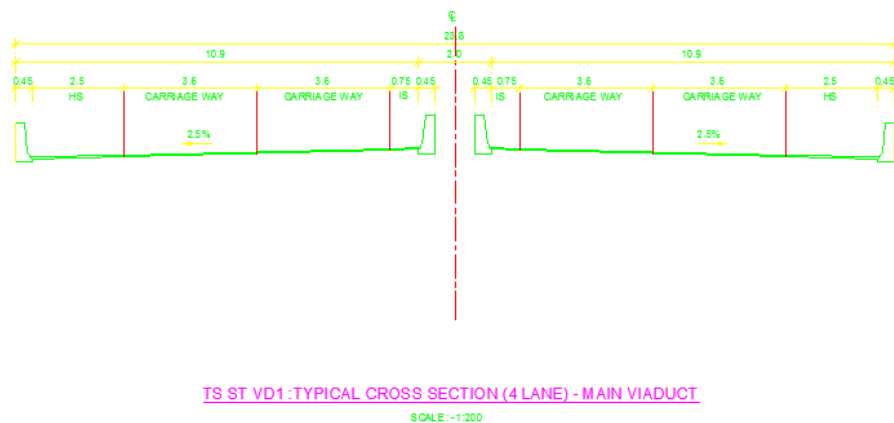
The Expressway (CEP) is designed as an initial dual two lane carriageway with a centre median and the expressway could be widened at the outer side as a dual three lane carriageway as the ultimate condition.



**Figure 8.1 – Typical Cross Sections of Embankment Cuts**



**Figure 8.2 – Typical Cross Sections of Embankment fill**



**Figure 8.3– Typical Cross Sections of Freeway Structures (Normal Cross Fall)**

## 8.7 Shoulder Width

Road shoulders are provided to carry out two functions; structural and traffic. The structural function of the shoulder is to provide lateral support to the road pavement layers. The traffic functions of the shoulder are:

- An initial recovery area for any errant vehicle
- A refuge for stopped vehicles on a firm surface at a safe distance from traffic lanes
- A trafficable area for emergency use
- Clearance to lateral obstructions
- Provision of additional width for tracking of large vehicles.

Accordingly, shoulder widths are selected as given in the *Table 8.4*:

**Table 8.4 – Shoulder Widths**

Expressway Component	Shoulder Widths	Reference
Freeway with Barrier Median		AASHTO- Chapter 8
-Right Shoulder	2.5 m	
-Left Shoulder	2.5 m	
-Right Inner Shoulder	0.75 m	
-Left Inner Shoulder	0.75 m	
-Verge	0.75 m	Austroads Part 3 Table 4.9
Ramps		Austroads Part 4C Table 5.1
Single Lane Pavement		
-Right Side	1.0 m	
-Left Side	3.0 m	
Double Lane Pavement		
-Right Side	1.0 m	
-Left Side	1.0 m	

See the Typical Cross section in *Figure 8.1, 8.2 and 8.3*

## 8.8 Level of Service

Level of Service (LOS) is defined as a qualitative measure describing operational conditions within a traffic stream, and their perception by motorists and/or passengers. A Level of Service (LOS) definition generally describes these conditions in terms of factors such as speed and travel time, freedom to maneuver, traffic interruptions, comfort and convenience, and safety.

Considering the Expressway Standards, following Level of Service (LOS) are used for different component of the Expressway (CEP).

**Table 8.5 – Level of Service**

Expressway Component	Level of Service	Reference
Freeway	LOS B	Austroads Part 2 Commentary T & Road Design Guidelines (Vic Roads) Part 5 Table 5.3.4.2
Main Roads (A & B Roads)	LOS C-D	
Ramps	LOS C-D	
Ramps/Crossroad Intersections	LOS C-D	

## **8.9 Geometric Designs of the Expressway**

Using the above criterion and the terrain details (Topography Survey details), the digital terrain model is developed and the Geometric Design is carried out with the use of Software, Civil 3D and following design details will be prepared.

- Horizontal Alignment
- Vertical Alignment
- Typical Cross Sections
- Basic Design Layouts of Interchanges and Intersections

These details will be prepared so that the details could be used as a basis for doing Preliminary Designs and Detailed Designs, and preparing Cost Estimations.

## **8.10 Horizontal Alignment (HA)**

The Horizontal Alignment (HA) of a road is usually a series of straights (tangents) and circular curves that may or may not be connected by transition curves. The speed adopted on an open road is affected more by the driver's perception of the horizontal alignment of the road than by any other single design feature. For this reason, whenever curves are used to change the direction of travel or to suit the topography, the radii must be large enough to permit travel speed commensurate with those expected on adjoining straight.

As with other elements of design, Horizontal Alignment (HA) should be generally provided for safe and continuous operation at a uniform travel speed. Sudden reduction in standards such as isolated curves of small radius (particularly at the end of long straights), introduce an element of surprise to the driver and should be avoided.

## **8.11 Normal Cross Fall**

Cross Fall is the slope of the surface of a carriageway measured normal to the design or road centre line. The purpose of the Cross Fall is to drain the carriageway on straights and curves and to provide super elevation on horizontal curves.

Cross Falls flatter than 2% do not drain adequately. The recommended range is from 2.5 to 3%.

## **8.12 Super Elevations**

When a vehicle moves in a circular path, it undergoes a centripetal acceleration that acts toward the center of curvature. This acceleration is sustained by a component of the vehicle's weight related to the roadway super elevation, by the side friction developed between the vehicle's tires and the pavement surface, or by a combination of the two. In design calculations side friction is represented by the Coefficient of Friction  $f$ , which is the friction force divided by the component of the weight perpendicular to the pavement surface. This is given with the basic curve formula.

$$f = \frac{V^2}{127R} - 0.01e$$

Where  $e$  = rate of roadway super elevation percent;  
 $f$  = side friction (demand) factor;  
 $V$  = vehicle speed, km/h;  
 $R$  = radius of curve measured to a vehicle's center of gravity, m

The maximum rates of super-elevation used on highways are controlled by four factors: Climatic conditions (i.e., frequency and amount of snow and ice); terrain conditions (i.e., flat, rolling, or mountainous); type of area (i.e., rural or urban); and frequency of very slow-moving vehicles whose operation might be affected by high super-elevation rates. Consideration of these factors jointly leads to the conclusion that no single maximum super-elevation rate is universally applicable. From accumulated research and experience, limiting values for super-elevation rate ( $e_{\max}$ ) and side friction demand ( $f_{\max}$ ) have been established for curve design.

The maximum value of super-elevation that should be used for high speed roads, speed greater than 90km/hr is 6%.

### 8.13 Minimum Radius and Maximum Side Friction

The minimum radius is a limiting value of curvature for a given design speed and is determined from the maximum rate of super-elevation and the maximum side friction factor selected for design (limiting value of  $f$ ).

The  $e$  and  $f$  distributions for Method 5 may be derived using the basic curve formula, neglecting the  $(1 - 0.01ef)$  term using the sequence of equations given in Exhibit 3 – 13 (**Methods of Distributing Super-elevation and Side Friction**) of AASHTO 2004.

Using this method a relationship is developed between the values of super-elevation and minimum radii of curves. By using this relationship, values of minimum radii are selected for necessary values of 'e', which are given below.

*Table 8.6 – Super Elevations and Radii*

Super-elevation (%)	Minimum Radius (m)
2.5	1990
3.0	1600
3.5	1310
4.0	1090
4.5	910
5.0	760
5.5	625
6.0	437

## 8.14 Minimum Horizontal Curve Length

Minimum curve lengths are required to avoid kinks in the road alignment and maintain a satisfactory appearance. However they should not be considered to be absolute minimum values. In flat terrain, aesthetics may be improved if curves of double the minimum length are provided.

## 8.15 Spiral Curves

Transition curves (or spirals) are normally used to join straights and circular curves to smooth the travel of vehicles within the traffic lane. Transition curves are usually based on the clothoid spiral, which provides a uniform change in centripetal acceleration as vehicles enter and exit the circular section of the curve. It is normal practice for horizontal curves to be transitioned, with the transition length based on the superelevation runoff length for the recommended combination of speed, radius and superelevation.

The selected parameters for different elements of the Horizontal Alignment are given in the *Table 8.7*.

*Table 8.7 – Horizontal Alignment Parameters*

HA Parameter	Expressway Component	Limiting Value of the Parameter	Reference
Maximum Curvature (minimum radius)	Freeway Main Roads (A & B Roads) Ramps	760 m 180m-250m 120m	AASHTO- Exhibit 3.26 Exhibit 3.15
Minimum Length of Curves	Freeway Main Roads (A & B Roads) Ramps	400 m 140 m -180 m 100 m	Austroads Part 3 Table 7.6
Maximum Compound Curve Ratio	Freeway Main Roads (A & B Roads) Ramps	Flatter radius to sharper radius not exceed 2:1	AASHTO- Chapter 3
Minimum Tangent Between Curves	Freeway Opposite Direction	Absolute minimum is 480 m	Austroads Part 3 Section 7.5.2
Maximum Superelevation	Freeway Main Roads (A & B Roads) Ramps	6% 6% 6%	AASHTO- Exhibit 3.26

## 8.16 Vertical Alignment

Vertical Alignment is the longitudinal profile along the centre line of a road. It is made up of a series of grades and vertical curves. The level of a road at any point along its route, and therefore its vertical alignment, is usually controlled to a large extent by features that the road passes through.

### **8.17 Grading Point**

The Grading Point is the design reference point (sometimes referred to as the design line) on the cross-section. For this design Grading Point is selected as the crown point of the centre median.

### **8.18 Maximum and Minimum Grades**

Grades should generally be as flat as possible, consistent with economy and longitudinal drainage requirements (where kerbing is to be incorporated). Flat grades permit all vehicles to operate at the same speed. Steeper Grades introduce variation in speeds between vehicles with varying power to weight ratios both in the uphill and downhill direction.

There are three aspects to the design of Grades that can be adopted in difficult terrain:

- The poorer performing vehicles using the road (generally trucks in the lower power ranges) must be able to climb the Grade.
- Grades cause the need for speed variations, gear changes and braking for all vehicles.
- Grades cause speed disparities between vehicle types, leading to increased queuing and overtaking requirements.

Maximum and Minimum Grades are selected considering above facts and it is appropriate to avoid the disparity among speeds of different type of vehicles.

### **8.19 Desirable Maximum Length of Grades**

When considering the performance of a vehicle on Grades, maximum Grade itself does not sufficiently control the situation, it is necessary to consider the maximum length of Grade which is discussed in terms of “Critical Length of Grades”. In this case, following factors are to be studied.

- Size and power of a representative truck or truck combination to be used as a design vehicle along with the Grade ability data for that vehicle. AASHTO propose adoption of a weight/power ratio of about 120 kg/KW. This is roughly equivalent to a 19 m semi-trailer carrying an average load.
- Minimum speed on the Grade below which the interference to following vehicles is unreasonable. AASHTO propose a maximum speed reduction of 15 km/h be adopted for the determination of critical lengths of Grade as the likelihood of the truck being involved in a crash increases significantly beyond this speed.
- Speed of the truck at the entrance to the critical length of Grade.

**Table 8.8 – Desirable Maximum Lengths of Grades**

<b>Grade %</b>	<b>Desirable Maximum Lengths of Grades</b>	<b>Reference</b>
2 – 3	1800	Table 8.4 Austroads 2009
3 – 4	900	
4 – 5	600	
5 – 6	450	
> 6	300	

## 8.20 Minimum Grades

Minimum Grades are typically driven by the need to ensure free drainage of the road surface to prevent aquaplaning. Consideration of the road pavement also needs to be made, as moisture will travel along the surface of the pavement boxing. The subgrade surface shall have Crossfall and Grade to match the pavement in order to prevent ponding of water and subsequent pavement failure. On curving roads in flat terrain, drainage problems may occur at the point of zero Crossfall within any Superelevation development areas. In these areas, some longitudinal Grade must be provided to maintain the depth of water within acceptable limits. The type of median drainage proposed may also control the Minimum Grade of the carriageways.

