インド共和国
カルナタカ州都市交通局

インド共和国

ベンガルール都市圏
ITS 機器供与計画準備

調査報告書（先行公開版）

平成 29 年 11 月
(2017 年)

独立行政法人
国際協力機構(JICA)

日本工営株式会社
東日本高速道路株式会社

基盤
JR(先)
17-128

序　文

独立行政法人国際協力機構は、インド共和国のベンガルール都市圏の ITS 機器供与計画にかかる準備調査を実施することを決定し、同調査を日本工営株式会社及び東日本高速道路株式会社に委託しました。

JICA 調査団は、平成 28 年 2 月 17 日から平成 29 年7月14日までインド国の政府関係者と協議を行うとともに、計画対象地域における現地調査を実施し、帰国後の国内作業を経て、ここに本報告書完成の運びとなりました。

この報告書が、本計画の推進に寄与するとともに、両国の友好親善の一層の発展に役立つことを願うものです。

終りに、調査にご協力とご支援をいただいた関係各位に対し、心より感謝申し上げます。

平成 29 年 11 月

独立行政法人　国際協力機構
社会基盤・平和構築部
部　長　　安達　一

要 約

1. 国の概要

インド共和国(以下「インド国」とする)は、南アジアに位置し、南アジア随一の面積と世界第 2 位の人口を持つ大国である。国の面積は、328 万 7,469 平方キロメートル、人口 12 億 1,057 万人(2011 年国勢調査)である。

インド国は、雨季、乾季、暑季の 3 つの季節に分かれ、6 月～10 月の雨季にはインド国西南からアラビア海の湿気を含んだ季節風(モンスーン)が吹き込み大雨となる。カルナタカ州の州都であるベンガルール都市圏は、人口約 870 万人(国内第 5 位)を擁する産業都市である。インド国最大の情報通信産業集積地であることから、インド国のシリコンバレーと称されている。インド国内外の有数の企業が進出し、ベンガルール都市圏はインド国南部地域における重要な経済拠点である。

2. プロジェクトの背景・経緯及び概要

道路セクターが全輸送シェアの約 57%を担うインド国では、第 12 次 5 カ年計画(2012 年 4 月～2017 年 3 月)において、道路等の包括的なインフラ整備が経済成長にとって重要とされており、今後のさらなる交通需要の増加に対応すべく、ハード対策として道路交通インフラの整備が進められている。本プロジェクトの対象地域であるベンガルールでは、周辺環状道路の建設が計画されている他、放射道路の改良、ベンガルールメトロの延伸などが進行中である。

ベンガルール都市圏の人口は、2001 年の約 570 万人から 2011 年の約 850 万人(同国第 5 位：Census 2011)と大幅に増加しており、経済成長も相まって車両登録台数増加率は過去 10 年間で平均 10%以上の増加率を記録している。それに伴い市内の交通量は増加の一途を辿り、特に通勤時においては激しい渋滞が発生し、経済活動への支障も出ている。

このような交通状況を踏まえハード対策に加え、道路交通インフラを有効活用し、交通渋滞の緩和及び交通流の正常化を目的としたソフト対策が益々重要となっている。高度道路交通システム(Intelligent Transport Systems 以下「ITS」とする)は情報通信技術を道路交通管理の分野に適用する重要なソフト対策であり、ベンガルール都市圏において、ITS の整備に対する期待が高まっている。

こうした背景の下、技術協力の一環として国際協力機構(Japan International Cooperation Agency 以下「JICA」とする)による「インド国ベンガルール及びマイソール

都市圏 ITS マスタープラン策定調査プロジェクト(2014 年 1 月～2015 年 6 月)」(以下「マスタープラン調査」とする)が実施された。マスタープラン調査では、ベンガルール都市圏における様々な ITS を短期(フェーズ 1 ：2015 年～2019 年)・中期(フェーズ 2 ：2020 年～2024 年)・長期(2025 年以降)に分け段階的に整備することが提唱されている。

中でも、定量的な交通データを、動的な交通情報の提供及び道路・交通インフラ計画・評価のために活用する「交通情報システム」と、交通流の整流化を目的とした「信号システム」の整備が最優先課題として特定された。

係る状況の中、これらの整備のために、カルナタカ州都市交通局(Directorate of Urban Land Transport 以下「DULT」とする)より日本政府に対して無償資金協力事業による整備のための要請書が提出された。

3. 調査結果の概要とプロジェクトの内容

インド国からの要請を受けて、日本政府は準備調査を決定し、JICA は 2016 年 2 月 27 日から 2017 年 7 月 14 日までの 5 回にわたり JICA 調査団をベンガルールに派遣した。JICA 調査団は、カルタナカ州都市交通局(DULT)、ベンガルール交通警察(Bengaluru Traffic Police 以下「BTP」とする)と本計画について協議を重ね要請内容の確認、フィールド調査、対象交差点、路側設備等の検討や交通量調査を実施した。帰国後、JICA 調査団は概略設計及び概略事業費積算を実施し、その成果を準備調査報告書(案)として取りまとめた。JICA は 2017 年 1 月 7 日から 1 月 18 日まで準備調査概要説明のため JICA 調査団をベンガルールへ派遣し、成果内容の説明及び協議を行い、協力対象事業について合意した。

また、DULT からの要望で、本プロジェクト完工引渡し後、DULT の経費負担の下に請負業者は運営・維持管理(Operation and Maintenance 以下「O&M」とする)業務を 5 年間継続することを前提に、その業務内容と契約の枠組みについて本準備調査の中で検討を行った。但し、O&M 経費(ランプサム契約、ユニットプライス単価等)は、DULT 負担とする。

JICA 調査団の派遣期間は、表-1 のとおりである。

表-1　JICA 調査団の派遣期間

項目	派遣期間
第 1 次現地派遣期間	2016/2/27 ～ 3/11
第 2 次現地派遣期間 前半	2016/4/1 ～ 4/27
第 2 次現地派遣期間 後半	2016/6/23 ～ 7/22
第 3 次現地派遣期間 前半	2016/12/7 ～ 12/15
第 3 次現地派遣期間 後半	2017/1/7 ～ 1/18
第 4 次現地派遣期間	2017/4/20 ～ 4/29
第 5 次現地派遣期間	2017/6/28 ～ 7/14

(出典：JICA 調査団)

インド国では近年急速な都市化が進む一方で、公共交通インフラ整備が十分進んでいないことから、大都市圏では交通渋滞が深刻な問題となっており、これに伴う深刻な経済損失が経済発展への大きな障害となっている。

ベンガルール開発庁(Bengaluru Development Authority 以下「BDA」とする)及び DULT は深刻化した交通渋滞の緩和を目的とした ITS の整備を急いでおり、本プロジェクトの実施は BDA 及び DULT による取組への支援を通じてベンガルール都市圏の地域経済発展に寄与するものである。

本プロジェクトにて整備するシステムと、その目的及び設置方針を表-2 に示す。

表-2　導入システムの目的と設置方針

システム		目的	設置方針
交通情報システム	センターシステム	各システムからのデータ収集・処理・蓄積・提供を行う	州データセンターに設置(1 式)
	プローブシステム	6700 台の市バスに搭載された GPS により車両の旅行速度算出を行う。	州データセンターに設置(1 式)
	渋滞長計測システム	プローブシステムを補完することを目的として、渋滞長の計測を行う。	市内で特に渋滞が顕著な 12 交差点(72 基)
	交通量計測システム	道路管理のために断面交通量(大型・小型)を計測する。	市内で特に交通量の多い代表的な幹線道の主要交差点の中間点 8 箇所(16 基)
	可変情報システム	プローブシステム及び渋滞長計測システムによって生成された動的な渋滞情報を、可変情報板より道路ユーザに対して提供する。	MG Road の他、主要道路の主要な分岐点等 3 箇所(3 基)
	インターネットシステム	プローブシステム及び渋滞長計測システムによって生成された動的な渋滞情報を、インターネットにより道路ユーザに対して提供する。	主に外環状道路までのエリアを中心に情報提供(1 式)
信号システム		交通量に応じて系統制御し、交通の整流化を図る	MG Road を中心に導入効果の高い 29 箇所を選定

(出典：JICA 調査団)

4.　プロジェクトの工期

本プロジェクトの必要工期は、実施設計に 4 ヶ月、工事工程に 15.5 ヶ月の計 19.5 ヶ月である。

5.　プロジェクトの評価

5-1 妥当性

ベンガルール都市圏では交通需要の増加に対応すべく、ハード対策として道路交通インフラの整備が進められている。しかし、渋滞が特に深刻な中心地では道路が狭隘しているため、道路拡幅余地の制約もあり緊急なソフト面での対策が必要となっている。

本プロジェクトの対象地域は、ベンガルール都市圏の中心地である商業地域で、交通渋滞が深刻な MG Road を中心とした地域を選定しており、交通渋滞が緩和されることにより

ベンガルールの経済発展に寄与する。

JICA は我が国の対インド国別援助計画(2016 年 3 月)において、インド国における経済成長を実現する上で最大のボトルネックの 1 つは経済インフラの未整備となっており、重点分野である「連結性の強化」のため、交通ネットワーク整備・維持管理への支援を行うこととしている。このように我が国の援助政策・方針との整合性の点からも本プロジェクトの妥当性はあると判断される。特に、チェンナイ・ベンガルール間産業回廊(CBIC)構想といった、広域の経済開発構想の具体化を進めることとしている。

また、DULT は、今後 ITS を交通計画に取り入れるべく対応できる人員の増強が進められており、BTP では、すでに多くの信号や可変情報板のシステム運用管理を実施している。DULT 及び BTP とも体制面での対応が可能であり、予算においても十分対応できる。

上記、上位計画との整合、事業の緊急性、経済への効果及び運用管理面を考慮し、本プロジェクトの妥当性は高いと考えられる。

5-2 有効性

(1)直接的効果

本プロジェクトにより、以下の直接的効果が期待される。

表-3　渋滞長及び平均旅行速度

指標名	基準値 (2016 年実績値)	目標値(2022 年) 【事業完成 3 年後】
渋滞長 (ピーク時 9:00～10:00)	対象交差点(*1)の流入路毎の最大値の合計： 844.8m	590m(-30%)(*2)
	対象交差点(*1)の全流入路の合計： 1576.9m	970m(-40%)(*3)
平均旅行速度(*4) (ピーク時 9:00～10:00)	13Km/h	15Km/h

(出典：JICA 調査団)

(*1)全 29 箇所のうち代表的な 7 箇所の交差点
(*2)設備導入により、信号システムの適切な青時間配分及びサイクル短縮によるもの
(*3)各交差点の最大値を対象とした 30%の削減率に基づき、その他の流入路の削減率も考慮した試算結果。
(*4)市内中心部の主要幹線道路
(注)前提条件：2022 年推計交通量によるもの。2016 年実測調査データをベースに「ベンガルールの周辺環状道路の事業実施に係る調査」の集中発生交通量の年増加率(3%)にて補正。

(2)間接的効果

ベンガルール都市圏の交通渋滞改善、移動の定時制確保による利便性の向上、ベンガルール都市圏の地域経済の発展が期待される。

インド共和国

ベンガルール都市圏 ITS 機器供与計画

準備調査報告書

序文

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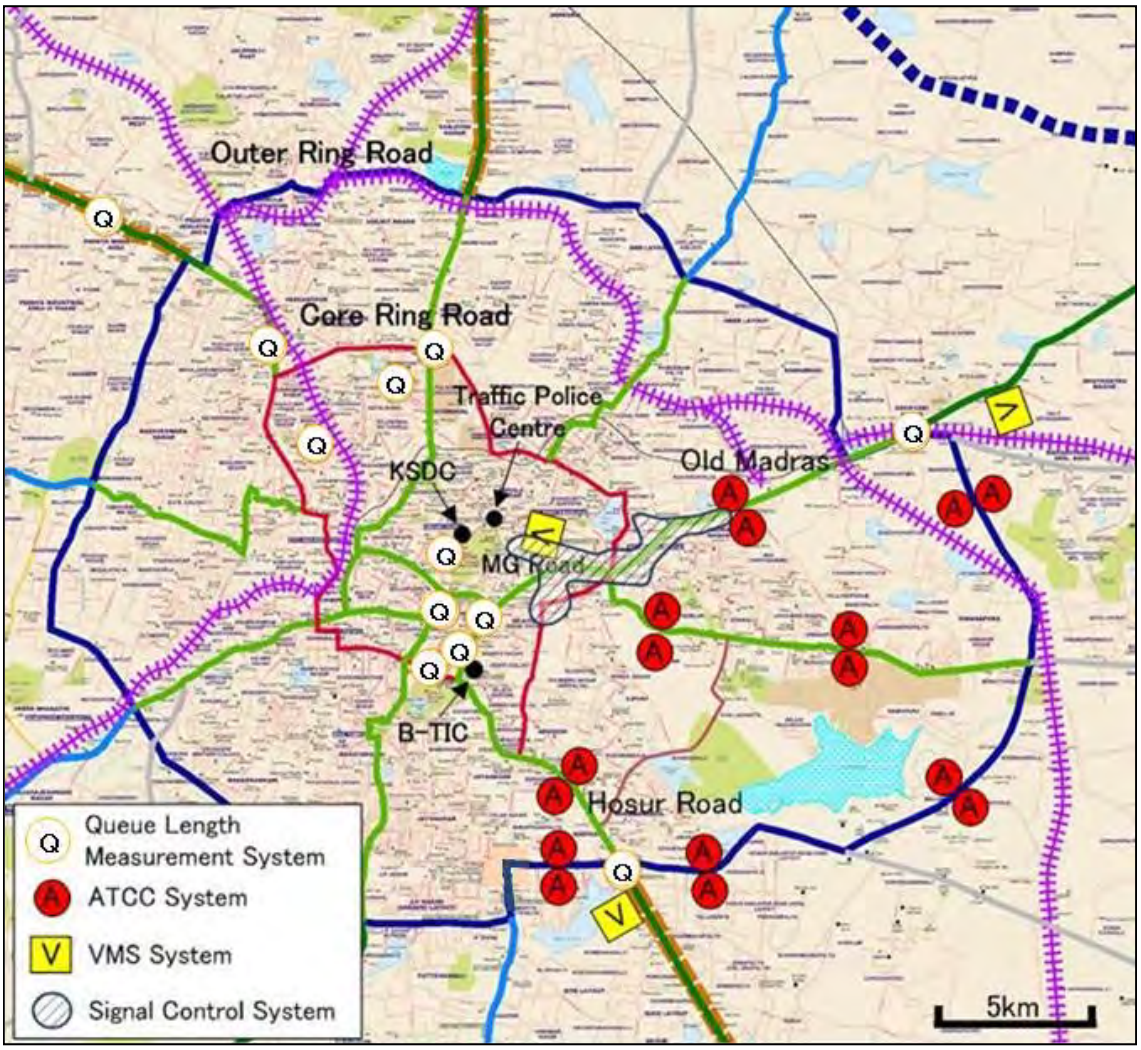
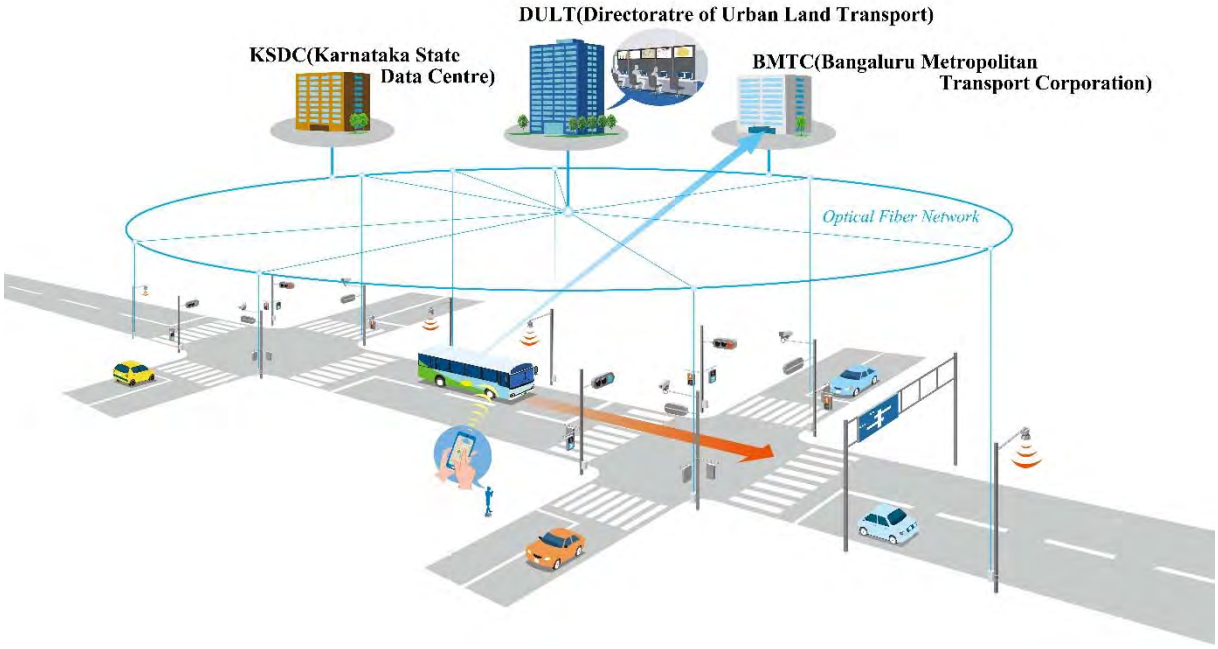
ベンガルール都市圏 ITS システム導入計画図



(出典：JICA 調査団)

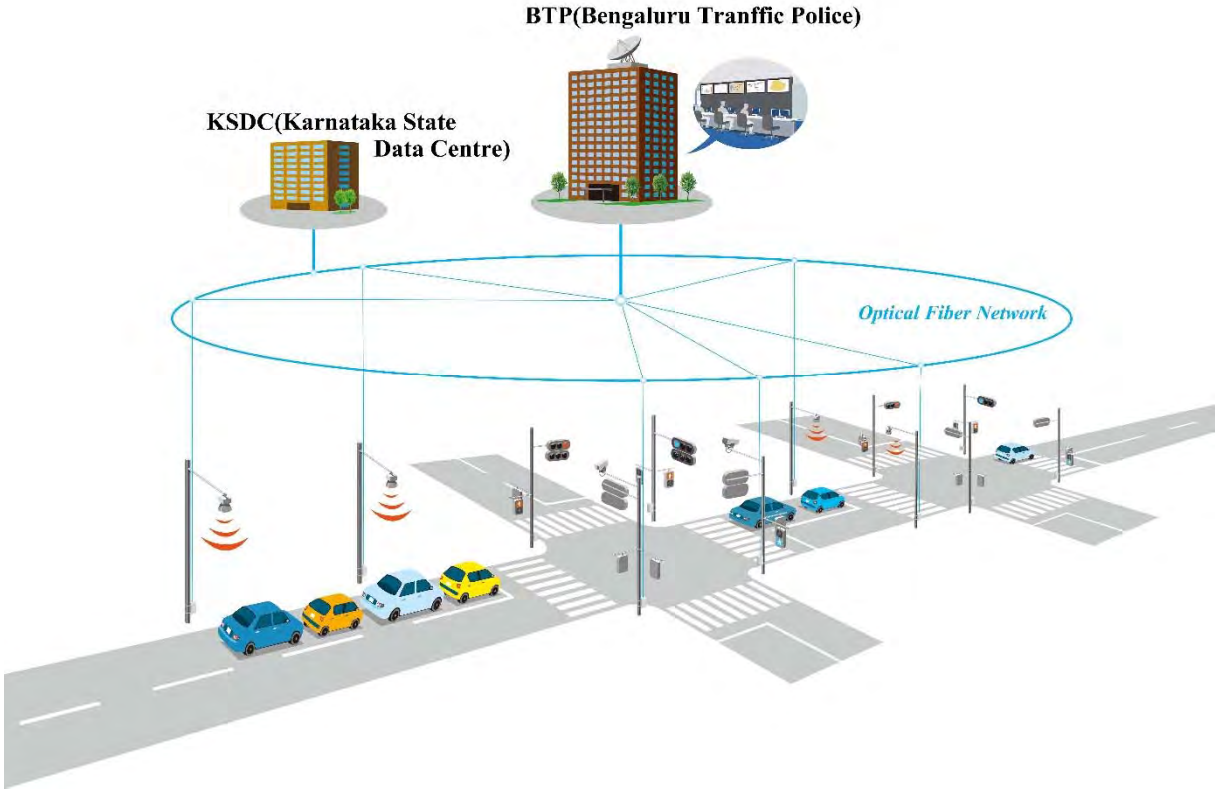
完 成 予 想 図

交通情報システム　完成予想図



(出典：JICA 調査団)

信号システム　完成予想図



(出典：JICA 調査団)

写　真 （出典：全て JICA 調査団）

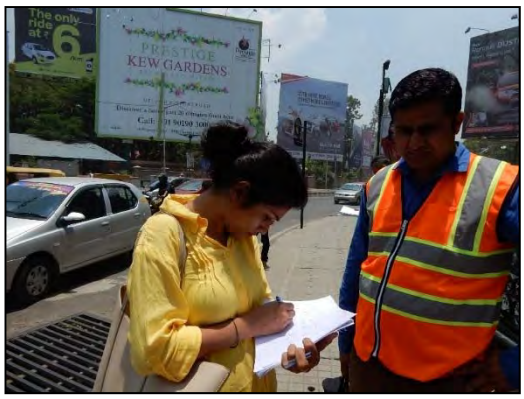


写真-1：MG Road エリア
交差点調査状況(交差点 No.6)

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可変表示板設置場所調査

写真- 13：Swamy Vivekananda Road エリア
可変表示板設置場所調査

写真- 14：Swamy Vivekananda Road エリア
可変表示板設置場所調査

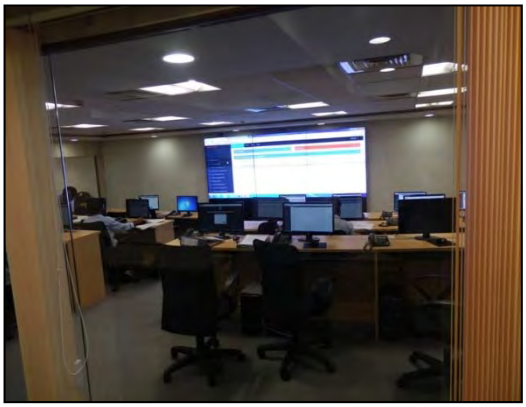

写真- 15：ベンガルール都市圏交通会社
バスコントロールセンタ（BMTC）

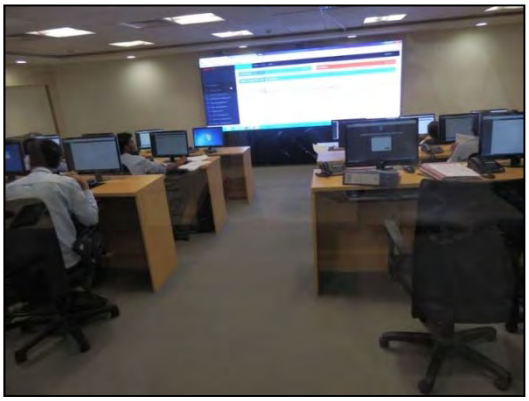

写真- 16：ベンガルール都市圏交通会社
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写真- 17：ベンガルール交通警察
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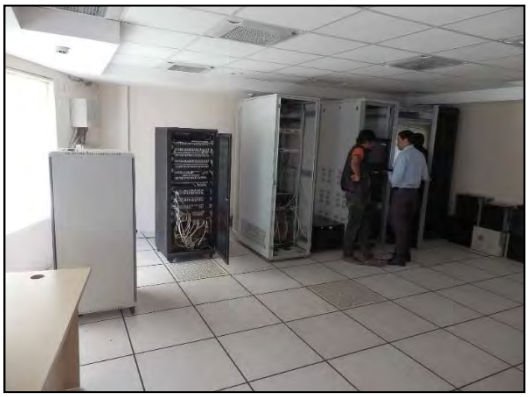

写真- 18：ベンガルール交通警察
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A/P	:	Authorization to Pay	支払授権書
ATCC	:	Automatic Traffic Counter-com-Classifier	交通量計測システム
B/A	:	Banking Arrangement	銀行取極め
BBMP	:	Bruhat Bengaluru Mahanagara Palike	ベンガルール市役所
BDA	:	Bengaluru Development Authority	ベンガルール開発庁
BEL	:	Bharat Electronics Ltd.	インド国有航空宇宙防衛会社
BESOCOM	:	Bengaluru Electricity Supply Co., Ltd.	ベンガルール電力供給公社
BETPL	:	Bengaluru Elevated Tollway Pvt. Ltd.	ベンガルール高架有料道路会社
BMTC	:	Bengaluru Metropolitan Transport Corporation	ベンガルール都市圏交通公社
BTIC	:	Bengaluru Traffic Information Centre	ベンガルール交通情報センター
BTP	:	Bengaluru Traffic Police	ベンガルール交通警察
DOT	:	Department of Telecommunications	電気通信庁
DULT	:	Directorate of Urban Land Transport of Karnataka State Government	カルナタカ州都市交通局
EGD	:	Electronic Government Division	電子政府局
E/N	:	Exchange of Note	交換公文
FOB	:	Free on Board	本船積込渡し
G/A	:	Grant Agreement	贈与契約
ITS	:	Intelligent Transport Systems	高度道路交通システム
ITU	:	International Telecommunication Union	国際電気通信連合
JICA	:	Japan International Cooperation Agency	国際協力機構
KRDC	:	Karnataka State Road Development Corporation	カルナタカ州道路開発公社
KSDC	:	Karnataka State Data Centre	カルナタカ州データセンター
KSRTC	:	Karnataka State Road Transport Corporation	カルナタカ州道路交通公社
MoRTH	:	Ministry of Road Transport and Highway	道路交通省
NHAI	:	National Highway Authority of India	インド国道庁
SUTP	:	Sustainable Urban Transport Program	持続する都市の交通プログラム
TMC	:	Traffic Management Centre	交通管理センター
O&M	:	Operation and Maintenance	運営・維持管理
VMS	:	Variable Message Sign	可変情報板
BRT	:	Bus Rapid Transit	バス・ラピッド・トランジット

単 位

mm	:	Millimeters	距 離
cm	:	Centimeters (10.0 mm)	
m	:	Meters (100.0 cm)	
km	:	Kilometers (1,000 m)	
cm^2 (cm2)	:	Square-centimeters (1/0 cm x 1.0 cm)	面積
m^2 (m2)	:	Square-meters (1.0 m x 1.0 m)	
km^2 (km2)	:	Square-kilometers (1.0 km x 1.0 km)	
cm^3 (cm3)	:	Cubic-centimeters (1.0 cm x 1.0 cm x 1.0 cm)	体積
m^3 (m3)	:	Cubic-meters (1.0 m x 1.0 m x 1.0 m)	
g	:	Grams	重量
kg	:	kilogram (1,000 g)	
ton	:	Metric ton (1,000 kg)	
INR	:	Indian Rupee	通貨
US$	:	United State Dollars	
JPY	:	Japanese Yen	
Lakh	:	1 Lakh = 10^5	

第1章　プロジェクトの背景・経緯

1.1　当該セクターの現状と課題

1.1.1　　現状と課題

インド国では近年急速な都市化が進む一方で、公共交通インフラ整備が十分進んでいないことから、大都市圏では交通渋滞が深刻な問題となっている。

ベンガルールは、カルナタカ州の州都であり、インド国で 5 番目に大きな都市であるが、急速な都市化に伴い、近年は交通渋滞が慢性化している。これに伴う深刻な経済損失が経済発展への大きな障害となっている。

これらの課題に対応するには、道路の改良やマス・トランジットの導入も考えられるが、これらは多額の予算を要するものであるため、既設インフラを有効活用するための交通管理政策の強化が望まれる。しかし、そうした政策や技術に関する知見が乏しく、現時点では十分な対応がなされていない。

1.1.2　　開発計画

道路セクターが全輸送シェアの約 57%を担うインド国では、上記課題に対応すべく、第 12 次 5 か年計画(2012 年 4 月～2017 年 3 月)において、道路等の包括的なインフラ整備が経済成長にとって重要とされており、道路セクターの開発に重点を置いている。今後のさらなる交通需要の増加に対応すべく、ハード対策として道路交通インフラの整備が進められている。

ベンガルールでは、上記状況に対応するため、周辺環状道路の建設が計画され、円借款事業で実施されることが検討されている。この他、放射道路の改良、ベンガルールメトロの延伸などが進行中である。

1.1.3　　社会経済状況

インド国カルナタカ州の州都であるベンガルール都市圏は、人口約 870 万人(国内第 5 位)を擁する産業都市である。インド国最大の情報通信産業集積地であることから、インド国のシリコンバレーと称されている。インド国内外の有数の企業が進出し、ベンガルール都市圏はインド国南部地域における重要な経済拠点である。

本プロジェクトの対象地域であるベンガルール都市圏の人口は、2001 年の約 570 万人から 2011 年の約 850 万人(同国第 5 位：Census 2011)と大幅増加しており 2014 年には約 1010 万人と推定され、経済成長も相まって車両登録台数増加率は過去 10 年間で平均 10%以上の増加率を記録している。それに伴い市内の交通量は増加の一途を辿り、特に通勤時においては激しい渋滞が発生し、経済活動へ支障が出ている。

1.2　無償資金協力要請の背景・経緯及び概要

上記「1.1.2 開発計画」で述べたハード対策に加え、道路交通インフラを有効活用し、交通渋滞の緩和及び交通流の正常化を目的としたソフト対策が益々重要となっている。高度道路交通システム(Intelligent Transport Systems　以下「ITS」とする)は情報技術を道路交通分野に適用した重要なソフト対策であり、ベンガルール都市圏において、ITS の整備に対する期待が高まっている。

こうした背景の下、技術協力の一環として国際協力機構(Japan International Cooperation Agency 以下「JICA」とする)による「インド国ベンガルール及びマイソール都市圏 ITS マスタープラン策定調査プロジェクト(2014 年 1 月～2015 年 6 月)」(以下「マ

スタープラン調査」とする)が実施された。マスタープラン調査では、ベンガルール都市圏における様々な ITS を短期(フェーズ１：2015 年～2019 年)・中期(フェーズ２：2020 年～2024 年)・長期(2025 年以降)に分け段階的に整備することが提唱されている。

中でも、定量的な交通データを、動的な交通情報の提供及び道路・交通インフラ計画・評価のために活用する「交通情報システム」と、交通流の整流化を目的とした「信号システム」の整備が最優先課題として特定された。

係る状況の中、これらの整備のために、カルナタカ州都市交通局(Directorate of Urban Land Transport　以下「DULT」とする)より日本政府に対して無償資金協力事業による整備のための要請書が提出された。

要請された業務概要を以下に示す。

表 1.1　無償資金協力事業及び業務の概要

ITS コンポーネント		要請時	O/D 時
交通情報システム	センターシステム	1 式	1 式
	プローブシステム	1 式	1 式
	渋滞長計測システム	13 箇所（100 基）	12 箇所(72 基)
	交通量計測システム	8 箇所（16 基）	8 箇所（16 基）
	可変情報システム	3 基	3 基
	インターネットシステム	1 式	1 式
信号システム		20 交差点	29 交差点

(出典：JICA 調査団)

1.3　我が国の援助動向

我が国の対インド国別援助計画(2016 年 3 月)において、インド国における経済成長を実現する上で最大のボトルネックの 1 つは経済インフラの未整備となっており、重点分野である「連結性の強化」のため、交通ネットワーク整備・維持管理への支援を行うこととしている。また、JICA の支援に対して特に大きなインパクトが期待できるインド国内 6 大都市圏(ベンガルールは含まれる)などの経済回廊等の産業集積地域を中心に、地域経済開発の促進、物流効率化、外国資本による投資拡大に資するインフラ整備が必要であると分析しており、「経済インフラ整備を通じた持続的経済成長の支援」を援助重点分野として掲げている。また、日印両国が推進する CBIC(チェンナイ・ベンガルール産業回廊)のマスタープラン調査の中でも、本プロジェクトは優先案件の一部として位置付けられている。なお、これまで道路・橋梁セクターに対して、円借款においては 9 件 1,657 億円の承諾実績(全承諾額の 4.1%)があり、無償資金協力では「ニザムディン橋建設計画(28.3 億円)(1995 年)」、技術協力では「ベンガルール及びマイソール都市圏 ITS マスタープラン策定調査プロジェクト(2014 年～2015 年)」を実施している。

運輸交通部門での過去 5 年間の主な JICA 案件を下表に示す。

表 1.2　運輸交通部門での過去５年間の主な JICA 案件

案件名	期間
デリー高速運輸システム建設事業(フェーズ３)	借款契約調印　2012 年 3 月
ビハール州国道整備事業	借款契約調印　2013 年 2 月
貨物専用鉄道建設事業(フェーズ２)(第二期)	借款契約調印　2013 年 3 月
チェンナイ地下鉄建設事業(第三期)	借款契約調印　2013 年 3 月
ムンバイメトロ３号建設事業	借款契約調印　2013 年 9 月
ビハール州国道整備事業(フェーズ２)	借款契約調印　2014 年 1 月
デリー高速輸送システム建設事業(フェーズ３)(第二期)	借款契約調印　2014 年 3 月
貨物専用鉄道建設事業(フェーズ１)(第三期)	借款契約調印　2016 年 3 月
チェンナイ地下鉄建設事業(第四期)	借款契約調印　2016 年 3 月
アーメダバード・メトロ事業(第一期)	借款契約調印　2016 年 3 月

チェンナイ地下鉄建設事業(第四期)	借款契約調印　2016 年 3 月
貨物専用鉄道建設事業(フェーズ 1)(第三期)	借款契約調印　2016 年 3 月
北東州道路網連結性改善事業(フェーズ 1)(第一期)	借款契約調印　2017 年 3 月
ムンバイ湾横断道路建設事業(第一期)	借款契約調印　2017 年 3 月
デリー東部外環道路高度道路交通システム導入事業	借款契約調印　2017 年 3 月
チェンナイ地下鉄建設事業(第五期)	借款契約調印　2017 年 3 月
ムンバイ・アーメダバード間高速鉄道研修施設建設事業	借款契約調印　2017 年 9 月
貨物専用鉄道建設事業（電気機関車調達）	借款契約調印　2017 年 9 月

(出典：JICA 調査団)

1.4 他ドナーの援助動向

世界銀行が、運輸交通セクターに対し、ムンバイ都市交通事業やカルナタカ州道路事業などを支援している。アジア開発銀行は、ビハール州、アッサム州、オリッサ州、西ベンガル州などの道路セクターに対し支援を行っている。

ITS に関しては、世界銀行のインド国での SUTP(Sustainable Urban Transport Programe：持続する都市の交通プログラム)において、様々な事業を実施している。主な事業を下記に示す。

(1) マイソール ITS

カルナタカ州ベンガルールの南西 140 ㎞に位置する旧都マイソールで、市内のバスの運行管理システム及び、バス停での到着時刻提供システムを実施している。

(2) BRT (Bus Rapid Transit)

カルナタカ州の北のフブリ-ダルワード間の 22.5 ㎞の BRT(Bus Rapid Transit:大量輸送システム)事業に融資している。また、マディア・プラデッシュ州のインドールでも 11.3 ㎞(パイロット区間で将来延長)の BRT に融資している。

他に、ムンバイの BTP の交通管制センターシステムと、路側のカメラ、連携信号システムを導入している。

第2章　プロジェクトを取り巻く状況

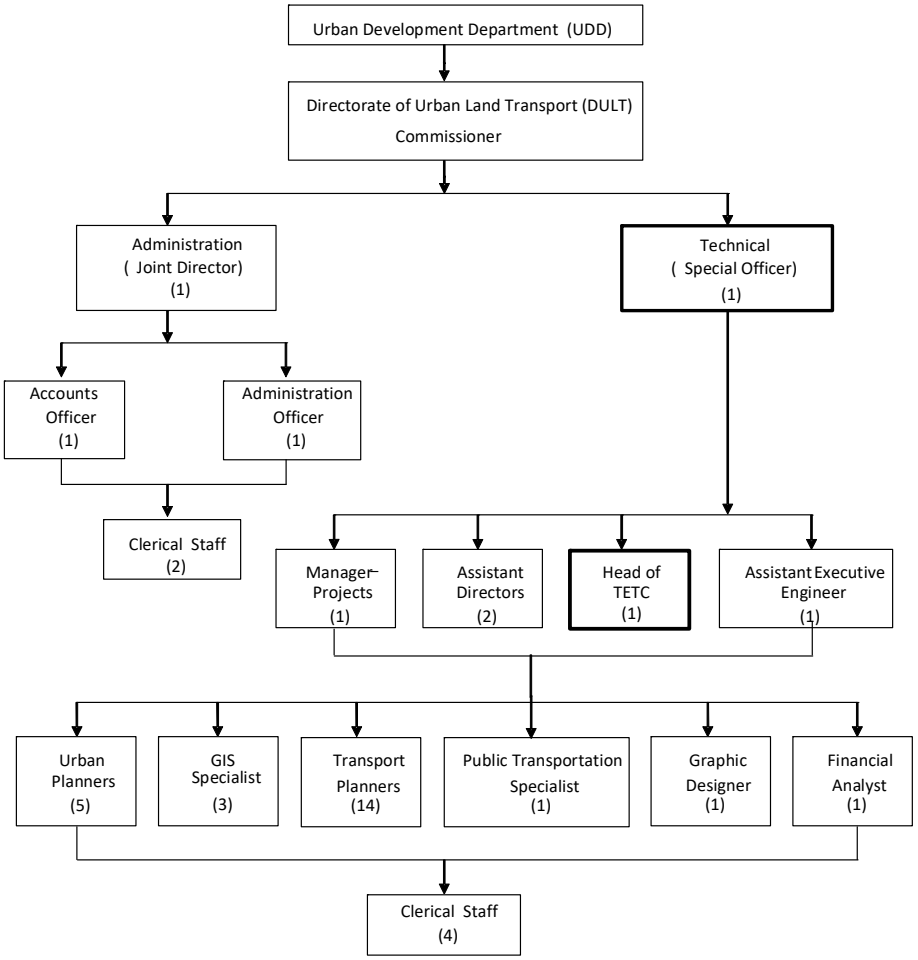
2.1　プロジェクト関係機関の組織体制

2.1.1　　組織・人員

実施機関は、DULT であり、監督官庁は、カルナタカ州都市開発省である。実施機関の他、幹線道路の交通取り締まりを実施しているベンガルール交通警察(Bengaluru Traffic Police 以下「BTP」とする)、市バスを運営しているベンガルール都市圏交通公社(Bengaluru Metropolitan Trnsport Corporation 以下「BMTC」とする)、カルナタカ州管理のデータセンター(Karnataka State Data Centre 以下「KSDC」とする)、ベンガルール市役所(Bruhat Bengaluru Mahanagara Palike 以下「BBMP」とする)が関係する。各関連機関の内容と組織図を以下に示す。

2.1.1.1　Directorate of Urban Land Transport (DULT)

DULT は、本プロジェクトの実施機関である。DULT はカルナタカ州都市開発省の管轄のもと、カルナタカ州の交通インフラに関する計画や事業を実施している。新しいシステムは、高度通信技官(Indian Telecom Service Special Officer)を中心とした技術部門(Technical Department)を基に新しい組織が誕生し運営する。

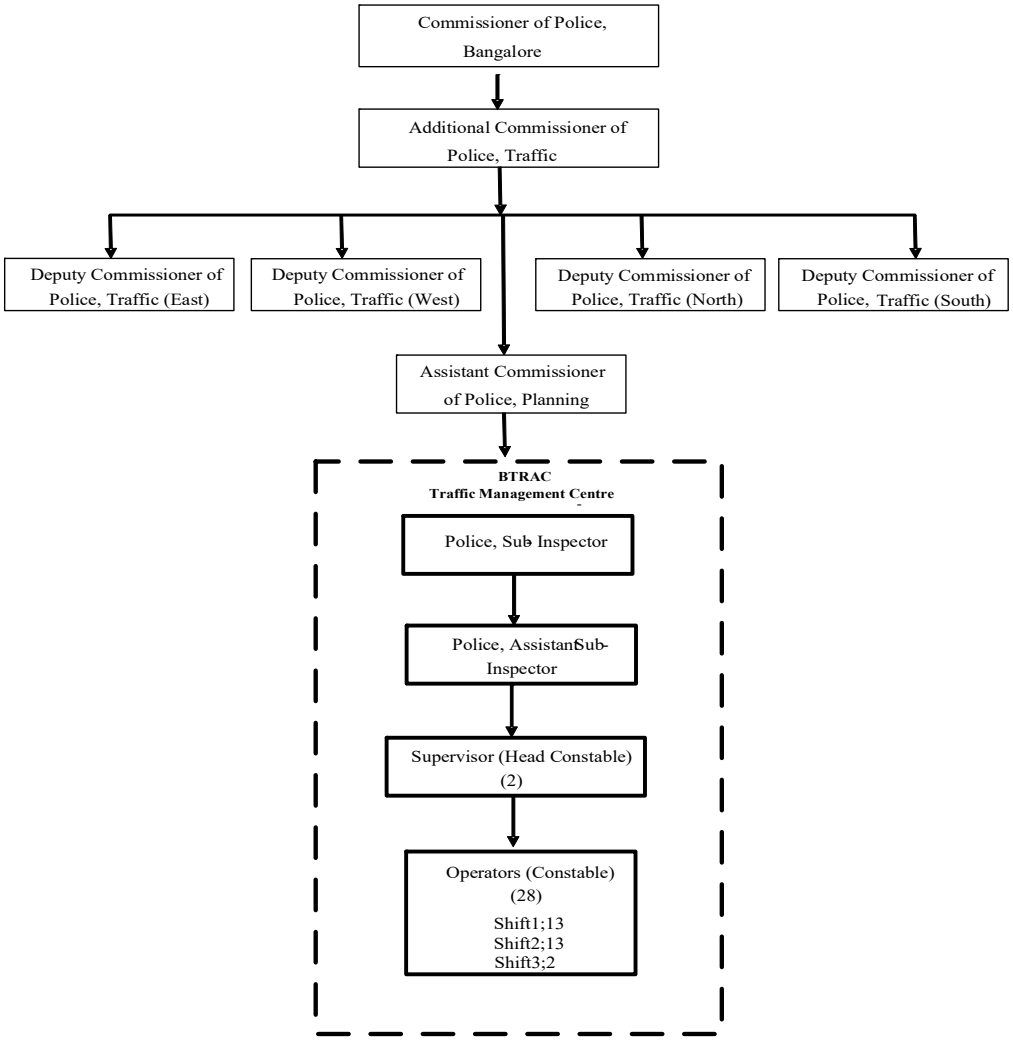


(出典：DULT)

図 2.1　DULT 組織図

2.1.1.2 Bengaluru Traffic Police (BTP)

BTP は、ベンガルール市の交通取り締まりを実施している。信号、カメラ及び可変情報板(Variable Message Signs 以下「VMS」とする)を用いて市内の交通監視制御を BTP にて実施している。

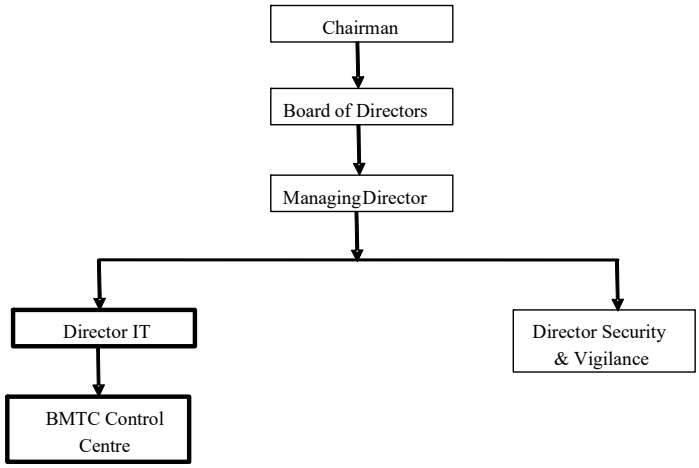


(出典：DULT)

図 2.2 BTP 組織図

2.1.1.3 Bengaluru Metropolitan Transport Corporation (BMTC)

BMTC は、市バスの運営を実施している。バスの運行は、BMTC Control Centre にて、管理している。

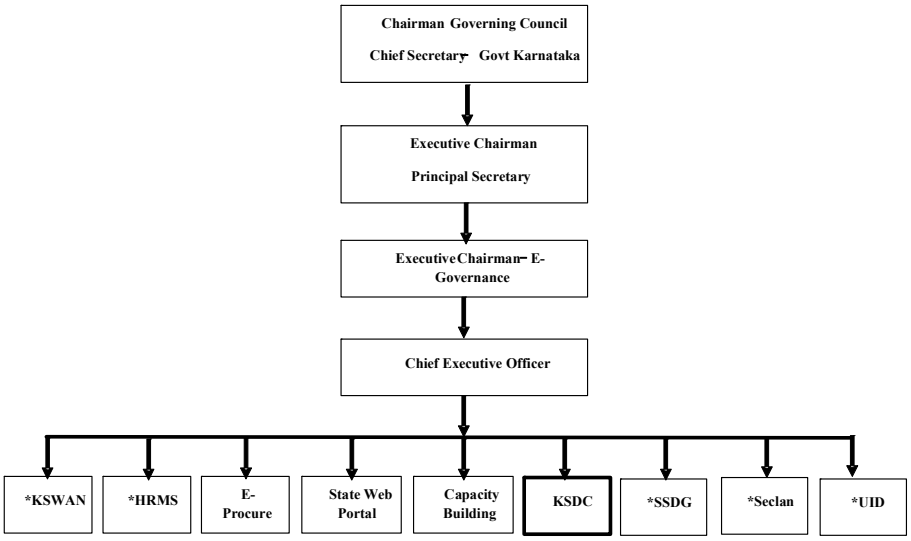


(出典：DULT)

図 2.3 BMTC 組織図

2.1.1.4 Karnataka State Data Centre (KSDC)

KSDC は電子政府局(Electronic Government Division 以下「EGD」とする)が管理するカルナタカ州のデータセンターであり、州の行政機関は KSDC に情報システムのサーバを設置している。

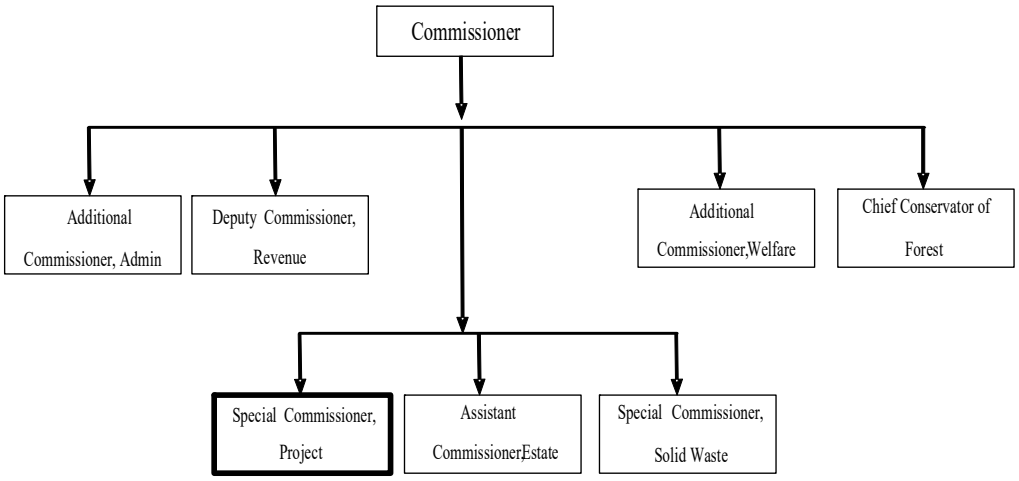


(出典：DULT)

図 2.4 KSDC 組織図

2.1.1.5 Bruhat Bengaluru Mahanagara Palike (BBMP)

市内インフラの計画、設計、許認可が市役所にて実施されている。



(出典：DULT)

図 2.5 BBMP 組織図

2.1.2 財政･予算

本プロジェクトで導入される交通情報システムについては、DULT が運営・維持管理(Operation and Maintenance 以下「O&M」とする)を実施し、信号システム及び可変情報システムについては、BTP が O&M を実施することとなる。

BTP は、既設の信号システム、可変情報システム及びカメラシステムを中心に ITS 設備の O&M を実施している。一方で、DULT については、ITS 設備の運用は初めてとなる。また、DULT 及び BTP の予算執行期間は 4 月から翌年 3 月までである。

2.1.2.1 DULT

DULT は、800Lakhs の雇用管理(HR/Admin)費用を予算化しているが、実際の支出予算(Actual Financial Data)によると、362.4Lakhs(2014-2015)、461.2Lakhs(2015-2016)となっており、437.6Lakhs(2014-2015)、338.8Lakhs(2015-2016)が予算残となっている。この予算残から毎年 250Lahks 相当の O&M 費用を捻出することが可能となる。

表 2.1　DULT 年度予算一覧

Badget allocation			(Lakhs)
Item		2015-2016	2016-2017
1.DULT(HR/Admin)		800	800
2.SUTF (State Urvan Transport Fund)			
	Project	5700	6240
	Consultant	100	100
3.Public Bicycle Sharing Scheme		600	400
4.HDBRTS		15000	15000
5.Bengalure Sub Urban Rail Project			10000
		22200	32580

DULT (HR/Admin Actual Financial Data			(Lakhs)
1.DULT (HR/Admin)		2014-2015	2015-2016
	Human Resouces	121.0	190.4
	Transportation	3.3	5.2
	Administration	238.1	265.6
	(total)	362.4	461.2
DULT	***Remaining Budget*** (from 800Lahks)	***437.6***	***338.8***

(出典：DULT)

2.1.2.2　BTP

BTP は、2016 年までにおおよそのシステムを構築し、2016-2017 年の O&M 予算は、1622Lakhs であり、2017-2018 年の予算要求は、5497Lahks である。毎年の O&M 費用は、250Lahk 程度であり、2016-2017 年の予算の 15%、2017-2018 年予算の 5%となり、O&M 費用の捻出は可能である。

表 2.2　BTP 年度予算一覧

(Lakhs)

Year	Budget	Item
2017-2018	5497	Requested budget for next year
2016-2017	1622	
2015-2016	4200	2nd BTRAC Improvement
2014-2015	500	
2013-2014	600	
2012-2013	2000	1st BTRAC Improvement

(出典：BTP)

2.1.3　技術水準

2.1.3.1　DULT

DULT は、これまでシステムの運用を実施したことがないが、高学歴な人員構成による戦略的な交通計画と事業実施を基本に運営されてきた。今後は、ITS 事業を積極的に進めていく方針を明確にし、コミッショナー(Commissioner)に次ぐ高度通信技官(Indian Telecom Service Special Officer)のポジションに、中央政府通信省電気通信局(Ministry of Communications Department of Telecommunications)からの管理職を投入し、ITS 技術者(ITS Engineer)の強化を図る。

今回、導入されるシステムは、基本的に常時操作する必要はなく、問い合わせ対応や収集した交通情報の交通計画等への利用が、DULT に求められる。基本的な運用対応は可能と考えられるが、今後、運用体制と運用技術の指導が求められる。

2.1.3.2 BTP

BTP は、175 箇所のカメラ、360 交差点の信号、20 箇所の VMS をすでに運用しており、運用操作及び維持管理の体制としては一応に整備されている。今後は、今回導入する新システムへの技術的な対応指導が望まれる。

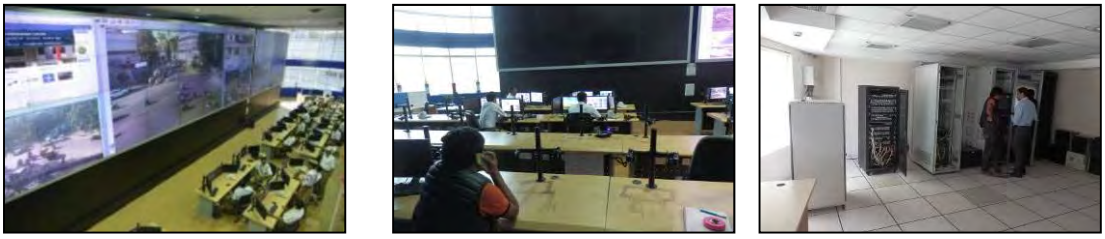
2.1.4 既設施設・機材

2.1.4.1 BTP

BTP における既設施設及び設備の状況を下記に示す。

- Contractor：BEL(Bharat Electronics Ltd)
- Video wall：Projector type
- オペレータコンソール：15 台以上　デスク空席有
- Server Room：立架スペースは充分に余裕有
- 自家発電設備：既設設備 360KVA(現用)、250KVA(予備)、容量は充分に余裕有

既　設　状　況



Control Centre　　Operator Desk　　Server Room

(出典：JICA 調査団)

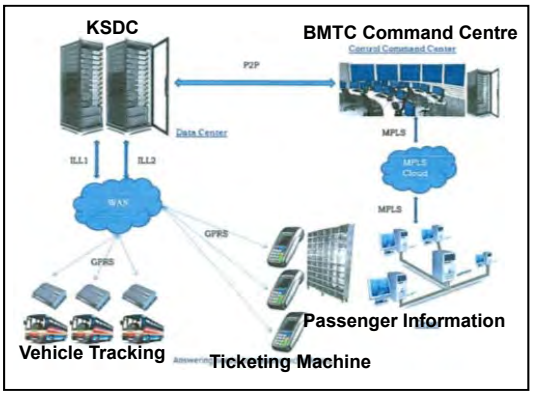
図 2.6　BTP 既設状況

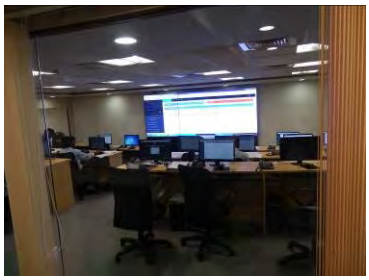
2.1.4.2 BMTC

BMTC における既設施設及び設備の状況を下記に示す。BMTC には、本プロジェクトで整備するプローブシステムへプローブデータを提供するバスロケーションシステムが整備されている。これは、BMTC が管理する 6,700 台の市バスに GPS を設置し、バスの位置情報を収集することにより運行状況を把握し、バスの定時運行の調整等に役立てるものである。

- Contractor：TRIMAX (Trimax IT Infrastructure & Services Ltd)
- Video wall：液晶ディスプレイ(Liquid Crystal Display) type
- オペレータコンソール：20 台以上
- 自家発電設備：既設設備 500KVA(このうち DULT 用として 300KVA 使用可：容量は充分に余裕有

既　設　状　況





BMTC Command Centre

(出典：JICA 調査団)

図 2.7　BMTC 既設システム構成及び Command Centre 状況

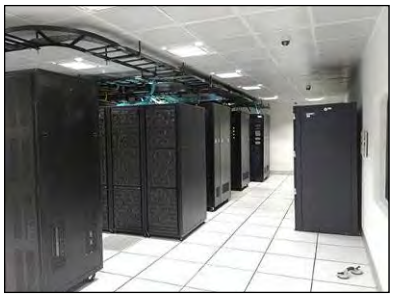
2.1.4.3　KSDC

KSDC における既設施設及び設備の状況を下記に示す。

- Server Room：新規立架のスペース無し。但し 12 架のサーバラックは未実装
- サーバラック内には UPS 系 240V 電源コンセント実装済
- 自家発電：1,200KVA（現状の負荷は 400KVA 程度)18 時間運転：容量は充分に余裕有
- UPS　：　800KVA　2 時間保証：容量は充分に余裕有

既　設　状　況

Server Room



Server Room

(出典：JICA 調査団)

図 2.8　KSDC Server Room

2.2 プロジェクトサイト及び周辺の状況

2.2.1 関連インフラの整備状況

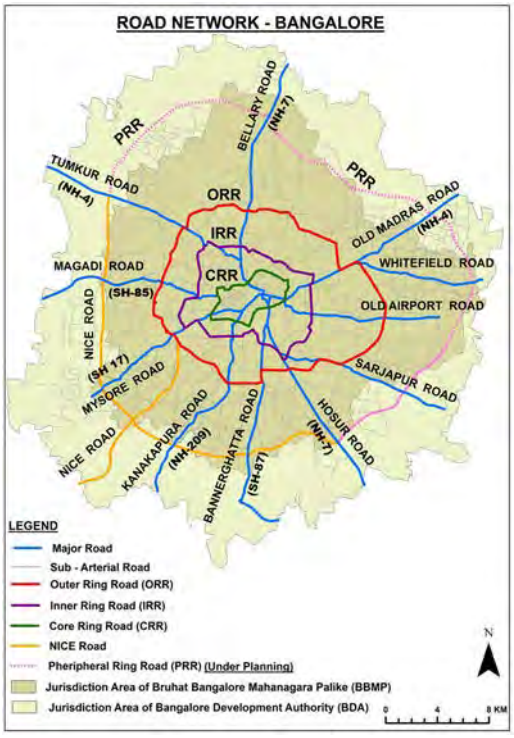
2.2.1.1 道路

ベンガルールの道路は、インド国道庁(National Highway Authority of India 以下「NHAI」とする)が管轄する国道、カルナタカ州道路開発公社(Karnataka Road Development Corporation 以下「KRDC」とする)が管轄する州道及び各県が管轄する県道がある。ベンガルールの主要幹線道路のネットワークは、放射状道路が 3 つの環状線で接続されている。放射状の主要幹線道路は、東西を貫く国道 4 号線(NH-4)、南北を貫く国道 7 号線(NH-7)及び、南方面の州道と接続する国道 209 号線(NH-209)の 3 つの国道と、旧都マイソールまでの 140 kmを接続する州道 17 号(SH17)である。州道 17 号は、現在 NHAI が新設道路の入札公示を行っている。

既設の 3 つの環状線は、中央環状道路(CRR)、内環状道路(IRR)及び外環状道路(ORR)となる。外環状道路のさらに外側にコンセッショネヤーが整備し運営を実施している“Nandi Infrastructure Corridor Enterprises Road”(NICE 道路)という環状道路がある。当道路は、国道 7 号の南側から国道 4 号の西側までを接続し、市外を半周する約 45 kmの自動車専用道路となっている。州政府は、NICE 道路のミッシングリンクである約 65 kmを、周辺環状道路として整備する計画である。

NICE 道路は現金徴収のみの有料道路で、ランプ上に料金所を設置している。本線上のバリアは両端部のみである。周辺環状道路も自動車専用道路であり、両端のトールプラザ以外では、ランプ上で料金徴収をする。

ベンガルールには、市の南側でエレクトロニック・シティと接続する有料道路もあり、ベンガルール高架有料道路会社(Bengaluru Elevated Tollway Pvt. Ltd. 以下「BETPL」とする) コンセッショネヤーが、外環状道路と国道 7 号線の接続部からその南に位置するエレクトロニック・シティまでを国道 7 号線上に約 9 kmの高架道路を整備・管理している。当有料道路はインド国道庁の標準 ETC である FasTag も導入している。BETPL と NICE は交差しているが、接続はされていない。



(出典：DULT)

図 2.9 ベンガルールの主要幹線道路ネットワーク

2.2.1.2　鉄道

ベンガルールの鉄道は、管理上インド国鉄道省の南西鉄道圏の 3 つの区のうちの一つに分類され、管理区の本部はベンガルールに置かれている。最大の駅であるベンガルール駅には、10 のプラットホームがあり、一日に 88 の列車と 22 万人の利用者に対応している。主な接続都市はチェンナイ、ハイデラバード、マイソールなどである。ベンガルール～チェンナイ間は電化されている。ベンガルール-マイソール間は現在複線化を進めている。

ベンガルール駅は市バスと都市間バスのターミナル及びメトロが接続しており、交通の要となっている。駅の周りの道路は狭隘しているため、バスの運行による慢性的な渋滞が発生している。

2.2.1.3　バス

ベンガルールには、BMTC が運営する市バスとカルナタカ州道路交通公社(Karnataka State Road Transport Corporation 以下「KSRTC」とする)が運営する都市間バスの二つのバス会社がある。

市内のバスの運用・管理を実施している BMTC は 6,700 台のバスを保有し、一日に 530 万人の乗客の足となっている。2 つの主要なバスターミナルの他に 26 のバスターミナルがあり、そのうち主要ターミナルの一つがベンガルール駅と接続している。

バス路線は、市内の全ての幹線道路をカバーしていて、運行頻度も高い。バス路線と、各路線の 4：30AM～10：30PM の運行頻度を図 2.10 に示す。

(出典：JICA 調査団)

図 2.10　市バスの路線別運行頻度(4：30AM～10：30PM)

2.2.1.4 信号

- 信号機の総数は 366 箇所、うち 175 箇所が中央制御下にある。今年中にあと 100 箇所を中央制御化する予定である。
- 車両感知器はなく、中央制御は、通常は予め設定した秒数による時間制御とカメラ映像をもとにしたオペレータのマニュアルによる秒数変更で運用している。
- 信号現示は方向別表示のような比較的単純なものと思われるが、矢印制御を多用している。
- 矢印信号は日本のように三色信号灯器の下に二段に設置するのではなく、横一列に設置しているところが多く、日本のように赤信号と矢印を同時に表示はしていない。また、直左矢印を１灯で表示しているところもある。
- 歩行者信号は独立して表示する、いわゆる「歩車分離」が多く、日本のように並行する車両と歩行者を青信号で同時に整理しているところはほとんどない。これは、車両通行が歩行者通行に優先するという意識が強く、右左折車があると歩行者の横断は著しく阻害されるためと思われる。歩行者信号が青表示の時に警告音が鳴動するところもあり、歩行者があることを知らせている。ただし、歩行者青時間はどこも 10 秒程度で、横断しきれる時間ではなく、さらに、歩行者の青時間もほとんどは直前の信号現示の車両クリアランスとして使われている。
- 車両信号の待ち時間表示(カウントダウンのデジタル表示)がされているが、カウントダウンの秒数が途中で変わったりするなど、効果については不明である。
- 矢印信号は点滅するところがあるが、交錯する交通流を矢印で組み合わせている場合に実施している。
- 信号は概ね守られている。
- 待ち時間は長いが、交通量が多いからか(安全のために)青信号になるまで待っている。ただし、サイクルが長いため交錯する交通が途切れるとフライングする(二輪車、リクシャー)。
- 信号サイクルは 3 分以上のところが多く、場所によっては 4 分を超えるところもあった。
- 管制センターのオペレータや現地警察官によるマニュアル調整により 400 秒を超える場合があった。
- 使用していない(滅灯)信号灯器が多い。
- 一部 LED 式があるが、多くは電球式信号灯器(３００φ)である。
- 歩行者信号が設置されていても横断歩道が未設置の場所がある。
- 二輪車の交通が非常に多いため、四輪車の交通に影響を与えている。したがって、信号制御をする場合、二輪車を把握することが必須と考えられる。

2.2.1.5 道路環境

- 車線の表示がほとんどないかまたは劣化して見えない。また、車線があっても守られていない。
- 交差点形状は比較的整備されており、歩道も設置されている。
- 横断歩道が圧倒的に少なく、歩行者の動線が確立されていない。そのため、いたるところで車の間を縫って乱横断している。
- 場所によっては、信号のない横断歩道の手前にハンプ(車両の速度を抑制するための道路上の突起)を設置し、車の速度を低下させるようにしている(現地では当然にように速度を落とすが予告がない)。
- 中央分離帯の片側だけに横断歩道を設置している場所がある。
- 路側に巨木が多く存在し、信号の視認を妨害しているところがある。
- 路側に巨木が多く存在し、樹木が路側設備の無線通信の障害となることが予想される。DULT に街路樹の伐採が必要である旨、報告したところ伐採自体問題がないとの回答を得た。伐採にあたっては着工前に BBMP から許認可を取得する。
- 架空ケーブル(電線、通信線)は、電柱への架渉だけではなく、樹木などに何条も大量かつ野放図に張られている。
- 地下埋設物は、歩道内に水道管(GI Pipeφ50mm～φ100mm)、電力線及び通信線が布設されており、土被りは 0.3m～1.0m 程度で、占用位置については特に決められた位置を占用していないため、本プロジェクトで新設される信号柱や路側柱の占用位置は前後左右にずらし確保が必要である。

2.2.2　交通量調査

2.2.2.1　調査目的

本業務において、既設の信号設備の運用実態の把握、及び本プロジェクトの ITS 設備の導入による定量的事業効果の算定を目的とした。

2.2.2.2　調査方法

調査項目は、表 2.3 のとおりとし、対象交差点(全 29 箇所のうち渋滞が顕著な 7 箇所の重要交差点)において、平日 2 日間・休日 1 日間実施した。

表 2.3　交通調査・信号調査

調査項目	目的	備考
方向別交通量調査	交差点における交通需要の把握	重要交差点、16時間
渋滞長調査	重要交差点における実態及び効果の把握	重要交差点、16時間、15分毎
旅行時間調査	対象路線の実態及び効果の把握	市内中心部の対象路線
無駄青・死に青調査(*1)	方向別の青時間の利用実態及び効果の把握	重要交差点、16時間、30分毎の1サイクル
サイクル、スプリット調査	現行の信号秒数の運用実態及び効果の把握	重要交差点、16時間、30分毎の1サイクル
捌け交通量調査	方向別の青時間開始から終了まで10秒毎の捌け交通量の変化を捉えることによりサイクル長の効率性の実態と効果を把握	重要交差点、16時間、30分毎の1サイクル、青時間中の10秒毎

(出典：JICA 調査団)

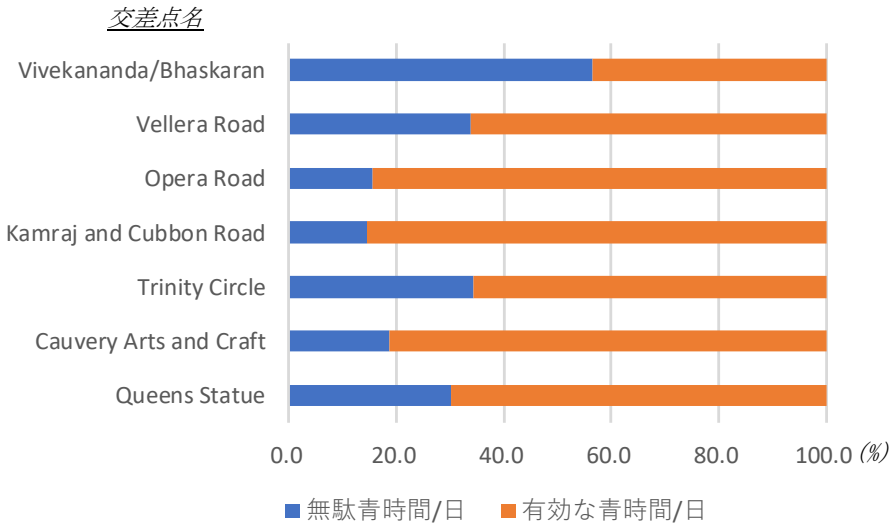
(*1) 無駄青：交通需要が少なく青表示中に通過交通が存在しない状態。
死に青：交通需要が大きく青表示中に先詰まりによって車両が交差点を通過できない状態。

2.2.2.3　調査結果

上記の調査結果より、以下の事項を確認した。

- 青時間中に捌け率が低下する現象がみられ、交通需要に見合った青表示がなされていない。また、隣接交差点間の信号のサイクルが同一でないため、交通流がランダムとなり、車群を形成していない。その結果、表 2.4 に示すとおり、一日のうちの無駄青時間の割合が大きいことが分かった。
- 日中帯はほぼ定常的に渋滞が発生しており、流入路によって渋滞長に不均衡がみられる。
- 信号による遅れを原因とした停止時間が多く観測され、旅行時間の増加が確認された。
- この他、概して信号サイクル長が長大であり、また歩行者信号の青時間が過少であることも確認された。

表 2.4　重要交差点における一日当りの無駄青時間の割合(%)



(*1)有効な青時間/日：一日当りの青時間合計－無駄青時間/日

以上の結果を踏まえ、本プロジェクトでは、信号制御をサブエリア構成とし、信号サイクルの統一化による系統制御、青時間の無駄をなくすため交通需要に応じ、動的に信号制御パラメータを変化させ適切な青時間を表示することにより、信号サイクル時間の低減(概ね 150 秒を基本とする)を図り、また同時に十分な歩行者青時間を確保する。

2.2.3　埋設物調査

2.2.3.1　フィールド調査

本プロジェクトで設置する信号機、可変情報板及び車両感知器等の路側設備は、ベンガルール中心地に位置し、そのエリアはビジネス街と商業地域が混在する地域である。JICA 調査団は設置場所を踏査し、埋設探知機を使用し、地下埋設物を調査した。また、地下埋設物について、関係機関へ問合せたところ、プラントレコード等の資料はなく一部の職員が記憶しているとの回答があった。

既設地下埋設物の事業主を以下に示す。

- 上下水道管[ベンガルール上下水道局：Bengaluru Water Supply and Sewerage Board ： BWSSB)]
- 電力ケーブル[ベンガルール電力供給公社：Bengaluru Electricity Supply Co., Ltd.： BESOCOM)]
- 通信ケーブル[電気通信庁：Department of Telecommunications (DOT)]