**Table 8.9 – Minimum Grades**

<b>Location</b>	<b>Minimum Grade</b>	<b>Reference</b>
Roads with kerb and channel	Des = 1% Abs. min = 0.3%	Table 8.4 Austroads 2009
Roads in cut		
Unlined drains	0.5%	
Lined drains	0.3%	
Roads without kerb and channel and not in cut	0%	

## 8.21 Curve Length

Parabola has been used as the form of suitable curve for vertical curves. In designing, most of the vertical curves can be represented using following equations. Here it is assumed height of driver's eye above roadway surface as 1.08 m and height of object above road way surface as 0.6 m.

$$\text{When } S < L \quad L = \frac{AS^2}{658} \quad \text{Equation 18 Austroads 2009}$$

$$\text{When } S > L \quad L = 2S - \frac{658}{A} \quad \text{Equation 19 Austroads 2009}$$

Where  $L$  = length of vertical curve, m;

$S$  = sight distance, m;

$A$  = algebraic difference in grades, percent;

## **8.22 Sight Distances**

The concept of Sight Distance provides a calculable parameter that can be related to the geometry of the road. This concept is based on a number of somewhat stylish assumptions of particular hazards and corresponding driver behavior. The hazard is assumed to be an object, of sufficient size to cause a driver to take evasive action, intruding into the driver's field of view.

Assumptions must be made about the following elements:

- Object height;
- Driver eye height; and
- Driver perception – reaction time.

## **8.23 Stopping Sight Distance (SSD)**

Stopping Sight Distance (SSD) is the distance to enable a normally alert driver, travelling at the design speed on wet pavement, to perceive, react and brake to a stop before reaching a hazard on the road ahead.

## **8.24 Vertical Curves and 'K' Values**

The Vertical Alignment of a road consists of a series of straight Grades joined by Vertical Curves. In the final design, the Vertical Alignment should fit into the natural terrain, considering earthworks balance, appearance and the maximum and minimum vertical curvature allowed, expressed as the  $K$  value. Large  $K$  value curves should be used provided they are reasonably economical.

$K = (\text{Length of Vertical Curve}) / (\text{Algebraic Difference in Grades})$

“Horizontal distance in ‘m’ needed to make one percent (1%) change in gradient”

Minimum  $K$  value for vertical curves should be selected on the basis of three controlling factors:

- Sight Distance: is a requirement in all situations for driver safety.
- Appearance: is generally required in low embankment and flat topography situations.
- Riding Comfort: is a general requirement with specific need on approaches to a floodway where the length of depression needs to be minimized.

Design criterion selected for different vertical curve parameters are given in the *Table 8.10*.

**Table 8.10 – Vertical Alignment Parameters**

<b>Vertical Curve Parameter</b>	<b>Expressway Component</b>	<b>Value</b>	<b>Reference</b>
Maximum Grades	Freeway	3%-5%	Austroads Part 3 Table 8.3
	Main Roads (A & B Roads)	4%-6%	
	With Stopped Storage	6%-8%	
	Diamond Ramps		Austroads Part 4C Table 9.2 and Table 9.3
	Exit ramp-Downhill		
	-Uphill	-6%	
	Entry ramp-Downhill	8%	
	-Uphill	-8%	
	Diamond Ramps	5%	
Minimum Grades	Freeway and Ramps	0.30%	Austroads Part 3 Table 8.5
	Main Roads (A & B Roads)	0.30%	
Minimum Length of Profile Tangent	Freeway	120 m	Austroads Part 3 Table 8.9
	Main Roads (A & B Roads)	70 m - 80 m	
	Ramps	30 m - 60 m	
Length of Vertical Curves, L	Freeway		For Crest Curves Austroads Part 3 Table 8.7 Figure 8.7
	-Crest	K=202.9	
	-Sag	K=112.0	
	Main Roads (A & B Roads)		Geometric design of Roads, RDA, 1998-Table 6.3 Table 6.6
	-Crest	K=80.0	
	-Sag	L=25.0	
	Ramps		For Sag Curves Austroads Part 3 Table 8.7 Figure 8.7 Reaction Time 2.0s
	-Crest	K=9.6 - K=44.6	
	-Sag	K=7 -K=17	
	L=KxA		
	A=Algebraic difference in grades		
	K=Length of Vertical Curves per percent change in A		

## 8.25 Pavement Designs

Pavement structure of the Extension of Expressway (ESE) was determined based on the projected cumulative traffic volume obtained through the JICA - STRADA Traffic model.

Layer thickness of the pavement structure are given in *Table 8.11*.

**Table 8.11 – Details of Structure Pavement**

Layer Type	Layer Thickness in mm
Capping	200 mm
Sub Base	250 mm
Aggregate Base Course	250 mm
Binder Course	75 mm
Wearing Course	50 mm

## 8.26 Vertical Clearance

Vertical Clearance is changing depending on the different site conditions and the usage. Expected vehicle mix and the local authority regulations decide the suitable values of clearance. The required values for location is to be decided considering the cost, safety and the usability.

The selected vertical clearances (which also satisfy the local conditions) for some of the conditions are given in the *Table 8.12*.

**Table 8.12 – Vertical Clearance for Different Elements**

Condition	Minimum Clearance (m)	Reference
Clearance at Under Passes – Minor Roads	4.6 m	Table 8.1 Austroads 2009
Clearance at Under Passes – Major Roads	5.4 m	
Clearance at Over Passes – All roads	5.4 m	
Railway Freight Roots (Under pass) without Electrification	4.8 m to 7.1 m	
Railway Freight roots (Under pass) with Electrification	5.7 m to 5.9 m	
Electricity Cable Lines - 220 KV 500 KV	14.5 m	

## 8.27 Interchanges

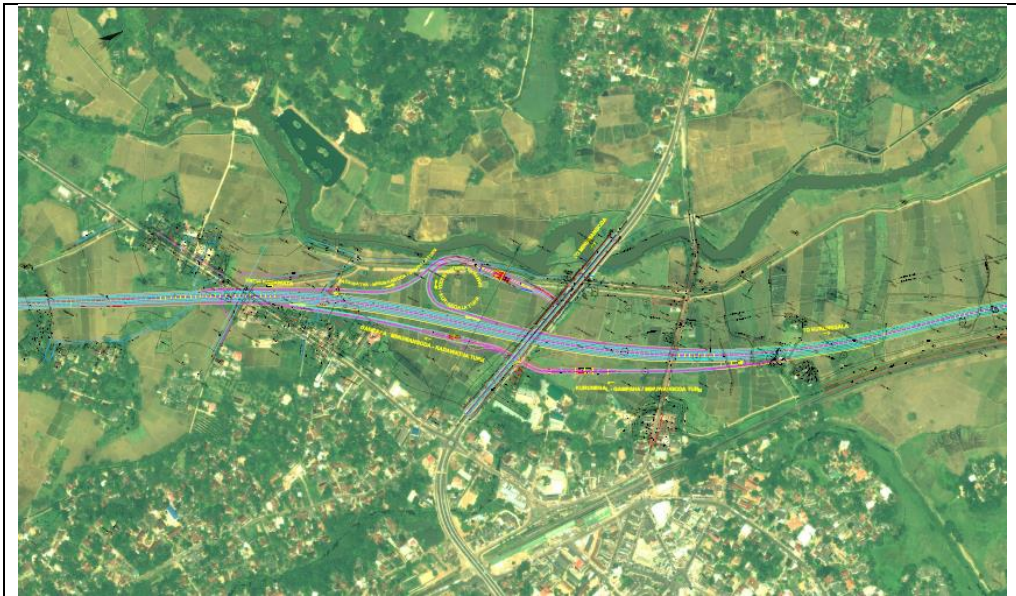
An interchange is a system of interconnecting roadways in conjunction with one or more grade separations that provides for the movement of traffic between two or more roadways or highways on different levels. The greatest efficiency, safety, and capacity are attained when the intersecting traveled ways are grade separated.

The selection of the appropriate type of grade separation and interchange, along with its design, is influenced by many factors, such as highway classification, character and composition of traffic, design speed, and degree of access control. In addition to these controls, signing needs, economics, terrain, and right-of-way are of great importance in designing facilities with adequate capacity to safely accommodate traffic demands.

When, the improvement of the transport facilities within the region and improvement of inter-regional connectivity are considered as main objectives, at first hand, it is important to understand the major roads to be connected to the Expressway (CEP). It has been proposed to construct interchanges at locations given in Table 8.13 with road indicated in the table.

**Table 8.13 - Interchange Locations - Section I (Ch 0+000km – Ch 37+600km)**

Location	Chainage	Type of Interchange	Connecting road
Kadawatha	0+000	Y type system	OCH
Gampaha	11+100	Diamond	Ja ela Ekala Gampaha Yakkala
Veyangoda	22+00	Diamond	
Mirigama south	33+500	Trumpet	Pasyala Mirigama
Mirigama North	37+600	System	Link to Ambepussa



Gampaha Interchange layout



Veyangoda Interchange Layout

## 8.28 Structural Designs of the Expressway

In search of the type of technical standards to be used, mainly British Standard codes will be considered for design of structures of this project. Accordingly, basic designs will be prepared with following structural details in the form of General Arrangement Drawings.

- Foundation Details
- Substructure Details
- Superstructure Details
- Miscellaneous Structures (lightening etc.)

In Structural Designs; software, SAP2000-Version 15 and STAADPRO-Version 8i, are used and sufficient details will be provided in order to prepare cost estimations.

Various structural forms along trace have been identified with the knowledge gained through studying maps and survey details, from information gathered during field inspections and from the hydrology data. Mainly following structural types have been identified.

The geometry of the Structure has been designed so that the road way geometry is no way disturbed by the existence of the structure.

## 8.29 Culverts

Considering the required capacities to be provided and the convenience of construction and maintenance work, all or most of the culverts have been designed as box culverts.

*Table 8.16– Number of Culverts*

Number of Box Culverts	39
------------------------	----

## 8.30 Underpasses and Overpasses

At locations where the Expressway crosses the byroads, the Expressway has been designed as an underpass or an overpass. This is mainly because; the Proposed Expressway (CEP) is designed as a limited access road in order to achieve a shorter travel time and a high Level of Service (LOS). In selecting the locations, it has been considered that minimum disturbance is caused to the existing facilities, minimize social problems created due to the Expressway and improve the existing facilities as far as possible.

*Table 8.17 – Number of Underpasses and Overpasses*

Type	Numbers
Underpass Box	4
Overpass Bridges	11

### 8.31 Viaducts

One major issue encountered during the studies is flood plains. Major flood plains encountered are across the Nilwala River Flood Plain and the Walawe River Flood Plain. These are very sensitive areas and any changes due to the construction of the Expressway (ESE) can affect the existing system and affect the people and the environment. Therefore, it has been decided to construct the Expressway (ESE) in these sections as an elevated structure (Viaducts) in order to minimize the damages to the people and the environment.

Typical cross sections of the viaduct are shown in the *Fig. 8.2*

Identified locations of viaduct are given in *the Table 8.18*.

**Table 8.18 – Locations of Viaducts**

Chainage		Length m	Chainage		Length m
Start	End		Start	End	
3+550	3+685	135	19+803	20+178	375
6+075	6+265	190	20+930	21+130	200
6+820	7+390	570	21+600	21+750	150
7+580	8+160	580	22+330	22+680	350
8+470	8+650	180	25+721	25+951	230
9+060	11+800	2740	30+430	30+905	475
13+666	14+726	1060	32+040	32+340	300
15+090	16+280	1190	33+326	33+476	150
16+800	17+820	1020	34+324	34+749	425
18+110	19+200	1090	36+521	36+811	290
19+320	19+650	330	<b>Total length</b>		12,030

### 8.32 Service Roads

The Service Roads (called diversion roads) are so planned to collect traffic to and from several access roads in close proximity to each other and to channel them to use a single underpass or overpass. The construction cost varies along the access roads as there are cutting and filling involved at underpasses and overpasses respectively to control the formation level that should be leveled together. In the design of the expressway service roads provided to improve connectivity of the local communities to the regional road network and through that to the CEP.

### 8.33 Service Centers

Mainly Service Centers should be selected considering the traffic safety and the land use patterns. Generally Service Centers should not be located at a spacing lesser than 50 km and sufficient warning should be given in advance to the drivers about the existence of a Service Center. These should include at least:

- Separate refueling facilities
- Designated parking areas
- Convenience shop, with retail floor area not greater than 240 sq.m.
- Toilets and changing rooms
- Food and refreshment facilities
- Public telephones
- Emergency vehicle repairs

No Service areas have been identified in this section of the expressway.

### 8.34 Utility and Service Easements

In general, public utility plant should not be installed in service tunnels where possible. Services should be avoided on freeway structures and if unavoidable, suitable safety measures should be taken as below:

- Pipes carrying fluids should not be placed within the cells of box girders;
- Services which are mutually hazardous should be carried on opposite sides of the structure;
- Maintenance need not to be carried out from the freeway or from ramps;

### 8.35 Toll Plazas

In selection of Toll Plazas, similar types which are currently used in other expressways in Sri Lanka were studied and parameters given in the *Table 8.19* were used.