2.2.3.2　試掘場所の検討

各関係機関からプラントレコードや埋設物に関する資料の入手が困難な状況と判断し、JICA 調査団は非接触型地下埋設探査機を用いて、信号機及び可変情報板設置想定位置より半径 1m～2m、地下 3m について調査を行った。

調査の結果、埋設物が検知された 7 箇所については埋設状況確認の目的で、検知され

なかった 1 箇所については探査機を検証する目的で、計 8 箇所を試掘対象とした。

試掘申請は、BBMP に対しては道路掘削許可を、また BTP に対しては道路使用許可を申請した。申請は DULT を通して行った。その結果、2 箇所については道路工事直後の掘削規制により認可が下りず、残り 6 箇所について夜間施工を条件に認可された。

対象地点毎の探査地点数、試掘対象抽出結果および許認可状況について、表 2.5 に示す。

表 2.5　探査地点数および試掘対象地点許認可結果

No.	交差点名	方向数	探査地点数	試掘対象	許認可	備考（エリア）
S1	Queens Rd-Kasturba Rd-MG Rd	5	6			MG Road
S 2	MG Rd-St Marks Rd	4	8	○	×	MG Road
S 3	MG Rd-Kamraj Rd-Brigad Rd	4	8			MG Road
S 4	MG Rd-Commisionrate Rd-Preseidency Rd	3	5			MG Road
S 5	MG Rd-Dickenson Rd	3	6			MG Road
S 6	Trinity Circle	4	7			MG Road
S 7	General KS Thimayya Rd-Trinity-Church Rd	3	3			MG Road
S 8	Kensington Rd-Ulsoor Rd-Bazaar st Begum Mahal Junction	4	7	○	○	MG Road
S 9	Dickenson Rd-Ulsoor Rd	3	5			MG Road
S 10	Cubbon Rd-Dickenson Rd	3	5			MG Road
S 11	Kamraj Rd-Cubbon Rd	4	8			MG Road
S 12	Central-st Cubbon Rd	4	7			MG Road
S 13	Residency Rd-Brigade Rd	4	5			Hosur Road
S 14	LIC India Circle	4	5			Hosur Road
S 15	Musuem Rd-Brigade Rd	4	8			Hosur Road
S 16	Brigade Rd-Hosur-rd-General KS Thimmaya Rd	4	7			Hosur Road
S 17	Leonard rd-Campbell-rd-Hosur Rd	4	5			Hosur Road
S 18	Generak KS Thimmaya Rd-wood st-Mother Teresa rd	4	4			Hosur Road
S 19	Mother tereda Rd-St. Philomena Rd-Campbell rd	4	8			Hosur Road
S 20	VictoriaRd-General Ks Thimmaya Rd-St Philemena	5	5			Hosur Road
S 21	KenSington Rd-D Bhaskaran Rd	3	3			Old Madras Road
S 22	D Bhaskaran Rd-Thamarai kannad rd	3	2	○	○	Old Madras Road
S 23	Swami Vicekanand Rd-D Bhaskaran Rd Anjenaya Temple Junction	3	4	○	○	Old Madras Road
S 24	Swami Vivekananda Rd-Paramahansa Dayanand Rd	3	3			Old Madras Road
S 25	Swami Vivekananda OM Rd & Indiranagar100 Ft Junction	3	4	○○	○○	Old Madras Road
S 26	A Nanjappa Circle	4	4			Old Madras Road
S 27	Swami Vivekananda Rd-Cambridge Rd-Bazaar st	4	5			Old Madras Road
S 28	Swami Vivekananda Station	3	5			Old Madras Road
S 29	Commissariat Rd Magrath Rd	4	6	○	×	Hosur Road
V 1	Near Trinity Metro Station	--	1	○	○	MG Road
V 2	KR Puram Bridge, Near Outer Ring Road, NH-4	--	1	-		Old Madras Road
V 3	Silk Board Junction, Near Outer Ring Road, NH-7	--	1	-		Hosur Road

※S1～S29…信号　　V1～V3…可変情報板(VMS)

(出典：JICA 調査団)

2.2.3.3 試掘作業状況

試掘作業はBBMP及びBTPの許認可のもと、2016年8月8日にベンガルールの建設業者により夜間施工で実施した。作業手順としては通行人が少なくなる夜間21時過ぎに保安施設を施し、車両が減り始める22時過ぎから同時施工で開始した。作業方法として、手掘掘削で深度を下げながら地下埋設物を確認した上で、埋設探知機での調査時データと照合しながら約2.0メートルまで深度を下げ確認した。

2.2.3.4 既設地下埋設物状況

試掘により、水道管、通信ケーブル(光ファイバケーブル及びメタルケーブル)及び電力ケーブルが確認された。なお、近年インターネットの普及からインターネット回線用の光ファイバケーブルが複数確認された。通信事業者であるDOTケーブル(加入者用メタルケーブル、光ファイバケーブル)は容易に判断できるもののインターネット回線ケーブルにはケーブルシースに事業者名がプリントされてないため、事業者を特定することが困難であることが分かった。

2.2.3.5 結論

(1) 信号機設置位置

フィールド調査結果で最も多く地下埋設物を検知した位置を試掘した結果、埋設探知機での調査時データとほぼ同じ場所に地下埋設物が確認された。新設信号機設置工事での占用位置決定に際し、位置を前後左右にずらすことで信号機設置工事は可能と判断された。他の信号機設置場所の選定に際し、工事着手時は必ず埋設物調査を実施し既設埋設物を損傷しないよう注意が必要である。また、詳細設計(D/D)時は関係機関(BBMP、水道局及び電力供給公社など)への立会いを依頼し、本概略設計(O/D)の調査結果に基づき現場での占用位置を再度確認する。

(2) 可変情報板設置位置

本プロジェクトにおいて、可変情報板設置場所は3箇所あるが、フィールド調査結果で最も多く地下埋設物を検知した、MG Roadの試掘を実施した。可変情報板設置場所には、高圧電力線、通信ケーブル(光ファイバケーブル及びメタルケーブル)、水道管等の地下埋設物が複数確認された。同位置への可変情報板設置は極めて困難であるため、詳細設計(D/D)時に設置場所について再検討を行う。また、地下埋設物が輻輳している場合は、特殊基礎設計についても検討する。

2.2.4 環境社会配慮

本プロジェクトは、基本的に都市部の既設道路用地内を占用するため、環境社会配慮(住民移転等)に関する重大な対応事項はないと想定している。

2.2.4.1 カテゴリ分類

本プロジェクトは「国際協力機構環境社会配慮ガイドライン」(2010年4月公布)上、環境への望ましくない影響は最小限であると判断されるため、環境社会配慮におけるカテゴリ分類は「C」と判断される。

2.2.4.2 ジェンダー分類

ジェンダー対象外と判断される。ジェンダー視点に立った具体的な活動内容の実施可能性に関して、準備調査において可能性が見込めないことが理由となる。

第3章　プロジェクトの内容

3.1　プロジェクトの概要

3.1.1　　事業の背景

インド国では近年急速な都市化が進む一方で、公共交通インフラ整備が十分進んでいないことから、大都市圏では交通渋滞が深刻な問題となっており、これに伴う深刻な経済損失が経済開発への大きな障害となっている。

道路セクターが全輸送シェアの約 57%を担うインド国では、上記課題に対応すべく、第 12 次 5 か年計画(2012 年 4 月～2017 年 3 月)において、道路等の包括的なインフラ整備が経済成長にとって重要とされており、同セクターの開発に重点を置いている。本プロジェクトの対象地域であるベンガルール都市圏の人口は、2001 年の約 570 万人から 2011 年の約 850 万人(同国第 5 位：Census 2011)と大幅増加しており、経済成長も相まって車両登録台数増加率は過去 10 年平均 10%以上の増加率を記録している。それに伴い市内の交通量は増加の一途を辿り、特に通勤時においては激しい渋滞が発生し、経済活動へ支障が生じている。

ベンガルール開発庁(BDA)及びカルナタカ州都市交通局(DULT)は深刻化した交通渋滞の緩和を目的とした ITS の整備が急務となっている。

3.1.2　　上位計画とプロジェクト目標

3.1.2.1　プロジェクト目標

ベンガルール都市圏の交通渋滞改善、移動の定時制確保による利便性の向上、ベンガルール都市圏の地域経済発展に寄与するものである。

3.1.2.2　業務の概要

(1) 整備対象

センターシステム、プローブシステム、渋滞長計測システム、交通量計測システム、可変情報システム、インターネットシステム、信号システムを構成する機器を整備する。

また、信号システムの対象交差点について、交差点改良工事を含む。

(2) 対象地域(サイト)

インド国カルナタカ州ベンガルール市

(3) 関係官庁・機関

実施機関：カルナタカ州都市交通局(DULT)

3.1.2.3　期待される成果

ベンガルール都市圏において、高度道路交通システム(ITS: Intelligent Transport System)機器を導入することにより、平均旅行速度の 15%向上、及び主要交差点における渋滞長の 30%改善が期待される。

3.2 協力対象事業の基本設計

3.2.1 設計方針

3.2.1.1 基本方針

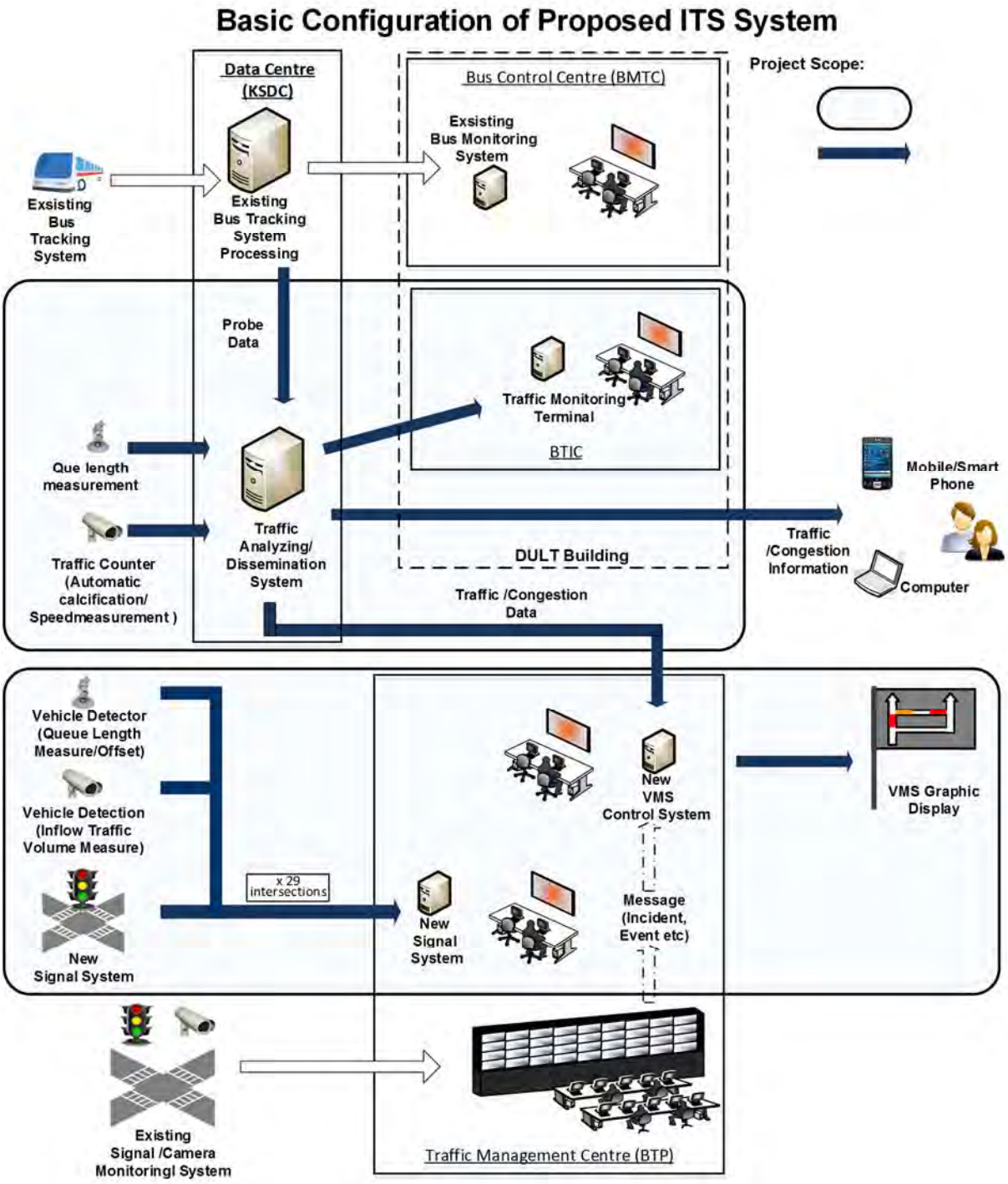
(1) 導入システムの構成

本プロジェクトは､大きく交通情報システム及び信号システムの導入を行うものである。導入システムのサブシステム、目的及び設置方針を表 3.1 に、全体システム構成を図 3.1 に示す。さらに、路側設備の全体配置図を図 3.2 に示す。

表 3.1 導入システムの目的と設置方針

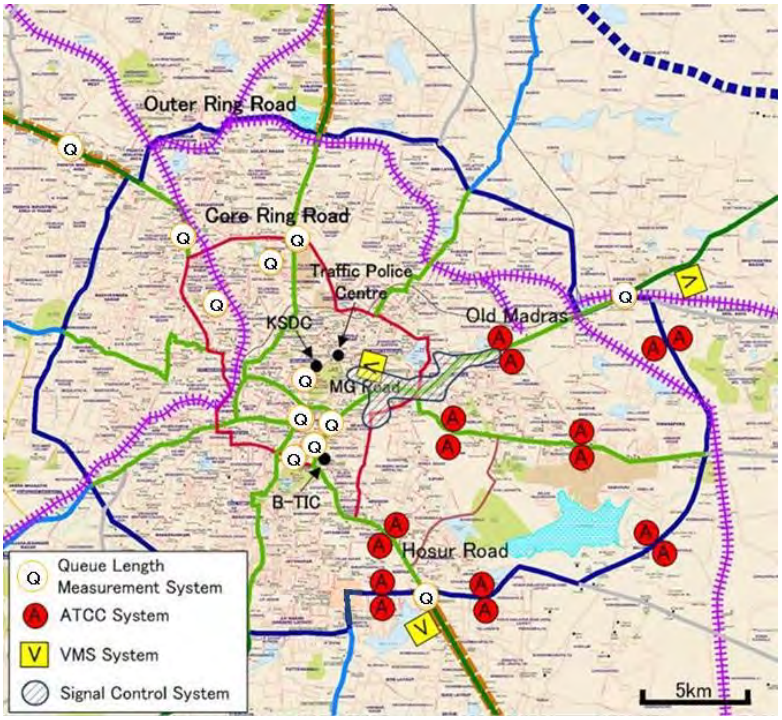
システム		目的	設置方針
交通情報システム	センター システム	各システムからのデータ収集・処理・蓄積・提供を行う	州データセンターに設置
	プローブ システム	6700 台の市バスに搭載された GPS により車両の旅行速度算出を行う。	州データセンターにて Probe Data を分岐
	渋滞長計測 システム	プローブシステムを補完することを目的として、渋滞長の計測を行う。	市内で特に渋滞が顕著な 12 交差点
	交通量計測 システム	道路管理のために断面交通量(大型・小型)を計測する。	市内で特に交通量の多い代表的な幹線道の主要交差点の 8 箇所(16 装置)
	可変情報 システム	プローブシステム及び渋滞長計測システムによって生成された動的な渋滞情報を､可変情報板より道路ユーザに対して提供する。	MG Road の他、主要道路の主要な分岐点等 3 箇所
	インターネット システム	プローブシステム及び渋滞長計測システムによって生成された動的な渋滞情報を､インターネットにより道路ユーザに対して提供する。	主に外環状道路までのエリアを中心に情報提供
信号システム		交通量に応じて系統制御し､交通の整流化を図る	MG Road を中心に導入効果の高い 29 箇所を選定

(出典：JICA 調査団)



(出典：JICA 調査団)

図 3.1　全体システム構成図



(出典：JICA 調査団)

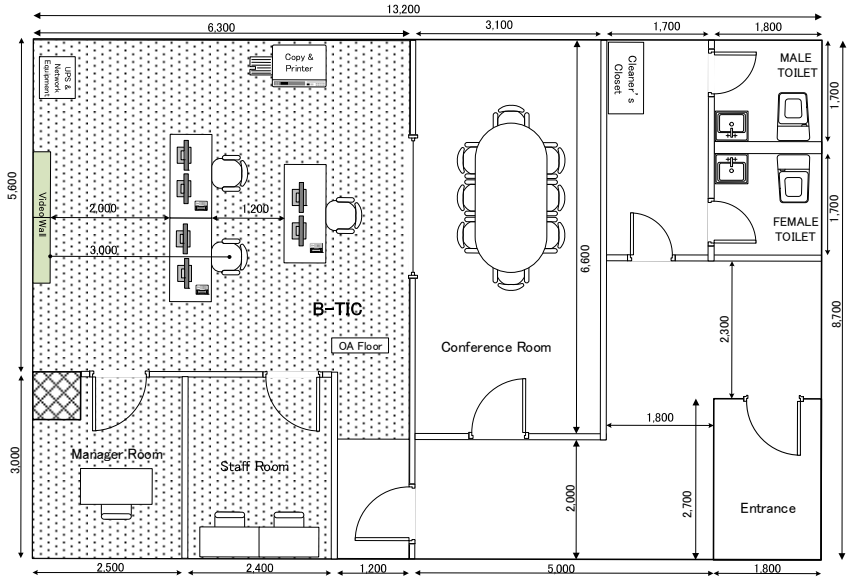
図 3.2　全体機器配置図

(2) 各箇所における設備設置方針

DULT、BTP 及び KSDC における設備設置方針は次のとおりである。

1) DULT

DULT は、交通情報システムの運営・維持管理を行うことから交通情報センターが設営される。設置される主な設備は、ビデオウォール、オペレータコンソール及びプリンタである。交通情報センターは DULT の 2 階フロアの一部に設営される予定であり、現在改装中である。2 階フロア図について図 3.3 に示す。



（出典：JICA 調査団）

図 3.3　DULT 設備設置予定場所

2) BTP

BTP は、信号システムの運営・維持管理を行うことから交通管理センターが設営される。設置される主な設備は、信号制御用コンソール及び可変情報システム用コンソールである。交通管理センターは、既設の交通監視センター内に設営する。BTP における設備設置予定場所を図 3.4 に示す。

（出典：JICA 調査団）

図 3.4　BTP 設備設置予定場所

3) KSDC

KSDC はカルナタカ州のデータセンターであり、行政システムなど重要なサーバ系設備が設置されており、セキュリティも強固に確保されている。本プロジェクトにおいて整備する交通情報システム及び信号システムは交通の安全に直結する重要なシステムでありセキュリティを十分に確保する必要があることから、当該データセンターへ設置する。

KSDC のサーバ室には、サーバの実装、非実装に関わらずサーバラック架がフルに設置されており、新規には立架が不可能な状況となっている。ただし、12 架のサーバラックは未実装であることが確認されている。未実装のサーバラック架で KSDC が指示する架に今回のサーバ等を実装することとしている。なお、サーバ未実装のサーバラックにおいても、架内に UPS 系 240V 電源コンセントが実装されていることを確認している。KSDC のサーバ室の状況を図 3.5 に示す。

（出典：JICA 調査団）

図 3.5　KSDC サーバ室

3.2.1.2 社会経済条件に対する方針

信号システムは自動車、二輪車、歩行者等全ての道路利用者を対象とするものである。これより、対象地域の道路利用者特性を考慮したシステムを構築する必要がある。

対象地域であるベンガルール都市圏の道路交通の特徴と対処方針を以下に示す。

(1) 路面標示

対象地域では、車線及び停止線等、路面標示が十分でないため車線及び停止線が守られないケースが多い。これより、交差点改良においては全ての交差点近傍に対して耐久性の高い路面標示を散布する。

(2) 歩行者信号整備

既設の交差点部には歩行者信号がない、もしくはあっても青点灯時間が著しく短い地点が存在する。また、車両が歩行者用信号を無視して歩行者の横断を妨げる。そのため、横断歩行者は歩行者信号と関係なく、車両の途切れたタイミングで横断をしている。本プロジェクトでは、一部を除き全ての交差点部に歩行者信号を設置する。

3.2.1.3 建設事情／調達事情若しくは業界の特殊事情／商習慣に対する方針

ベンガルール都市圏では建設機械・工具のリース会社が存在するため、リース会社から調達することが可能である。また、ローカルコントラクターも建設機械を所有しているため、現地調達は容易である。鉄筋、セメント、骨材、型枠機並びにレディーミックスコンクリート等についても現地調達は可能である。

3.2.1.4 現地業者(建設会社、コンサルタント)の活用に係る方針

ベンガルール都市圏の土木工事については、道路改修、道路改良工事等の小規模土木工事は現地の施工会社で施工可能である。また電気 通信工事についても、現地の電気通信事業者で施工が可能である。

3.2.1.5 運営・維持管理に対する対応方針

(1) 運営・維持管理責任体制

本プロジェクトの実施機関は DULT であるが、システム導入後の運営・維持管理(Operation and Maintenance 以下、O&M とする)の責任体制は、表 3.2 に示すとおりである。

表 3.2 各システムの O&M 実施体制一覧

システム名称		O&M 実施における システム名称	O&M 実施
交通情報システム	センターシステム プローブシステム 渋滞長計測システム 交通量計測システム インターネットシステム	BTIC システム	DULT
	可変情報システム	TMC システム	BTP
信号システム			

(出典：JICA 調査団)

また、O&M 実施にあたり DULT が管轄するシステムを BTIC(Bengaluru Traffic Information Centre)システム、BTP が管轄するシステムを TMC システム(Traffic Management Centre)システムと呼ぶ。O&M を実施する DULT、BTP 及びコントラクターの基本的な役割を表 3.3 に示す。詳細は 3.4 章に記載のとおり。

表 3.3　実施機関毎の基本的役割

実施機関名	基本的役割
DULT	DULT は O&M サービス業務の発注者となる。また、O&M 実施のための予算確保を行う。
BTP	BTP は O&M サービス業務の BTP 管轄システム(信号システム及び可変情報システム)の発注者代理人となる。
コントラクター	DULT から O&M サービス業務を受注し、O&M サービスを実施する。

(出典：JICA 調査団)

(2) 技術的対応方針

現在、信号機の設置・運用は、BTP が担当しているが、信号システムのうちリアルタイム制御の専門家がおらず、固定サイクル信号機の故障に対応しているのみである。また、交通情報システムは、ほぼ自動で情報交換が行われるシステムであるが、新たに操作・運用管理を担当する組織が作られる。

新たなシステムの導入と同時にシステムを所管する部署の体制強化と適切な技術による運用・維持管理を行うことが必要であり、請負業者による操作・運用指導の他、コンサルタントによるソフトコンポーネントによる運用管理技術の習得を図る。

また、維持管理に関しては、システムを導入した会社または、その会社の下請けの現地の会社にアウトソースすることが望まれる。これによりシステムを熟知した技術者による維持管理とインド国側への技術移転を図る。

3.2.1.6　施設、機材等のグレードの設定に係る方針

センターシステムを構成する機器及びソフトウェアの障害はシステムの運用に重大な影響を与える。したがってこれらについては高い機能と信頼性が求められる。

また、信号システム及びプローブシステムについては特に高度なレベルの情報処理が必要となる。

そのためこれらを構成する機器については、高い信頼性と高度かつ柔軟な機能を持った日本製品を想定する。

信号機及び路側機器設置工事の中で大きな比重を占める信号柱、支柱及びケーブルの設置については、仕様を満たせば相手国製品でも問題がない。

3.2.1.7　工法に係る方針

本プロジェクトでは、交差点での信号機と各灯器を結ぶ灯器ケーブルを、地下埋設した管路内に収容する地下埋設方式を採用する。地下管路にて道路横断する区間について、道路幅員が狭い区間は開削工法を採用し、道路幅員が広い区間は非開削工法(削進工 HDD:Horizontal Directional Drilling)にて実施する。

なお、非開削工法は、インド国の配管工事で既に採用されており、施工能力と実績を持つ現地請負業者が存在することを確認済みである。

3.2.2　基本計画

3.2.2.1　導入システム及び全体構成

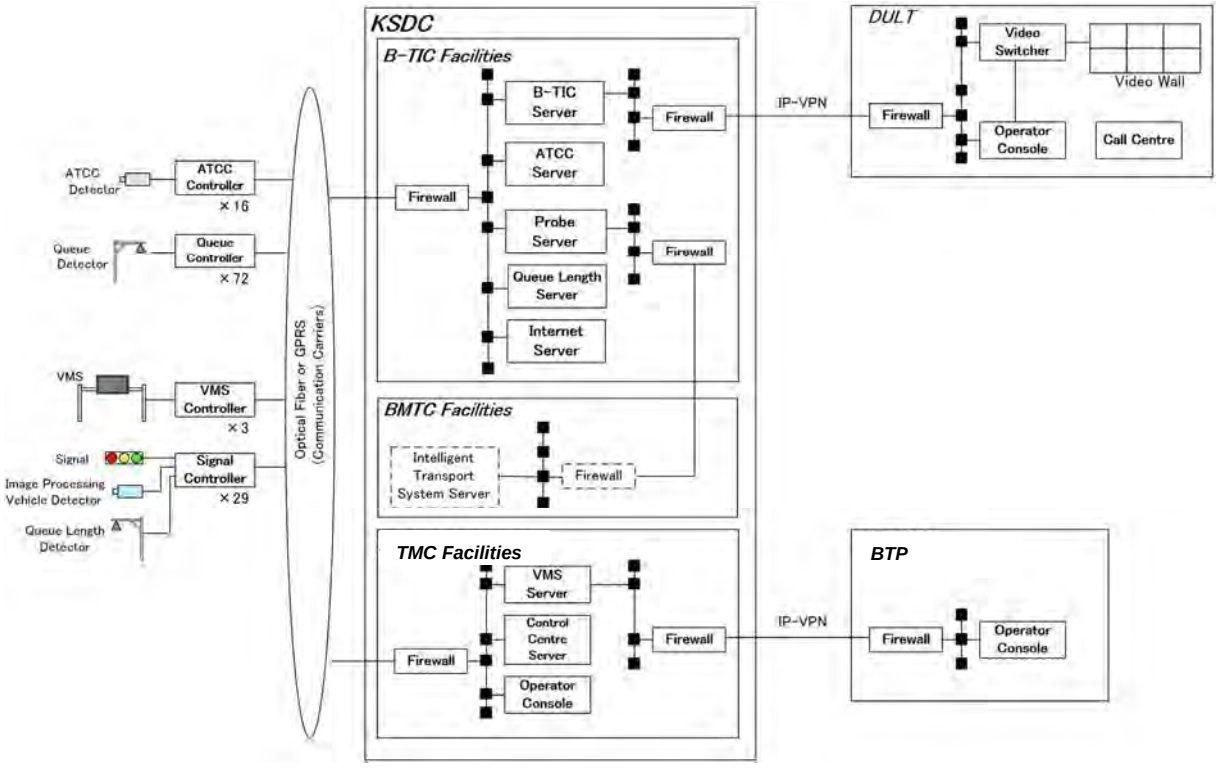
本プロジェクトにて導入するシステムを表 3.4 に示す。また、これらシステムの構成図を図 3.6 に示す。

路側機器より収集した情報は全て、強固なセキュリティを確保するため、州データセンターに集約、運用する。

表 3.4　本プロジェクトにて導入するシステム

システム		目的	数量
交通情報システム	センターシステム	各システムからのデータ収集・処理・蓄積・提供を行う	1 式
	プローブシステム	6700 台の市バスに搭載された GPS により車両の旅行速度算出を行う。	1 式
	渋滞長計測システム	プローブシステムを補完することを目的として、渋滞長の計測を行う。	12 交差点 計 72 箇所
	交通量計測システム	道路管理のために断面交通量(大型・小型)を計測する。	8 箇所上下方向 計 16 箇所
	可変情報システム	プローブシステム及び渋滞長計測システムによって生成された動的な渋滞情報を、可変情報板より道路ユーザに対して提供する。	3 箇所
	インターネットシステム	プローブシステム及び渋滞長計測システムによって生成された動的な渋滞情報を、インターネットにより道路ユーザに対して提供する。	1 式
信号システム		交通量に応じて系統制御し、交通の整流化を図る	29 交差点

(出典：JICA 調査団)



(出典：JICA 調査団)

図 3.6　全体システム構成図

3.2.2.2 交通情報システム

交通情報システムは、道路利用者に対する有益な道路交通情報の提供や将来的な道路交通計画への活用を視野に入れた日々の道路交通情報の蓄積を目的として整備される。

交通情報システムは、以下に示す「センターシステム」、「プローブシステム」、「渋滞長計測システム」、「交通量計測システム」、「可変情報システム」及び「インターネットシステム」から構成される。

(1) センターシステム

1) 目的

交通情報システムの各サブシステムより必要なデータを収集し、蓄積を行うことを目的とする。

2) 基本機能

主に以下の機能を実現することとする。

(A) データベース管理機能

取得した道路交通情報を将来の道路交通計画に活用するために、各種システムで処理されたデータはデータベースを利用して保存される。データ保存期間は 10 年程度とし、ストレージデバイスに移して保存できるものとする。保存した情報は、MS Excel 等の形式でファイル出力が可能とする。

(B) サブシステム管理機能

交通情報システムを構成する各サブシステムの動作を監視する機能を有する。

(C) ネットワーク管理と制御機能

ネットワーク管理プロトコル(SNMP 等)を利用して交通情報システムのネットワークを監視する機能を有する。

(D) システムパラメータの監視・管理機能

画面形式によるパラメータ監視と修正機能を有する。また、各サブシステムも同様にパラメータの監視と修正機能を有するが、パラメータの変更は唯一交通情報システムを介してのみ可能である。

(E) レポート編集と印刷機能

交通情報システムは蓄積されたデータを日次、月次及び年次報告書として自動編集・印刷可能な機能を有する。また、それら報告書はオペレータにより編集可能であるものとする。

(2) プローブシステム

1) 目的

プローブシステムは、BMTC が所有する GPS を搭載した 6700 台の市バスから得られるプローブデータを BMTC より受信し、それに基づき交通情報システムで道路利用者に提供する交通情報を生成することを目的とする。

2) 基本機能

主に以下の機能を実現することとする。

(A) 情報受信機能

バスプローブデータ及び渋滞長計測システムからの渋滞長の収集を行う機能である。バスプローブデータ(6700 台分)は 60 秒間隔で BMTC から当該プローブサーバへ送出される。なお、データフォーマットは CSV 形式である。

(B) 情報生成機能

バス運行ルート及びバス停等の登録情報及び受信したバスプローブデータに基づき、地図情報に渋滞状況等の交通情報をマッチングさせ、可変情報板及びインターネットシステムへ表示すべき情報を生成する機能を有する。

また、混雑が顕著な交差点の混雑状況は渋滞長計測システムからの渋滞長データを優先し渋滞長の生成を行う。なお、データの処理時間は、プローブデータの収集に 15 分、処理配信に 5 分とし、これらをパイプライン方式で制御し、可変情報板等への配信は 5 分ごとに更新するものとする。

プローブシステムが生成する情報は次のとおりである。

- リンク/セクションにおける交通状況データの生成
- 可変情報板に表示すべき画面の生成
- 可変情報板に表示すべき地点間の平均旅行時間の生成
- 上記生成データをインターネットシステム用(Web 用)に生成

3) バス停データ登録及びデータ補正機能

プローブシステムでは、バス停データを予め登録可能であり、市内を走行するバスによるバスプローブデータを、バス停で停止することのない一般車両の交通状態に近似するための補正を行う機能を有する。またバス停位置が変更になった際は、バス停データをあたらしいものへ上書きすることで更新可能とする。

4) BMTC から交通情報システムへのプローブデータ伝送

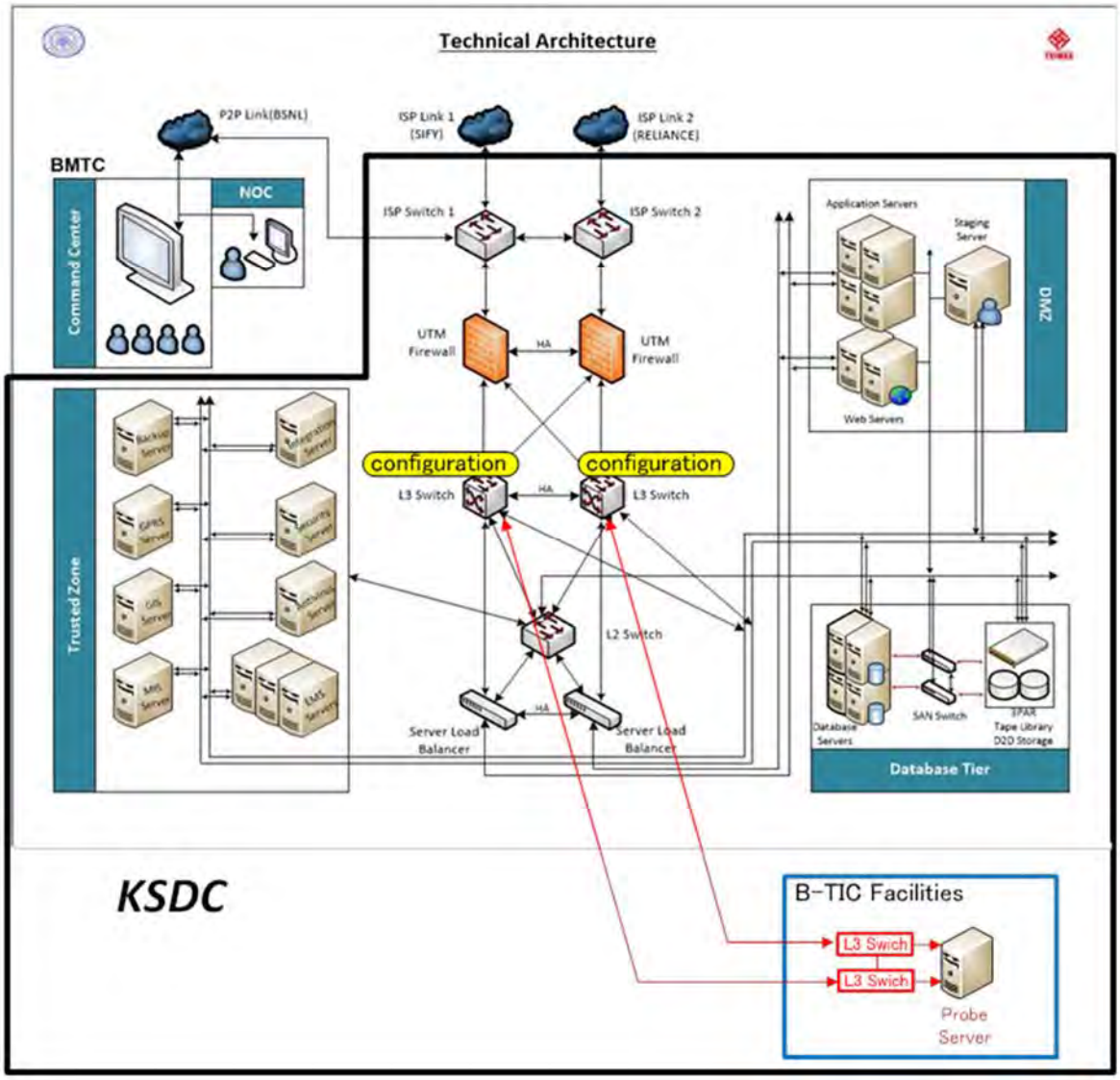
市内を走行するバスの位置情報等のデータは、BMTC 所管のプローブサーバへ集約され、当該サーバから本プロジェクトのプローブサーバへ送信される手順となる。BMTC 所管のプローブサーバは KSDC に設置されており、本プロジェクトのプローブサーバも KSDC に設置される計画である。

BMTC 側のプローブサーバでは、10 秒おきにバスの位置情報を収集し、BMTC は 60 秒間隔で直近 6 回分のプローブデータを交通情報システムに送出する。

プローブデータの伝送に際し、BMTC 側の既設システムの改造及び設定変更が必要となるが、これは BMTC が負担することを BMTC と合意している。また、DULT が BMTC からプローブデータの提供を受けることについて、費用は発生しないことを BMTC と

合意している。プローブデータ伝送に係るネットワーク構成を図 3.7 に示す。

また、BMTC から提供されたプローブデータのサンプルデータフォーマットを表 3.5 に示す。プローブデータのファイル形式は CSV 形式で送信される。



(出典：JICA 調査団)

図 3.7　プローブデータ伝送ネットワーク構成

表 3.5 データフォーマット一覧

Sr. No.	Data Name
1	Header
2	Device Serial Number
3	Packet Code
4	Miscellaneous Byte
5	Ignition Status
6	Accumulated Distance (in meters)
7	Signal Strength
8	Country Code
9	Network Code
10	Location Area Code
11	Cell ID
12	Number of Satellites in view
13	External Battery Voltage
14	Internal Battery Voltage
15	Sensor Information
16	Digital Input
17	Digital Output
18	Analog Input
19	Maximum Speed
20	String Heading
21	GPS Device Time
22	Long Lat Info
23	GPS Device Date
24	String
25	Server Date and Time

市バスの緯度経度情報

(出典：JICA 調査団)

(3) 渋滞長計測システム

1) 目的

渋滞長計測システムは、対象交差点の停止線から 300m、600m 及び 900m の位置に車両感知器(超音波式)を設置し、交差点から感知器までの車両占有率を求めることで渋滞長を計測することを目的とする。

2) 基本機能

主に以下の機能を実現することとする。

(A) 情報受信機能

路側に設置された車両感知器(超音波式)から、「通過車両台数」、「占有率」及び「装置状態」のデータを 1 分毎に受信する機能を有する。

(B) 情報生成機能

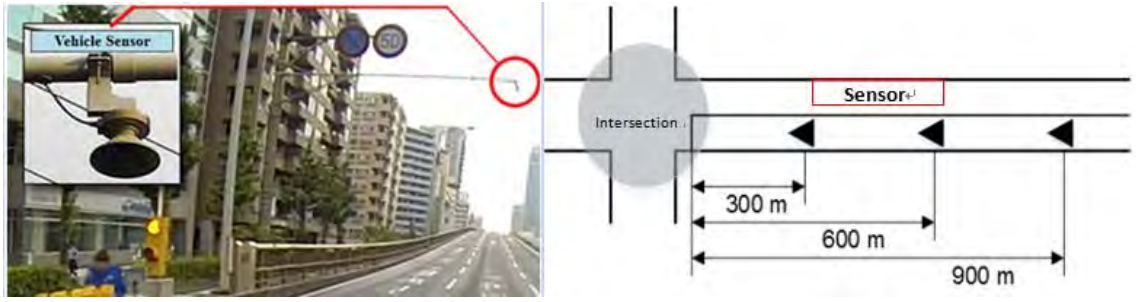
渋滞長計測システムサーバにて、交通量、平均占有率及び平均渋滞長を 5 分毎に生成する機能を有する。

(C) 情報保存・管理機能

収集した交通データを 1 時間、日、月単位にて集計し渋滞長計測システムサーバに一定期間(3 か月分以上)ファイル保存する。なお、保存期間を超過したデータは古いものから順に消去するものとし、旧データはセンターシステムのストレージデバイスに移行し 10 年間長期保存を行う。また、保存したデータはファイル出力(MS Excel 等)が可能なものとする。

3) 車両感知器(超音波式)の設置方法

ベンガルール市内の道路では、第一車線(最も左側の車線)に多くの車両が滞留する傾向にあることから、渋滞長を正確に把握するため車両感知器(超音波式)は第二車線の車両を検知可能な位置までアームを出して設置する。設置間隔は、交差点の停止線より 300m、600m 及び 900m の位置とする。設置対象場所は、市内で特に渋滞が顕著な 12 交差点を選定した。



(出典：JICA 調査団)

図 3.8 路側車両感知器設置イメージ(渋滞長計測システム)

(4) 交通量計測システム

1) 目的

交通量計測システムは、交差点における流入交通量を計測することを目的とし、画像式車両感知器により交通量及び車速を計測し交通量計測システムサーバへ送信する。

2) 基本機能

主に以下の機能を実現することとする。

(A) 情報受信機能

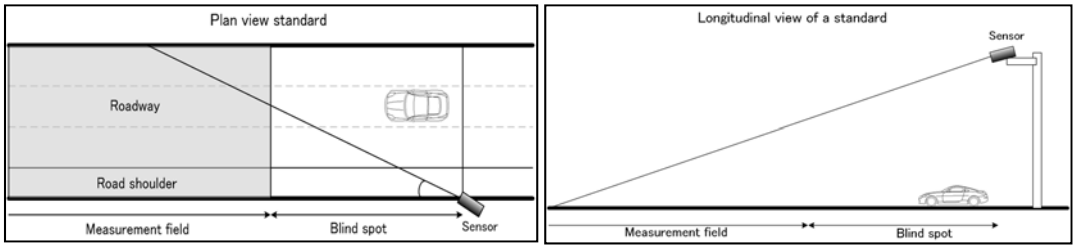
路側に設置された車両感知器(画像式)から、「車両タイプ別台数(大型/小型)」、「車速」及び「装置状態」のデータを 1 分毎に受信する機能を有する。

(B) 情報保存・管理機能

交通量計測システムは、車両感知器(画像式)から 1 分毎に受信した交通量データを基に 5 分毎データ、1 時間毎データ、24 時間毎データを生成する。生成データは交通量計測システムサーバへ一定期間(3 か月分以上)ファイル保存した後、センターシステムのストレージデバイスへ移行し 10 年間長期保存を行う。また、保存したデータはファイル出力(MS Excel 等)が可能なものとする。

3) 車両感知器(画像式)の設置方法

車両感知器はカメラによる画像処理によって検知する方式とする。交差点の停止線より約 50m 後方地点の車両流入量を計測する。設置場所は、市内で特に交通量の多い代表的な幹線道の主要交差点 8 箇所(16 装置)を選定した。



(出典：JICA 調査団)

図 3.9 路側機器設置イメージ(車両感知器)

(5) 可変情報システム

1) 目的

プローブシステムによって生成された動的な渋滞情報を、路上に設置されている可変情報板により道路ユーザに対して提供することを目的とする。

2) 基本機能

主に以下の機能を実現することとする。

(A) 情報受信機能

プローブシステムから交通情報データを 5 分毎に受信する機能を有する。

(B) 情報生成機能

プローブシステムからの交通情報データに基づき、可変情報板へ表示可能な形式のデータを生成する機能を有する。

(C) 情報配信機能

可変情報板へ交通情報を配信する機能を有する。これは 5 分毎に更新されるものとする。

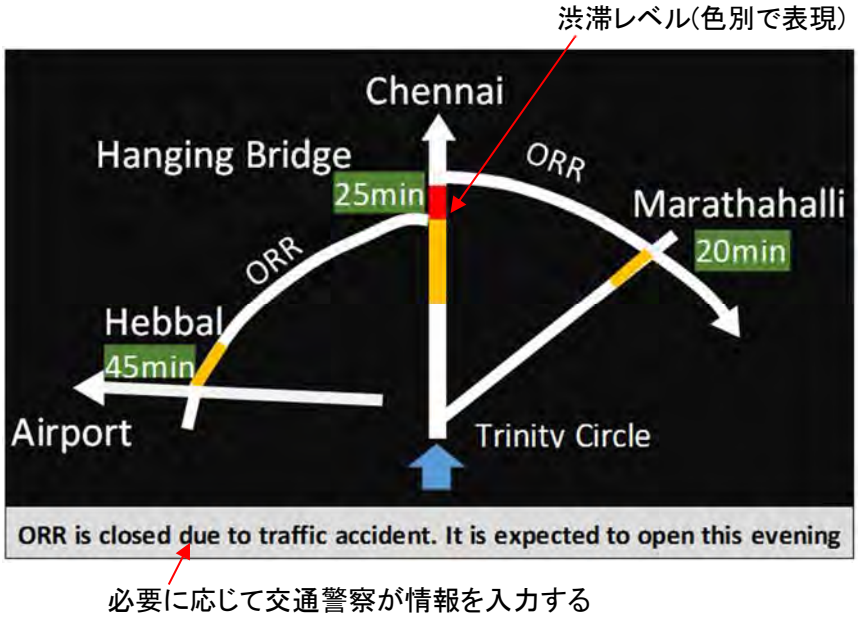
(D) 情報保存・管理機能

可変情報板への配信データ及び操作ログを 1 時間、日、月単位にて集計し、可変情報システムサーバへ一定期間(3 か月分以上)ファイル保存する。なお、保存期間を超過したデータはセンターシステムのストレージデバイスへ移行し 10 年間長期保存を行う。また、保存したデータはファイル出力(MS Excel 等)が可能なものとする。

3) 可変情報板による交通情報配信イメージ

可変情報板による交通情報の配信イメージは、模式的な地図とテキストメッセージを用いた表示によるものとする。模式地図上には、リアルタイムの交通情報及び主要方向への所要時間を表示する。また、BTP により必要に応じて事故情報や工事等の情報を入力可能とする。

可変情報板による交通情報の配信イメージを図 3.10 に示す。



(出典：JICA 調査団)

図 3.10 可変情報板表示イメージ

(6) インターネットシステム

1) 目的

プローブシステムによって生成された動的な渋滞情報を、インターネットにより道路ユーザに対して提供することを目的とする。

2) 基本機能

主に以下の機能を実現することとする。

(A) 情報受信機能

プローブシステムから交通情報データを 5 分毎に受信する機能を有する。

(B) 情報配信機能

ウェブサイト上に交通情報を配信する機能を有する。これは 5 分毎に更新されるものとする。

(C) 情報保存・管理機能

配信した交通情報を 1 時間、日、月単位で集計しインターネットシステムサーバへ一定期間(3 か月分以上)ファイル保存する。なお、保存期間を超過したデータはセンターシステムのストレージデバイスへ移行し 10 年間長期保存を行う。また、保存したデータはファイル出力(MS Excel 等)が可能なものとする。

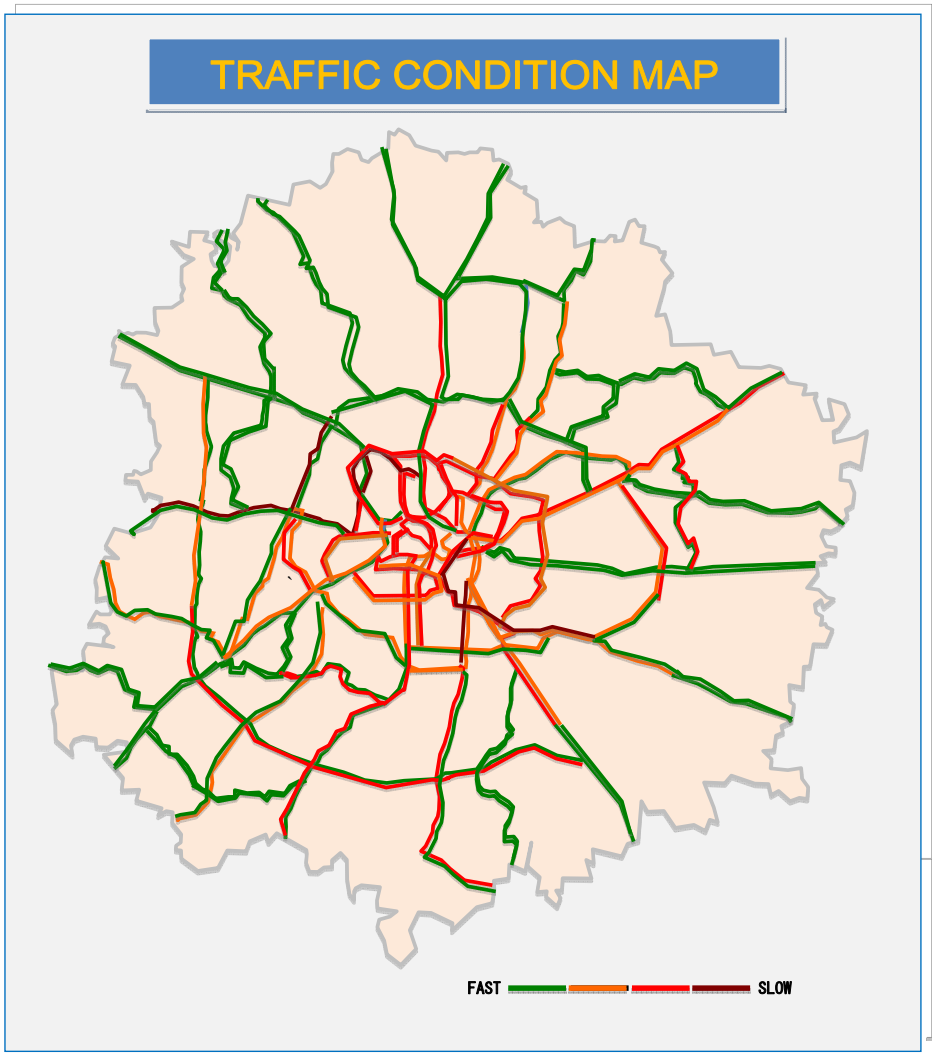
3) インターネットシステムによる交通情報配信イメージ

ウェブサイトを介して地図上に下記交通情報を提供する機能を有する。なお情報配信は、主に外環状道路までのエリアを対象とする。

＊ 地図の道路上に渋滞長及び渋滞レベルを色別表示する。

＊ 地図上にイベント情報(交通規制、事故、通行止め等)を表示する。

インターネットシステムによる交通情報の配信イメージを図 3.11 に示す。



(出典：JICA 調査団)

図 3.11　インターネット情報提供イメージ

3.2.2.3　信号システム

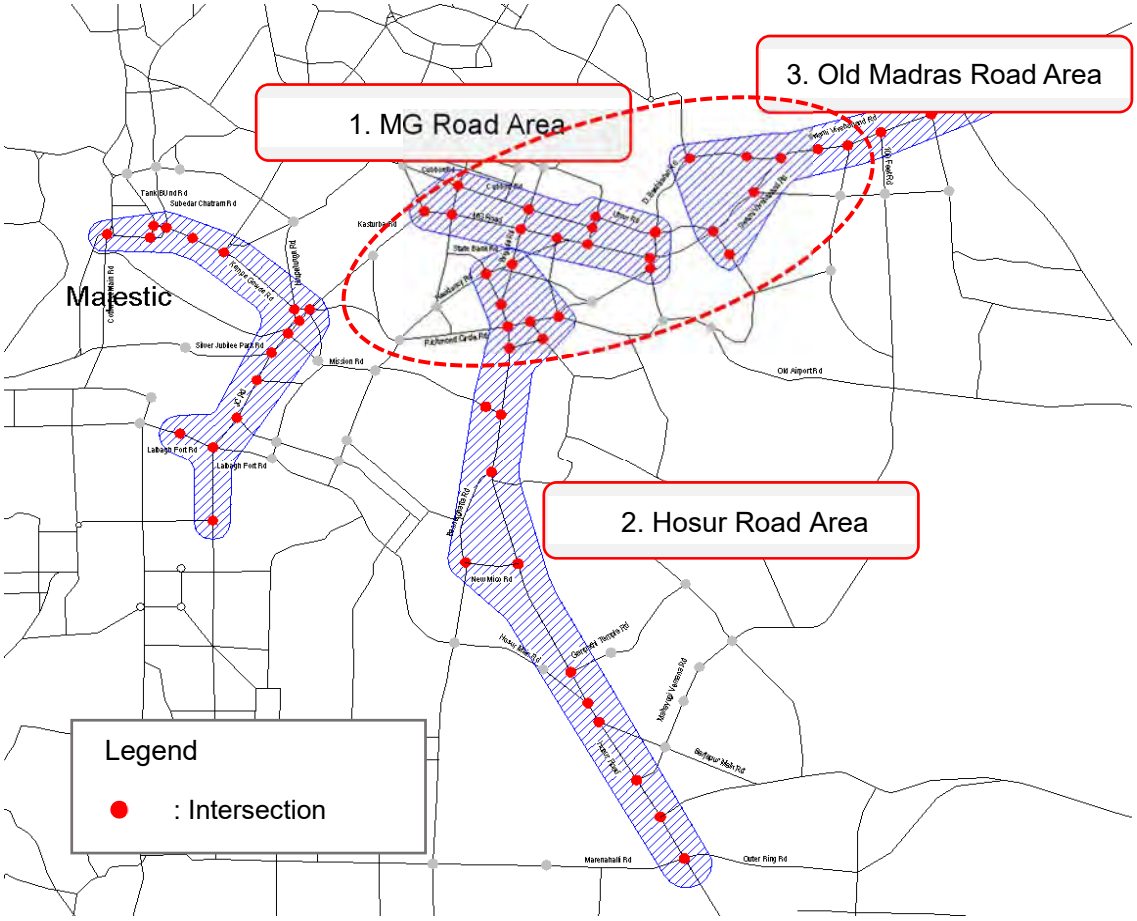
(1) 目的

「2.2.2 交通量調査」で述べたとおり、ベンガルール市内の交通渋滞は、交通需要に見合った適切な信号現示がなされていないことが一因となっている。信号システムを導入することで、実際の交通需要に応じた適切な信号制御を行うことを目的とする。

(2) 対象交差点

信号設置対象交差点は、図 3.12 に示すとおり、ベンガルール市内の幹線道路(MG Road、Hosur Road、Old Madras Road、Majestic Road)の中から、MG Road エリアで 12 箇所、Hosur Road エリアで 9 箇所、及び Old Madras Road エリアで 8 箇所の計 29 交差点を選定した。対象交差点は、交通需要が大きい MG Road、Hosur Road 及び Old Madras Road で信号システム導入効果が最大限発揮されるよう連続した交差点を対象とした。

各エリアの交差点位置を図 3.13、図 3.14 及び図 3.15 に示す。

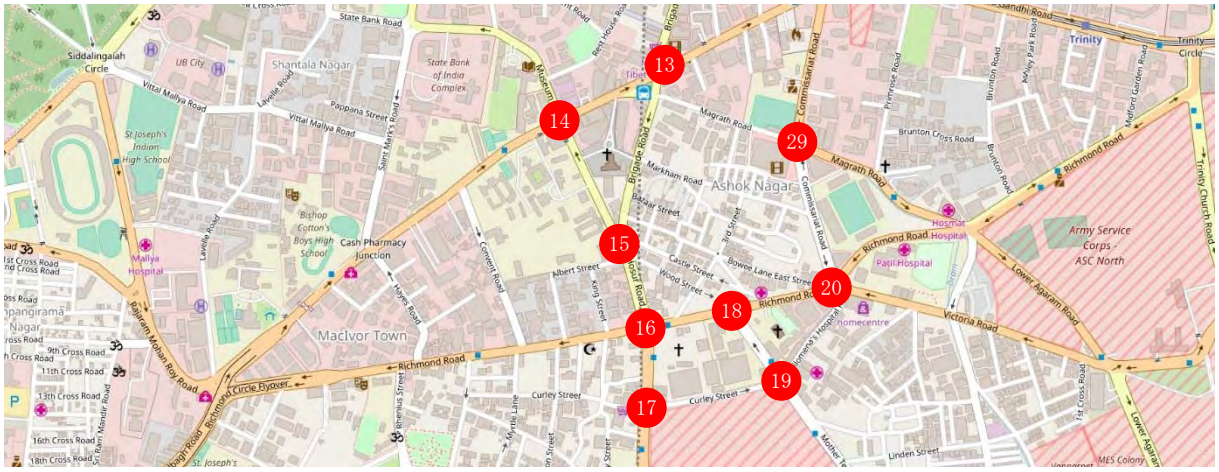


(出典：JICA 調査団)

図 3.12　信号設置対象交差点位置図

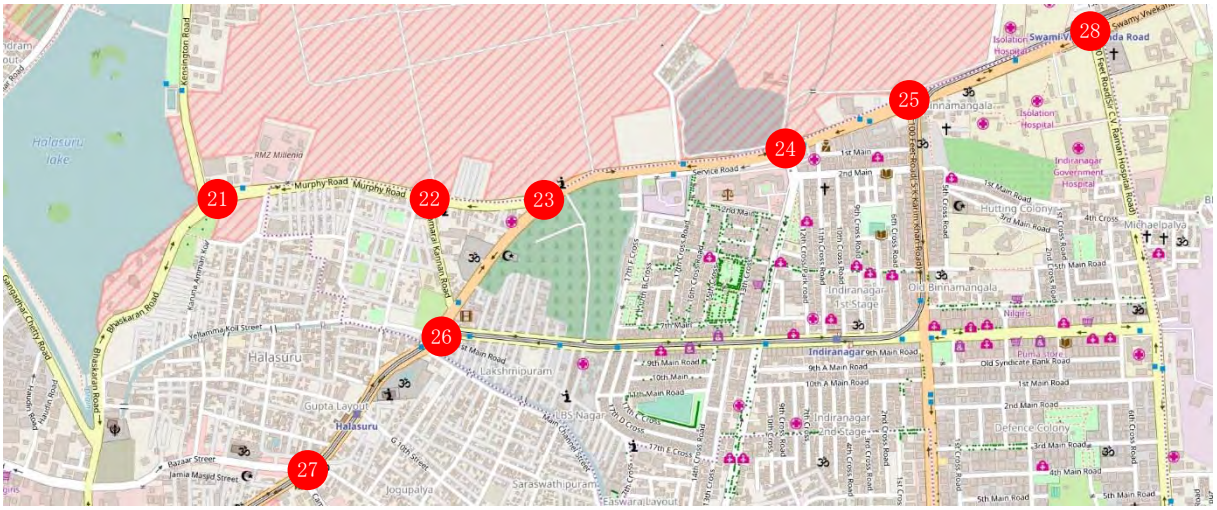
(出典：JICA 調査団)

図 3.13　MG Road エリアの交差点位置及び番号(12 交差点)



(出典：JICA 調査団)

図 3.14　Hosur Road エリアの交差点位置及び番号(9 交差点)



(出典：JICA 調査団)

図 3.15　Old Madras Road エリアの交差点位置及び番号(8 交差点)

また、対象となる 29 交差点について交差する道路等の情報を表 3.6 に示す。

表 3.6　信号設置対象交差点一覧

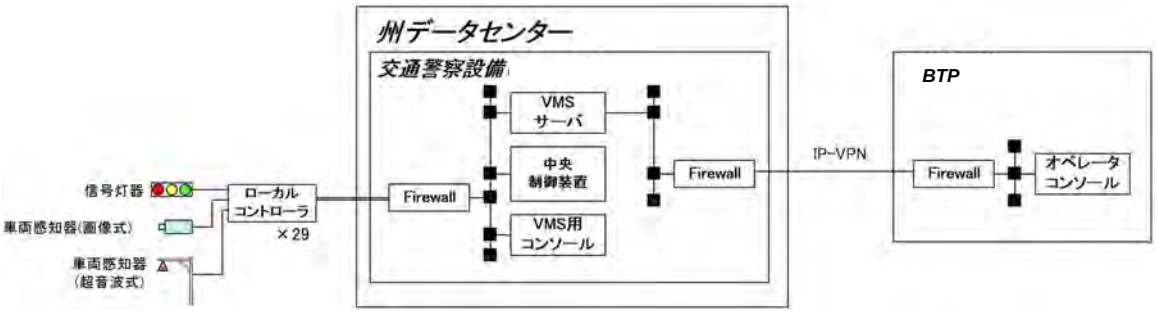
No.	交差する道路名（又は交差点名）			方向数	エリア
1	Queens Rd	Kasturba Rd	MG Rd	5	MG Road
2	MG Rd	St Marks Rd		4	MG Road
3	MG Rd	Kamraj Rd	Brigad Rd	4	MG Road
4	MG Rd	Commisionrate Rd	Preseidency Rd	3	MG Road
5	MG Rd	Dickenson Rd		3	MG Road
6	Trinity Circle			4	MG Road
7	General KS Thimayya Rd	Trinity	Church Rd	3	MG Road
8	Kensington Rd	Ulsoor Rd	Bazaar St	4	MG Road
9	Dickenson Rd	Ulsoor Rd		3	MG Road
10	Cubbon Rd	Dickenson Rd		3	MG Road
11	Kamraj Rd	Cubbon Rd		4	MG Road
12	Central St	Cubbon Rd		4	MG Road
13	Residency Rd	Brigade Rd		4	Hosur Road
14	LIC India Circle			4	Hosur Road
15	Musuem Rd	Brigade Rd		4	Hosur Road
16	Brigade Rd	Hosur Rd	General KS Thimmaya Rd	4	Hosur Road
17	Leona Rd	Campbell Rd	Hosur Rd	4	Hosur Road
18	Generak KS Thimmaya Rd	Wood St	Mother Teresa Rd	4	Hosur Road
19	Mother teresa Rd	St. Philomena Rd	Campbell Rd	4	Hosur Road
20	VictoriaRd	General Ks Thimmaya Rd	St Philemena	5	Hosur Road
21	Kensington Rd	D Bhaskaran Rd		3	Old Madras Road
22	D Bhaskaran Rd	Thamarai kannad rd		3	Old Madras Road
23	Swami Vicekanand Rd	D Bhaskaran Rd		3	Old Madras Road
24	Swami Vivekananda Rd	Paramahansa Dayanand Rd		3	Old Madras Road
25	Swami Vivekananda Rd	100 Ft Road		3	Old Madras Road
26	Swami Vivekananda Rd	Yellaman 2nd Cross Rd	Chinmaya Mission Hospital Rd	4	Old Madras Road
27	Swami Vivekananda Rd	Cambridge Road-Bazaar St		4	Old Madras Road
28	Swami Vivekananda Rd	80 Ft Rd		3	Old Madras Road
29	Commissariat Rd	Magrath Rd		4	Hosur Road

(出典：JICA 調査団)

(3) システム構成

システムを構成する機器を下図に示す。信号灯器本体、リアルタイムな点灯制御を行うための車両感知器(画像式、超音波式)を現場に設置し、KSDC と連携する。

信号システムは BTP の管轄となるが、中央制御装置等については、よりセキュリティが強固で信頼性の高い州データセンターに設置する。



(出典：JICA 調査団)

図 3.16　信号システム構成図

(4) 基本機能

信号システムの基本機能を以下に示す。

1) 路側設備(車両感知器)

交通状況に応じた信号制御を実現するため、実際の交通状況把握を目的とし画像式及び超音波式車両感知器を路側に設置する。それぞれの車両感知器における計測項目及び必要な機能を表 3.7 に示す。

表 3.7　信号システム車両感知器の計測項目一覧

感知器種別	計測項目	計測機能
画像式	台数計測	感知領域内の車両の台数を計測する
	速度計測	感知領域内を通過した車両の速度を計測する
	占有時間計測	感知領域内の車両の存在(占有時間)を計測する
超音波式	占有時間計測	感知領域内の車両の存在(占有時間)を計測する

(出典：JICA 調査団)

2) 中央制御装置

信号システムの中央処理設備が具備する主な機能は次のとおりである。

(A)　交通情報収集機能

信号制御に使用する交通量及び占有時間等の車両感知器情報を収集する機能を有する。

(B)　交通指標算出機能

車両感知器情報に基づき、行列長(渋滞長)を算出し、行列長と交通量等から交差点流入路毎の負荷率を算出する。

(C) 交差点サイクル長算出機能

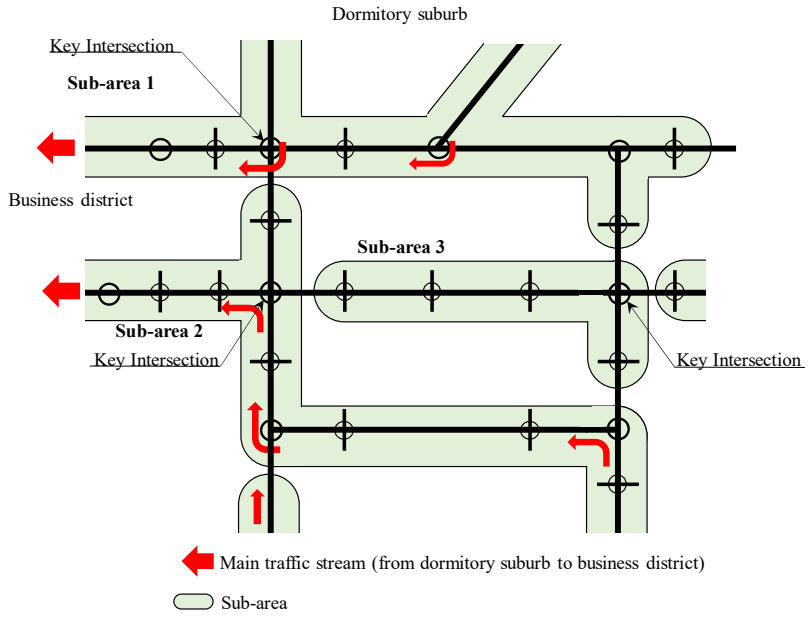
重要交差点の各流入路の負荷率をもとに、交差点のサイクル長を算出する機能を有する。

※ 重要交差点：交通需要の大きい幹線道路が相互に交差するなどの信号制御において重要となる交差点のこと。

(D) サブエリアサイクル長算出機能

サブエリアを構成する重要交差点のサイクル長をもとに、サブエリアサイクル長を算出する機能を有する。また、サブエリア内の全交差点はこのサイクル長で制御する。

※ サブエリア：重要交差点を核として近接する 5 交差点程度をひと括りとしたエリアのことである。サブエリア単位でサイクル長等の信号パラメータを制御し車両通過台数の最大化による渋滞緩和を図ることが可能である。サブリアのイメージを図 3. 17 に示す。

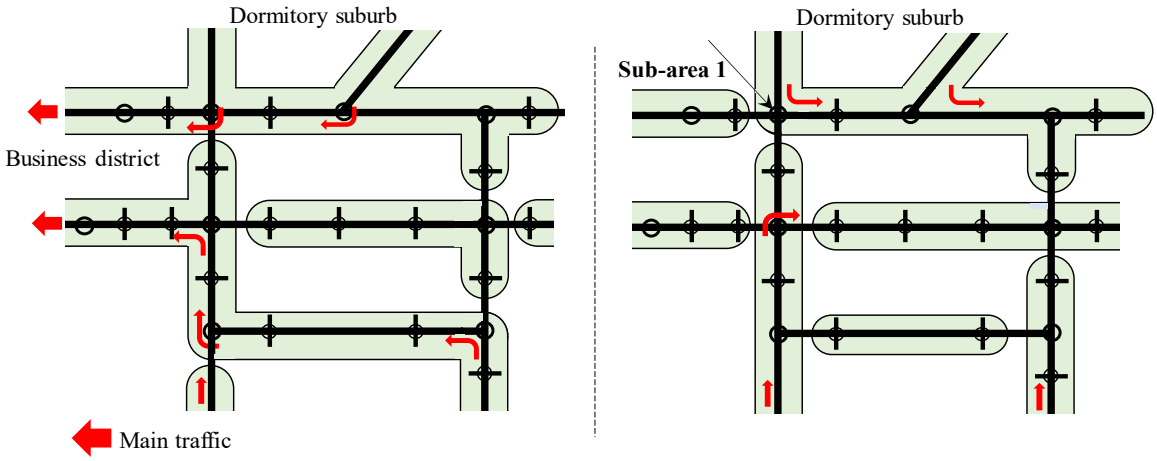


(出典：JICA 調査団)

図 3.17 サブエリアのイメージ図

(E) サブエリア結合機能

隣接するサブエリア間において、サブエリアサイクル長の差が指定した条件を満足した場合にサブエリアの結合を行う機能を有する。交通状況の類似するエリアを一つのサブエリアとすることで、よりスムーズな交通流を実現することを可能とする。サブエリア結合によるサブエリアの遷移イメージを図 3.18 に示す。



(出典：JICA 調査団)

図 3.18 サブエリア遷移イメージ図

(F) その他

信号システムにある種の障害(通信障害、停電等)が発生してもその影響を軽減するためにフェールセーフ機能を導入し、観測データのバックアップや通信障害時の自動運転を行う。

3.2.2.4 システム拡張における接続性と機器調達

(1) 信号システム

1) 中央制御装置の拡張性

本プロジェクトにより調達される中央制御装置は、本邦の UTMS(Universal Traffic Management System)規格に基づいており、128 箇所の信号交差点を制御することが可能である。したがって、本プロジェクトの対象である 29 交差点から 128 交差点まで拡張可能であり、拡張時は中央制御装置の設定変更のみで対応可能で、システム改造等は不要である。

128 交差点以上の拡張は、中央制御装置に対して補助的な装置を追加することにより可能となる。中央制御装置は UTMS 規格に準拠し、当該規格は公開されていることから多くのメーカーで製作が可能であると考えられる。