*Table 8.19 – Dimensions of Toll Gate Components*

Toll gate Component	Item	Value	Reference
Cross Section Elements	Width Outer Carriageway	3.6 m	Japanese
	Width of Other Carriageway	3.0 m	Standard
	Width of Shoulder	0.5 m	
	Width of Toll Island	2.2 m	
	Cross Fall	2.50%	
Size of Toll Island	Length, Entrance	35.7 m	Japanese
	Length, Exit	22.4 m	Standard
	Width	2.2 m	
	Height of Curve Stone	0.15 m	

### 8.36 Drainage Designs

Surface drainages and the subsurface drainages should be provided to run off the water which falls on the road surface and the adjacent catchment areas. Considering the geometry of the ground along the trace and the hydrology of the area, necessary longitudinal drains and cross drainage will be provided. It is inevitable that natural drainage paths will be disturbed by the construction of the Expressway and there is a tendency of upstream flooding, unless proper drainage paths are provided. Specially, the Attanagalu Oya Flood Plain is considered as the most sensitive areas when the drainage problem is concerned. In order to keep the damages to these sensitive areas minimum, it has been decided to construct the Expressway on an elevated structure (Via duct).

### 8.37 Raw Material Requirement

Various type of construction materials in different quantities are required for the construction of the Expressway. Out of those, the materials which are important in an environmental point of view and are obtained from natural sources as are listed below.

*Table 8.20 – Requirement of Raw Material*

	<b>Section I from Kadawatha to Mirigamma</b>
Sand -cu m	400,180
Earth -cu m	3,036,600
Aggregate-cu m	1,063,870

The construction methodology is to be selected in a manner to get the maximum usage from the material arising out of excavation process. The balance requirements are to be obtained from quarry sites and borrow sites, which are approved by the Geological Survey and Mines Bureau (GS & MB), Central Environmental Authority (CEA) and respective local authorities

Accordingly, aggregate, earth and sand transport distance may vary in the range of 10 km to 50 km, 5 km to 25 km and 20 km to 75 km respectively.

The above requirements for materials have been calculated based on the preliminary designs and accurate figures can be obtained, once the designs are finalized.

Special care has to be taken in the selection of quarry, borrow and mining areas so as to avoid any adverse impact on the environment pertaining to the relevant operations and the transport with minimal impact to humans, flora, fauna and wildlife.

### 8.38 Project Cost

The total estimated construction cost of the Central Expressway from Kadawatha to Mirigama is given below as per the commercial contract.

**Table 9.5- Cost Break Down**

<b>Item No</b>	<b>Items</b>	<b>Amount - LKR</b>
1	Preliminaries	8,421,085,340.90
2	Earth works	21,911,484,919.74
3	Sub-base and Base course	3,375,154,473.80
4	Pavement	5,498,156,254.30
5	Structures	82,525,916,578.60
6	Drainage	2,601,938,298.04
7	Incidentals	4,222,812,038.96
8	Facilities	898,499,603.14
9	Day works	99,652,066.79
10	Provisional sums	7,080,592,800.00
	Sub total	136,635,292,374.27
	Physical Contingencies 10%	13,663,529,237.43
	Allow for Price escalation -5%	8,087,049,647.37
	Total cost	158,385,871,259.06

## 9.0 Economic Analysis

# Chapter 9

### 9.1 Introduction

The Government of Sri Lanka (GOSL) expects assistance in funding for the Construction of Central Expressway first section from Kadawatha to Mirigama from the Government of China through the EXIM Bank of China.

In this context it was decided to carry out the full Economic Feasibility Study for the project by a team of RDA staff using outputs of several studies carried out in the past. The task of compilation of a feasibility study report for the section from Kadawatha to Mirigama has been entrusted to Planning Division of RDA. In this Feasibility Study, Economic Analysis is one of the major parts.

In the Economic Analysis, economic parameters such as Economic Internal Rate of Return (EIRR) and Net Present Value (NPV) and Benefit Cost Ratio (B/C ratio) are calculated to check the feasibility of the project.

For the above purpose, economic cost and benefits are calculated using the data collected.

#### 9.1.1 Principles for Selecting Cost and Benefits.

Following three principles are used in selecting cost and benefits.

- Selected costs and benefits of a project shall be clearly observable (in terms of either quantity or quality) in order to avoid attributing incorrect cost and benefits.
- Avoid double counting of costs and benefits.
- Adopt continuously generating costs and benefits.

When considering the costs and benefits of a project, following are to be used in the evaluation based on project costs and benefits.

Project cost and benefits can be categorized in to following two categories.

1. Tangible and
2. Intangibles

**Table 9.1 - Cost and Benefit Items of Extension of Southern Expressway (ESE) Project which are taken into Consideration in the Economic Analysis**

Purpose of Application	Output of Application	Cost and Benefit Items
Calculation of the Evaluation indices	Tangible cost	Project cost Operation and maintenance cost
	Tangible benefit	Vehicle running reduction benefit Running time reduction benefit Air pollution reduction benefit Traffic accident reduction benefit
Synthetic economic evaluation	External economy (Intangible benefit)	Contribution of the ESE on socio-economic development in the Southern provinces and connecting provinces
	External diseconomy (Intangible cost)	Impacts of the ESE Project on physical, biological and social environment at the adjacent stops along the ESE route

### 9.1.2 Necessity to Calculate Expressway Prices Correctly

- a) In daily financial transactions, values of goods and services to be transacted are expressed at current prices, accordingly they include:
- Price escalation portion, and
  - Transfer costs such as taxes

Project costs are initially estimated at constant prices. They do not include the price escalation portion but include transfer costs.

- b) In the economic evaluation of a project, value must basically be expressed in opportunity cost prices. This is because evaluation has to be carried out from the socio-economic view points of the country or region concerned.
- c) Therefore, values expressed at prices used for daily transactions are unsuitable for the economic evaluation.

### 9.2 Price for Economic Evaluation

Attributes of the prices for economic evaluation are summarized in *Table. 9.1*. The prices are constant prices and not current or nominal price. Comments related to these prices are listed below:

- a) Behind the adoption of resource value prices and CIF, FOB prices as proxies for opportunity cost prices, there is the following assumption, almost perfect competition is assumed in the domestic and international markets for the goods and services planned for the project.
- b) If the above assumption is invalid the value of goods and services are to be measured at their opportunity cost prices. To estimate opportunity cost prices a detailed analysis of the price mechanism of the project goods and services and basic data for estimation are required.

- c) There are two types of competition for two types of transaction markets: Competition in the domestic market and international market. For resource value prices and opportunity cost prices, the competition in the international market for the goods and services concerned is not reflected, while it is reflected in the CIF and FOB prices when border prices are adopted as the numeraire for economic evaluation, this issue will be discussed again later.
- d) The value of goods and services measured with any one of the three categories of prices shown in *Table 9.2* does not consider the external economies and diseconomies of goods and services. There exists a “Market Failure”, since external economies and diseconomies are generated outside of the markets.

*Table 9.2 - Attributes of Prices adopted for Economic Evaluation of Projects*

Item	Resource Value Prices	Opportunity Cost Prices	CIF-FOB Prices
Definition	Prices that can be calculated based on the values of goods and services expressed at the resource base. They exclude transfer costs, which are included in at daily transaction prices.	Prices equivalent to maximum value of the goods and services that would be obtained for usage other than that for a particular project. Transfer costs are not included.	Cost – Insurance and Freight (CIF) and Free on Board (FOB) prices of tradable goods and services.  Transfer costs are not included.
Estimation Method	$P^R = P^T - T + S$ $P^R$ : Resource value of prices for goods and services $P^T$ : Prices at market transaction $T$ : Taxes imposed on Goods and services $S$ : Subsidy for goods And services	The value of goods and services that would be lost by being used in a particular project, which is the maximum value to be obtained if they were used in another project	Citation of prices from trade statistics
Conditions for Estimation	Transaction market for the concerned goods and service exists and the market is perfectly competitive.	Either no transaction market exists or it is imperfect.	No conditions required, since semi perfect competition has been a part of competition has been a part of international trade.
Goods and Services Covered	(1) Goods and services that can be produced domestically (2) Skilled labor	(1) Land (2) Unskilled labor	(1) Tradable goods and services

### 9.3 Benefits and Beneficiaries

Benefits from the proposed road construction project are expected to be mainly from the saving of vehicle operating costs, passenger travel time and reduction of accidents. Vehicle operating costs and maintenance costs consist mainly of foreign exchange costs. Therefore, the proposed project will save foreign exchange too. Employment generation will also take place within the construction period.

The reduction of vehicle operating costs will benefit the owners of vehicles. Saving of passenger travel time will benefit employees who commute daily. Increasing producer surpluses will increase agricultural products and improve the quality of life of people in the adjacent areas as well as whole country.

The traffic in the project areas consists of car, light, medium and heavy goods vehicles, large and medium buses. The road transport, freight as well as passenger, has been unregulated and operated on a competitive environment. Under these circumstances, reduction of vehicle operating costs will at least partly be passed on to passengers and producers in these areas.

Therefore, both producers and consumers will constitute the main group of beneficiaries.

### **9.4 Estimation of Economic Returns**

The economic evaluation was carried out for the Expressway (ESE) to derive the Economic Internal Rate of Return (EIRR). Stream of costs and benefits were established for over 25 starting from 2016 to 2041 year period as the project is expected to put on operation from 2021.

Even though the life of road pavement can be 20 years, the life time of the structures will be much more than 20 years. The discounted benefit of structures after 20 years has not been considered as the discounted value of these benefits are small and will not add considerable value to the present worth. However the salvage value of the project has been taken as 30 % of the project cost after the 20 year period.

The costs were estimated based on the market price in year 2015. The travel time was estimated based on the values provided in the book "Assessing Public Investment in the Transport Sector" published by Department of National Planning in the year 2001. The values were updated using Colombo Consumer Price Index (CCPI) as given in the book. The calculation of unit vehicle operating cost was based on the output of HDM 4 model calibrated for the National Road Network.

Quantifiable benefits for the proposed project have been derived by comparing costs and benefits associated with and without the project scenario. Saving on vehicle operating costs, passenger travel time and accident costs are the main quantifiable benefits of the project.

### **9.5 Project Risks**

There are no significant risks which are likely to impede the successful implementation of the project other than the increase in cost and reduction of benefits. The risks to be considered are institutional capacity for implementation, acquisition of land and cost for land acquisition and the funding for implementation. The risk related to the institutional capacity for the construction and supervision of the project can be handled by a method employed on the project of this nature such as used for the construction of other expressways by outsourcing the requirement to consulting firms. However the risk in increasing the cost and reduction of benefits also to be considered and that were analyzed

as sensitivity analysis of this analysis. Risk of land acquisition has to be minimized by adopting same methodology used in other Expressway.

## **9.6 Base Case and Alternatives**

The simple definition of base case is “maintaining of existing road network with minimum cost” (do minimum scenario) with the implementation of other enhancement work of the network.

The base case of this study is defined as the whole network of national highways and expressways without the CEP and all traffic is using the existing roads to approach the area served by the proposed Expressway.

In this base case, the traffic on all roads in influential area has been considered without CEP link.

With provision of the CEP link, there will be diversion of traffic to the link from other roads in the area. And this will create an efficiency in the network by reducing length and time of vehicle operating.

### **9.6.1 Modeling Results**

The Traffic model is used to generate outputs for use in economic analysis. The model outputs include a daily estimate of the following measures for both base case and project case.

- Vehicle (Car and commercial vehicle ) trips per day
- Vehicle Kilometre Travelled (VKT)
- Vehicle Hour Travelled (VHT) per day.

The results of the traffic modelling for the base case are shown in Table 9.3 and for project scenarios is shown in Table 9.4.