2) 路側設備の拡張性

(A) 信号灯器及び車両感知器

信号灯器及び車両感知器(超音波式)は、現状でも技術的にインド国企業で製作可能であるが、導入にあたっては信頼性の担保への十分な検討が必要である。

また、中央制御装置からの制御信号に基づき路側にて信号灯器及び車両感知器の制御を行うローカルコントローラとのインターフェースは、国際規格(ISO 14827-1,2 及び ISO 15784)に準拠している。

(B) ローカルコントローラ

信号灯器及び車両感知器とのインターフェースは国際規格(ISO 14827-1,2 及び ISO 15784)に準拠しており、また当該装置の機器仕様が規定されることから多くのメーカーで製作可能である。

短期的に追加調達が必要な場合は、複数の本邦企業から購入が可能であるほか、本邦企業がインド国企業へ主要部品を提供し OEM(Original Equipment Manufacturer)として現地製作することも可能であると考えられる。また、ローカルコントローラの追加は、中央制御装置側の設定変更のみで対応可能であり、システムの改造等は不要である。

(2) 交通情報システム

1) 渋滞長計測システム及び交通量計測システムの拡張性

渋滞長計測システムの車両感知器(超音波式)及び交通量計測システムの車両感知器(画像式)とローカルコントローラ間のインターフェースは国際規格(ISO 14827-1,2 及び ISO 15784)に準拠している。

車両感知器(超音波式)は、現状でも技術的にインド国企業で製作可能であるが、導入にあたっては信頼性の担保への十分な検討が必要である。

2) 可変情報システムの拡張性

可変情報システムには NTCIP(National Transportation Communications for ITS Protocol)というインド国も含めて国際的に広く使われ、公開されている米国規格が存在し、本プロジェクトで導入する可変情報システムも同規格に準拠することとしている。本邦企業を含め今後現地での OEM で当該規格に準拠した製作は可能であり、現地企業の中には既に NTCIP 規格に則って製作を進めている企業もある。

3.2.2.5　交差点改良計画

(1) 概要

交差点改良工事に係る交差点形状変更の検討については､信号改良効果を一層高めるため、信号設置対象の 29 交差点全てに対して行うこととした。また、改良工事は用地確保や住民移転など大きな線形変更を伴わない、軽微な改良にとどめることとした。

表 3.8　交差点形状改良の方針及び改良方式

項　目	内　容
交差点改良の方針	1. 信号制御の効果を高めるため、今回信号を設置する 29 交差点全てに実施する 2. 改良内容は用地確保や住居移転などの必要がない軽微な改良にとどめる
改良方式	1. 通行車線の塗り直しによる車線の明確化 2. 進行方向矢印の標示による右折車線、直進車線、及び左折車線等の明確化 3. 横断歩道、停止線などの塗り直しや移動による明確化 4. 右側通行路線の廃止 5. 交差点内面積の縮小(停止線の調整など)歩道嵩上げによる歩道部の安全確保 6. 道路横断者を妨げる遮蔽物の撤去等

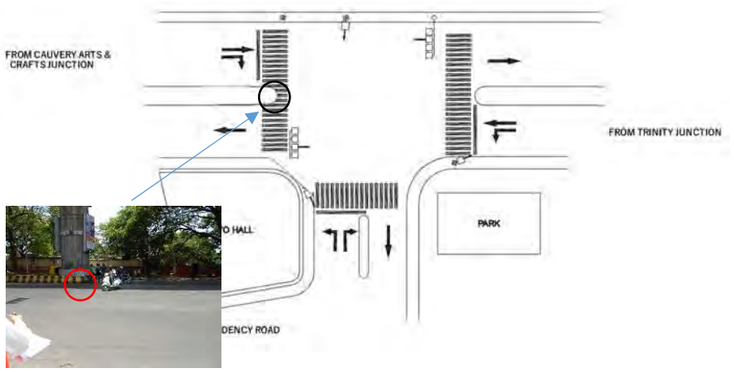
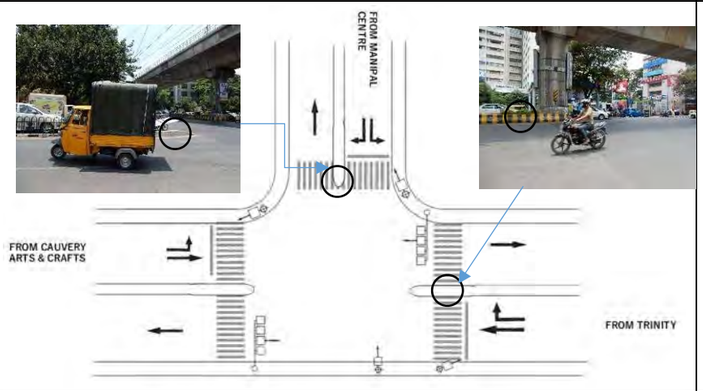
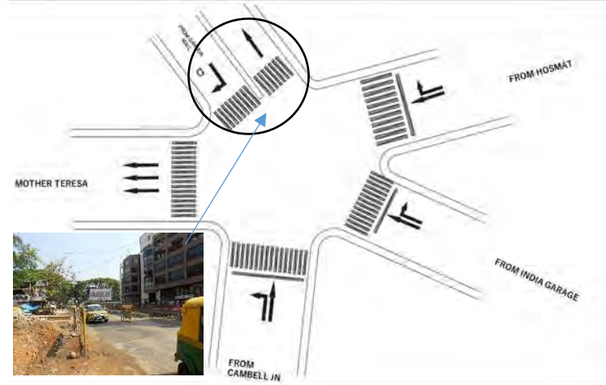
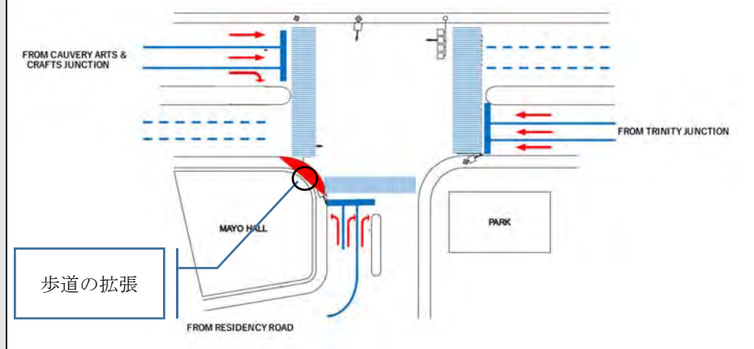
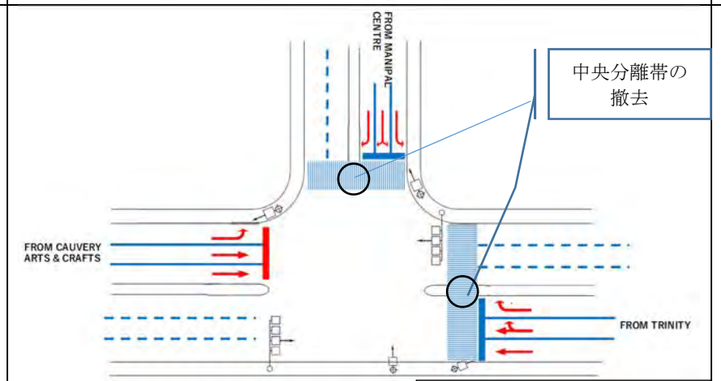
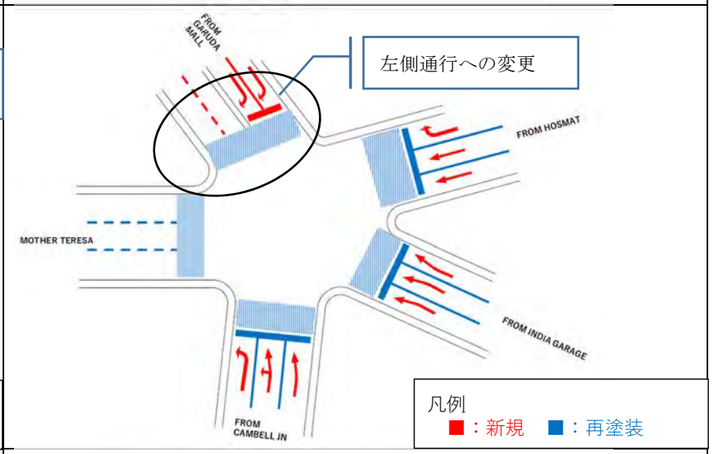
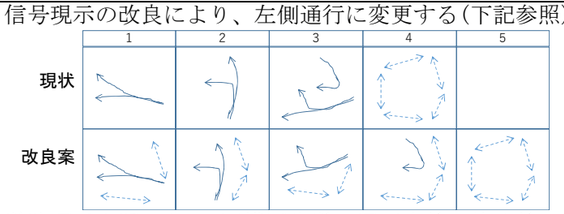
(出典：JICA 調査団)

改良対象交差点 29 箇所については、関係機関から入手する図面等を基に、改良後の完成予想図案、仕様、及び概算改良工事費等、日本側負担事項として取りまとめた。なお、第一次現地作業期間中に収集した交差点図面を確認したところ、29 交差点のうち 14 交差点について図面が存在しないあるいは内容が不十分であったため、追加調査として 14 交差点分の平面測量調査を行い、29 交差点分の図面を準備した。

(2) 交差点改良ポイント

信号改良(別項目で詳細に説明)
1. 信号現示の組み合わせとサイクル長の変更による改良　2. 安全の確保　3. 歩行者横断時間の確保
交差点改良(信号改良効果を更に高める)
1. 路面標示再塗装による明確化（横断歩道、通行車線、進行方向矢印、他）　2. 通行車線の分割　3. 歩道の拡張(嵩上げ)　4. 障害物の撤去　5. その他軽微な改良

表 3.9　交差点形状改良案(3 交差点を抜粋)

	No.4　MG Road – Commissariat Road – Residency Road	No.5　MG road – Dickenson Road	No.20　Victoria Rd – General KS Thimayya Rd – St Philomena
現状			
改良案			
問題点	横断歩道が橋脚により妨げられている。 歩行者横断時間が短すぎる。 歩行者用信号が見えづらい。	横断歩道が中央分離帯により妨げられている。 歩行者横断時間が短すぎる。 歩行者用信号が見えづらい。	右側通行の区間がある。 歩行者横断時間が短すぎる。
改良内容	歩道拡張を行い、歩行者用信号及び横断歩道の位置を移動する。 道路標示を明確化する(横断歩道、通行車線、停止線、進行方向別矢印)。	中央分離帯を撤去する。 道路標示を明確化する(横断歩道、通行車線、停止線、進行方向別矢印)	信号現示の改良により、左側通行に変更する(下記参照)。  道路標示を明確化する(横断歩道、通行車線、停止線、進行方向別矢印)。

(出典：JICA 調査団)

(3) 交差点改良内容

全ての信号設置対象 29 交差点に対し、路面標示工を実施する。また、一部の交差点には縁石工、既設構造物の撤去工を実施する。内訳を表 3.10 に示す。

表 3.10　交差点形状改良内訳一覧

	路面標示工								計 (m2)	歩道工 (縁石含む) (m3)	歩道撤去工 (m3)
	横断歩道 (*1) (m2)		停止線 (*2) (m2)		通行車線 (*3) (m2)		進行方向矢印 (*4) (m2)				
基準幅等	4.00		0.45		0.15	20.00	0.15	5.00			
交差点番号	全長(m)	数量(m2)	全長(m)	数量(m2)	本数	数量(m2)	個数	数量(m2)			
1	101.8	203.6	37.9	17.1	13.0	39.0	20.0	15.0	274.7	17.0	-
2	101.6	203.2	50.2	22.6	13.0	39.0	24.0	18.0	282.8	-	-
3	107.0	214.0	47.0	21.2	12.0	36.0	20.0	15.0	286.2	6.4	-
4	64.0	128.0	31.1	14.0	10.0	30.0	18.0	13.5	185.5	13.1	-
5	46.3	92.5	29.9	13.5	10.0	30.0	16.0	12.0	148.0	-	5.3
6	75.5	151.0	60.7	27.3	16.0	48.0	28.0	21.0	247.3	-	-
7	0.0	0.0	30.0	13.5	9.0	27.0	15.0	11.3	51.8	6.8	-
8	45.7	91.4	17.4	7.8	7.0	21.0	10.0	7.5	127.7	-	-
9	42.9	85.8	21.0	9.5	6.0	18.0	12.0	9.0	122.3	-	-
10	60.4	120.8	28.2	12.7	9.0	27.0	14.0	10.5	171.0	-	-
11	83.4	166.8	42.5	19.1	15.0	45.0	24.0	18.0	248.9	-	-
12	76.1	152.2	32.1	14.4	13.0	39.0	18.0	13.5	219.1	-	-
13	66.4	132.8	42.6	19.2	6.0	18.0	12.0	9.0	179.0	-	-
14	57.5	115.0	28.6	12.9	9.0	27.0	14.0	10.5	165.4	-	-
15	88.6	177.2	44.4	20.0	9.0	27.0	18.0	13.5	237.7	-	-
16	77.7	155.4	36.0	16.2	13.0	39.0	19.0	14.3	224.9	-	-
17	18.0	36.0	19.8	8.9	7.0	21.0	10.0	7.5	73.4	-	-
18	36.5	73.0	29.6	13.3	8.0	24.0	14.0	10.5	120.8	-	-
19	47.0	94.0	24.9	11.2	5.0	15.0	12.0	9.0	129.2	-	-
20	52.9	105.8	36.3	16.3	8.0	24.0	20.0	15.0	161.1	-	-
21	52.7	105.4	24.2	10.9	8.0	24.0	15.0	11.3	151.5	2.6	-
22	0.0	0.0	15.7	7.1	5.0	15.0	9.0	6.8	28.8	9.3	-
23	39.2	78.4	24.6	11.1	6.0	18.0	12.0	9.0	116.5	2.0	-
24	20.7	41.4	21.6	9.7	6.0	18.0	10.0	7.5	76.6	-	-
25	64.4	128.8	31.0	14.0	9.0	27.0	15.0	11.3	181.0	28.4	-
26	21.0	42.0	15.8	7.1	3.0	9.0	10.0	7.5	65.6	8.3	-
27	31.2	62.4	30.6	13.8	6.0	18.0	15.0	11.3	105.4	-	-
28	30.4	60.8	22.9	10.3	10.0	30.0	16.0	12.0	113.1	-	-
29	50.6	101.2	27.5	12.4	3.0	9.0	10.0	7.5	130.1	-	-
合計		3118.9		406.8		762.0		337.5	4625.2	93.8	5.3

(出典：JICA 調査団)

算出条件

(*1)：横断歩道は、幅 4m x 全長 x 比率 0.50 とする。

(*2)：停止線は、幅 0.45m x 入側の道路幅で算定する。

(*3)：通行車線は、幅 0.15m で方向別に交差点から 20m 地点まで塗布する。

(*4)：進行方法別矢印は、1 進入路ごとに交差点直近及び交差点手前 30～40m 付近の 2 箇所に塗布する。進行方向別矢印のサイズは幅 0.15m x 長さ 5m とする。矢印の種類は考慮しない。

3.2.3 概略設計図

概略設計図は次のとおりとし、付属資料 6-参考資料(基本図面)に示す。

1) Location of roadside equipment
2) Detail Location of Traffic signal
3) TYPICAL DRAWING OF VMS TYPE 1
4) TYPICAL DRAWING OF VMS TYPE 2
5) TYPICAL DRAWING OF VMS TYPE 3
6) Pole of sensor

3.2.4 施工計画／調達計画

3.2.4.1 施工方針／調達方針

(1) 機器据付工事

機器据付工事は､所定の土木工事(建柱工事､ガントリー基礎工事等)､プルボックス、ハンドホール設置工事及び管路布設工事が完了し、日本からの機器到着後に実施する。機器据付工事は、機器の搬入・設置・固定等の据付作業と機器の調整試験からなる。各機器の据付・組立作業に続き単体テスト、対向テストを実施して総合動作テストを実施する。

(2) 路側機器据付工事

交通情報システム及び信号システムにおける路側機器据付工事について以下に示す。

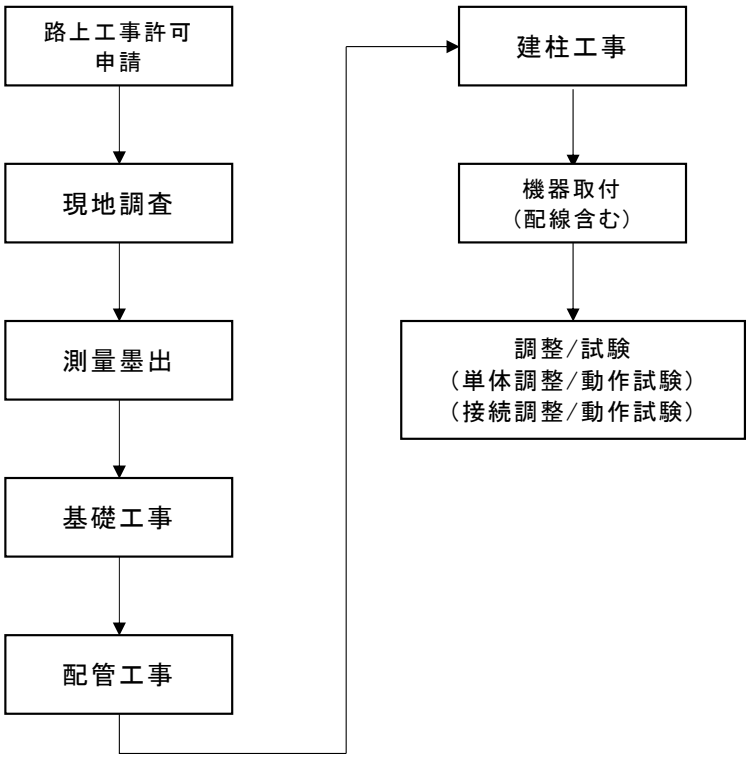
1) 交通情報システム

交通情報システムでは、次に示すシステムの路側機器据付工事を行う。

- ■ 交通量計測システム:車両感知器(画像式)他　16 箇所
- ■ 渋滞長計測システム:車両感知器(超音波式)他　72 箇所
- ■ 可変情報システム:可変情報板他　3 箇所

路側機器据付工事手順について、図 3.19 に示す。

工事の実施にあたり、事前に関係機関から路上工事許可(道路占用許可及び道路使用許可等)の承認を得る必要がある。これはコントラクターが用意する施工図等をベースに、DULT が道路占用許可を BBMP へ、また道路使用許可を BTP へそれぞれ申請を行う。また、現地調査にてコントラクターは、対象設備の設置位置及び周辺状況の確認を行い、工事対象箇所の地中埋設物の有無を確認する。



※：接続動作試験は、路側機器の据付・単体動作試験が終わった後に行う

(出典：JICA 調査団)

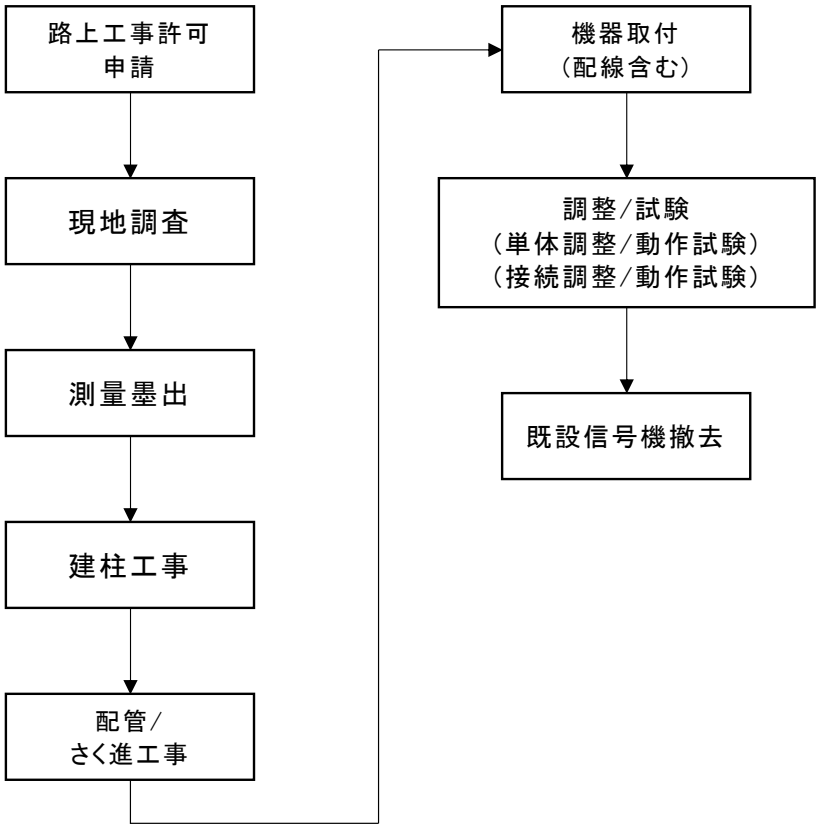
図 3.19　交通情報システム　路側機器据付工事手順フロー図

2) 信号システム

信号システムの機器据付工事では、対象となる各交差点(全 29 箇所)に信号灯器及び車両感知器(超音波式及び画像式)を設置する。路側機器機器据付工事手順を図 3.20 に示す。工事実施にあたり、事前に関係機関から路上工事許可の承認を得る必要がある。これはコントラクターが用意する施工図等をベースに、DULT が道路占用許可を BBMP へ、また道路使用許可を BTP へそれぞれ申請を行う。また、現地調査にてコントラクターは工事対象箇所の地中埋設物有無を確認する。

信号システムの機器据付工事は、機器据付工事が完了するまで既設信号機を運用した状態で実施する。機器据付工事が完了した後、BTP が既設信号機を撤去する。

信号システム工事手順について、次頁の図 3.20 に示す。



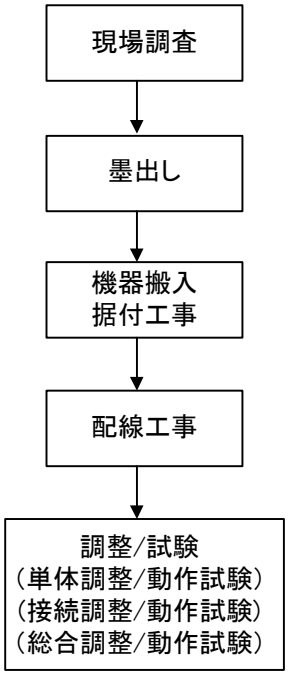
※：接続動作試験は、路側機器の据付・単体動作試験が終わった後に行う

(出典：JICA 調査団)

図 3.20　信号システム　路側機器据付工事手順フロー図

(3) 中央機器据付工事

中央機器据付工事は、KSDC に設置する各システムのサーバと DULT に設置するビデオウォール、オペレータコンソール及び BTP に設置するオペレータコンソールの据付工事に分けられる。



(出典：JICA 調査団)

図 3.21　中央側機器据付工事手順フロー図

1) 中央機器据付工事(KSDC 設置機器)

中央機器据付工事は、表 3.11 に示す各システムにおける主要な中央機器を既設キャビネット内に収容する。

表 3.11　各システムにおける主要な中央機器

No.	システム名称	サーバ名称
交通情報システム	センターシステム	BTIC サーバ (BTIC: Bengaluru Traffic Information Centre)
	プローブシステム	プローブサーバ
	渋滞長計測システム	渋滞長計測サーバ
	交通量計測システム	ATCC サーバ (ATCC: Automatic Traffic Counter & Classifier)
	可変情報システム	VMS サーバ (VMS: Variable Message Sign)
	インターネットシステム	インターネットサーバ
信号システム	信号システム	中央制御装置

(出典：JICA 調査団)

(A) BTIC サーバ

- BTIC サーバは据付後、DULT 側でのビデオウォール、オペレータコンソールの単体動作試験が終了した後、それら機器との接続動作確認を行い、最後に総合動作確認を行う。

(B) プローブサーバ

- プローブサーバは、BMTC の既設プローブサーバと接続しプローブデータの取得が可能であることを確認する。
- プローブサーバは、渋滞長計測サーバと接続し渋滞長情報の取得が可能であることを確認する。
- ソフトウェアのインストール後、単体動作試験を実施する。その後、BTIC サーバからビデオウォールへの表示確認及び総合動作確認を行う。

(C) 渋滞長計測サーバ

- 渋滞長計測サーバは、路側機器の据付・機器単体動作試験が終了した後、路側機器との接続動作確認を行い、最後に総合動作確認を行う。

(D) ATCC サーバ

- ATCC サーバは、路側機器の据付・機器単体動作試験が終了した後、路側機器との接続動作確認を行い、最後に総合動作確認を行う。

(E) VMS サーバ

- VMS サーバは、路側機器の据付・機器単体動作試験が終了した後、路側機器との接続動作確認を行い、最後に BTIC サーバと接続し総合動作確認を行う。

(F) インターネットサーバ

- インターネットサーバは、据付後各ユーザ端末に情報提供を行うための画面作成を行い、PC 端末の HTML 画面で閲覧可能なことを確認する。

(G) 中央制御装置

- 信号灯器を制御する中央制御装置を設置する。路側機器の据付・機器単体動作試験が終了した後、路側機器との接続動作確認を行い、最後にシステムとしての総合動作確認を行う。

2) 中央側機器据付工事(DULT 設置機器)

ビデオウォール、オペレータコンソールの据付・機器単体動作試験が終了した後、BTIC サーバと接続動作確認を行い、最後に総合動作確認を行う。

3) 中央側機器据付工事(BTP 設置機器)

オペレータコンソール(可変情報システム用及び信号システム用)は BTP に設置する。VMS 及び VMS サーバの据付･機器単体動作試験が終了した後、それら機器との接続動作確認を行う。

(4) 施工時の留意事項

その他の工事として、路上機器のための基礎・建柱・配管・配線等が挙げられる。基礎・配管・配線工事においては、車道・歩道・中央分離帯にあり、掘削時は既設埋設物に細心の注意を払い、破損させることの無いように実施する。

1) MG Road に設置する可変情報システムのガントリー

MG Road に設置する可変情報システムのガントリー基礎杭、建柱、可変情報板取付工事に際し、中央分離帯の上空にはメトロレールが存在するため、十分留意する必要がある。

2) Silkboard に設置する可変情報システムのガントリー

Silkboard に設置する可変情報システムのガントリーは、既設標識ガントリーの後方に設置する。可変情報システムの試験調整を終えた後、既設標識ガントリーを撤去する。

3.2.4.2 施工上／調達上の留意事項

(1) 工事全体

本プロジェクトでは、土木工事、ならびに機器据付工事等(センターシステム、プローブシステム、渋滞長計測システム、交通量計測システム、可変情報システム、インターネットシステム及び信号システム)の多岐に渡る工事で構成されているため、細部に亘り連携を取りながら工事を実施し工期内完成を目指す必要がある。施工計画立案における着目点は以下のとおりである。

- 土木工事は施工性や安全面を考慮し、雨季(6 月～10 月)を避けて実施する。特に降雨量が多い時期(8 月～9 月)は、屋内工事を実施する。
- 現状稼働しているシステムの停止時間を極力短くすることが重要であり、特に雨季にはシステム停止を伴わないよう配慮する必要がある。
- 施工場所エリア周辺は交通量が多いため、安全管理を徹底する。

(2) 関連機関への機器設置

また、本工事では、DULT、KSDC、BTP 等の関連機関への機器供与・機器設置を行う。

1) インド国側により工事、調達開始までに行われる事項

- 課税等の免税に必要な予算の確保
- 必要技術者の確保
- 工事、調達への協力(詳細情報提供、道路占用許可、道路使用許可、必要な許認可)

2) インド国側により工事、実施中に行われるべき事項

- 工事及び設置機材用電源の提供、通信ケーブル(光ケーブル)の提供、電源ケーブルの提供、既設分電盤への接続
- 工事、調達に必要なスペースの確保
- 工事、調達への協力(詳細情報提供、必要な許認可、安全対策)
- ソフトコンポーネントが実施された場合の担当者の決定と受講

3.2.4.3 施工区分／調達･据付区分

本プロジェクトでは、センターシステム、プローブシステム、渋滞長計測システム、交通量計測システム、可変情報システム、インターネットシステム、信号システム等の据付工事及び土木工事(信号柱の建柱、可変情報板基礎工事、プルボックス・ハンドホール設置工事、管路布設工事、削進工、路面標識工等)が多種多様な工事が複数のサイトで輻輳して行われるが､受注業者とインド国側とがデマケーションを明確にしたうえで、連携・協力関係を密にして事業を進めていく必要がある。

本計画における施工区分けは以下のとおりである。

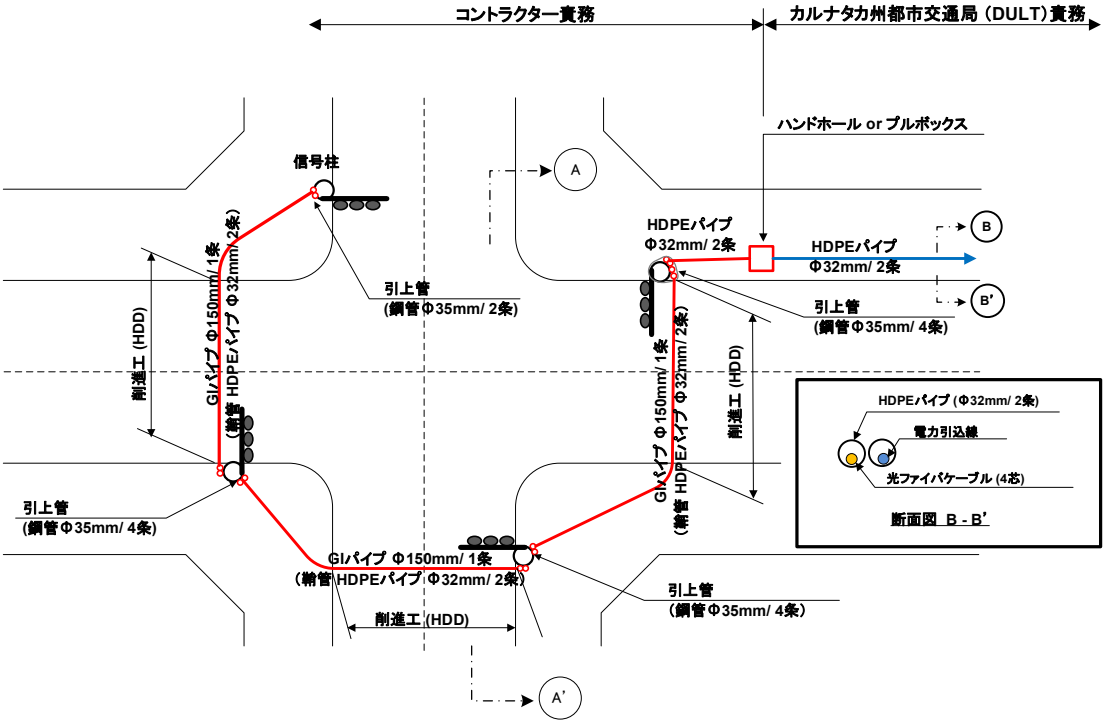
表 3.12 本計画における施工区分け

日本国側	インド国側
・センターシステム(一式) ・プローブシステム(一式) ・渋滞長計測システム(12 箇所) ・交通量計測システム(8 箇所) ・可変情報システム(3 箇所) ・インターネットシステム(1 式) ・信号システム(29 交差点) ・土木工事(管路工事、プルボックス設置工事、建柱工事、削進工事、基礎工事、路面標示工事、歩道改良工事、歩道撤去工事等)	・機器室の清掃・補修及び提供 ・各種関連機関との調整・申請手続 ✓免税措置及び通関手続き ✓道路占用・使用許可 ✓その他の許可取得(建物への入館、水道、ガス、電気など) ・既設機器の撤去(信号柱及びガントリー撤去工事) ・保守用予備品(信号柱及びセンサ用支柱) ・電源引込工事、通信工事等、管路工事 ・機器据付工事／調整工事(試運転)の立会い ・受入検査の立会い ・完了検査の立会い ・カウンターパート要員の割当て ・還付予算確保・支払い

(出典：JICA 調査団)

請負業者は、コンサルタント作成の仕様書に従って、土木工事等、資機材の設計、製作、工場試験、輸出梱包、現地までの輸送、各システム据付工事後の性能を検証した上で引渡しを行う。また、一連の建設及び現場試験の期間中にインド国側への技術移転のための要員訓練を行う。

本計画における施工区分け図を以下に示す。



(出典：JICA 調査団)

図 3.22 施工区分け図

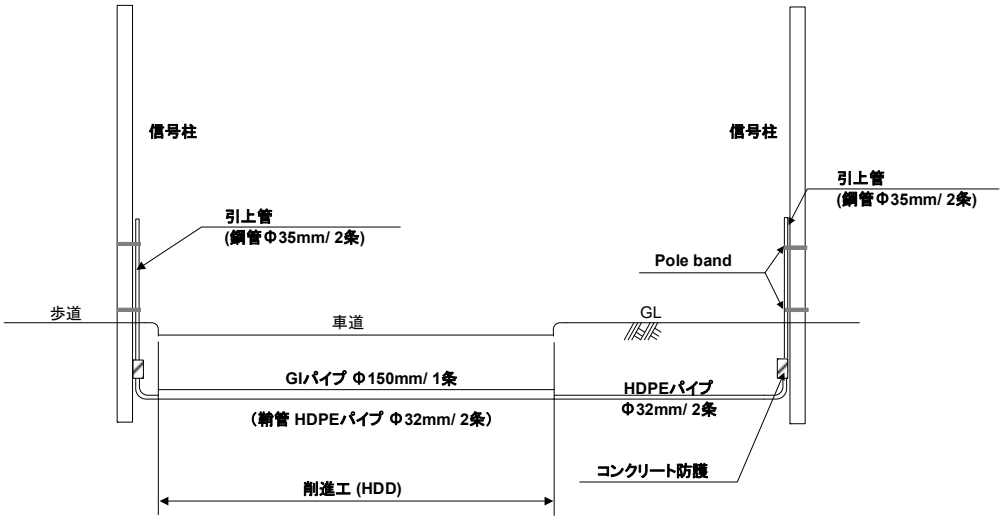


図 3.23 横断図 A-A'

(出典：JICA 調査団)

インド国側によって実施される作業は、関連工事工程と調整を図って、事前、且つ適時に実施される必要がある。インド国側、日本側双方、お互いに協調を図り、本プロジェクトの円滑な遂行並びに工期内の完成を図らねばならない。

3.2.4.4 施工監理計画／調達監理計画

(1) コンサルタントの実施設計・調達監理計画

1) 詳細設計体制

インド国側の実施機関である DULT と日本人コンサルタントの間でコンサルタント業務契約を結ぶ。コンサルタント業務契約に含まれる実施設計内容は次のとおりとする。

(A) 相手国との協議

本概略設計の結果を踏まえ、インド国側との協議を通して事業内容、全体工程の確認を行うと共に DULT の負担工事も明確にする。

(B) 入札書類の作成

詳細設計、施工計画及び無償資金協力の制度に従い入札図書を準備する。コンサルタントによる詳細設計と入札図書の作成には、下記の要員が必要である。

表 3.13 コンサルタントによる詳細設計と入札図書の作成に必要な要員

名称	担当業務内容
業務主任	機材仕様等のレビュー・入札書類作成（入札に係る業務全体の総括）、計画内容最終確認
交通情報システム設計（センターシステム、プローブシステム、インターネットシステム）	計画内容の最終確認・入札図書（技術仕様）、入札業務
交通情報システム設計（渋滞長計測システム、交通量計測システム、可変情報システム）	計画内容の最終確認・入札図書（技術仕様）、入札業務
信号システム設計	計画内容の最終確認・入札図書（技術仕様）、入札業務

(出典：JICA 調査団)

2) 調達監理体制

コンサルタント業務契約に含まれる調達監理内容は次のとおりである。

(A) 入札業務

入札公示、質問・回答、入札の立会い、入札結果の評価、契約交渉の補助及び業者契約の立会いを実施する。

(B) 監督業務

着手前関係者協議、設計図の承認業務、出荷前製品検査、現地据付工事監理、工事工期中の業務報告書の作成、中間出来高証明書の発行、竣工検査と手続き等を実施する。

(C) 機器据付工事完了後業務

竣工証明書の発行、竣工引渡手続き業務、最終業務報告書等が含まれる。これらに必要な人員は、次のとおりである。なお、本工事では施工期間の短縮の観点から、複数箇所で同時に施工を行うため、調達監理補助として、現地傭人を雇用するものとする。

表 3.14　業務契約に含まれる調達監理内容(コンサルタント)

名称	担当業務内容
業務主任	－引渡し立会い
常駐調達監理技術者	－現地施工期間を通して現地に駐在し、全体の調達監理業務を実施 －品質監理、工事全体進捗監理、支払手続き、安全管理、インド国側との協議・交渉及び報告 －交通情報システム(センターシステム、プローブシステム、インターネットシステム)施工監理
調達監理技術者 1 (事前打合せ、検収・完了検査・引渡し等)	－機材輸送前の事前打合せ －検収・完了検査・引渡し立会い －メーカー保証期間満了前検査の立会い
調達監理者 2	－交通情報システム(渋滞長計測システム、交通量計測システム、可変情報システム)施工の進捗監理、施工監理、品質監理、安全管理
調達監理者 3	－信号システム施工の進捗監理、施工監理、品質監理、安全管理
検査技術者 1	－ITS システム全体の図面確認・照合作業、工場立会検査及び出荷前検査立会い
検査技術者 2	－船積前検査立会い

(出典：JICA 調査団)

表 3.15　業務契約に含まれる調達監理内容(ローカルコンサルタント)

名称	担当業務内容
調達監理補助要員	－全体の調達監理における補助業務の取り纏めの実施

(出典：JICA 調査団)

3.2.4.5　品質管理計画

本プロジェクトで調達する資機材及び工事の品質管理は次の方法で実施する。

(1) 図面審査

請負業者に全ての資機材及び施工計画に関する図面の提出を義務づけ、コンサルタントは、それらの仕様及び品質が契約仕様書と一致していることを確認する。

(2) 工場立会い検査

請負業者が機材の製造、資材の購入を完了後、システムとしての総合動作を確認し仕様書の性能・数量を満足した時点で、工場での立会い検査を行い、数量・性能の検証を行う。

(3) 第三者機関による船積み前機材照合検査

工場検査が完了し、請負業者が全ての資機材を梱包し出荷準備が出来たところで、第三者機関による検査を実施し、資機材の梱包数量、荷姿、シッピングマークなどをパッキングリストにより検査し、環状輸送及びインド国内海陸輸送に耐え得る梱包であることを検査する。

(4) 現地試験

現場での据付工事の成果は、据付検査及び現場試験により確認する。現場試験は、個々の機器の機能を確認するための単体試験と総合的なシステム機能確認のための総合試験に分けられる。現場試験は、請負業者が主導で実施し、コンサルタントと DULT の責任者がこれに立ち会う。総合試験を行った後、JICA、インド国政府に検査完了報告書を提出し完了を証明する。

(5) 瑕疵保証

請負業者は、完工引渡し検査完了後 1 年間、資機材の品質を保証し、不具合が生じた場合には遅滞なく復旧に努めるものとする。

3.2.4.6 資機材等調達計画

(1) 調達の方針

本プロジェクトは、ITS システムとして位置付けられるものであり、システムには高い信頼性を要求される。このような ITS 機材は、インド国内で流通・製造されてないため、全ての ITS 機材は日本国から調達する。

本プロジェクトにおける主要資機材の調達先を表 3.16 に示す。

表 3.16　主要資機材調達先

No.	資機材名／システム機材名	現地調達	日本
1	センターシステム		○
2	プローブシステム		○
3	渋滞長計測システム		○
4	交通量計測システム		○
5	可変情報システム		○
6	インターネットシステム		○
7	信号システム		○
8	信号柱	○	
9	制御支柱	○	
10	カメラ用柱	○	
11	ガントリー (3 type)	○	
12	レディーミックスコンクリート	○	
13	鉄筋、セメント、砂、砕石	○	
14	PVC パイプ、GI パイプ、HDPE パイプ	○	
15	電源ケーブル	○	
16	通信ケーブル	○	
17	縁石、歩道用タイル、道路標示線	○	

(出典：JICA 調査団)

信号柱､制御支柱､ガントリー及び土木工事材料については､現地調達にて対応する。

(2) 輸送計画

日本国調達機材は､横浜港または同等地から海上輸送によりインド国チェンナイ港に到着する。各種機材、材料は、陸揚げ港より、ベンガルールの倉庫へ陸路輸送を行い、保管される。その後、施工計画に合わせて各サイトへ機器搬入を行う。

日本国調達品は請負業者から輸出梱包済みで横浜港又は同等地へ搬入しインド国チェンナイ港へ船舶輸送する。チェンナイ港到着後、通関業務はインド国側が行い、通関後のベンガルール倉庫までの内陸輸送は請負業者が行う｡その後実施工程に従い各現場へ小出し輸送する。

また、メイン倉庫及びサイトデポットについては、契約者負担とする。

3.2.4.7　運用指導等計画

(1) 運用指導実施計画

導入された機材を､長期間のあいだ継続的に運用していくために､日本人技術者による運用指導を実施する。運用指導には、日本人技術者が、OJT を兼ねて、運用指導期間として、交通情報システムで 2.5 ヶ月、信号システムで 2.5 ヶ月を見込むものとする。また、両システムの指導は各々の日本人技術者により並行して実施するものとする。

(2) 指導内容

運用指導は請負業者により実施され、机上講習の他、実装置を使用しての以下のような技術習得を目的とした指導を実施する。

表 3.17　技術習得を目的とした指導内容

日本国側
1. 基本的な電気、通信、ITS 技術のガイダンス
2. 操作技術
3. 点検方法
4. 不具合発見方法
5. 不具合対処方法
6. 保守に係る記録簿の運用方法

(出典：JICA 調査団)

3.2.4.8　ソフトコンポーネント計画

(1) ソフトコンポーネントの目的

ソフトコンポーネントは、以下の目的で実施する。

1) 交通情報システム

DULT は、交通情報システムの運営管理の経験を有さない。このため、請負業者による操作・維持管理の指導のみでは、円滑な立ち上がりに問題がある。また交通情報の解析方法についても知識は十分ではなく、持続的、発展的な交通情報の利用に課題がある。

このため、システムの運用・維持管理マニュアルを作成し、立ち上がりに必要な運用・維持管理能力を指導する必要がある。また、交通情報の解析方法と交通計画への活用方法、及び適切な情報管理の方法について、ソフトコンポーネントにて指導することが必要である。

2) 信号システム

本プロジェクトで整備される信号システムは、交通状況の変化に伴い各種のパラメータの見直しを行う必要がある。BTP は既に信号システムを運用しているが、交通状況を適切に把握し、変化する交通状況に応じた最適なパラメータ設定など、信号システムの制御機能を持続的に維持させてゆく経験や能力が十分ではない。また、信号機を設置する交差点についても、信号機能を効果的に発現させるための交差点の改良・維持管理能力や、警察職員による交通安全指導の方法等にも課題がある。

このため、パラメータの見直しのための交通調査方法、パラメータの設定方法、及び交通情報の管理方法を中心に、既設の運用・維持管理マニュアルの修正を含めたソフトコンポーネントによる技術指導が必要である。また、信号制御の効果を高めるための交差点の改良方法、及び警察職員による運転者や住民に対する交通安全に係る啓発活動等についてもソフトコンポーネントによる指導が必要である。

3) 可変情報システム

BTP は既に可変情報システムを運用しているが、交通情報システムによって交通情報を把握したうえで、必要な提供情報を可変情報システムに設定する運用の経験を有さない。

このため、交通情報システムによる交通情報の把握方法、事故などの提供情報の収集・管理手法、提供すべき情報の決定方法を中心にソフトコンポーネントによる指導が必要である。

なお、システムや装置の操作やメンテナンス方法に関しては、別途請負業者により、マニュアルが提示され研修が実施される。

(2) ソフトコンポーネント教育内容と活動

以下の項目についてソフトコンポーネント教育を実施する。

- 各システムの総合的・効率的な運用・管理
- 交通情報システムにおける交通情報の管理と解析
- 信号システムにおける各種パラメータ設定に関する運用・管理、交通調査、交差点改良、交通安全に係る啓蒙活動
- 可変情報システムにおける情報提供方法に関する運用管理

【実施時期】2019 年 9 月～10 月

(3) ソフトコンポーネント対象者と技術支援の活動内容

1) ソフトコンポーネント対象者

ソフトコンポーネント教育は、DULT と BTP の技術者を中心に実施する。また、市役所である BBMP にも、交通計画や交差点設計に携わる部署があるため、DULT や BTP と連携し効果的な交通計画や交差点設計ができるよう BBMP の技術者も対象に含める。以下に、技術支援の専門別受講対象者数と受講者グループを示す。

表 3.18　技術支援の専門別受講対象者数とグループ

機関	担当業務	人数		受講者グループ
		責任者	担当	
DULT	運用担当	1 名	2 名	A
	交通計画担当	1 名	6 名	B
BTP	運用担当	1 名	6 名	C
	パラメータ設定担当	1 名	6 名	D
	交差点設計担当	1 名	6 名	E
BBMP	交通計画担当	1 名	4 名	F
	交差点設計担当	1 名	4 名	G

(出典：JICA 調査団)

2) 技術支援の活動内容

技術支援の活動内容を以下に示す。

表 3.19　技術支援の活動内容

BTIC システム(1 ヶ月)

活動内容	受講者グループ	必要期間(週)
1. 関連組織の役割分担と各機関との連携方法	A- F（責任者）	0.5
2. システムの運営・維持管理マニュアルの策定	A	1.5
3. 情報の管理方法	A	0.5
4. 情報の解析方法と利用方法	B, F	1.0
5. 今後の交通情報管理体制と交通情報システムの説明	A, B, F	0.5
6. 評価	A, B, F	-

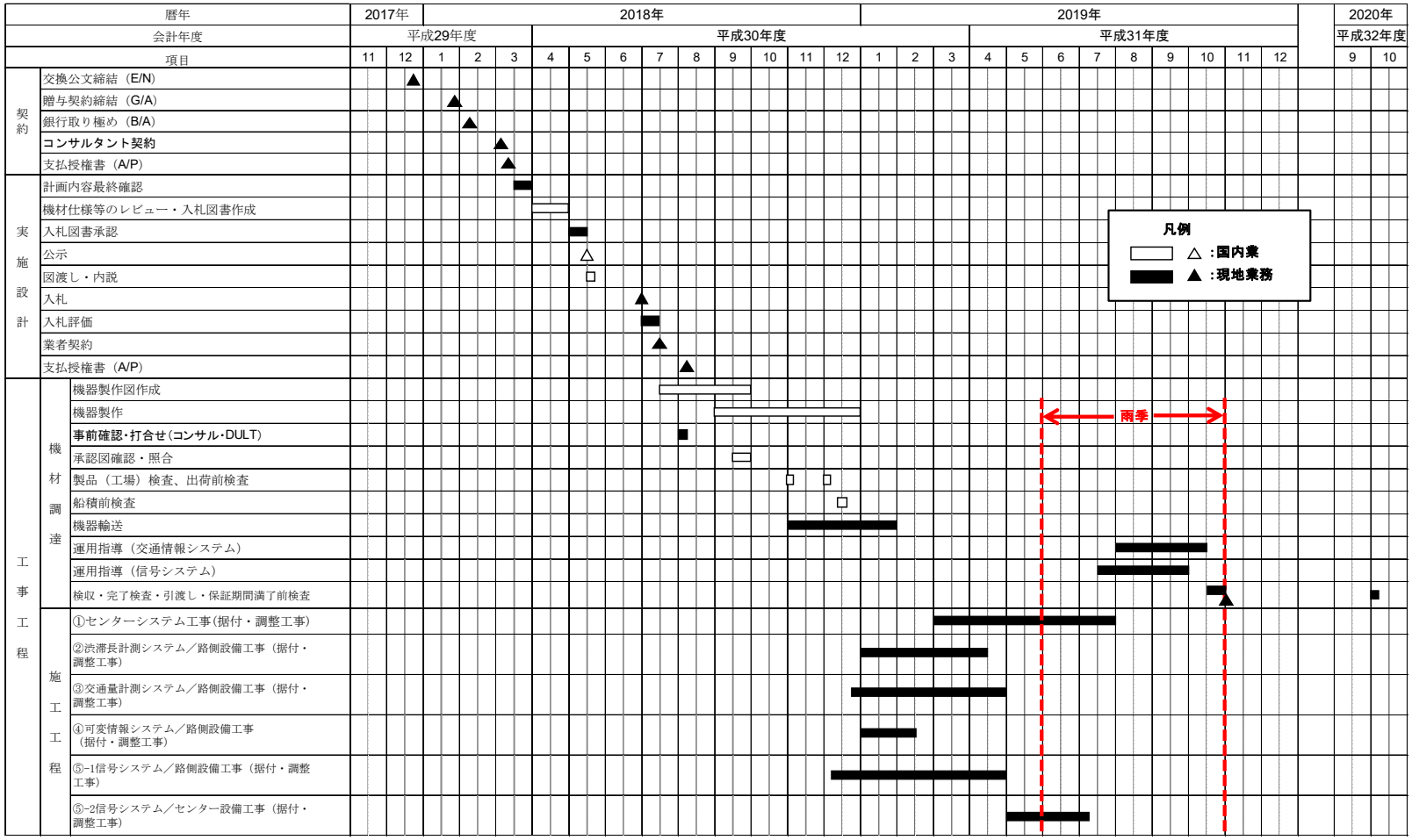
TMC システム(1 ヶ月)

活動内容	受講者グループ	必要期間(週)
1. システムの運営・維持管理マニュアルの修正	C	1.5
2. 情報の管理方法	D	0.5
3. 交通調査方法・分析と信号設計への適用方法	D	0.5
4. 信号機運用のパラメータ等の見直し方法	D	0.5
5. 交差点設計・維持管理方法	E, G	0.5
6. 交通誘導方法、安全マナー向上のための啓発活動	C, D, E	0.5
7. 評価	C, D, E, G	-

(出典：JICA 調査団)

3.2.4.9　調達実施工程

表 3.20　調達実施工程表



(出典：JICA 調査団)

3.3 相手国側分担事業の概要

日本国側及びインド国側負担事業範囲を表 3.21 に示す。

表 3.21 日本国側及びインド国側負担事業範囲

No.	項目	日本国負担事業	インド国負担事業	備考
1	センターシステム（一式）	○		プロジェクト実施中(工事)
2	プローブシステム（一式）	○		〃
3	渋滞長計測システム（12 箇所）	○		〃
4	交通計測システム（8 箇所）	○		〃
5	可変情報システム（3 台）	○		〃
6	インターネットシステム（一式）	○		〃
7	信号システム（29 交差点）	○		〃
8	土木工事（管路工事、プルボックス設置工事、建柱工事、削進工事、基礎工事、路面表示工事、歩道改良工事、歩道撤去工事等）	○		〃
9	機材調達・据付／調整工事	○		〃
10	海上輸送、内陸輸送、工事サイトへの搬入	○		〃
11	工場検査、受入検査、最終検査	○		〃
12	試掘作業（既設埋設物調査）	○		〃
13	銀行取纏め（B/A）		○	入札前
14	支払授権書（A/P）コンサルへの支払		○	〃
15	道路管理者（国道、市道）から交差点改良及び路側機器設置工事図面の承認		○	〃
16	装置設置場所を確保・清掃		○	〃
17	支払授権書（A/P）受注業者への支払		○	プロジェクト実施中(工事)
18	カウンターパート要員の割当て		○	〃
19	インド国通関手続き・内陸輸送業務の支援		○	〃
20	日本人技術者及び第三国人技術者の就労許可の支援		○	〃
21	輸入機材・現地購入材料及び役務（工事管理）にて、インド国で課される関税、内税、法人税、及び所得税等の免税措置		○	〃
22	装置設置場所（BTIC, KSDC, BTP）には、エアコン、電気器具、照明器具及び必要に応じた改装工事の実施		○	〃
23	BMTC における既設プローブシステムの改造及び設定変更		○	〃
24	道路占用・使用許可及び、その他許可取得（水道、ガス及び電気等）		○	〃
25	サイトアクセス及び屋内立入の許可証の取得		○	〃
26	HDPE パイプ（32 mm, 2 ways）の布設、電源ケーブルの布設及び通信		○	〃
27	屋内機器室内の配線工事一式		○	〃
28	プロジェクトサイトにおける障害物の撤去		○	〃
29	員数チェック、工事 SV、受入検査、運転訓練及び契約に基づき各作業後のプロジェクト状況報告書の準備・提出		○	〃
30	プロジェクト進捗報告書の準備・提出		○	〃
31	プロジェクト完了報告書の準備・提出		○	工事完工前
32	運用・保守要員（O&M）の確保		○	運用開始直後
33	交通標識板及びガントリー撤去工事		○	〃
34	既設灯器及び信号柱撤去		○	引渡後
35	運用・保守コストの確保		○	〃
36	保守用予備品の準備（信号柱及びセンサ用支柱）		○	〃
37	電源・通信網を含む運用・保守		○	〃
38	日常点検・定期点検		○	〃

(出典：JICA 調査団)

3.4 プロジェクトの運営・維持管理計画

導入システムを持続させるためには、導入システムの運営・維持管理(O&M)のため、適切な人員配置をしなければならない。DULT に設営される交通情報センターは新たな組織となるため、O&M 要員を確保する必要がある。一方で、BTP は、現況の交通管理センターに追加の要員を確保する必要がある。

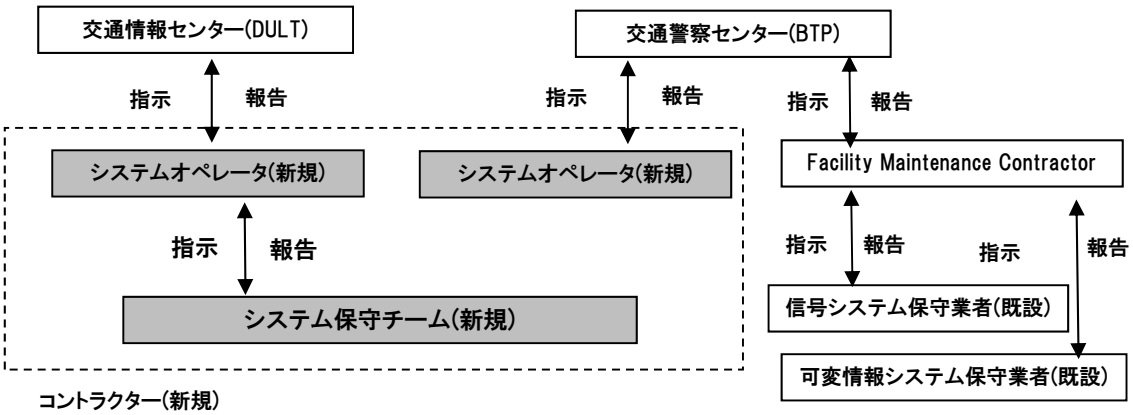
また、コントラクターにより実施される O&M サービス仕様書(案)を付属資料 7-4 に示す。本仕様書(案)の内容は実施段階で、実施機関との協議を踏まえ、さらに精査・更新されていくものである。

3.4.1 O&M 実施体制

O&M は、本プロジェクトにて機器を整備したコントラクターが、据付完了後、インド国側予算にて 5 年間継続して実施する。

現在、BTP は信号、可変情報板及び CCTV 等の既設設備の維持管理を Facility Maintenance Contractor(以下、「FMC」とする)に外注している。既設システムの不具合が発生した場合、FMC が不具合の原因を特定し、原因に応じて保守会社または通信会社等に指示を行っている。

コントラクターは、交通情報センター及び交通管理センターにシステムオペレータを常駐派遣するとともに、定期保守や緊急対応等のためシステム保守チームを構成し、DULT 及び BTP に導入した新規システムの O&M サービスを実施する。



(出典：JICA 調査団)

図 3.24 システム維持管理体制

3.4.2 O&M 実施上の役割と要員

3.4.2.1 交通情報センターの体制(DULT)

交通情報センターでは、交通情報システムのうちセンターシステム、プローブシステム、渋滞長計測システム、交通量計測システム、インターネットシステムについて O&M を実施する。交通情報センターには、DULT の職員から総括責任者 1 名及びそのサポートスタッフ 1 名が配置される。また、コントラクターからシステムオペレータ 1 名が、総括責任者の下に配置される。交通情報センターのスタッフの役割と責任を表 3.22 に示す。交通情報センターのシステムオペレータが最低限必要な経験を表 3.23 に示す。

表 3.22 交通情報センタースタッフの役割と責任

ポジション	役割と責任	勤務時間
総括責任者 (DULT 職員) 1 名	• 交通情報センターの全ての活動の管理と指揮の責任 • 交通情報センターと BTP をはじめ他の政府機関との様々な調整 • 関係する政府機関の要請に従い、データ/情報の編集、分析、提供 • 関係する政府機関からの問い合わせへの対応 • 交通情報センターに必要な情報がある場合に、他の政府機関への情報提供依頼 • コントラクターから提出される報告書のチェック	—
オペレータ (コントラクター) 1 名	(運用) • 一般利用者からの問い合わせの対応 • ATCC と渋滞長計測システムの作動状況の監視 • ビデオウォールの地図上での交通状況の監視 • オペレータコンソールから、KSDC に設置したサーバの作動状況の監視 • コントラクターの担当者の指示に従い、サーバのエラー記録を確認 • 台帳と予備品突合を定期的に実施 • 予備品の補充計画の作成 • コントラクターの活動を、日、月、四半期ごとに DULT へ提出 • 事象報告を基に、四半期ごとの機器稼働状況を計算 (一次対応) • システムの不具合の状況と原因を特定 • 不具合や事象が発生した場合に、コントラクターのメンテチームに対応を依頼 • 事象が発生し、解決された場合に、DULT へ機器の状況を報告 • 事象報告書を、DULT へ報告及び提出	週日と土曜日の 10:00-17:30 但し、第二土曜日は除く (1 シフト)

(出典：JICA 調査団)

表 3.23 交通情報センターのスタッフの要件

ポジション	必要な経験
総括責任者 (DULT 職員)	• Director 級の職員が望まれる • DULT 内の職務と兼務可能
オペレータ (コントラクター)	• IT 業務経験年数：8 年 • 言語能力：堪能な英語及び現地語の能力

(出典：JICA 調査団)

3.4.2.2 交通管理センターの体制(BTP)

交通管理センターでは、信号システム及び可変情報システムの O&M を実施する。交通管理センターには、BTP 職員から総括責任者 1 名及びそのサポートスタッフ 1 名が配置され、これらは BTP 内の職務と兼務が可能である。また、コントラクターからシステムオペレータ 2 名が総括責任者の下に配置される。交通管理センターのスタッフの役割と責任を表 3.24 に示す。交通管理センターのシステムオペレータに最低限必要な経験を表 3.25 に示す。

表 3.24　交通管理センターのスタッフの役割と責任

ポジション	役割と責任	勤務時間
統括責任者 (BTP 職員) 1 名	• 交通管理センターの全ての活動の管理と指揮の責任 • 交通管理センターと交通情報センターをはじめ他の政府機関との様々な調整 • システムの更新計画 • データ/情報の編集、分析、提供 • 関係する政府機関からの問い合わせへの対応 • 交通管理センターに必要な情報がある場合に、他の政府機関への情報提供依頼 • モニターの結果や住民の要請に応じて、信号のパラメータ(サイクル、スプリット、オフセット)の変更のシステムオペレータへの指示 • 必要に応じて、手動切り替えをシステムオペレータへ指示 • 必要に応じて、可変表示板へメッセージのインプット • 事象が勤務時間外に発生した場合に､コントラクターへ早急な解決の指示 • コントラクターから提出される報告書のチェック	―
オペレータ (コントラクター) 2 名	(運用) • 可変情報システムの作動状況のチェック • オペレータコンソールから、KSDC に設置したサーバの作動状況の監視 • コントラクターの担当者の指示に従い､サーバのエラー記録を確認 • 台帳と予備品突合を定期的に実施 • 予備品の補充計画の作成 • コントラクターの活動を、日、月、四半期ごとに DULT へ提出 • 事象報告を基に、四半期ごとの機器稼働状況を計算 (一次対応) • システムの不具合の状況と原因を特定 • 不具合や事象が発生した場合に､コントラクターのメンテチームに対応を依頼 • 事象が発生し、解決された場合に、BTP へ機器の状況を報告 • インシデントレポートを作成して BTP の責任者へ提出する	8:00-20:00 週末、祝日を含む (2 シフト)

(出典：JICA 調査団)

表 3.25　交通管理センターのシステムオペレータに最低限必要な経験

ポジション	必要な経験
総括責任者 (BTP 職員)	• Director 級の職員が望まれる • BTP 内の職員と兼務可能
オペレータ (コントラクター)	• IT 業務経験年数：8 年 • 言語能力：堪能な英語及び現地語の能力

(出典：JICA 調査団)

3.4.2.3　O&M サービスにおけるコントラクターの体制

O&M サービスにおけるコントラクターの体制は、前述の DULT 及び BTP に配置されるオペレータ及び保守チームから構成される。保守チームは、現地事務所のスタッフ、日本から派遣される日本人エンジニア及び日本からのホームサポートスタッフで構成される。

保守チームは、BTIC システム及び TMC システムの両システムを保守対象とする。システムや機器の不具合が現地の保守チームで解決できる能力を超えている場合には、コントラクターのチーフエンジニアへ解決に必要なエンジニアの派遣を要請する。コールオペレータ以外の現地事務所のスタッフは、常駐する必要はないがいつでも即座に対応できる準備はしておかなければならない。O&M サービスにおけるコントラクターの役割と責任を表 3.26 に示す。

表 3.26　O&M サービスにおけるコントラクターの役割と責任

ポジション		役割	配置
オペレータ	オペレータ(DULT)	• 一般利用者からの問い合わせの対応 • システムの不具合の状況と原因を特定 など	交通情報センター
	オペレータ(BTP)	• 可変情報システムの作動状況のチェック • システムの不具合の状況と原因を特定 など	交通管理センター
保守チーム	コントラクターのチーフエンジニア	• 現地事務所の保守チームへの定期検査及び予防保守の指導	日本 (必要時に現地へ派遣) BTIC システム用に 1 名 TMC システム用に 1 名
	日本からの遠隔操作サービスのための日本人スタッフ	• システムを監視するため、現地事務所から遠隔操作サービスの実施 • 問題解決のため、日本から遠隔操作サービスの実施 • 現地事務所から遠隔操作サービスを実施するローカルスタッフへの支援	日本 (必要時に対応)
	現地保守チームのチームリーダ	• 現地事務所に所属する保守チームの管理と監視	現地事務所 BTIC システム用に 1 名 TMC システム用に 1 名
	現地保守チームのローカルエンジニア	• 機器や部品の欠陥やダメージを特定し、予備品との交換 • ダメージを受けた機器の交換と修理 • 修理が可能な場合に、回収した欠陥またはダメージを受けた部品の修理.	現地事務所
	定期検査と予防保守のためのメンテナンスチーム	• 定期検査と予防保守計画を策定し、雇用主へ提出 • 提出した計画に従い、清掃等定期検査と予防保守の実施 • 定期検査と予防保守の報告書を雇用主へ提出 • 予備品と台帳の管理と雇用主へ報告 • バグの修正とソフトウェアの更新	現地事務所
	現地事務所からの遠隔操作サービスのためのローカルスタッフ	(通常の業務) • 現地事務所から、KSDC にあるサーバの作動状況を定期的に診断 (緊急対応) • システムの不具合の状況と原因を特定 • 遠隔操作で不具合の修正 • 交通情報センターのオペレータからの要請により、事象に関する必要な情報の提供	現地事務所
	現地事務所のコールオペレータ	• DULT 及び BTP のオペレータや現地事務所関係者からの、電話応答。	現地事務所

(出典：JICA 調査団)

上記の主要ポジションに必要な経験と能力を以下に示す。

表 3.27　主要ポジションに必要な経験と能力

ポジション	必要な経験
現地保守対応チームのチームリーダ	• IT の業務経験年数：10 年
定期検査と予防保守のためのチーフエンジニア	• ITS の業務経験年数：10 年 • プロジェクト・マネージャー、チーフエンジニア又は同様のポジションでの類似業務の保守の経験年数：： 5 年
現地事務所のコールオペレータ	• 言語能力、堪能なカンナダ語、ヒンディー語及び英語

(出典：JICA 調査団)

3.4.2.4　トレーニング及びセミナーの実施

コントラクターは年に 1 回、DULT 及び BTP へのトレーニング及び ITS 関係団体への技術継承セミナーを実施する。

3.4.2.5　システム調整

コントラクターは年に 1 回、下記のシステムの調整を実施する。

(1) 交通情報システム

コントラクターが実施する走行調査の結果から､提供する交通情報と実際の交通状況に大きな乖離が見られた場合、その結果に基づき交通情報システムの調整を実施する。

(2) 信号システム

インド国側が別途契約するコンサルタントにて実施される交通状況調査の結果及びシステムログ情報に基づき信号制御パラメータ(サイクル、スプリット、オフセット)の調整を行う。調整にあたり表 3.28 の項目を確認する。

表 3.28　調整目的に応じた確認項目

調整目的	確認項目	データ入手元
交通流の変化状況の改善	旅行時間・遅れ時間	(現地調査)
青時間の変化状況の改善	捌け交通量	(現地調査)
無駄青時間の改善	捌け交通量	(現地調査)
死に青時間の改善	捌け交通量	(現地調査)
交差点の交通処理状況の改善	捌け交通量	(現地調査)
渋滞の増減・偏り状況の改善	渋滞長(*1)	コントラクター (*2)

(*1)重要交差点(7 交差点)方向別　(*2)システム履歴より取得。

(出典：JICA 調査団)

3.4.3 O&M サービスの達成目標

3.4.3.1 事象の深刻度に応じた対応目標

コントラクターは、事故やシステムの不調等の異常事象発生時に、事象の深刻度に応じた対応目標時間以内での対処に努めなければならない。事象の深刻度は、道路利用者や歩行者に与える危険性の度合いに応じて、「非常に危険」、「危険」、「危険性が低い」の３分類とし、それに応じて、応答時間(事象の発生地点への到達時間)と対処時間(現地到達後、応急対応も含めた回復ないし危険防除に要する時間)の要件を表 3.29 のように定める。事故、システム不調等の事象(インシデント)が発生した場合、コントラクターは、深刻度に応じた応答及び対処時間の目標値よりも短い時間での対応を行うものとする。

表 3.29 事象の深刻度の定義と対応目標

事象の深刻度	定義	応答時間	対処時間	
			システムの不具合	現地での施設の事故
非常に危険	道路利用者に即座に危険が及ぶ可能性が高い事象	<1 時間	<6 時間	<24 時間
危険	道路利用者に危険が及ぶ可能性がある事象	<1 時間	<12 時間	
危険性が低い	道路利用者の安全を脅かす可能性のない、制御システムの不具合や路側機器の軽度の損傷	<2 時間	<24 時間	

(出典：JICA 調査団)

コントラクターは、重大性を分類する責任があるが、分類が困難であると判断した場合には、雇用主と協議しなければならない。交通情報システムと信号システムにおける事象と深刻度の例を下表に示す。

表 3.30 交通情報システムにおける事象と深刻度の例

深刻度	交通情報システムにおける事象の例
非常に危険	• 交通量計測システムや渋滞長計測システムの支柱が、事故により倒壊しているか、短時間で倒壊につながる可能性が高い破損が起こった場合
危険	• 事故により破損した交通量計測システムや渋滞長計測システムの支柱が、直ちに倒壊する可能性は低いが迅速な対応が求められる場合
危険性が低い	• 交通量計測システムや渋滞長計測システムの支柱が小規模に破損し、倒壊の危険性がない場合 • BMTC のプローブシステムと交通情報システム間や車両感知器などの路側設備と中央処理設備間での通信トラブル

(出典：JICA 調査団)

表 3.31　信号システムにおける事象と深刻度の例

深刻度	信号システムにおける事象の例
非常に危険	• 交差する道路の信号現示が、同時に青を表示した場合 • 赤と黄色の現示が点滅している場合 • 信号の灯器の消灯 • 複数の信号灯器が同時に点灯(例えば、青と赤、青と黄色などが同時点灯する) • 支柱や可変表示板のガントリーが事故により甚大な損傷を被って、倒壊しているか、倒壊することが想定できる状況の場合
危険	• 支柱や可変表示板のガントリーが事故により損傷を被っており、直ちに倒壊する可能性は低いが迅速な対応が求められる場合 • 信号システムの停止により信号の照明がつかないものがあり、道路利用者による信号の現示の確認が難しい場合。
危険性が低い	• 交通事故により、支柱やガントリーが小規模に破損しているが、倒壊の可能性がない場合。 • 交通情報センター、交通管理センター、コントローラ、信号及び可変表示板間での通信トラブル • 交通管理センターから信号や可変表示板への異常データの送付 • 信号や可変表示板の照度が不十分な場合 • 可変表示板のスクリーンの消灯

(出典：JICA 調査団)

3.4.3.2　システムや機器の作動状況の評価の基本的考え方

システムや機器の稼働率は、利用可能度に基づいて四半期ごとに評価され、パフォーマンス目標は 99%とする。

3.4.3.3　評価方法

システムの稼働率は、コントラクターの責任による稼働停止時間に基づき下記のとおり計算する。

$$\text{稼働率} = (1 - \frac{\text{稼働停止時間} - \text{許容される稼働停止時間}}{\text{総稼働時間} - \text{許容される稼働停止時間}}) * 100$$

稼働停止時間 ： 特定の技術及びサービス基準に基づくサービスの稼働停止の合計時間

許容される稼働停止時間: 定期点検や予防保守、第三者に起因する破損の修理や保守に必要な時間(例：交通事故、停電、雷雨による落雷、火災、通信ラインの停止、破壊行為他)及び、雇用主の指示による停止時間

稼働停止時間は、下記のシステム・機器の状況を基に計算される。

交通情報センター(BTIC システム)

(1)　交通量計測システムや渋滞長計測システムのセンサ： 機器の稼働状況ベース

(2)　オペレータコンソール: コンソールの稼働状況ベース

(3)　サーバ: サーバの稼働状況ベース

交通管理センター(TMC システム)

(1)　信号: 交差点での稼働状況ベース

(2)　可変表示板: 現地での稼働状況ベース

(3)　オペレータコンソール: コンソールの稼働状況ベース

(4)　サーバ: サーバの稼働状況ベース

合計時間: 評価期間での総合計時間（3 か月： 2,160 時間）.