**Table 9.3. Base case 'Do Minimum' Traffic Modelling Results**

	Units	2021	2026	2036
<b>Demand</b>				
PV NB	trips	721,917	934,397	1,656,314
PV B	trips	106,449	141,270	247,719
LCV	trips	48,950	58,836	107,786
MCV	trips	204,332	235,039	439,371
HCV	trips	12,245	13,839	26,084
<b>VHT</b>				
PV NB	hours	529,254	859,585	4,006,841
PV B	hours	72,979	122,327	557,533
LCV	hours	39,774	54,668	167,842
MCV	hours	181,412	243,675	719,816
HCV	hours	11,252	15,369	48,376
<b>Total</b>	<b>hours</b>	<b>834,671</b>	<b>1,295,624</b>	<b>5,500,408</b>
<b>VKT</b>				
PV NB	km	14,564,572	19,667,544	37,647,292
PV B	km	2,126,751	3,077,440	6,108,509
LCV	km	1,202,059	1,439,661	2,046,218
MCV	km	5,427,723	6,334,658	8,500,243
HCV	km	321,800	369,574	484,208
<b>Sub Total</b>	<b>km</b>	<b>23,642,905</b>	<b>30,888,877</b>	<b>54,786,470</b>

**Table 9.4 : Traffic Modelling Results : Scenario 1**

	Units	2021	2026	2036
<b>Demand</b>				
PV NB	trips	723,225	935,800	1,520,096
PV B	trips	106,715	141,529	234,884
LCV	trips	49,092	59,007	82,738
MCV	trips	204,706	235,456	302,749
HCV	trips	12,258	13,853	17,151
<b>VHT</b>				
PV NB	hours	520,999	839,698	3,586,443
PV B	hours	72,007	119,507	499,874
LCV	hours	39,303	53,436	148,984
MCV	hours	179,299	238,664	636,133
HCV	hours	11,003	14,787	41,744
<b>Total</b>	<b>hours</b>	<b>822,611</b>	<b>1,266,092</b>	<b>4,913,178</b>
<b>VKT</b>				
<b>FOR TOLLED ROADS</b>				
PV NB	km	380,842	709,669	2,332,228
PV B	km	66,378	139,574	429,685
LCV	km	14,375	20,288	36,283
MCV	km	78,437	11,524	199,631
HCV	km	5,552	7,050	10,860
<b>Sub Total</b>	<b>km</b>	<b>545,584</b>	<b>888,105</b>	<b>3,008,687</b>
<b>FOR NON TOLLED ROADS</b>				
PV NB	km	14,225,638	19,012,498	35,036,443
PV B	km	2,070,478	2,943,135	5,637,188
LCV	km	1,190,451	1,422,048	2,007,067
MCV	km	5,359,530	6,224,246	8,274,075
HCV	km	317,211	364,230	472,033
<b>Sub Total</b>	<b>km</b>	<b>23,163,308</b>	<b>29,966,157</b>	<b>51,426,806</b>
<b>Grant Total</b>	<b>km</b>	<b>23,708,892</b>	<b>30,854,262</b>	<b>54,435,493</b>

## **9.7 Cost Stream Analysis - Methodology and Assumption**

### **9.7.1 Construction Cost**

The construction cost is based on estimate prepared by the Project Director of the Central Expressway in accordance with the preliminary design for loan assessment from the Government of China through the EXIM Bank of China.

The cost has been estimated based on the unit rates of 2015. The summary of cost is given in Table 9.5.

**Table 9.5- Cost Break Down**

Item No	Items	Amount - LKR
1	Preliminaries	8,421,085,340.90
2	Earth works	21,911,484,919.74
3	Sub-base and Base course	3,375,154,473.80
4	Pavement	5,498,156,254.30
5	Structures	82,525,916,578.60
6	Drainage	2,601,938,298.04
7	Incidentals	4,222,812,038.96
8	Facilities	898,499,603.14
9	Day works	99,652,066.79
10	Provisional sums	7,080,592,800.00
	Sub total	136,635,292,374.27
	Physical Contingencies 10%	13,663,529,237.43
	Allow for Price escalation -5%	8,087,049,647.37
	Total cost	158,385,871,259.06

### Consultancy cost

It was assumed 2% of construction cost for the supervision considering the mainly involvement of local consultant in the supervision during the construction along with the review of the design. Accordingly the consultancy cost is taken as Rs. 3,000,000,000.00

The construction and consultancy cost distribution according to the construction programme are given below Table 9.6 and Table 9.7.

**Table 9.6 Construction Cost Distribution during Construction**

Year	Financial cost Rs.	Economic Cost Rs
2,016	13,198,822,604.92	12,367,296,780.81
2,017	39,596,467,814.77	37,101,890,342.44
2,018	39,596,467,814.77	37,101,890,342.44
2,019	39,596,467,814.77	37,101,890,342.44
2,020	26,397,645,209.84	24,734,593,561.62
	158,385,871,259.06	148,407,561,369.74

**Table 9.7 Consultancy Cost Distribution during Construction**

Year	Financial cost Rs.	Economic Cost Rs
2,016	250,000,000.00	234,250,000.00
2,017	750,000,000.00	702,750,000.00
2,018	750,000,000.00	702,750,000.00
2,019	750,000,000.00	702,750,000.00
2,020	500,000,000.00	468,500,000.00
	3,000,000,000.00	2,811,000,000.00

The cost was converted to economic value using the shadow price index calculated as given below.

### **9.8 Shadow Pricing**

Most of data used to estimate financial costs are expressed in market prices. However, the market prices may not be equal to the economic prices.

For example, the tax on construction material is a cost to those who pay the tax, but it does not necessarily reflect economic costs to the country as a whole in a sense that an increase in the tax does not mean that more economic resources are required to produce the same material.

In this study, the local currency portion of the goods and materials includes Income Tax, Surcharge and the Value Added Tax (VAT). The economic costs of foreign goods and materials are calculated by subtracting the customs duties and Value Added Tax (VAT) from the financial costs.

$$SCF = \frac{I + E}{(I + Di) + (E - De)}$$

Where,

I : total amount of imports

E : total amount of exports

**Table 9.8- Export and Import of the Country**

Year	Commodity Exports Rs Mn	Commodity Import Rs. Mn	Import Duty Rs.Mn	SCF
2000	418,457	554,861	42,842	0.9578
2001	430,536	533,747	45,317	0.9551
2002	449,506	583,909	60,717	0.9445
2003	495,437	644,271	80,465	0.9341
2004	582,753	809,419	105,955	0.9293
2005	656,280	916,434	118,751	0.9298
2006	715,557	1,065,902	145,335	0.9246
2007	845,137	1,249,564	157,979	0.9299
2008	337,015	1,526,478	164,773	0.9188
2009	814,067	1,172,784	147,179	0.9310
2010	975,256	1,520,770	163,743	0.9384
2011	1,202,670	2,308,639	188,320	0.9491

Di : total amount of import duty

De : total amount of export tax

The Standard Conversion Factor used in this study was estimated by the formula given above. The calculated Standard Conversion Factor is 0.937.

## 9.9 Economic Cost Estimate

The total financial costs of the proposed project are converted to economic costs in order to carry out the economic analysis. The costs of goods and materials in the local currency portion are changed to economic costs by using the Standard Conversion Factor of 0.937.

In addition, the costs of goods and materials in the foreign currency portion which are imported from foreign countries are converted to economic costs by subtracting the custom duties, taxes and levies and the VAT from the financial costs.

## 9.10 Maintenance Cost

The goal of maintenance is to preserve the asset, not to upgrade it. Unlike major road works, maintenance must be done regularly. Road maintenance comprises “activities to keep pavement, shoulders, slopes, drainage facilities and all other structures and property within road reservations as near as possible to their as-constructed or renewed condition” It includes minor repairs and improvements to eliminate the cause of defects and to avoid excessive repetition of maintenance efforts. For management and operational convenience, road maintenance is categorized as routine, periodic, and urgent. In addition, for expressway there will be the cost for operation such as toll collection, traffic management and accident removal. The list given in *Table 9.9* identifies these activities.

**Table 9.9 - Road Maintenance Activities**

Type of Maintenance	Description	Time Frame
Routine Maintenance	Consists of works such as weeding, drainage cleaning, road sweeping, culvert maintenance, road sign maintenance, pot hole repair, patching, edge corrections etc.	Required on daily basis or at frequent intervals during the year.
Periodic maintenance	Resealing, road surface markings	Required at interval of several years depend on surface type
Urgent maintenance	Consists of works such as removal of accidents and other obstacles etc.	Executed as needed to deal with emergencies and problems requiring immediate attention
Operational	Consists of works such as Toll collecting, Traffic management by own staff as well as Police etc.	Required on daily basis and periodic replacement of vehicles and equipment

### 9.11 Maintenance Cost Calculation

The maintenance cost for the operation and maintenance of the proposed Cental Expressway (CEP) is based on the operation and maintenance cost prepared for operational sections of the Southern Expressway (E-1-1). The following activities are considered for calculating annual routine maintenance cost of the Expressway (ESE).

1. Spot Patching and edge breaks
2. Cleaning and obstacle removing works
3. Repair of guard walls
4. Maintenance of street lights
5. Cleaning of vegetation and shoulder maintenance
6. Road furniture
7. Other minor repair works

Operational costs of the Expressway are based on manpower, equipment and machineries. The followings are considered for calculating operational cost.

1. Wages of operational staff
2. Cost for communication, fuel, electricity, water etc
3. Cost for staff training
4. Maintenance of office equipment, vehicles, toll system equipment etc

It was assumed that the annual maintenance of equipment and vehicles is 2 % of the total cost of equipment. According to the construction of the Central Expressway (CEP), the cost of equipment is Rs. 770,866,690.00.

## 9.12 Periodic Maintenance Cost

In estimating the periodic maintenance cost following were assumed:

1. 50 mm overlay of surface every 07 years period
2. Replacement of electronic equipment of user fee collection every 10 years
3. Replacement of vehicle fleet after 10 years

With the experience of maintenance and operation of Southern Expressway (E-1), the following costs were estimated to be used in this analysis.

**Table 9.10 - Maintenance Cost**

Item	Unit	Cost-Rs.Mn
Routine Maintenance of Road	Rs.mn/km/year	1.1789
Emergency Maintenance	Rs.mn/km/year	0.5895
Maintenance Cost of Equipment	Rs. mn /year	40.0
Periodic Maintenance	Rs. mn /km at every 7 years	105.0

**Table 9.11 Operating Cost**

Item	Unit	Cost-Rs.Mn
Toll Collection and Traffic Management	Rs.mn/km/year	4.95
Replacement of Equipment and Vehicle fleet	Rs.mn/Every 10 year	1250.0

## 9.13 Benefit Stream Analysis - Methodology and Assumption

### 9.13.1 Saving on Vehicle Operating Cost (VOC)

The quantifiable benefits from the proposed road project were derived by comparing associated cost of operating vehicles with and without the effects of the project.

Savings in Vehicle Operating Costs (VOC) are the most direct and one of the most important benefits of development of transport infrastructure. These savings are mostly achieved by upgrading technology, increasing speed, reducing congestion, reducing road roughness and improving geometric design. Value of the saving is usually calculated as a derivative of the vehicle specification, road features, cost of operational input and operating speed. VOC saving from a project are usually estimated by calculating the differences before and after completion of the project concerned.

Using the traffic model outputs of produce by the University Moratuwa study on the Central Expressway Total vehicle km in the network is calculated without CEP link and with CEP link for year 2021, 2026 and 2036. If the new link is added to the network, if it is a viable

project there should be a reduction in total vehicle km in the network. That saving in vehicle km can be converted to vehicle operating cost saving. The total vehicle km of each year during the period of analysis was calculated by interpolation and extrapolation of these values considering the variation between forecasted years.

It was assumed that the vehicle km saved is due to the new Expressway (CEP) link and those vehicles that use the link and unit cost of VOC were taken with respect to roughness and the speed relevant to the new link.

*Table 9.12 - Vehicle Km Base case without CEP (Output of the Traffic Model of UOM study)*

Year	PV-NB	PV-B	LCV	MCV	HCV
2021	14,564,572	2,126,751	1,202,059	5,427,723	321,800
2026	19,667,544	3,077,440	1,439,661	6,334,658	369,574
2036	37,647,292	6,108,509	2,046,218	8,500,243	484,208

*Table 9.13 - Vehicle Km with CEP (Output of the Traffic Model of UOM study)*

a) For toll roads

Year	PV NB	PV B	LCV	MCV	HCV
2,021	380,842	66,378	14,375	78,437	5,552
2,026	709,669	139,574	20,288	11,524	7,050
2,036	2,332,228	429,685	36,283	199,631	10,860

(a) For non-Toll roads

Year	PV NB	PV B	LCV	MCV	HCV
2,021	14,225,638	2,070,478	1,190,451	5,359,530	317,211
2,026	19,012,498	2,943,135	1,422,048	6,224,246	364,230
2,036	35,036,443	5,637,188	2,007,067	8,274,075	472,033

The VOC rate was taken from the HDM-4 model in RDA calibrated for National Road Network. If the new link is not in operation, these vehicles would use the existing network.