3.4.3.4　支払いの削減

コントラクターの責任による不具合に対する支払いの削減は、目標とするシステムや機器の利用可能時間と実績との差に基づいて評価する。実績の利用可能時間が目標に到達しなかった場合、雇用主は O&M サービスの支払いから計算した金額を削減する。以下に削減額の計算式を示す。

削減額　＝ O&M サービスへの支払額(ランプサム)×(目標利用可能度(%)―実績(%))/50

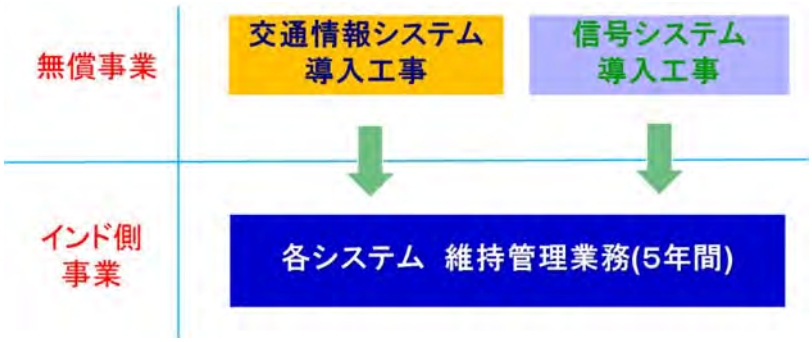
ケーススタディー)　稼働停止時間:110 時間、合計時間:2160 時間(24 時間×90 日)、許容される稼働停止時間:60 時間、目標利用可能時間:99%、維持管理業務支払額(四半期ごと):INR 8,000,000

利用可能度　＝ (1-((110-60)/(2160-60)))×100　利用可能度＝97.62%
削減額＝80×(99-97.62)/50
削減額＝INR 288,000

3.4.4　O&M サービス業務契約

3.4.4.1　本プロジェクトのスキーム

本プロジェクトは、無償事業で実施する交通情報システムと信号システムの導入工事、及び導入完了後にインド国側事業として実施する O&M がある。

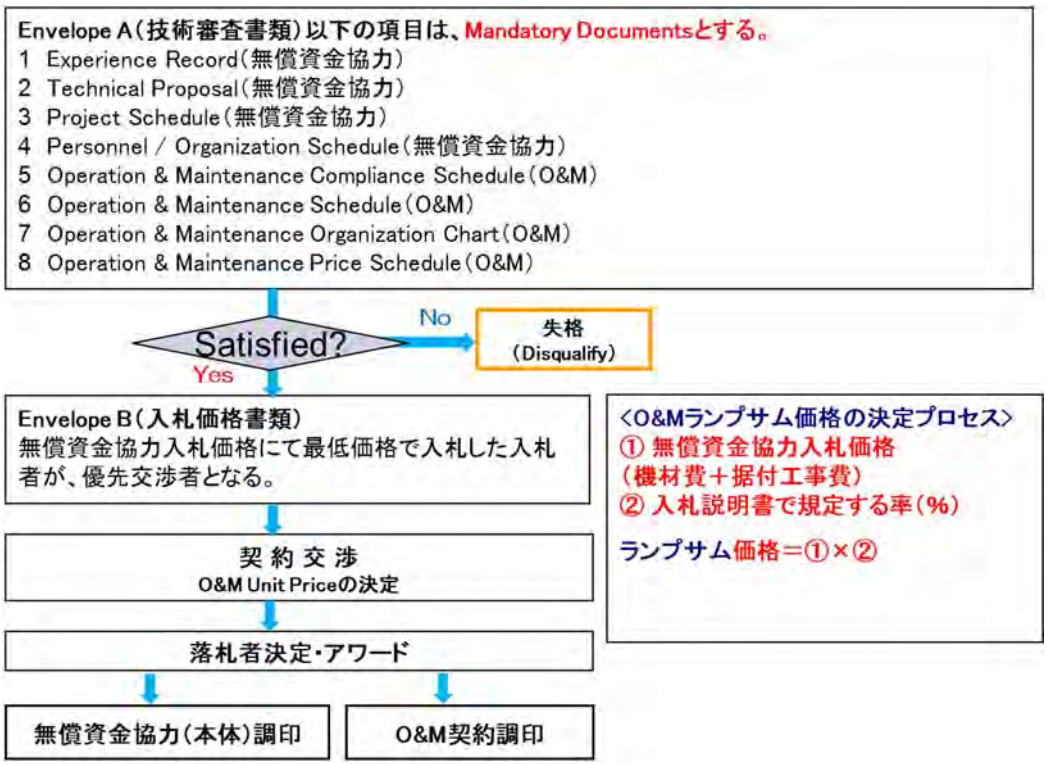


（出典：JICA 調査団）

図 3.25　本プロジェクトのスキーム

3.4.4.2　入札評価方法

本プロジェクトは、無償事業で実施する導入工事、及び導入完了後にインド国側事業として実施する運営維持管理業務により、以下のような方法により無償事業の契約と運営維持管理業務の契約の２つの契約を結ぶ。



(出典：JICA 調査団)

図 3.26　入札評価方法

3.4.4.3 運営維持管理業務契約書事例の整理

本プロジェクトの運営維持管理契約書(案)の作成に当たり、運営維持管理に関連する契約書事例を収集した。

(1) FIDIC Gold Book (Conditions of Contract for Design, Build and Operate Projects)

- 発電所や浄水場など、大規模インフラ施設の設計・建設・長期運営の一括請負用の契約書フォーム。
- 運営に係る箇所は参考となり得る。
- 運営時に“Performance damages for production outputs”が規定されている。

(2) BTP の契約書

- IT 機器の調達・据え付け・試運転・維持管理の一括請負の契約書。
- 国際機関の Small Works 用標準契約書の一般条件書を直接書き換えている。
- 維持管理サービスで“Penalty”を規定している。

(3) カルナタカ州都市交通局の契約書

- IT 機器の調達・据え付け・試運転・維持管理の一括請負の契約書。
- ”Design, Development, Supply, Installation, Testing, Commissioning, Training, Operation and Management of Intelligent Transport System [ITS] for Karnataka State Road Transport Corporation [KSRTC], Mysore”の契約書は、世界銀行の Information Systems 用標準契約書で、維持管理サービスに“Penalty”は規定されていない。
- “Vehicle Tracking and Monitoring System (VTMS) & Passenger Information System (PIS) project”の契約書は、独自フォームで、維持管理サービスに“Penalty”が規定されている。

(4) 国際機関の Small Works 用標準契約書

- 簡易な契約書フォームで、上述の BTP が一部書き換えをして使用している。
- 本契約書は基本的に建設用で、維持管理サービスのみには適当でない。

(5) 世界銀行の Management Services 用標準契約書

- インフラ施設の運営維持管理サービスに特化した契約書フォーム。
- 下記条項のとおり、基本的に”Penalty”は想定されていない。

  Clause 7. Performance Targets: Failure to achieve the Performance Targets is not to result in any penalty, or create ground for termination of the Contract, except to the extent specified in Schedule C or Schedule G.

(6) 世界銀行の Output-and Performance-based Road 用標準契約書

- 上記 Management Services 用契約書と異なり、運営時にコントラクターが“Performance Targets”を未達成の場合、支払いが減額される条項がある。

(7) その他

■ Repair and Maintenance Contract (Joint Contracts Tribunal: JCT, UK)

3.4.4.4 運営維持管理契約書(案)作成

3.4.4.3 章で示した関連契約書の検討の結果、本プロジェクトの運営維持管理業務に対しては、(5)世界銀行の Management Services 用標準契約書が最適と判断した。

尚、当契約書は、発電所や浄水場など、大規模インフラ施設の長期運営用の契約書フォームで、関係組織及びその役割、支払いスキームなど、構造がシンプルな本ケースには不適な条項も含まれている。従って、それら不要な条項は特記条件書で削除した。

但し、当契約書にはサービス要求未達成に対する請負者への支払い金額の減額に係る記載は無いため、同じく世界銀行の Output-and Performance-based Road 用標準契約書における、該当条項を特記条件書で追加した。

また、当契約書フォームは世界銀行の著作物である為、使用許可を得る必要がある。要点は下表のとおりである。

表 3.32 運営維持管理契約書(案)の概要

項目	概要
(1) 一般条件	• 世界銀行の Management Services 用標準契約書
(2) 特記条件	• 発注者は DULT。 • BTP 施設の業務については、DULT が BTP に対して発注者代理人としての委任状を発行する。 • サービス要求未達成に対する請負者への支払い金額の減額に係る条項を特記条件書で追加した。 • オリジナルの一般条件書で規定されている紛争解決のための独立専門家を留めている。独立専門家の報酬の支払いは、発注者と請負者で折半される。

(出典：JICA 調査団)

運営維持管理契約書(案)を付属資料 7-5 に示す。本契約書(案)の内容は実施段階で、実施機関との協議を踏まえ、さらに精査・更新されていくものである。

3.5 プロジェクトの概算事業費

3.5.1 協力対象事業の概算事業費

積算時の為替変換レート等の情報を、表 3.33 に示す。

表 3.33 積算時の情報

積算時点	平成 28 年 7 月
為替変換レート	1 米ドル＝¥109.04、1INR＝¥1.47
施工期間	第 3 章　表 3.20「調達実施工程表」に示したとおりである。

(出典：JICA 調査団)

(1) 日本側負担経費

施工業者契約承認まで非公開

(2) 相手国負担経費

本プロジェクトのインド国の負担費用を表 3.34 に示す。

表 3.34 インド国側負担経費

項目	単位	費用 (INR)	円換算 (円)
1)信号柱撤去工事費	式	1,345,000	1,977,150
2)電源引込ケーブル、通信ケーブル敷設工事費	式	3,612,000	5,309,640
3)センター内配線工事費(電源配線ケーブル、通信ケーブル)	式	126,000	185,220
4)ガントリー撤去工事	式	349,000	513,030
5)予備品(保守用材料費)	式	1,013,000	1,489,110
計		6,445,000	9,474,150

(出典：JICA 調査団)

上記インド国負担経費の他に、銀行取極め(B/A)手続き費用、支払い授権書(A/P)発給費用、インド国内で発生する GST 還付費用、インド国への輸入許可取得及び、そのための費用の負担がある。計画の円滑な実施のため、事前にこれらの予算を確保しておく必要がある。予算申請のタイミングは 2018 年の 4 月となる。

3.5.2 運営･維持管理費

施工業者契約承認まで非公開

3.6 協力対象事業実施に当たっての留意事項

本プロジェクトの円滑な実施に直接影響を与えると考えられる留意事項は、3.3 節に述べたインド国側負担分事業の全てを、プロジェクトの進行に合わせてタイムリーに実施することが必要である。その中で特に重要な項目は、免税措置である。免税措置が遅延すれば据付工事着工・完工に影響する。

また、許認可(道路占用許可、道路使用許可及びその他許可)の取得が遅れると、これに伴い路側設備工事進捗が大きく遅れることが懸念される。

土木工事(路側設備)に対する留意事項として、施工費、安全面の点より、雨期(6 月～10 月)で最も降雨量が多い 8 月～9 月は避けて屋内工事へと切り替える。

さらに基本的な留意事項として、現状稼働している信号機等が障害事故(システム停止)

を起こさないよう既設埋設物に注意して施工する必要がある。

3.6.1 免税措置調査

無償資金協力事業では免税が原則であるため、免税措置がどの機関によって、どのような手続きで行われるか、現地で調達する資材や業者へはどのような税金が含まれ、免税をどのような方法において実現するのかについて調査を実施した。

これら調査の結果は無償資金協力として事業を実施する際の相手国負担事項としてミニッツに記載され、実施のタイミングや予算の概算と共に事業実施時の相手国負担事項の根拠となる。

なお、本準備調査では、2017 年 7 月に新税制(GST Act)が施行されたのを受けて、施行後における手続き一切について税制調査を実施した。

3.6.1.1 調査内容

申請準備段階から還付を受けるまでについて把握すべく、下記の項目について調査を実施した。

- 申請にあたっての条件整理
- 納税対象となる具体的な税目、税率など
- 申請に必要な書類及び申請先
- 申請から許認可までの流れ
- 申請から還付までに要する期間

等

3.6.1.2 調査業務委託先

調査にあたっては、現地に法人のある国際会計コンサルタント「Price Water House Coopers Pvt. Ltd.」社に業務委託した。

委託結果レポートを付属資料 7-3「税制調査報告書」に別添する。

3.6.1.3 新税制GST

2017 年 7 月より新税制 GST (Goods & Service Tax)が実運用開始となった。これは中央政府と州政府における諸間接税の一本化、及び申請のオンライン化による処理プロセスの簡略化と円滑化を主目的としている。

運用後においてはオンラインシステムにより一度のオペレーションで納入および還付申請を行うことが可能となる。

GST の枠組みは従来の VAT、Central Sales Tax、Excise Duty、Custom Duty、Service Tax 等の間接税を一本化したものである。法人税と個人所得税などの直接税、関税のうち基本関税については GST の対象外となる。

GST には CGST(中央政府 GST)、SGST(州 GST)、IGST(Integrated GST：国、州をまたぐ取引に関するもの)がある。

3.6.1.4 対象税目概要

新税制施行により、本プロジェクトにおいて発生する税目とその概要について下表に示す。免税、還付のいずれが適用となるかについては、インド国内における実績に基づき記載したものであり、本プロジェクトにおいて同様の適用となるかは現時点で確定しておらず、今後も精査が必要である。

表 3.35　対象税目概要

No.	分類	税目	税率(%)	免税/還付	備考(還付実績等)
1	間接税	GST	5,12,18,28	還付	GST 法施行直後のため実績無
2		基本関税	10	免税	実績有り
3		教育目的税	3	免税	実績有り
4	直接税	個人所得税	0,5,20,30,40,45	免税/還付	免税実績一例/還付実績有り
5		法人税	40	還付	免税実績無し/還付実績有り

(出典：JICA 調査団)

3.6.1.5　免税プロセス概要

(1) 申請の前提条件

納税、還付申請を行うためには現地オフィスの銀行登録を行った後、中央政府より PIN(Personal Income Number)、州政府より TIN(Tax Identity Number)を取得することが必要である。過去の実績では、いずれも取得期間に 2 週間程を要したとある。

(2) 免税適用要件

免税適用を受けるためには、日印にて取り交わされる E/N,G/A 文書を元に日本政府により DULT を通して州財務省及び関税当局に免税措置を求めるレターを出し、それに基づいて財務省が文書による通達にて免税を周知する流れとなる。

上記に関わる全てのプロセスに必要な書類については、作成及び提出等の実務を請負者が行うのが通例である。

(3) 還付適用要件

税還付について、インド国は以下の通り発表している。

- GST の還付承認は、毎月 2 回行われる GST Council にて決定される。
- GST Council は、Finance Ministory(Central Government)を議長とし、各州の Finance Ministory をメンバーとして構成されている。
- GST Council では各州の Finance Ministory が、Council に対して承認申請を行う。
- GST は申請した約 90%が 7 日以内に還付され、残りについては、承認機関による審査(1 年間程度要するとのこと)後還付となる。

全税目における還付審査にあたっては、少なくとも下記書類を承認機関に提出、協議を行う必要がある。過去には更なる資料提出を求められた例もあり、都度確認が必要である。

〈必要書類：交換公文、プロジェクトの有効性・公共性が示されたプロジェクト概要資料、及び申請対象品目リスト、法人概要等〉

3.6.1.6　その他

(1) 下請企業への還付制度

下請企業への還付は行われない。還付対象は主請負者のみとなる。

(2) 日本とインド国、二国間での租税条約の影響範囲について

日印租税条約である「所得に対する租税に関する二重課税の回避及び脱税の防止のための日本国政府とインド国政府との間の条約　〔平成元年十二月四日号外条約第八号・改正平成一八年六月二日条約第六号〕」によると、下記のとおり考察される。

日本とインド国との 2 国間租税条約における免税規定については、個人の金融機関よ

り受ける利子、文化交流事業における所得税、教育訓練給付金についてのみ言及されている。

しかるに、本プロジェクトが対象とする品目の免税については、本条約の適用を受けるものは存在しない。したがって、免税及び還付の申請にあたっては、本プロジェクトの G/A 及び E/N 文書へ免税の旨を明記した上で、実施機関および承認機関との合意を取り付けるアクションが必要である。

(3) 留意事項

新税制施行後、新法の運用に必要な体制が十分に整備されているとはいえない。

インド国政府は GST 導入前に、輸出業者に対して還付申告提出から 7 日以内に 90%の税金の還付を実施すると明言していたが、実際には還付の仕組みがいまだ整備されていない。

税に関する制度や運用は変わりうるため、GST のみならず、法人税、所得税等においても、今後の政府の動きをみながら実施段階までにさらに精査・更新されていくものである。

第4章　プロジェクトの妥当性の検証

4.1　事業実施のための前提条件

(1) 工事許可

各種装置を市道、州道、国道に設置するに際して、市や国の関係機関からの工事許可を取得する必要がある。

(2) 本プロジェクトに必要な予算処置・免税処置

銀行取り決め手続きと免税処置の準備及び必要な予算処置を実施する必要がある。

(3) 交通情報センターの整備

DULT2 階に計画されている交通情報センターの空調、照明、電気設備、管内配線等の整備が必要である。

(4) KSDC との調整

サーバ等を導入するための KSDC との調整が必要である。

(5) 工事担当の選任

本プロジェクトの推進にあたり、DULT 及び BTP から工事担当の選任が必要。

表 4.1　事業実施のための前提条件

No.	Items	Deadline	In charge
1	To open bank account (B/A)	within 1 month after the signing of the G/A	DULT
2	To issue A/P to a bank in Japan (the Agent Bank)　for the payment to the consultant	within 1 month after the signing　of the contract	DULT
3	To acquire approval of intersection improvement and equipment installation drawings from road administrators (National Highway Agency India and Municipal)	before Detail Design	DULT
4	To secure and clear the location where the equipment would be installed	before notice of the bidding document	DULT
5	To submit Project Monitoring Report (with the result of Detail Design)	before preparation of bidding documents	DULT

(出典：JICA 調査団)

4.2　プロジェクト全体計画達成のための必要な相手方投入(負担)事項

本プロジェクトの効果を発現・維持するため相手国側が取り組むべき事項について下記に示す。

(1) 維持管理体制

本システム運用のための操作員及び管理要員の配置、維持体制の整備が必要となる。

(2) 維持管理のための予算処置

上記維持管理体制費用及び電気通信費等システム維持管理に係る予算処置が必要となる。

4.3 プロジェクトの評価

4.3.1 妥当性

第 12 次 5 カ年計画(2012 年 4 月～2017 年 3 月)において、道路等の包括的なインフラ整備が経済成長にとって重要とされており、同セクターの開発に重点を置いている。また、円借款事業「ベンガルール周辺環状道路建設事業」についても案件形成中であり、国家上位計画やベンガルールでの計画目標に資するものとなっている。

ベンガルール都市圏では交通需要の増加に対応すべく、ハード対策として道路交通インフラの整備が進められている。しかし、渋滞が特に深刻な中心部では道路拡幅余地の制約もあり緊急なソフト対策が必要となっている。

今回の無償協力事業の対象地域としては、ベンガルール都市圏の中でも商業の中心で交通渋滞が深刻な MG Road を中心とした地域を選定しており、ベンガルールの経済発展に寄与する。

JICA は我が国の対インド国別援助計画(2016 年 3 月)において、インド国における経済成長を実現する上で最大のボトルネックの 1 つは経済インフラの未整備となっており、重点分野である「連結性の強化」のため、交通ネットワーク整備・維持管理への支援を行うこととしている。このように我が国の援助政策・方針との整合性の点からも本プロジェクトの妥当性はあると判断される。特に、チェンナイ・ベンガルール間産業回廊(CBIC)構想といった、広域の経済開発構想の具体化を進めることとしている。

また、DULT は、今後 ITS を交通計画に取り入れるべく対応できる人員の増強が進められており、BTP では、すでに多くの信号や可変情報板(VMS)のシステム運用管理を実施している。DULT 及び BTP とも体制面での対応が可能であり、予算においても十分対応できる。

上記、上位計画との整合、事業の緊急性、経済への効果及び運用管理面を考慮し、本プロジェクトの妥当性は高いと考えられる。

4.3.2 有効性

4.3.2.1 直接的効果

本プロジェクトにより、以下の直接的効果が期待される。

表 4.2 渋滞長及び平均旅行速度

指標名	基準値 (2016 年実績値)	目標値(2022 年) 【事業完成 3 年後】
渋滞長 (ピーク時 9:00～10:00)	対象交差点(*1)の流入路毎の最大値の合計： 844.8m	590m(-30%)(*2)
	対象交差点(*1)の全流入路の合計： 1576.9m	970m(-40%)(*3)
平均旅行速度(*4) (ピーク時 9:00～10:00)	13Km/h	15Km/h

(出典：JICA 調査団)

(*1)全 29 箇所のうち代表的な 7 箇所の交差点
(*2)設備導入により、信号システムの適切な青時間配分及びサイクル短縮によるもの
(*3)各交差点の最大値を対象とした 30%の削減率に基づき、その他の流入路の削減率も考慮した試算結果。
(*4)市内中心部の主要幹線道路
(注)前提条件：2022 年推計交通量によるもの。2016 年実測調査データをベースに「ベンガルールの周辺環状道路の事業実施に係る調査」の集中発生交通量の年増加率(3%)にて補正。

(出典：JICA 調査団)

表 4.3　重要交差点における無駄青時間

	交差点名	一日当たり信号稼働時間（単位：分）	一日当たり無駄青時間(*1)	
			分	率
01	Queens Statue 交差点	930	281	30%
02	Cauvery Arts and Craft 交差点	960	179	19%
03	Trinity Circle 交差点	960	329	34%
04	Kamraj and Cubbon Road 交差点	870	127	15%
05	Opera Road 交差点	930	144	15%
06	Vellera Road 交差点	240 (*2)	81	34%
07	Vivekananda/Bhaskaran 交差点	900	510	57%

(*1)　無駄青時間とは青時間のうち車両が通過せず無駄になった青時間の合計のことである。既存の信号運用実態調査より確認された無駄青時間。本プロジェクトにより、上記に示した無駄青時間の低減が図られる。

(*2)　本交差点における調査時間は上記に示した時間に限定されるため、これを掲載。

(出典：JICA 調査団)

4.3.2.2　間接的効果

ベンガルール都市圏の交通渋滞改善、移動の定時制確保による利便性の向上、ベンガルール都市圏の地域経済の発展が期待される。

4.4　導入システムの効果検証

4.4.1　　交通情報システム

4.4.1.1　目的

可変情報板(3 箇所)より表示される予想旅行時間情報が実態と大きく乖離していないかを確認し､大きな乖離が認められる場合はシステム調整を行うことを目的として検証を実施する。

4.4.1.2　実施主体と役割

コントラクターの責任の下、下記に示す検証を実施する。(下記の現地調査は必要に応じてコントラクターにより現地調査会社へ発注することも可能)

4.4.1.3　方法

以下を年一回、コントラクターにより実施する。

(1) 現地調査

可変情報板設置箇所手前より可変情報板にて表示中の主要目的地へ向けて選択ルート別(3 ルート程度)に車両を走行させ、実際の所要時間を計測する。この時、可変情報板にて表示中の主要目的地までのルート別の予想旅行時間を記録する。また、車両走行中は進行方向に向けてドライブレコーダーにて走行ルートの状況を記録する。

上記の調査を可変情報板 3 箇所について、平日 2 日間、及び休日 1 日間ずつ、朝・夕ピーク時及びピーク時以外の時間帯で実施する。

(2) 効果検証

上記の調査結果を基に、システムで算出した予想旅行時間と実際の所要時間を突合し、乖離の有無を確認する。大きな乖離が認められる場合、原因の究明と必要に応じてシステム調整を行う。

4.4.2 信号システム

4.4.2.1 目的

信号システムの検証は導入効果の短期的指標の検証、及びシステム調整の 2 つを目的として、原則として 1 年に 1 回実施する。

4.4.2.2 実施主体と役割

導入効果の短期的指標の検証はインド国側にて別途契約するコンサルタント(以下、モニタリングコンサルタントとする)が第三者の立場で実施し、その結果に基づくシステム調整はコントラクターが実施する。

4.4.2.3 モニタリングコンサルタントの作業

短期的指標及びシステム調整のための現地調査、そして、現地調査結果及びシステム蓄積情報を基にした短期的指標の検証を行う。

(1) 現地調査

下表に示す現地調査を実施する。また、下記で得られた現地調査結果は、コントラクターによるシステム調整でも活用することを目的として、コントラクターに対しても提供する。

表 4.4 モニタリングコンサルタントによる現地調査内容一覧

調査名	内容
旅行時間・遅れ時間調査	信号システム導入対象路線における旅行時間及び遅れ時間調査(交差点での停止時間)
方向別交通量調査	重要交差点(7交差点)における流入路別の交通量調査
捌け交通量調査	重要交差点(7交差点)における青時間内の単位時間毎の捌け交通量調査

(出典：JICA 調査団)

(2) 検証項目

下表に示す導入効果の各短期的指標について、基準値が改善されているかを検証する。

表 4.5 渋滞長及び平均旅行速度 基準値

指標名	基準値 (2016 年実績値)
渋滞長 (ピーク時 9:00～10:00)	対象交差点(*1)の流入路毎の最大値の合計：844.8m
	対象交差点(*1)の全流入路の合計：1576.9m
平均旅行速度(*2) (ピーク時 9:00～10:00)	13Km/h

(*1)全 29 箇所のうち 7 箇所の重要交差点 (*2)市内中心部の主要幹線道路

(出典：JICA 調査団)

表 4.6　重要交差点における無駄青時間　基準値

No.	交差点名	一日当たり信号稼働時間（単位：分）	一日当たり無駄青時間基準値(*1)	
			分	率
01	Queens Statue 交差点	930	281	30%
02	Cauvery Arts and Craft 交差点	960	179	19%
03	Trinity Circle 交差点	960	329	34%
04	Kamraj and Cubbon Road 交差点	870	127	15%
05	Opera Road 交差点	930	144	15%
06	Vellera Road 交差点	240(*2)	81	34%
07	Vivekananda/Bhaskaran 交差点	900	510	57%

(*1)2017 年実績値　(*2)本交差点における調査時間は上記に示した時間に限定されるため、これを掲載。

(出典：JICA 調査団)

(3) 短期的指標の検証方針

導入効果の短期的指標の基準値が改善されているか検証するため、下表に示す項目を確認する。

表 4.7　検証目的に応じた確認項目

検証目的	確認項目	データ入手元
平均旅行速度の改善	旅行時間・遅れ時間	(現地調査)
無駄青時間の改善	捌け交通量	(現地調査)
渋滞長の改善	渋滞長(*1)	コントラクター (*2)

(*1)重要交差点(7 交差点)方向別　(*2)システム履歴より取得。

(出典：JICA 調査団)

(4) 導入効果の短期的指標の検証のためのデータ提供

コントラクターは、モニタリングコンサルタントが短期的指標を検証できるように、信号システムから得られるシステムログ情報として重要交差点(７交差点)における方向別の渋滞長に関するデータをモニタリングコンサルタントに提供する。その際、第 3 者が容易に理解可能な形式(例:交差点毎流入路毎時間帯毎渋滞長など)に取り纏めて提供するものとする。

4.5　課題･提言

4.5.1　相手国側の取り込むべき課題･提言

DULT の運営・維持管理は、新たな組織でスタートするため、運用管理技術や運用体制の構築が課題となる。一方、BTP については既設設備があるため、既に個別制御による信号システムや可変情報システムの基本運用技術は習得されており、運用維持管理体制も構築されていると言える。今回導入される、信号システムや可変情報システムの運用管理技術の向上が課題となる。

さらに、継続的発展的なシステムの運用のため、DULT と BTP は以下に掲げる課題を確実に実行していく必要がある。

(1) DULT

交通情報の蓄積管理機能については､詳細で膨大な交通情報を一定の管理情報に変換し長期間蓄積し､そのうえ交通情報システムに基づく交通状況の解析及び交通計画を継続的に実施するとともに、関係者機関と連携し、問題点の共有と優先的計画を定期的、継

続的に協議していく必要がある。交通情報の提供方法については、関係機関と定期的、継続的に協議を行い、公共の交通情報システムとして必用な提供情報の収集につとめ、ニーズを意識した情報提供方法や提供情報を検討し今後､改良を進めていく必要がある。

また､DULT は O&M の実施主体であるため､O&M 予算の確保に係る調整を実施することが必要である。

(2) BTP

今回導入する信号システムは、渋滞長の削減とエリア制御を主目的に各信号を制御するシステムであり、交通状況に敏感にそして適切に対応できるよう各種パラメータの設定が必要である。地域の施設整備の変化や交通状況の変化に対応して継続的に信号パラメータ等運用の見直しをする必要があるため、交通状況調査を実施し交通状況の把握とそれに伴う運用見直しを定期的に実施する必要がある。

また､BTP は、交差点での信号システムが効果的に機能するよう、現場の BTP の交通誘導等の方法を継続的に指導していくとともに、歩行者マナー、運転者マナーなどを住民及び運転者に周知させ、交通マナー向上のための啓蒙活動も推進していく必要がある。

4.5.2 技術協力･他ドナーとの連携

交通セクター及び本プロジェクト実施に関しては、他ドナーとの関係は少ない。

本プロジェクトで導入するシステムを持続的、発展的に運用する課題を前項で述べたが、そのためには、本プロジェクトに続き組織的な強化を目的とした技術協力を実施することが有効である。

4.6 結論

ITS は、情報技術を道路交通分野に適用した重要なソフト対策であり、短期間に実施可能な施策として、今回、ベンガルール都市圏の交通渋滞の緩和と交通流の正常化を目的として”交通情報システム“と”信号システム“を計画した。

日本の“交通情報システム”及び“信号システムの技術”が、早期の渋滞緩和に効果をもたらし、ベンガルール都市圏の経済発展に寄与するものと期待している。

資料　1

JICA 調査団員・氏名

調査団員・氏名

No.	担当	氏名	組織名
1	団長	川原　俊太郎	JICA　社会基盤・平和構築部
2	計画管理	川崎　賢宏	JICA　社会基盤・平和構築部 計画・調整課　兼　運輸交通・情報通信グループ第一チーム
3	計画管理	坂部　英孝	JICA　社会基盤・平和構築部 運輸交通・情報通信グループ第一チーム
4	計画管理	市川　裕一	JICA　資金協力業務部実施監理第一課
5	業務主任／交通計画1	奥田　真人	日本工営株式会社
6	副業務主任／交通計画2	戸谷　浩也	日本工営株式会社
7	交通管制システム計画	近藤　升	東日本高速道路株式会社
8	信号連携システム計画・設計	野田　素良	日本工営株式会社
9	管制センター設備設計	若月　英司	東日本高速道路株式会社
10	路側システム設計	高橋　雅人	日本工営株式会社
11	交差点形状改良計画	伊関　道夫	日本工営株式会社
12	調達計画／積算	大塚　雄一郎	日本工営株式会社
13	施工計画／積算	田原　照博	日本工営株式会社

資料　2

調査行程

第1次調査工程

Day			JICA		Consultant								
			Kawahara	Sakabe	Okuda	Totani	Kondo	Wakatsuki	Noda	Takahashi	Iseki	Otuka	Tahara
Feb	27	Sat				***Arrival at Bengalure***	***Arrival at Bengalure***						
	28	Sun			***Arrival at Bengalure*** AM Internal Meeting PM Site survey for signal	AM Internal Meeting PM Site survey for signal	AM Internal Meeting PM Site survey for signal						
	29	Mon			AM Internal Meeting with Local engineer PM Meeting with DULT	AM Internal Meeting with Local engineer PM Meeting with DULT	AM Internal Meeting with Local engineer PM Meeting with DULT						
Mar	1	Tue			AM Site survey for VMS PM Meeting with BMTC at BMTC	AM Site survey for VMS PM Meeting with BMTC at BMTC	AM Site survey for VMS PM Meeting with BMTC at BMTC						
	2	Wed			AM Site survey for VMS PM Meeting with BTRAC at BTRAC	AM Site survey for VMS PM Meeting with BTRAC at BTRAC	AM Site survey for VMS PM Meeting with BTRAC at BTRAC						
	3	Thu	***Arrival at Bengalure***		AM Preparation for Traffic survey	AM Preparation for Traffic survey	AM Preparation for Traffic survey						
	4	Fri	AM Internal Meeting PM Data Centre (KDSC)		AM Internal Meeting PM Data Centre (KDSC)	AM Internal Meeting PM Data Centre (KDSC)	AM Internal Meeting PM Data Centre (KDSC)						
	5	Sat	PM Meeting with DULT at DULT		PM Meeting with DULT at DULT	PM Meeting with DULT at DULT	PM Meeting with DULT at DULT						
	6	Sun	Documentation		Documentation	***Departure from Bengalure***	Documentation						
	7	Mon	Site Survey （MGRoad, Majestic, Old Madras Road, Hunging Bridge, ORR, Silk Board JCT, Electric City, Houseur Road, Nice Road)		Site Survey （MGRoad, Majestic, Old Madras Road, Hunging Bridge, ORR, Silk Board JCT, Electric City, Houseur Road, Nice Road)		Site Survey （MGRoad, Majestic, Old Madras Road, Hunging Bridge, ORR, Silk Board JCT, Electric City, Houseur Road, Nice Road)						
	8	Tue	AM Visit and Discussion with BMTC PM Visit and discussion with BTRAC		AM Visit and Discussion with BMTC PM Visit and discussion with BTRAC		AM Visit and Discussion with BMTC PM Visit and discussion with BTRAC						
	9	Wed	PM Discussion with DULT, BMTC BTRAC and BBMP on M/D		PM Discussion with DULT, BMTC BTRAC and BBMP on M/D		PM Discussion with DULT, BMTC BTRAC and BBMP on M/D						
	10	Thu	***Departure from Bengalure***		AM Discussion with Trimax and PWC on BMTC existing system PM Finalization of M/D with DULT		AM Discussion with Trimax and PWC on BMTC existing system PM Finalization of M/D with DULT						
	11	Fri			***Departure from Bengalure***		***Departure from Bengalure***						