**Table 9.14. Vehicle Operating Costs for Vehicle Types**

Type	VOC Expressway (Rs./km)	VOC Highway Network (Rs./km)
Private vehicle	25.9	28.8
Light commercial vehicle	25.9	28.8
Medium commercial vehicle	39.1	47.1
Heavy commercial vehicle	56.8	68.4

It was assumed that the project construction will be commenced in 2017 and completed by end 2020 and project will be in operation from the start of 2021. The economic analysis period has been taken as 20 years from 2021.

### 9.13.2 Travel Time Saving

Saving in travel time is a primary economic outcome sought in a transport project. Simply increased speed or reduced waiting time results in shorter travel time and savings in corresponding economic values of time. Generally, three types of transport user groups benefited by travel time savings.

- Passengers
- Freight consignees
- Transport operators

Travel time saving for passengers is a recognized benefit in most transport sector projects. It comprises a significant proportion of all benefits and therefore, it is considered as an important component. Therefore, passenger travel time saving is considered for the economic analysis.

Travel time also is an important function in the movement of freight and it directly affects the economy of the country. On the other hand, increased travel time leads to higher transport costs. Travel time is very important in perishable goods transportation. But due to non-availability of data on freight transport especially perishable goods, no travel time on freight transportation was considered.

Travel time difference between ‘without project’ and ‘with project’ has been estimated and converted in to money values using the Time Values given in the book "Assessing Public Investment in the Transport Sector" published by Department of National Planning in the year 2001. The value of passenger time for various types of vehicles are given in *Table 9.15*.

**Table 9.15 -VOT for Transport User Groups (In 1999 Rs/hour)**

User Group	Urban	Rural	Intercity	All Sectors
Car	100.06	78.62	135.81	106.50
Van	51.15	37.62	51.15	48.44
Motor Cycle	19.05	27.00	14.29	19.22
Public Transport	10.83	12.41	12.41	11.62
Non Motorized Modes	6.78	8.62	0.00	7.39
All Motorized Modes (AV)31	24.61	23.01	28.81	25.55

Source: Assessing Public Investment in the Transport Sector – Department of National Planning 2001

The 1999 values of VOT for passenger transport user groups is converted to the 2015 values using the Colombo Consumer Price Index (CCPI) and is given in *Table 9.16*.

**Table 9.16 VOT for Transport User Groups (In 2015 Rs. /hour)**

User Group	Urban	Rural	Intercity	All Sectors
Car	420	330	570	447
Van	215	158	215	203
Motor Cycle	80	113	60	81
Public Transport	45	52	52	49
Non Motorized Modes	28	36	0	31
All Motorized Modes (AV)31	103	97	121	107

Using outputs of traffic model run by University of Moratuwa study, total vehicle hours in the network was calculated with and without the CEP for years 2021, 2026 and 2036 in the analysis period. Saving in vehicle hours is the saving due to the implementation of the project. Vehicle hours calculated using the model is given in *Table 9.17*.

**Table 9.17 – Vehicle Hours in the Network in Different Years**

	Total Vehicle Hours (vehi. hours)- without Project				
	PV-NB	PV-B	LCV	MCV	HCV
2021	529,254	72,979	39,774	181,412	11,252
2026	859,585	122,327	54,668	243,675	15,369
2036	4,006,841	557,533	167,842	719,816	48,376
	Total Vehicle Hours (vehi. hours)- with Project				
2021	511,943	70,072	38,222	176,027	10,845
2026	824,567	115,971	51,819	233,483	14,557
2036	3,508,220	484,390	144,181	618,227	41,076

The vehicle hour saving was calculated by considering total network vehicle hours with and without the project using above traffic model results.

As the model calculates the vehicle hours in 4 categories of vehicles only vehicle hour saving of private vehicles are used in the calculation of travel time saving. Travel time saving of Light Commercial vehicles and Goods vehicles have not been considered in the calculation even though there can be saving of travel time in transport of perishable goods. Vehicle Hour Saving of each vehicle type was converted to money value using the rate for intercity travel given in the *Table 9.16* above.

### 9.13.3 Accident Cost Saving

Accident cost generally comprise of direct tangible components, which can be readily determined and intangible components relating to injury, death, pain and suffering.

Accident rate in Sri Lanka are still relatively high compared with developed countries, but are consistent with most other developing countries. This is due to a number of reasons which are:

- Poor road design and geometry
- Congestion in urban areas
- Mix of slow moving and fast moving vehicles
- Poor enforcement of traffic regulations
- In-experience and poor driver training
- Poor vehicle fitness
- Over loaded vehicles and so on

There is a relationship between total numbers of vehicle km in the network and the numbers of accidents. When, vehicle km in a network is high, the accident rate is also high. If there is saving in vehicle km due to any project that saving in accident can be attributed to the project. As such there is a saving in accident in this project that can be calculated using the saving in vehicle km every year. Value of the saving can be calculated using the values given in the table 4.11 in the book "Assessing Public Investment in the Transport Sector" published by Department of National Planning in the year 2001. The value is Rs 0.083 per vehicle km in 1999. The value converted to 2015 value using the Colombo Consumer Price Index (CCPI) and the value is Rs.0.348 per Veh- km.

However even though there is reduction of vehicle operating cost due to diversion of traffic to expressway, there is no total reduction in vehicle km in the network at the initial period of the project implementation. As such no any accident reduction has been considered in the study

#### **9.13.4 Regional Benefits (Development Benefits)**

Transport infrastructure is a prerequisite for Socio-Economic Development. This also referred to as Regional Development. This is illustrated by the new commercial, industrial, residential and agricultural activity that often springs up after a project is implemented. Transport projects, however, do not guarantee that such development will occur. Availability of other factors of development, supporting infrastructure (eg. Electricity) and Government Policy also play a significant role.

Regional Development is dependent on number of different contributory factors. The transportation access is a major contributing factor out of them. The regional benefits would be more significant and very hard to quantify. The main impacts of transport are the access it provides to markets, resources, services and employment opportunities. Accessibility is measured by the quality of transport infrastructure and services available. Improved access to areas will give number of socio economic benefits to the people who live in the area and to the region such as:

1. Exposed hinter lands for future developments
2. Increase resource utilization, productivity and employment opportunities
3. Increase of land values in the area

#### 4. Improving social conditions (education, health, per capita income etc.)

If development is dependent on investment in non transport infrastructure, benefit should not all be credited to the transport project, but must be apportioned through a suitable method. Furthermore, transport project generally would have less effect on economic development where adequate services are already available than where services are poor or not available.

The study area considered close to the CEP is given in the Map 1 of Annex 1 According to the present situation most of the areas that the expressway passes have reasonable transport facility even though transport facility of few areas are poor. Accordingly provision of interchanges at most of the National Roads which cross the Expressway (CEP) has increased the accessibility the contribution to land value increase to consider as a development benefit is not reasonable.

#### 9.13.5 Discount rate

The discount rate recommended for transport project feasibility studies by ADB is 10% - 12%. However to account for inflation the discount rate needs to be adjusted to calculate the real discount rate which is used for the economic analysis. The five year average inflation is estimated as 5%, assuming a discount rate of 12%, the real discount rate would be 6.7%. For the purpose of the study, a discount rate of 7% is used. Similar rate was adopted in the Northern Expressway Feasibility Study Report.

### 9.14 Result of the Economic Analysis with Sensitivity Analysis

#### 9.14.1 Economic Analysis

The Economic Analysis was carried out for Kadawatha to Mirigama section of Central Expressway for the traffic forecasted only that section in operation using the economic cost and benefit calculated as given above and result is given below

Economic indicator	Value
Net Present Value ( At discount rate of 7%)	Rs. Mn 143,053.72.0
Economic Internal Rate of Return	12.09
Benefit cost Ratio	2.12

The detail economic analysis calculations are given in *Annex I*.

#### 9.14.2 Sensitivity Analysis

The sensitivity analysis was carried out to test the economic strength of the project. The change in cost and benefits of the project can affect the viability of the project. This has been tested by sensitivity analysis by increasing cost and reducing benefits of the project under the following consideration under two discount rates.

**Table - 9.18– Sensitive Analysis**

<b>Sensitivity Case</b>	<b>Discount Rate</b>	<b>Case Description</b>
Case 1	7%	Basic case No change of benefit and cost
Case 2		Construction cost reduce by 10% no change in benefits
Case 3		Construction cost increase by 10% and no change in benefits
Case 4		Construction cost increase by 10% and benefit reduce by 10%
Case 5		Construction cost increase by 10 % and benefit increase by 10%
Case 6		Construction cost increase by 20% No change of benefit
Case 7		Construction cost increase by 20% and benefit reduce by 10%
Case 8		Construction cost increase by 20% and benefit reduce by 20%
Case 9		Construction cost remain as base case and benefit reduce by 10%
Case 10		Construction cost remain as base case and benefit reduce by 10%

The final results of the economic and sensitivity analysis are summarized and given in *Table 9.15* for different alternative sensitivity cases. Details of analysis are given in *Annex1A*.

**Table 9.19-Results of Economic Analysis**

<b>Discount Rate</b>	<b>Sensitivity Case</b>	<b>Case Description</b>	<b>NPV (Rs.Mn)</b>	<b>EIRR (%)</b>	<b>B/C Ratio</b>
7%	Case 1	Basic case No change of benefit and cost	143,053.72	12.09	2.1
	Case 2	Construction cost reduce by 10% no change in benefits	155,300.47	12.73	2.3
	Case 3	Construction cost increase by 10% and no change in benefits	130,806.97	11.51	7.93
	Case 4	Construction cost increase by 10% and benefit reduce by 10%	104,518.89	10.88	1.75
	Case 5	Construction cost increase by 10 % and benefit increase by 10%	157,095.07	12.09	2.12
	Case 6	Construction cost increase by 20% No change of benefit	118,560.22	10.99	1.78
	Case 7	Construction cost increase by 20% and benefit reduce by 10%	92,272.13	10.36	1.61
	Case 8	Construction cost increase by 20% and benefit reduce by 20%	65,984.03	9.68	1.43
	Case 9	Construction cost remain as base case and benefit reduce by 10%	116,765.62	11.45	1.91
	Case 10	Construction cost remain as base case and benefit reduce by 10%	90,477.52	10.75	1.71

### **9.14.3 Conclusion**

According to the Economic Analysis, the project has positive NPV at discount rate of 7% and EIRR more than 12% which is considered as the Government Investment Threshold (GIT) for normal projects. As such the project is viable for the implementation.

Based on the analysis conducted Central Expressway Project section 1 is economically feasible and it will be more attractive considering the unquantified benefits such as regional development that would result with the improved mobility to the Central, and Northern parts of the country. Accident reduction with the use of expressway has not taken in the analysis and that will be another added benefit.

Results of Sensitivity Analysis show that the project is sensitive to Cost Increase and Reduction of Benefits.

As such cost control is very important in the implementation of the project.

# Financial Analysis

## Chapter 10

### 10.1 Introduction

The Financial Analysis was done to check the financial viability of the project taking into consideration of collection of revenue from toll.

### 10.2 Estimation of Toll Revenue

#### Toll Rates

There is no separate toll rates has been identified for Central Expressway. At present 3 expressways in operation

The Southern Expressway (E-1) in combination with Outer Circular Highway is operating with Toll as long distance expressway serving urban area as well as rural area. It is assumed that the Central Expressway project (CEP) also will charge the same rates. Rates which are applicable at present are given below.

*Table 10.1 – Rates Charging at Present*

	Vehicle Category			
	1	2	3	4
Toll Fee for E-1 and E3 of 145.45 km-Rs.	650	1000	1750	2500
Toll rate Rs. per km	4.40	6.80	12.03	17.18

The forecasted traffic of the expressway is given in the chapter 7 and is used in calculation of toll revenue. The composition of vehicles of different toll category was used same as the Southern expressways.

The projected traffic on the Expressway and the toll revenue according to the above toll rates are given in Table 1 to Table 4 of Annex -1B.

In the toll revenue calculation uniform toll rate was assumed throughout the analysis period.

### 10.3 Financial Calculation

A preliminary financial analysis on Central Expressway from Kadawatha to Mirigama was carried out based on the revenue from traffic and the assumed loan condition and loan repayment details considering the approved loan of Outer Circular section 3. The assumed cash flows are as follows.

Following cash inflow and cash outflow was considered in calculation.

Cash inflow

- 1 Cash inflow from Exim bank loan for 95% of Construction Cost with following details
  - a. Maturity period of 20 years
  - b. Grace period 5 years
  - c. Interest rate is 2%
  - d. Management fee is 0.25%
  - e. Commitment fee is 0.25%
- 2 Cash inflow from GOSL for 5% Construction cost
- 3 Cash inflow from local bank rupee loan for construction supervision with following details
  - a. Loan amount Rs.3000.0 mn
  - b. Interest Rate is AWPLR +2.25%
  - c. Repayment period is 15 years
  - d. Grace period is 3 years
- 4 Toll revenue
- 5 Residual value of the project at the end of the analysis period. It was assumed that 30% of the initial cost of the project as the residual value

Cash outflow

- 1 Payment for contractor and consultant during the construction period
- 2 Operation and maintenance cost
- 3 Loan interest repayment for Construction loan start from 2017 at the rate of 2 % paid for disbursed amount
- 4 Loan interest payment for Supervision loan start from 2017 at the rate of AWPLR +2.25% paid for the withdrawn amount (AWPLR is taken as 9.69% as per the central bank published for commercial banks monthly average of July 2016)
- 5 Loan capital repayment for construction loan start from 2022
- 6 Loan capital repayment for consultancy loan will start from 2020
- 7 Payment of Management fee and the commitment fee for construction loan at 0.25% each of loan total to be paid in 2017 from the loan

- 8 Interest to be paid for capital payment on GOSL components also considered at same rate of loans and considered to be paid from 2017
- 9 Repayment of GOSL component to be paid at the same period of loans

Repayment calculations are given in Annex 1B Table 5 and Table 6

All cash flows and the calculation of financial analysis is given in Table 10.2.

According to the result of financial analysis the NPV of the project is negative and the value is US\$ 822.14 mn at 2% discount rate.

The negative FNPV indicate that the project is not financially viable. As such private sector investment is not possible.



Table 10.2												
Feasibility Study of Central Expressway Project - section 1 from Kadawatha to Mirigama												
Financial Analysis												
US \$ Rate =			144									
Year	Cash (US\$.Mn)											
	Payment for Construction	Construction Cash Flow (From Loan)	Constructi on Cash Flow (GOSL)	Payment for consultant	Construct Supervision from loan	Repayment of constructio n loan	Repayment of construction GOSL Component	Repayment of Supervision loan	Operational & Maintenance Cost	Toll Revenue	Residual Value Us \$	Total Cash flow (US\$ Mn)
2016	(91.658)	36.663	54.995	(1.736)	1.736	-	-	-	-	-		-
2017	(274.975)	274.975	-	(5.208)	5.208	(0.838)	(1.100)	(0.207)	-	-		(2.14)
2018	(274.975)	274.975	-	(5.208)	5.208	(6.337)	(1.100)	(0.829)	-	-		(8.27)
2019	(274.975)	274.975	-	(5.208)	5.208	(11.837)	(1.100)	(1.451)	-	-		(14.39)
2020	-		-		-	(17.336)	(1.100)	(3.602)	-	-		(22.04)
2021	-					(21.003)	(1.100)	(3.809)	(1.736)	2.473		(25.17)
2022						(89.611)	(4.693)	(3.602)	(1.736)	2.832		(96.81)
2023						(88.211)	(4.620)	(3.394)	(1.736)	3.191		(94.77)
2024						(86.811)	(4.546)	(3.187)	(1.736)	3.550		(92.73)
2025						(85.411)	(4.473)	(2.980)	(1.736)	3.909		(90.69)
2026						(84.011)	(4.400)	(2.773)	(1.736)	4.268		(88.65)
2027						(82.610)	(4.326)	(2.565)	(26.163)	5.052		(110.61)
2028						(81.210)	(4.253)	(2.358)	(1.736)	5.837		(83.72)
2029						(79.810)	(4.180)	(2.151)	(1.736)	6.622		(81.25)
2030						(78.410)	(4.106)	(1.943)	(1.736)	7.406		(78.79)
2031						(77.010)	(4.033)	(1.736)	(10.417)	8.191		(85.00)
2032						(75.609)	(3.960)	-	(1.736)	8.975		(72.33)
2033						(74.209)	(3.886)	-	(26.163)	9.760		(94.50)
2034						(72.809)	(3.813)	-	(1.736)	10.544		(67.81)
2035						(71.409)	(3.740)	-	(1.736)	11.329		(65.56)
2036						(70.009)	(3.666)	-	(1.736)	12.113		(63.30)
2037						-	-	-	(1.736)	12.898		11.16
2038						-	-	-	(26.163)	13.682		(12.48)
2039						-	-	-	(1.736)	14.467		12.73
2040						-	-	-	(1.736)	15.251		13.52
2041						-	-	-	(10.417)	16.036	329.971	335.59
Discount Rate =		2%										
							Financial Net Present vaule US \$ mn				=	(\$822.14)

## ***Conclusion and Recommendation***

# *Chapter 11*

A key component of the overall economic development policy of the Government of Sri Lanka (GOSL) is the high priority assigned to enhancing the socio-economic status of the under privileged citizens living in the less developed areas of the country.

With the realization of uncontrolled traffic increase of the National network and issues in widening the existing network to cater to the demand RDA has recommended the government in development of a high mobility network connecting major development centers. Accordingly several highways have been identified. As per the National Road Master plan about 600 km of high mobility network has been identified. One of the high mobility road identified is the Alternate Colombo Kandy Highway.

The existing Colombo-Kandy Road (Route A1) is one of the major trunk routes radiating from the City of Colombo. This road connects Colombo to Kandy which is the provincial centre of the Central Province and the second largest city of the country. Townships along the Colombo Kandy road have been developed as ribbon development which impedes the flow of traffic. The importance of this road is further enhanced as two important trunk roads, namely Ambepussa-Kurunegala-Trincomalee Road and Peradeniya-Nuwara Eliya-Badulla Chenkaladi Road branch off from this road. As such traffic from Colombo to Kurunegala, Anuradhapura, Jaffna and Trincomalee, Nuwara Eliya, Badulla use the Colombo Kandy Road.

With a view to overcome the serious traffic congestion encountered on this road it has been decided to construct a new access controlled highway the Central Expressway, from Colombo to Dambulla with a link to Kandy to promote economic development of the Central, North Western and Eastern Provinces of the Country.

The feasibility study has been done separately for Section 1 of the Central Expressway. The area of influence considered in the study includes the entire area covering the Gampaha Kurunegala, Kandy district. The study has noted that the integration of the North western, North Central, Eastern and Northern provinces for purposes of connectivity of the Road Network has been considered in the project.

The study also notes that all Environmental and Social Impact issues have been addressed and the Environmental Action Plan and the Resettlement Plan are to be adopted appropriately during the design and construction stage.

The outcome of the economic analysis shows an EIRR of 12.09 %. The values exceed slightly the Government Investment thresholds for normal projects (12%). But Investment of this nature can be considered even for lower rates. Therefore the project is viable for implementation. However special attention has to be paid in controlling the project cost as the sensitivity analysis done shows that the project is sensitive to increase in cost and reduction of benefits.

According to the result of financial analysis the FNPV of the project is negative and the value is US\$ 816.63 mn at 2% discount rate.

The negative FNPV indicate that the project is not financially viable. As such private sector investment is not possible

The appropriate implementation of this project will contribute towards the overall economic development of the country, in accord with the high priority assigned in the policy of the GOSL to enhancing the socio-economic status of the citizens of the country. This project very much benefit for the development of tourism industry and reduction of traffic congestions taking place at present.

# Annex 1

Annex 1A

Table -1

Feasibility Study of Central Expressway Project - section 1 from Kadawatha to Mirigama											
Economic Analysis					Case 1		Base Case				
Discount Rate =			7%		Guss		0.1				
Year	Cost Rs.mn				Cost Total	Benefits Rs mn				Benefits Total	Net Benefits
	Construction	Supervision	Maintenance of road & equipments	Operation		VOc Saving	VOT Saving	Accident cost saving	Salvage Value		
2016	12,367.30	234.25	0	0	12,601.55	0	0			0.00	-12601.55
2017	37,101.89	702.75	0	0	37,804.64	0	0			0.00	-37804.64
2018	37,101.89	702.75	0	0	37,804.64	0	0			0.00	-37804.64
2019	37,101.89	702.75	0	0	37,804.64	0	0			0.00	-37804.64
2020	24,734.59	468.50	0	0	25,203.09	0	0			0.00	-25203.09
2021			78.93	155.30	234.23	-34.85783	697.6097			662.75	428.52
2022			78.93	155.30	234.23	83.410756	907.2962			990.71	756.48
2023			78.93	155.30	234.23	201.67934	1116.983			1318.66	1084.43
2024			78.93	155.30	234.23	319.94793	1326.669			1646.62	1412.39
2025			78.93	155.30	234.23	438.21651	1536.356			1974.57	1740.34
2026			78.93	155.30	234.23	556.4851	1746.042			2302.53	2068.30
2027			3374.83	155.30	3,530.13	1248.4891	5235.726			6484.21	2954.09
2028			78.93	155.30	234.23	1940.4931	8725.409			10665.90	10431.67
2029			78.93	155.30	234.23	2632.4972	12215.09			14847.59	14613.36
2030			78.93	155.30	234.23	3324.5012	15704.78			19029.28	18795.05
2031			1250.18	155.30	1,405.48	4016.5052	19194.46			23210.96	21805.48
2032			78.93	155.30	234.23	4708.5092	22684.14			27392.65	27158.42
2033			3374.83	155.30	3,530.13	5400.5133	26173.83			31574.34	28044.21
2034			78.93	155.30	234.23	6092.5173	29663.51			35756.03	35521.80
2035			78.93	155.30	234.23	6784.5213	33153.19			39937.71	39703.48
2036			78.93	155.30	234.23	7476.5254	36642.88			44119.40	43885.17
2037			78.93	155.30	234.23	7740.5526	62114.72			69855.27	69621.04
2038			3374.83	155.30	3,530.13	7493.8969	100804.7			108298.59	104768.46
2039			78.93	155.30	234.23	6533.6813	158808.3			165341.94	165107.71
2040			78.93	155.30	234.23	4600.0544	244857.7			249457.75	249223.52
2041			1250.18	155.30	1,405.48	1362.0066	371418		47,515.76	420295.76	418890.28
					128,009.27					271,062.99	143053.72
	Case										1
	Net Present Value at 7% discount Rate										143,053.72
	Economic Internal Rate of Return										12.09%
	Benefit Cost Ratio										2.12

Annex 1A

Table -2

Feasibility Study of Central Expressway Project - section 1 from Kadawatha to Mirigama											
Economic Analysis				Case 2	Construction cost reduce 10% Benefit as base case						
Discount Rate =		7%		Guss	0.1						
Year	Cost Rs.mn				Cost Total	Benefits Rs mn				Benefits Total	Net Benefits
	Construction	Supervision	Maintenance of road & equipments	Operation		VOc Saving	VOT Saving	Accident cost saving	Salvage Value		
2016	11,130.57	210.83	0	0	11,341.39	0	0			0.00	-11341.39
2017	33,391.70	632.48	0	0	34,024.18	0	0			0.00	-34024.18
2018	33,391.70	632.48	0	0	34,024.18	0	0			0.00	-34024.18
2019	33,391.70	632.48	0	0	34,024.18	0	0			0.00	-34024.18
2020	22,261.13	421.65	0	0	22,682.78	0	0			0.00	-22682.78
2021			78.93	155.30	234.23	-34.85783	697.6097			662.75	428.52
2022			78.93	155.30	234.23	83.410756	907.2962			990.71	756.48
2023			78.93	155.30	234.23	201.67934	1116.983			1318.66	1084.43
2024			78.93	155.30	234.23	319.94793	1326.669			1646.62	1412.39
2025			78.93	155.30	234.23	438.21651	1536.356			1974.57	1740.34
2026			78.93	155.30	234.23	556.4851	1746.042			2302.53	2068.30
2027			3374.83	155.30	3,530.13	1248.4891	5235.726			6484.21	2954.09
2028			78.93	155.30	234.23	1940.4931	8725.409			10665.90	10431.67
2029			78.93	155.30	234.23	2632.4972	12215.09			14847.59	14613.36
2030			78.93	155.30	234.23	3324.5012	15704.78			19029.28	18795.05
2031			1250.18	155.30	1,405.48	4016.5052	19194.46			23210.96	21805.48
2032			78.93	155.30	234.23	4708.5092	22684.14			27392.65	27158.42
2033			3374.83	155.30	3,530.13	5400.5133	26173.83			31574.34	28044.21
2034			78.93	155.30	234.23	6092.5173	29663.51			35756.03	35521.80
2035			78.93	155.30	234.23	6784.5213	33153.19			39937.71	39703.48
2036			78.93	155.30	234.23	7476.5254	36642.88			44119.40	43885.17
2037			78.93	155.30	234.23	7740.5526	62114.72			69855.27	69621.04
2038			3374.83	155.30	3,530.13	7493.8969	100804.7			108298.59	104768.46
2039			78.93	155.30	234.23	6533.6813	158808.3			165341.94	165107.71
2040			78.93	155.30	234.23	4600.0544	244857.7			249457.75	249223.52
2041			1250.18	155.30	1,405.48	1362.0066	371418		47,515.76	420295.76	418890.28
					115,762.53					271,062.99	155300.47
	Case										2
	Net Present Value at 7% discount Rate										155,300.47
	Economic Internal Rate of Return										12.73%
	Benefit Cost Ratio										2.34

Annex 1A

Table 3

Feasibility Study of Central Expressway Project - section 1 from Kadawatha to Mirigama											
Economic Analysis				Case 3	Construction cost increase 10% Benefit as base case						
Discount Rate =		7%		Guss	0.1						
Year	Cost Rs.mn				Cost Total	Benefits Rs mn				Benefits Total	Net Benefits
	Construction	Supervision	Maintenance of road & equipments	Operation		VOC Saving	VOT Saving	Accident cost saving	Salvage Value		
2016	13,604.03	257.68	0	0	13,861.70	0	0			0.00	-13861.70
2017	40,812.08	773.03	0	0	41,585.10	0	0			0.00	-41585.10
2018	40,812.08	773.03	0	0	41,585.10	0	0			0.00	-41585.10
2019	40,812.08	773.03	0	0	41,585.10	0	0			0.00	-41585.10
2020	27,208.05	515.35	0	0	27,723.40	0	0			0.00	-27723.40
2021			78.93	155.30	234.23	-34.85783	697.6097			662.75	428.52
2022			78.93	155.30	234.23	83.410756	907.2962			990.71	756.48
2023			78.93	155.30	234.23	201.67934	1116.983			1318.66	1084.43
2024			78.93	155.30	234.23	319.94793	1326.669			1646.62	1412.39
2025			78.93	155.30	234.23	438.21651	1536.356			1974.57	1740.34
2026			78.93	155.30	234.23	556.4851	1746.042			2302.53	2068.30
2027			3374.83	155.30	3,530.13	1248.4891	5235.726			6484.21	2954.09
2028			78.93	155.30	234.23	1940.4931	8725.409			10665.90	10431.67
2029			78.93	155.30	234.23	2632.4972	12215.09			14847.59	14613.36
2030			78.93	155.30	234.23	3324.5012	15704.78			19029.28	18795.05
2031			1250.18	155.30	1,405.48	4016.5052	19194.46			23210.96	21805.48
2032			78.93	155.30	234.23	4708.5092	22684.14			27392.65	27158.42
2033			3374.83	155.30	3,530.13	5400.5133	26173.83			31574.34	28044.21
2034			78.93	155.30	234.23	6092.5173	29663.51			35756.03	35521.80
2035			78.93	155.30	234.23	6784.5213	33153.19			39937.71	39703.48
2036			78.93	155.30	234.23	7476.5254	36642.88			44119.40	43885.17
2037			78.93	155.30	234.23	7740.5526	62114.72			69855.27	69621.04
2038			3374.83	155.30	3,530.13	7493.8969	100804.7			108298.59	104768.46
2039			78.93	155.30	234.23	6533.6813	158808.3			165341.94	165107.71
2040			78.93	155.30	234.23	4600.0544	244857.7			249457.75	249223.52
2041			1250.18	155.30	1,405.48	1362.0066	371418		47,515.76	420295.76	418890.28
					140,256.02					271,062.99	130806.97
	Case										3
	Net Present Value at 7% discount Rate										130,806.97
	Economic Internal Rate of Return										11.51%
	Benefit Cost Ratio										1.93

Annex 1A

Table 4

Feasibility Study of Central Expressway Project - section 1 from Kadawatha to Mirigama											
Economic Analysis				Case	4	Construction costincrease 10% Benefit reduce 10 % as base case					
Discount Rate =		7%		Guss		0.1					
Year	Cost Rs.mn				Cost Total	Benefits Rs mn				Benefits Total	Net Benefits
	Construction	Supervision	Maintenance of road & equipments	Operation		Voc Saving	VOT Saving	Accident cost saving	Salvage Value		
2016	13,604.03	257.68	0	0	13,861.70	0	0			0.00	-13861.70
2017	40,812.08	773.03	0	0	41,585.10	0	0			0.00	-41585.10
2018	40,812.08	773.03	0	0	41,585.10	0	0			0.00	-41585.10
2019	40,812.08	773.03	0	0	41,585.10	0	0			0.00	-41585.10
2020	27,208.05	515.35	0	0	27,723.40	0	0			0.00	-27723.40
2021			78.93	155.30	234.23	-31.37205	627.8488			596.48	362.25
2022			78.93	155.30	234.23	75.069681	816.5666			891.64	657.41
2023			78.93	155.30	234.23	181.51141	1005.284			1186.80	952.57
2024			78.93	155.30	234.23	287.95313	1194.002			1481.96	1247.73
2025			78.93	155.30	234.23	394.39486	1382.72			1777.11	1542.88
2026			78.93	155.30	234.23	500.83659	1571.438			2072.27	1838.04
2027			3374.83	155.30	3,530.13	1123.6402	4712.153			5835.79	2305.67
2028			78.93	155.30	234.23	1746.4438	7852.868			9599.31	9365.08
2029			78.93	155.30	234.23	2369.2475	10993.58			13362.83	13128.60
2030			78.93	155.30	234.23	2992.0511	14134.3			17126.35	16892.12
2031			1250.18	155.30	1,405.48	3614.8547	17275.01			20889.87	19484.39
2032			78.93	155.30	234.23	4237.6583	20415.73			24653.39	24419.16
2033			3374.83	155.30	3,530.13	4860.4619	23556.44			28416.91	24886.78
2034			78.93	155.30	234.23	5483.2656	26697.16			32180.42	31946.19
2035			78.93	155.30	234.23	6106.0692	29837.87			35943.94	35709.71
2036			78.93	155.30	234.23	6728.8728	32978.59			39707.46	39473.23
2037			78.93	155.30	234.23	6966.4973	55903.25			62869.75	62635.52
2038			3374.83	155.30	3,530.13	6744.5073	90724.22			97468.73	93938.60
2039			78.93	155.30	234.23	5880.3132	142927.4			148807.75	148573.52
2040			78.93	155.30	234.23	4140.049	220371.9			224511.97	224277.74
2041			1250.18	155.30	1,405.48	1225.8059	334276.2		47,515.76	383017.76	381612.28
					140,256.02					244,774.89	104518.87
	Case										4
	Net Present Value at 7% discount Rate										104,518.87
	Economic Internal Rate of Return										10.88%
	Benefit Cost Ratio										1.75

Annex 1A

Table 5

Feasibility Study of Central Expressway Project - section 1 from Kadawatha to Mirigama											
Economic Analysis				Case	5	Construction costincrease 10% Benefit increase by 10 % of base case					
Discount Rate =		7%			Guss	0.1					
Year	Cost Rs.mn				Cost Total	Benefits Rs mn				Benefits Total	Net Benefits
	Construction	Supervision	Maintenance of road & equipments	Operation		VOc Saving	VOT Saving	Accident cost saving	Salvage Value		
2016	13,604.03	257.68	0	0	13,861.70	0	0			0.00	-13861.70
2017	40,812.08	773.03	0	0	41,585.10	0	0			0.00	-41585.10
2018	40,812.08	773.03	0	0	41,585.10	0	0			0.00	-41585.10
2019	40,812.08	773.03	0	0	41,585.10	0	0			0.00	-41585.10
2020	27,208.05	515.35	0	0	27,723.40	0	0			0.00	-27723.40
2021			78.93	155.30	234.23	-38.34361	767.3707			729.03	494.80
2022			78.93	155.30	234.23	91.751832	998.0258			1089.78	855.55
2023			78.93	155.30	234.23	221.84728	1228.681			1450.53	1216.30
2024			78.93	155.30	234.23	351.94272	1459.336			1811.28	1577.05
2025			78.93	155.30	234.23	482.03816	1689.991			2172.03	1937.80
2026			78.93	155.30	234.23	612.13361	1920.646			2532.78	2298.55
2027			3374.83	155.30	3,530.13	1373.338	5759.298			7132.64	3602.51
2028			78.93	155.30	234.23	2134.5425	9597.95			11732.49	11498.26
2029			78.93	155.30	234.23	2895.7469	13436.6			16332.35	16098.12
2030			78.93	155.30	234.23	3656.9513	17275.25			20932.20	20697.97
2031			1250.18	155.30	1,405.48	4418.1557	21113.91			25532.06	24126.58
2032			78.93	155.30	234.23	5179.3602	24952.56			30131.92	29897.69
2033			3374.83	155.30	3,530.13	5940.5646	28791.21			34731.77	31201.65
2034			78.93	155.30	234.23	6701.769	32629.86			39331.63	39097.40
2035			78.93	155.30	234.23	7462.9735	36468.51			43931.49	43697.26
2036			78.93	155.30	234.23	8224.1779	40307.16			48531.34	48297.11
2037			78.93	155.30	234.23	8514.6079	68326.19			76840.80	76606.57
2038			3374.83	155.30	3,530.13	8243.2866	110885.2			119128.45	115598.32
2039			78.93	155.30	234.23	7187.0495	174689.1			181876.14	181641.91
2040			78.93	155.30	234.23	5060.0598	269343.5			274403.52	274169.29
2041			1250.18	155.30	1,405.48	1498.2073	408559.8		47,515.76	457573.76	456168.28
					140,256.02					297,351.09	157095.07
	Case										5
	Net Present Value at 7% discount Rate										157,095.07
	Economic Internal Rate of Return										12.09%
	Benefit Cost Ratio										2.12

Annex 1 A Table 6Annex 1 A Table 6

Feasibility Study of Central Expressway Project - section 1 from Kadawatha to Mirigama											
Economic Analysis				Case 6	Construction cost increase 20% Benefit as of base case						
	Discount Rate =		7%	Guss	0.1						
Year	Cost Rs.mn				Cost Total	Benefits Rs mn				Benefits Total	Net Benefits
	Construction	Supervision	Maintenance of road & equipments	Operation		Voc Saving	VOT Saving	Accident cost saving	Salvage Value		
2016	14,840.76	281.10	0	0	15,121.86	0	0			0.00	-15121.86
2017	44,522.27	843.30	0	0	45,365.57	0	0			0.00	-45365.57
2018	44,522.27	843.30	0	0	45,365.57	0	0			0.00	-45365.57
2019	44,522.27	843.30	0	0	45,365.57	0	0			0.00	-45365.57
2020	29,681.51	562.20	0	0	30,243.71	0	0			0.00	-30243.71
2021			78.93	155.30	234.23	-34.85783	697.6097			662.75	428.52
2022			78.93	155.30	234.23	83.410756	907.2962			990.71	756.48
2023			78.93	155.30	234.23	201.67934	1116.983			1318.66	1084.43
2024			78.93	155.30	234.23	319.94793	1326.669			1646.62	1412.39
2025			78.93	155.30	234.23	438.21651	1536.356			1974.57	1740.34
2026			78.93	155.30	234.23	556.4851	1746.042			2302.53	2068.30
2027			3374.83	155.30	3,530.13	1248.4891	5235.726			6484.21	2954.09
2028			78.93	155.30	234.23	1940.4931	8725.409			10665.90	10431.67
2029			78.93	155.30	234.23	2632.4972	12215.09			14847.59	14613.36
2030			78.93	155.30	234.23	3324.5012	15704.78			19029.28	18795.05
2031			1250.18	155.30	1,405.48	4016.5052	19194.46			23210.96	21805.48
2032			78.93	155.30	234.23	4708.5092	22684.14			27392.65	27158.42
2033			3374.83	155.30	3,530.13	5400.5133	26173.83			31574.34	28044.21
2034			78.93	155.30	234.23	6092.5173	29663.51			35756.03	35521.80
2035			78.93	155.30	234.23	6784.5213	33153.19			39937.71	39703.48
2036			78.93	155.30	234.23	7476.5254	36642.88			44119.40	43885.17
2037			78.93	155.30	234.23	7740.5526	62114.72			69855.27	69621.04
2038			3374.83	155.30	3,530.13	7493.8969	100804.7			108298.59	104768.46
2039			78.93	155.30	234.23	6533.6813	158808.3			165341.94	165107.71
2040			78.93	155.30	234.23	4600.0544	244857.7			249457.75	249223.52
2041			1250.18	155.30	1,405.48	1362.0066	371418		47,515.76	420295.76	418890.28
					152,502.77					271,062.99	118560.22
	Case										6
	Net Present Value at 7% discount Rate										118,560.22
	Economic Internal Rate of Return										10.99%
	Benefit Cost Ratio										1.78

Annex 1 A

Table 7

Feasibility Study of Central Expressway Project - section 1 from Kadawatha to Mirigama											
Economic Analysis				Case	7	Construction cost increse 20% Benefit reduce by 10 % of base case					
Discount Rate =		7%			Guss	0.1					
Year	Cost Rs.mn				Cost Total	Benefits Rs mn				Benefits Total	Net Benefits
	Construction	Supervision	Maintenance of road & equipments	Operation		Voc Saving	VOT Saving	Accident cost saving	Salvage Value		
2016	14,840.76	281.10	0	0	15,121.86	0	0			0.00	-15121.86
2017	44,522.27	843.30	0	0	45,365.57	0	0			0.00	-45365.57
2018	44,522.27	843.30	0	0	45,365.57	0	0			0.00	-45365.57
2019	44,522.27	843.30	0	0	45,365.57	0	0			0.00	-45365.57
2020	29,681.51	562.20	0	0	30,243.71	0	0			0.00	-30243.71
2021			78.93	155.30	234.23	-31.37205	627.8488			596.48	362.25
2022			78.93	155.30	234.23	75.069681	816.5666			891.64	657.41
2023			78.93	155.30	234.23	181.51141	1005.284			1186.80	952.57
2024			78.93	155.30	234.23	287.95313	1194.002			1481.96	1247.73
2025			78.93	155.30	234.23	394.39486	1382.72			1777.11	1542.88
2026			78.93	155.30	234.23	500.83659	1571.438			2072.27	1838.04
2027			3374.83	155.30	3,530.13	1123.6402	4712.153			5835.79	2305.67
2028			78.93	155.30	234.23	1746.4438	7852.868			9599.31	9365.08
2029			78.93	155.30	234.23	2369.2475	10993.58			13362.83	13128.60
2030			78.93	155.30	234.23	2992.0511	14134.3			17126.35	16892.12
2031			1250.18	155.30	1,405.48	3614.8547	17275.01			20889.87	19484.39
2032			78.93	155.30	234.23	4237.6583	20415.73			24653.39	24419.16
2033			3374.83	155.30	3,530.13	4860.4619	23556.44			28416.91	24886.78
2034			78.93	155.30	234.23	5483.2656	26697.16			32180.42	31946.19
2035			78.93	155.30	234.23	6106.0692	29837.87			35943.94	35709.71
2036			78.93	155.30	234.23	6728.8728	32978.59			39707.46	39473.23
2037			78.93	155.30	234.23	6966.4973	55903.25			62869.75	62635.52
2038			3374.83	155.30	3,530.13	6744.5073	90724.22			97468.73	93938.60
2039			78.93	155.30	234.23	5880.3132	142927.4			148807.75	148573.52
2040			78.93	155.30	234.23	4140.049	220371.9			224511.97	224277.74
2041			1250.18	155.30	1,405.48	1225.8059	334276.2		47,515.76	383017.76	381612.28
					152,502.77					244,774.89	92272.13
	Case										7
	Net Present Value at 7% discount Rate										92,272.13
	Economic Internal Rate of Return										10.36%
	Benefit Cost Ratio										1.61

Annex 1 A

Table 8

Feasibility Study of Central Expressway Project - section 1 from Kadawatha to Mirigama											
	Economic Analysis			Case	8	Construction cost increse 20% and Benefit reduce by 20 % of base case					
	Discount Rate =		7%		Guss		0.1				
Year	Cost Rs.mn				Cost Total	Benefits Rs mn				Benefits Total	Net Benefits
	Construction	Supervisio n	Mainten ance of road & equipme nts	Operatio n		VOc Saving	VOT Saving	Accident cost saving	Salvage Value		
2016	14,840.76	281.10	0	0	15,121.86	0	0			0.00	-15121.86
2017	44,522.27	843.30	0	0	45,365.57	0	0			0.00	-45365.57
2018	44,522.27	843.30	0	0	45,365.57	0	0			0.00	-45365.57
2019	44,522.27	843.30	0	0	45,365.57	0	0			0.00	-45365.57
2020	29,681.51	562.20	0	0	30,243.71	0	0			0.00	-30243.71
2021			78.93	155.30	234.23	-27.88626	558.0878			530.20	295.97
2022			78.93	155.30	234.23	66.728605	725.837			792.57	558.34
2023			78.93	155.30	234.23	161.34347	893.5862			1054.93	820.70
2024			78.93	155.30	234.23	255.95834	1061.335			1317.29	1083.06
2025			78.93	155.30	234.23	350.57321	1229.085			1579.66	1345.43
2026			78.93	155.30	234.23	445.18808	1396.834			1842.02	1607.79
2027			3374.83	155.30	3,530.13	998.7913	4188.58			5187.37	1657.24
2028			78.93	155.30	234.23	1552.3945	6980.327			8532.72	8298.49
2029			78.93	155.30	234.23	2105.9977	9772.074			11878.07	11643.84
2030			78.93	155.30	234.23	2659.601	12563.82			15223.42	14989.19
2031			1250.18	155.30	1,405.48	3213.2042	15355.57			18568.77	17163.29
2032			78.93	155.30	234.23	3766.8074	18147.31			21914.12	21679.89
2033			3374.83	155.30	3,530.13	4320.4106	20939.06			25259.47	21729.34
2034			78.93	155.30	234.23	4874.0138	23730.81			28604.82	28370.59
2035			78.93	155.30	234.23	5427.6171	26522.55			31950.17	31715.94
2036			78.93	155.30	234.23	5981.2203	29314.3			35295.52	35061.29
2037			78.93	155.30	234.23	6192.4421	49691.78			55884.22	55649.99
2038			3374.83	155.30	3,530.13	5995.1176	80643.75			86638.87	83108.74
2039			78.93	155.30	234.23	5226.9451	127046.6			132273.55	132039.32
2040			78.93	155.30	234.23	3680.0435	195886.2			199566.20	199331.97
2041			1250.18	155.30	1,405.48	1089.6053	297134.4		47,515.76	345739.76	344334.28
					152,502.77					218,486.79	65984.03
	Case										8
	Net Present Value at 7% discount Rate										65,984.03
	Economic Internal Rate of Return										9.68%
	Benefit Cost Ratio										1.43

Annex 1 A

Table 9

Feasibility Study of Central Expressway Project - section 1 from Kadawatha to Mirigama											
	Economic Analysis			Case	9	Construction cost as base case and Benefit reduce by 10 % of base case					
	Discount Rate =		7%		Guss		0.1				
Year	Cost Rs.mn				Cost Total	Benefits Rs mn				Benefits Total	Net Benefits
	Construction	Supervision	Maintenance of road & equipments	Operation		VOc Saving	VOT Saving	Accident cost saving	Salvage Value		
2016	12,367.30	234.25	0	0	12,601.55	0	0			0.00	-12601.55
2017	37,101.89	702.75	0	0	37,804.64	0	0			0.00	-37804.64
2018	37,101.89	702.75	0	0	37,804.64	0	0			0.00	-37804.64
2019	37,101.89	702.75	0	0	37,804.64	0	0			0.00	-37804.64
2020	24,734.59	468.50	0	0	25,203.09	0	0			0.00	-25203.09
2021			78.93	155.30	234.23	-31.37205	627.8488			596.48	362.25
2022			78.93	155.30	234.23	75.069681	816.5666			891.64	657.41
2023			78.93	155.30	234.23	181.51141	1005.284			1186.80	952.57
2024			78.93	155.30	234.23	287.95313	1194.002			1481.96	1247.73
2025			78.93	155.30	234.23	394.39486	1382.72			1777.11	1542.88
2026			78.93	155.30	234.23	500.83659	1571.438			2072.27	1838.04
2027			3374.83	155.30	3,530.13	1123.6402	4712.153			5835.79	2305.67
2028			78.93	155.30	234.23	1746.4438	7852.868			9599.31	9365.08
2029			78.93	155.30	234.23	2369.2475	10993.58			13362.83	13128.60
2030			78.93	155.30	234.23	2992.0511	14134.3			17126.35	16892.12
2031			1250.18	155.30	1,405.48	3614.8547	17275.01			20889.87	19484.39
2032			78.93	155.30	234.23	4237.6583	20415.73			24653.39	24419.16
2033			3374.83	155.30	3,530.13	4860.4619	23556.44			28416.91	24886.78
2034			78.93	155.30	234.23	5483.2656	26697.16			32180.42	31946.19
2035			78.93	155.30	234.23	6106.0692	29837.87			35943.94	35709.71
2036			78.93	155.30	234.23	6728.8728	32978.59			39707.46	39473.23
2037			78.93	155.30	234.23	6966.4973	55903.25			62869.75	62635.52
2038			3374.83	155.30	3,530.13	6744.5073	90724.22			97468.73	93938.60
2039			78.93	155.30	234.23	5880.3132	142927.4			148807.75	148573.52
2040			78.93	155.30	234.23	4140.049	220371.9			224511.97	224277.74
2041			1250.18	155.30	1,405.48	1225.8059	334276.2		47,515.76	383017.76	381612.28
					128,009.27					244,774.89	116765.62
	Case										9
	Net Present Value at 7% discount Rate										116,765.62
	Economic Internal Rate of Return										11.45%
	Benefit Cost Ratio										1.91

Annex 1 A

Table 10

Feasibility Study of Central Expressway Project - section 1 from Kadawatha to Mirigama											
Economic Analysis				Case	10	Construction cost as base case and Benefit reduce by 20 % of base case					
Discount Rate =		7%		Guss		0.1					
Year	Cost Rs.mn				Cost Total	Benefits Rs mn			Salvage Value	Benefits Total	Net Benefits
	Construction	Supervision	Maintenance of road & equipments	Operation		VOc Saving	VOT Saving	Accident cost saving			
2016	12,367.30	234.25	0	0	12,601.55	0	0			0.00	-12601.55
2017	37,101.89	702.75	0	0	37,804.64	0	0			0.00	-37804.64
2018	37,101.89	702.75	0	0	37,804.64	0	0			0.00	-37804.64
2019	37,101.89	702.75	0	0	37,804.64	0	0			0.00	-37804.64
2020	24,734.59	468.50	0	0	25,203.09	0	0			0.00	-25203.09
2021			78.93	155.30	234.23	-27.88626	558.0878			530.20	295.97
2022			78.93	155.30	234.23	66.728605	725.837			792.57	558.34
2023			78.93	155.30	234.23	161.34347	893.5862			1054.93	820.70
2024			78.93	155.30	234.23	255.95834	1061.335			1317.29	1083.06
2025			78.93	155.30	234.23	350.57321	1229.085			1579.66	1345.43
2026			78.93	155.30	234.23	445.18808	1396.834			1842.02	1607.79
2027			3374.83	155.30	3,530.13	998.7913	4188.58			5187.37	1657.24
2028			78.93	155.30	234.23	1552.3945	6980.327			8532.72	8298.49
2029			78.93	155.30	234.23	2105.9977	9772.074			11878.07	11643.84
2030			78.93	155.30	234.23	2659.601	12563.82			15223.42	14989.19
2031			1250.18	155.30	1,405.48	3213.2042	15355.57			18568.77	17163.29
2032			78.93	155.30	234.23	3766.8074	18147.31			21914.12	21679.89
2033			3374.83	155.30	3,530.13	4320.4106	20939.06			25259.47	21729.34
2034			78.93	155.30	234.23	4874.0138	23730.81			28604.82	28370.59
2035			78.93	155.30	234.23	5427.6171	26522.55			31950.17	31715.94
2036			78.93	155.30	234.23	5981.2203	29314.3			35295.52	35061.29
2037			78.93	155.30	234.23	6192.4421	49691.78			55884.22	55649.99
2038			3374.83	155.30	3,530.13	5995.1176	80643.75			86638.87	83108.74
2039			78.93	155.30	234.23	5226.9451	127046.6			132273.55	132039.32
2040			78.93	155.30	234.23	3680.0435	195886.2			199566.20	199331.97
2041			1250.18	155.30	1,405.48	1089.6053	297134.4		47,515.76	345739.76	344334.28
					128,009.27					218,486.79	90477.52
	Case										10
	Net Present Value at 7% discount Rate										90,477.52
	Economic Internal Rate of Return										10.75%
	Benefit Cost Ratio										1.71

# Annex 1 B

# Annex 2