第2次調査工程

Day			JICA		Consultant								
			Kawahara	Sakabe	Okuda	Totani	Kondo	Wakatsuki	Noda	Takahashi	Iseki	Otuka	Tahara
April	1	Fri					***Arrival at Bengalure***		***Arrival at Bengalure***	***Arrival at Bengalure***			
	2	Sat					Internal Meeting Meeting with DULT		Internal Meeting Meeting with DULT	Internal Meeting Meeting with DULT			
	3	Sun											
	4	Mon			***Arrival at Bengalure***	***Arrival at Bengalure***	I/F&Analyze of Probe data		Equipment location (Signalx3)	Pow/Com & Buried material (Signalx3)	***Arrival at Bengalure***		
	5	Tue			I/F&Analyze of Probe data	Traffic Survey Review	I/F&Analyze of Probe data		Equipment location (Signalx3)	Pow/Com & Buried material (Signalx3)	IS Improvement Concept (Signalx3)		
	6	Wed			I/F&Analyze of Probe data	Traffic Survey Review	I/F&Analyze of Probe data	***Arrival at Bengalure***	Equipment location (Signalx3)	Pow/Com & Buried material (Signalx3)	IS Improvement Concept (Signalx3)		
	7	Thu			Equipment location & Pow/Com (BTRAC)	Equipment location (Signalx3)	Equipment location & Pow/Com (BTRAC)	Equipment location & Pow/Com (BTRAC)	Equipment location (Signalx3)	Pow/Com & Buried material (Signalx3)	IS Improvement Concept (Signalx3)		
	8	Fri			Equipment location & Pow/Com (BTIC)	Equipment location (Signalx3)	Equipment location & Pow/Com (BTIC)	Equipment location & Pow/Com (BTIC)	Equipment location (Signalx3)	Pow/Com & Buried material (Signalx3)	IS Improvement Concept (Signalx3)		
	9	Sat			Equipment Location (VMSx3)	Equipment location (Signalx3)	Equipment Location (VMS)	Equipment Location (VMS)	Equipment location (Signalx3)	Pow/Com & Buried material (Signalx3)	IS Improvement Concept (Signalx3)		
	10	Sun											
	11	Mon			I/F&Analyze of Probe data	Equipment location (Signalx3)	I/F&Analyze of Probe data	I/F&Analyze of Probe data	Equipment location (Signalx3)	Pow/Com & Buried material (Signalx3)	IS Improvement Concept (Signalx3)		
	12	Tue			Equipment Location (VMSx3)	Equipment location (Signalx3)	Equipment Location (VMS)	Equipment Location (VMS)	Equipment location (Signalx3)	Pow/Com & Buried material (Signalx3)	IS Improvement Concept (Signalx3)		
	13	Wed			Equipment location & Pow/Com (KSDS)	Equipment location (Signalx3)	Equipment location & Pow/Com (KSDS)	Equipment location & Pow/Com (KSDS)	Equipment location (Signalx3)	Pow/Com & Buried material (Signalx3)	IS Improvement Concept (Signalx3)		
	14	Thu			Equipment location & Pow/Com (BTRAC)	Equipment location (Signalx2)	Equipment location & Pow/Com (BTRAC)	Equipment location & Pow/Com (BRTC)	Equipment location (Signalx2)	Pow/Com & Buried material (Signalx2)	IS Improvement Concept (Signalx2)		
	15	Fri			Buried Material Spare (Signalx3)	Buried Material Spare (Signalx3)	***Departure from Bengalure***	Equipment location & Pow/Com (BTIC)	***Departure from Bengalure***	Buried Material Spare (Signalx3)	IS Improvement Concept (Signalx3)		
	16	Sat			Buried Material Spare (Signalx3)	Buried Material Spare (Signalx3)		Equipment location & Pow/Com (BRTC)		Buried Material Spare (Signalx3)	Buried Material Spare (Signalx3)		
	17	Sun				***Departure from Bengalure***							
	18	Mon			***Departure from Bengalure***			I/F&Analyze of Probe data		Buried Material Spare (Signalx3)	Buried Material Spare (Signalx3)		
	19	Tue						Pow/Com & Buried material (VMSx2)		Pow/Com & Buried material (VMSx2)	IS Improvement Drawing (signalx3)		
	20	Wed						Pow/Com & Buried material (VMSx1)		Pow/Com & Buried material (VMSx1)	IS Improvement Drawing (signalx3)		
	21	Thu						location/Cable Drawing (BTIC)		Select Trial Digging location	IS Improvement Drawing (signalx3)		
	22	Fri						location/Cable Drawing (BTRAC)		location/Cable Drawing (VMS)	IS Improvement Drawing (signalx3)		
	23	Sat						location/Cable Drawing (KSDS)		Contract of Trial Digging	IS Improvement Drawing (signalx3)		
	24	Sun						***Departure from Bengalure***					
	25	Mon								Trial Digging Test (VMS)	IS Improvement Drawing (signalx3)		
	26	Tue								Trial Digging Test (Signal)	IS Improvement Drawing (signalx3)		
	27	Wed								***Departure from Bengalure***	***Departure from Bengalure***		
Jun	23	Thu				***Arrival at Bengalure***	***Arrival at Bengalure***	***Arrival at Bengalure***	***Arrival at Bengalure***	***Arrival at Bengalure***		***Arrival at Bengalure***	***Arrival at Bengalure***
	24	Fri				Internal Meeting Meeting with DULT	Internal Meeting Meeting with DULT	Internal Meeting Meeting with DULT	Internal Meeting Meeting with DULT	Internal Meeting Meeting with DULT		Internal Meeting Meeting with DULT	Internal Meeting Meeting with DULT
	25	Sat				Basical Concept of OM (BTIC/KSDS)	Basical Concept of OM (BTIC/KSDS)	Basical Concept of TS (BTIC/BTRAC/KSDS)	Basical Concept of OM (BTRAC)	Basical Concept of TS (Signal/ATCC/Que)		Centre Equipment & Installation (TMC/KSDS)	Centre Equipment & Installation (TMC/KSDS)
	26	Sun											
	27	Mon				Basical Concept of OM (BTRAC)	Basical Concept of OM (BTIC/KSDS)	Basical Concept of TS (BTIC/BTRAC/KSDS)	Basical Concept of OM (BTRAC)	Basical Concept of TS (Signal/ATCC/Que)		Equipment location & Pow/Com (VMSx1)	Equipment location & Pow/Com (VMSx1)
	28	Tue				Basical Concept of OM (BTIC/KSDS)	Basical Concept of OM (BTIC/KSDS)	Basical Concept of TS (BTIC/BTRAC/KSDS)	Basical Concept of OM (BTRAC)	Basical Concept of TS (Signal/ATCC/Que)		Equipment location & Pow/Com (VMSx2)	Equipment location & Pow/Com (VMSx2)
	29	Wed			***Arrival at Bengalure***	Basical Concept of OM (BTRAC)	Basical Concept of OM (BTIC/KSDS)	Basical Concept of TS (BTIC/BTRAC/KSDS)	Basical Concept of OM (BTRAC)	Basical Concept of TS (Signal/ATCC/Que)		Gathering information of the Sub Contractor	Gathering information of the Sub Contractor
	30	Thu			***Meeting with DULT***	***Meeting with DULT***	***Meeting with DULT***	Basical Concept of TS (BTIC/BTRAC/KSDS)	Basical Concept of OM (BTRAC)	Basical Concept of TS (Signal/ATCC/Que)		Equipment location & Pow/Com (Signalx4)	Equipment location & Pow/Com (Signalx4)
July	1	Fri			***Meeting with Commissioner DULT*** Basical Concept of OM &TS (BTRAC)	***Meeting with Commissioner DULT*** Basical Concept of OM &TS (BTRAC)	***Meeting with Commissioner DULT*** Basical Concept of OM &TS (BTIC/KSDS)	***Meeting with Commissioner DULT*** Basical Concept of OM &TS (BTIC/KSDS)	***Meeting with Commissioner DULT*** Basical Concept of OM &TS (BTRAC)	***Meeting with Commissioner DULT*** Basical Concept of OM &TS (BTRAC)		***Meeting with Commissioner DULT*** Equipment location & Pow/Com (Signalx5)	***Meeting with Commissioner DULT*** Equipment location & Pow/Com (Signalx6)
	2	Sat			***Meeting with DULT on OM***	***Meeting with DULT on OM***	Basical Concept of OM &TS (BTIC/KSDS)	Basical Concept of OM &TS (BTIC/KSDS)	Basical Concept of OM & TS(BTRAC)	Basical Concept of TS (Signal/ATCC/Que)		Equipment location & Pow/Com (Signalx5)	Equipment location & Pow/Com (Signalx5)
	3	Sun											
	4	Mon			***Meeting with BRTC on OM***	***Meeting with BRTC on OM***	***Meeting with Trimax on BMTC I/F***	***Meeting with Trimax on BMTC I/F***	***Meeting with BRTC on OM***	Basical Concept of TS (Signal/ATCC/Que)		Equipment location & Pow/Com (Signalx5)	Equipment location & Pow/Com (Signalx5)
	5	Tue			***Meeting with Commissioner BTRAC/ Director IT BMTC***	***Meeting with Commissioner BTRAC/ Director IT BMTC***	***Meeting with Commissioner BTRAC/ Director IT BMTC***	***Meeting with Commissioner BTRAC/ Director IT BMTC***	***Meeting with Commissioner BTRAC/ Director IT BMTC***	***Meeting with Commissioner BTRAC/ Director IT BMTC***		***Meeting with Commissioner BTRAC/ Director IT BMTC***	***Meeting with Commissioner BTRAC/ Director IT BMTC***
	6	Wed			Basic Concept of TS &OM (DULT)	Basic Concept of TS &OM (DULT)	Basic Concept of TS &OM (DULT)	Basic Concept of TS &OM (DULT)	Basic Concept of TS &OM (DULT)	Basic Concept of TS &OM (DULT)		Meeting on Basic Concept of TS &OM (DULT)	Meeting on Basic Concept of TS &OM (DULT)
	7	Thu			***Meeting with Commissioner DULT***	***Meeting with Commissioner DULT***	***Meeting with Commissioner DULT***	***Meeting with Commissioner DULT***	***Departure from Bengalure***	***Meeting with Commissioner DULT***		***Meeting with Commissioner DULT***	***Meeting with Commissioner DULT***
	8	Fri			***Sign of Comissioner DULT***	***Sign of Comissioner DULT***	***Departure from Bengalure***	***Departure from Bengalure***		Basical Concept of TS (Signal/ATCC/Que)		Equipment location & Pow/Com (Signalx5)	Equipment location & Pow/Com (Signalx5)
	9	Sat			***Departure from Bengalure***	***Departure from Bengalure***				Basical Concept of TS (Signal/ATCC/Que)		Equipment location & Pow/Com (Quex1)	Equipment location & Pow/Com (Quex1)
	10	Sun											
	11	Mon								Gathering information of the Sub Contractor		Gathering information of the Sub Contractor	Gathering information of the Sub Contractor
	12	Tue								Equipment location & Pow/Com (Quex1)		Equipment location & Pow/Com (Quex1)	Equipment location & Pow/Com (Quex1)
	13	Wed								Basical Concept of TS (Signal/ATCC/Que)		Equipment location & Pow/Com (Quex2)	Equipment location & Pow/Com (Quex2)
	14	Thu								***Departure from Bengalure***		Equipment location & Pow/Com (Quex2)	Equipment location & Pow/Com (Quex2)
	15	Fri										Equipment location & Pow/Com (Quex2)	Equipment location & Pow/Com (Quex2)
	16	Sat										Equipment location & Pow/Com (Quex2)	Equipment location & Pow/Com (Quex2)
	17	Sun										Equipment location & Pow/Com (Quex2)	Equipment location & Pow/Com (Quex2)
	18	Mon										Equipment location & Pow/Com (Quex2)	Equipment location & Pow/Com (Quex2)
	19	Tue										Equipment location & Pow/Com (ATCCx2)	Equipment location & Pow/Com (ATCCx2)
	20	Wed										Equipment location & Pow/Com (ATCCx3)	Equipment location & Pow/Com (ATCCx3)
	21	Thu										Equipment location & Pow/Com (ATCCx3)	Equipment location & Pow/Com (ATCCx3)
	22	Fri										***Departure from Bengalure***	***Departure from Bengalure***

第3次調査工程

Day			JICA		Consultant								
			Kawahara	Sakabe	Okuda	Totani	Kondo	Wakatsuki	Noda	Takahashi	Iseki	Otuka	Tahara
Dec	7	Wed			***Arrival at Bengalure***					***Arrival at Bengalure***			
	8	Thu			Internal Meeting with Counterpart Meeting with Commercial Tax Department					Internal Meeting with Counterpart Meeting with Commercial Tax Department			
	9	Fri			Meeting with DULT ITS Special Officer					Meeting with DULT ITS Special Officer			
	10	Sat			Documentation					Documentation			
	11	Sun			Documentation					Documentation			
	12	Mon			Meeting with Mr.P.N.Karanth Meeting with Shimizu Corp. India					Meeting with Mr.P.N.Karanth Meeting with Shimizu Corp. India			
	13	Tue			Discussion with Bharat Sanchar Nigam Ltd(インド国通信事業者).					Discussion with Bharat Sanchar Nigam Ltd(インド国通信事業者).			
	14	Wed			Meeting with DULT Commissioner Meeting with PWC					Meeting with DULT Commissioner Meeting with PWC			
	15	Thu			***Departure from Bengalure***					***Departure from Bengalure***			

Day			JICA		Consultant								
			Kawahara	Sakabe	Okuda	Totani	Kondo	Wakatsuki	Noda	Takahashi	Iseki	Otuka	Tahara
Jun	7	Sat			***Arrival at Bengalure***	***Arrival at Bengalure***				***Arrival at Bengalure***			
	8	Sun			Documentation	Documentation				Documentation			
	9	Mon			Meeting with DULT ITS Special Officer	Meeting with DULT ITS Special Officer				Meeting with DULT ITS Special Officer			
	10	Tue			Documentation	Documentation				Documentation			
	11	Wed			Meeting with DULT ITS Special Officer	Meeting with DULT ITS Special Officer				Meeting with DULT ITS Special Officer			
	12	Thu			Meeting with DULT ITS Special Officer	Meeting with DULT ITS Special Officer				Meeting with DULT ITS Special Officer			
	13	Fri			Meeting with DULT Commissioner	Meeting with DULT Commissioner				Meeting with DULT Commissioner			
	14	Sat			Documentation	Documentation				Documentation			
	15	Sun			Meeting with Commercial Tax Department	Meeting with Commercial Tax Department				Meeting with Commercial Tax Department			
	16	Mon			Discussion with Bharat Sanchar Nigam Ltd(インド国通信事業者).	Discussion with Bharat Sanchar Nigam Ltd(インド国通信事業者).				Discussion with Bharat Sanchar Nigam Ltd(インド国通信事業者).			
	17	Tue			Meeting with DULT ITS Special Officer	Meeting with DULT ITS Special Officer				Meeting with DULT ITS Special Officer			
	18	Wed			***Departure from Bengalure***	***Departure from Bengalure***				***Departure from Bengalure***			

第4次調査工程

Day			JICA		Consultant								
			Kawahara	Sakabe	Okuda	Totani	Kondo	Wakatsuki	Noda	Takahashi	Iseki	Otuka	Tahara
Apr	20	Thu		***Arrival at Delhi***									
	21	Fri		Meeting with JICA Office Meeting with JICA Experts	***Arrival at Bengalure***	***Arrival at Bengalure***							
	22	Sat		***Arrival at Bengalure***									
	23	Sun	***Arrival at Bengalure***	Site Survey						***Arrival at Bengalure***			***Arrival at Bengalure***
	24	Mon	Meeting with Karnataka State	Meeting with Karnataka State	Meeting with Karnataka State	Meeting with Karnataka State	Meeting with Karnataka State			Meeting with Karnataka State			Meeting with Karnataka State
	25	Tue	Meeting with Karnataka State	Meeting with Karnataka State	Meeting with Karnataka State	Meeting with Karnataka State	Meeting with Karnataka State			Meeting with Karnataka State			Meeting with Karnataka State
	26	Wed	Meeting with Karnataka State PM:***Departure from Bengalure***	Meeting with Karnataka State	Meeting with Karnataka State	Meeting with Karnataka State	Meeting with Karnataka State			Meeting with Karnataka State			Meeting with Karnataka State
	27	Thu		AM:Leaving to Delhi PM:Meeting with MoUD	AM:Leaving to Delhi PM:Meeting with MoUD ***Departure from Delhi***	Meeting with Karnataka State	Meeting with Karnataka State ***Departure from Bengalure***			Meeting with Karnataka State			Meeting with Karnataka State
	28	Fri		***Departure from Delhi***		other duty				Meeting with Karnataka State ***Departure from Bengaluru***			Meeting with Karnataka State ***Departure from Bengaluru***
	29	Sat				Follow up work for Sub Contractor ***Departure from Bengaluru***							
	30	Sun											

第5次調査工程

Day			JICA		Consultant								
			Kawahara	Sakabe	Okuda	Totani	Kondo	Wakatsuki	Noda	Takahashi	Iseki	Otsuka	Tahara
Jun	28	Wed			***Arrival at Bengalure***	***Arrival at Bengalure***			***Arrival at Bengalure***	***Arrival at Bengalure***	***Arrival at Bengalure***		***Arrival at Bengalure***
	29	Thu			Metting with DULT	Metting with DULT			Metting with DULT	Metting with DULT	Metting with DULT		Metting with DULT
	30	Fri			Metting with DULT	Metting with DULT			Metting with DULT	Metting with DULT	Metting with DULT		Metting with DULT
Jul	1	Sat			Metting with DULT(ITS Officer)	Metting with DULT(ITS Officer)			Metting with DULT(ITS Officer)	Metting with DULT(ITS Officer)	Metting with DULT(ITS Officer)		Metting with DULT(ITS Officer)
	2	Sun			Documantation	Documantation	***Arrival at Bengalure***	***Arrival at Bengalure***	Documantation	Documantation	Documantation		Documantation
	3	Mon			Meeting with BTP(Facility Management Contractor)	Meeting with BTP(Facility Management Contractor)	Meeting with BTP(Facility Management Contractor)	Meeting with BTP(Facility Management Contractor)	Meeting with BTP(Facility Management Contractor)	Meeting with BTP(Facility Management Contractor)	Meeting with BTP(Facility Management Contractor)	***Arrival at Bengalure***	Meeting with BTP(Facility Management Contractor)
	4	Tue			Meeting with BTP	Meeting with BTP	Meeting with BTP	Meeting with BTP	Meeting with BTP	Meeting with BTP	Meeting with BTP	Meeting with BTP	Meeting with BTP
	5	Wed	***Arrival at Delhi***	***Arrival at Delhi***	Metting with DULT(Commissioner)	Metting with DULT(Commissioner)	Metting with DULT(Commissioner)	Metting with DULT(Commissioner)	Metting with DULT(Commissioner)	Metting with DULT(Commissioner)	Metting with DULT(Commissioner)	Metting with DULT(Commissioner)	Metting with DULT(Commissioner)
	6	Thu	Meeting with JICA Meeting with MoUD	Meeting with JICA Meeting with MoUD	Meeting with JICA Meeting with MoUD	Meeting with DULT, BTP	Meeting with DULT, BTP	Meeting with DULT, BTP	Meeting with DULT, BTP	Meeting with DULT, BTP	Meeting with DULT, BTP	Meeting with DULT, BTP	Meeting with DULT, BTP
	7	Fri	AM:Meeting with MoUD PM: DEL->BLR	AM:Meeting with MoUD PM: DEL->BLR	AM:Meeting with MoUD PM: DEL->BLR	Meeting with DULT, BTP	Meeting with DULT, BTP	Meeting with DULT, BTP	Meeting with DULT, BTP	Meeting with DULT, BTP	Meeting with DULT, BTP	Meeting with DULT, BTP	Meeting with DULT, BTP
	8	Sat	Meeting with DULT	Meeting with DULT	Meeting with DULT	Meeting with DULT	Meeting with DULT	Meeting with DULT	Meeting with DULT	Meeting with DULT	Meeting with DULT	Meeting with DULT	Meeting with DULT
	9	Sun	Documentation	Documentation	Documentation	Documentation	Documentation	Documentation	Documentation	Documentation	Documentation	Documentation	Documentation
	10	Mon	Discussion with DULT	Discussion with DULT	Discussion with DULT	Discussion with DULT	Discussion with DULT	Discussion with DULT	Discussion with DULT	Discussion with DULT	Discussion with DULT	Discussion with DULT	Discussion with DULT
	11	Tue	Discussion with DULT	Discussion with DULT	Discussion with DULT	Discussion with DULT	Discussion with DULT	Discussion with DULT	Discussion with DULT	Discussion with DULT	Discussion with DULT	Discussion with DULT	Discussion with DULT
	12	Wed	Signing of M/D PM: BLR->DEL	Signing of M/D PM: BLR->DEL	Signing of M/D PM: BLR->DEL	Documantation Follow-UP works	Documantation Follow-UP works	Documantation Follow-UP works	Documantation Follow-UP works	Documantation Follow-UP works	Documantation Follow-UP works	Documantation Follow-UP works	Documantation Follow-UP works
	13	Thu	Report to JICA Office (Follow up on MoUD)	Report to JICA Office (Follow up on MoUD)	Report to JICA Office (Follow up on MoUD)	Documantation Follow-UP works	Documantation Follow-UP works	Documantation Follow-UP works	Documantation Follow-UP works	Documantation Follow-UP works	Documantation Follow-UP works	Documantation Follow-UP works	Documantation Follow-UP works
	14	Fri	***Departure from Delhi***	***Departure from Delhi***	***Departure from Delhi***	***Departure from Bengalure***	***Departure from Bengalure***	***Departure from Bengalure***	***Departure from Bengalure***	***Departure from Bengalure***	***Departure from Bengalure***	***Departure from Bengalure***	***Departure from Bengalure***

資料　3

関係者（面会者）リスト

関係者リスト

Directorate of Urban Land Transport (DULT)	
Ms. Majula IAS	Commissioner, DULT
Mr. Darpan Jain IAS	Commissioner, DULT
Mr. N.Murali Krishna	ITS Special Officer
Mr. Shamanth.P.K	Head of TETC (Traffic Engineering Transportation Cell)
Mr. Siva Subramaniam.J	Transport Planner
Mr. Manohar Meena	ITS Specialist
Bengaluru Traffic Police (BTP)	
Mr. RI Kasim	Assistant Commissioner of Police (Traffic & Planning)
Mr. Diwakar	Traffic Police
Mr. Malikarjuna	Project Manager, CMS
Bengaluru Metropolitan Transport Corporation (BMTC)	
Mr. Bishwajit Mishra	Director (Information Technology)
Mr. Nagendra	Chief Manager
Bruhat Bengaluru Mahanagara Palike (BBMP)	
Mr. Basvaraj R Kabade	Executive Engineer, Traffic Cell

資料　4

討議議事録（現地調査時）

MINUTES OF DISCUSSIONS
ON THE PREPARATORY SURVEY FOR
THE PROJECT FOR BENGALURU METROPOLITAN REGION ITS
IN THE REPUBLIC OF INDIA

In response to the request from the Government of India, the Government of Japan decided to conduct a Preparatory Survey for the Project for Bengaluru Metropolitan Region ITS (hereinafter referred to as "the Project"), and entrusted the Preparatory Survey to Japan International Cooperation Agency (hereinafter referred to as "JICA").

JICA sent the Preparatory Survey Team for the Outline Design (hereinafter referred to as "the Team") to India headed by Mr. Shuntaro KAWAHARA, Senior Advisor, JICA, and is scheduled to stay in India from February 27 to March 11, 2016.

The Team held a series of discussions with the officials concerned of the Indian side and conducted a field survey in the Project area. In the course of the discussions, both sides have confirmed the main items described in the attachment. The Team will proceed to further works and prepare the Interim Report.

Bengaluru, March 10, 2016

Shuntaro KAWAHARA
Leader
Preparatory Survey Team
Japan International Cooperation Agency
Japan

V. MANJULA, IAS
Commissioner
Directorate of Urban Land Transport
Government of Karnataka
India

Dr. M. A. Saleem, IPS
Additional Commissioner
Bengaluru Traffic Police
Karnataka State Police
India

ATTACHMENT

1. Objective of the Project

The Objective of the project is to establish a new traffic control system through introduction of ITS equipment to the Karnataka Government, thereby contributing to relieving traffic congestion and environmental conservation in Bengaluru City Area.

2. Project Sites

Both sides confirmed that the sites of the Project are Bengaluru, which are shown in Annex-1-1 and Annex-1-2.

3. Executing Agency

Both sides confirmed the executing agency is Directorate of Urban Land Transport (hereinafter referred to as "DULT") : which is under the Department of Urban Development, Government of Karnataka. The executing agency shall coordinate with all the relevant agencies to ensure smooth implementation of the Project and ensure that the Undertakings are taken by relevant agencies properly and on time. The organization charts including relevant agencies are shown in Annex-2.

4. Items requested by the India side

4-1 As a result of discussions, both sides confirmed that the items requested by the India side are as follows:

Both sides reviewed the request contents and confirmed that request should be based on the Technical Review Report for Loan Assistance completed after the request for the Grant aid.

Request		Technical Review Report	
ITS Component	Quantity	ITS Component	Quantity
Traffic Information Centre	1 set	Center System	1 set
Probe Data Systems	6700 units	Probe System	1 set
Vehicle Detectors	5,000 units	Queue Length Measurement System	13 locations (100 units)
Traffic Counters	56 units	Automatic Traffic Counter-Com Classifier (ATCC)	8 locations (16 units)
VMS systems	6 units	Variable Message Sign System (VMS System)	3 units
-	-	Internet System	1 set
Advanced Signal Controllers	20 intersections	Signal Control System	20 intersections

The both side agreed regarding the probe system of the Project as follows:

(1) The probe system would utilize GPS data generated by the bus-tracking system introduced by Bengaluru Metropolitan Transport Corporation (BMTC) although the availability of the GPS data must be verified by the Team during the second mission around April 2016;

(2) The India side would submit the GPS data set of bus-tracking system as early as possible; and

(3) The Project would not cover GPS devices attached to buses owed by the Corporation.

The Team requested India side that the bus tracking system of BMTC must be properly operated and maintain even after the end of five years BOT contract with TRIMAX in order to secure sustainability of the probe system of the Project.

4-2 JICA will assess the appropriateness of the above requested items through the survey and will report findings to the Government of Japan. The final components of the Project would be decided by the Government of Japan.

5. Japanese Grant Scheme

5-1 The India side understands the Japanese Grant Scheme and its procedures as described in Annex-3, Annex-4 and Annex-5, and necessary measures to be taken by the India side. A template of the Project Monitoring Report to be submitted by the executing agency is as attached in Annex 6.

5-2 The India side understands to take the necessary measures, as described in Annex 7, for smooth implementation of the Project, as a condition for the Japanese Grant to be implemented. The detailed contents of the Annex-7 will be worked out during the survey and shall be agreed no later than by the Explanation of the Draft Preparatory Survey Report.

The contents of Annex-7 will be used to determine the following:

(1) The scope of the Project.

(2) The timing of the Project implementation.

(3) Timing and possibility of budget allocation.

Contents of Annex-7 will be updated as the Preparatory Survey progresses, and will finally be the Attachment to the Grant Agreement.

5-3 To respond questions of Indian side, the Team explained as follows.

(1)Ex-Post Evaluation

JICA will conduct ex-post evaluation three (3) years after the project completion with respect to five evaluation criteria (Relevance, Effectiveness, Efficiency, Impact, Sustainability) of the Project. Result of the evaluation will be publicized. The Indian side is required to provide necessary support for them.

(2)Source country and specification of products and services

The Grant Aid may be used for the purchase of the products or services of a third country other than Japan and India, if necessary, taking into account the quality, competitiveness and economic rationality of products and services necessary for achieving the objective of the Project. The functions and specifications of products procured by the Project will be carefully considered during the preparatory survey consulting the Indian relevant agencies, and finalized in the tender document approved by the Executing Agency.

6. Schedule of the Survey

6-1 The Team will proceed with further survey in India until March 11, 2016.

6-2 JICA will prepare an Interim Report in English and dispatch a mission around April 2016 to explain the result of scoping the project site for installation of equipment. And the Team proceeds to collect information to design specifications of equipment.

6-3 The Team will prepare a draft Preparatory Survey Report in English and dispatch a mission to India in order to explain its contents around July 2016.

6-4 If the contents of the draft Preparatory Survey Report is accepted in principle and the Undertakings are fully agreed by the India side, JICA will complete the final report in English and send it to India around October, 2016.

6-5 The above schedule is tentative and subject to change.

7. Environmental and Social Considerations

7-1 The India side confirmed to give due environmental and social considerations during implementation of the Project, and after completion of the Project, in accordance with the JICA Guidelines for Environmental and Social Considerations (April, 2010).

7-2 The Project is categorized as Category C because the scope of the Project is limited to installation of equipment, and its potential adverse impacts on the environment are not likely to be significant. The India side confirmed to conduct the necessary procedures concerning the environmental assessment (including stakeholder meetings, Environmental Impact Assessment (EIA) /Initial Environmental Examination (IEE) and information disclosure, etc.) and make EIA/IEE report of the Project as needed. The EIA/IEE approval shall be received from the responsible authorities and submitted to JICA before the Cabinet approval of the Project by the Government of Japan.

7-3 The India side confirmed the Project would not need EIA/IEE approval by the Indian relevant agencies.

8. Other Relevant Issues

8-1 Provision of Conveniences to the Team by the India Side

The India side shall, at its own expenses, provide the Team with the following items in cooperation with DULT and other organizations concerned.

(1) Security-related information as well as measures to ensure the safety of the Team members;
(2) Data and information necessary for the Survey.
(3) Counterpart personnel;
(4) Suitable office space with necessary equipment and services;
(5) Credentials or identification cards;
(6) Appointments arrangement;
(7) Entry permits necessary for the Team members to conduct field surveys; and
(8) Support in obtaining other privileges and benefits if necessary including:
    1) Permission to photograph and to enter into private properties and restricted areas for the Team for proper execution of the Survey, if necessary, and
    2) Arrangement to allow the Team to bring back to Japan any necessary data, maps and materials related to the survey, subject to approval by the Government of India, in order to analyze the Project and prepare the reports.

8-2 Responsible organizations for ITS introduction and operation

As a result of discussions, both sides confirmed In-charge organizations of ITS by the India side are as follows:

ITS Component		Implementation (Procurement)	Operation & Maintenance	Ownership
Bengaluru Traffic Information System	Centre System Probe System Queue Length Measurement System Automatic Traffic Counter-Com Classifier Internet System	DULT, Government of Karnataka	DULT, Government of Karnataka	DULT, Government of Karnataka
	Variable Message Sign System	DULT, Government of Karnataka	Bengaluru Traffic Police	Bengaluru Traffic Police
Signal Control System		DULT, Government of Karnataka	Bengaluru Traffic Police	Bengaluru Traffic Police

8-3 The Project owner

The Indian side stated that DULT would be the owner of the Project and enter in to contract with a Japanese contractor.

8-4 Selection of location for ITS

The both sides agreed the locations of ITS equipment shown in Annex-1-1 and Annex-1-2.

(1) Intersection of Signal Control

Target intersections of signal control system are 29 ones along MG Road zone shown in Annex-1-2 combined with parts of both Old Madras Road and Hosur

Road.

(2) VMS

The proposed VMS will display the information on the traffic congestion status, time to major destinations and other messages as necessary. They will be installed at three locations, MG Road, in the vicinity of Hanging Bridge and in the vicinity of Silk Board Junction shown in Annex-1-1.

(3) ATCC

8 locations (16units) of ATCCs will be installed at middle point between major intersections shown in Annex-1-1.

(4) Queue Length Measurement

13 locations (100units) of Queue Length Measurement System will be installed at the intersections shown in Annex-1-1.

(5) Data Server

From the point of view of the maintenance and security, installation of servers necessary for the Project in Karnataka State Data Center (KSDC) is rational selection.

8-5 Installation of signal control

The Traffic Police stated that:

(1) New signals procured by Project should be, firstly, installed at proper positions, secondly the Traffic Police will confirm the operation of them, thirdly the Traffic Police will relocate previous signals by their own expense;

(2) Preferable signal controlling data transmission device is Wi-Fi, and aerial cable is not applicable.

8-6 Confirmation of necessary procedure for approving on road works of the contractor on roads

The Team requested DULT to confirm followings:

(1) The necessary approvals by relevant agencies and their procedure for the Japanese contractor to conduct on-site installation works on roads;

(2) Who owes costs of utility relocation; and

(3) What kind of safety measures for works on roads should be taken by Japanese contractor and relevant agencies.

8-7 Acceleration of the Project progress

Indian side requested that the Preparatory Survey would include preparing detailed design and draft tendering document so as to accelerate the Project progress.

As a response to its request, the Team explained followings:

(1) Tendering document and Detailed Design of the Project must be approved by both the Executing Agency and JICA according to administrative due process after signing E/N and G/A;

(2) In order to accelerate the Project, JICA would prepare the Final Preparatory Survey

Report describing, as clearly and in detail as possible, quantities, functions and specification of the equipment procured by the grant; and

(3) Crucial issues on accelerating the Project are for relevant agencies,
   1) To present prompt decision on the Project content such as functions and installation locations of ITS equipment;
   2) To avert modification of decision in later process; and
   3) To submit the Team necessary materials such as:
      - Drawings of target roads and intersections including buried utility ducts and location of the existing power and communication cable to connect the equipment;
      - Design standards of structure (pole and gantry etc);
      - Data format of Bus-tracking system;
      - Drawings of traffic information center and traffic management center, and related equipment;
      - Building Permission of traffic information center, traffic management center and KSDC; and
      - Frequency of power failure and total time of every area where equipment will be installed.

8-8 Tax Exemption

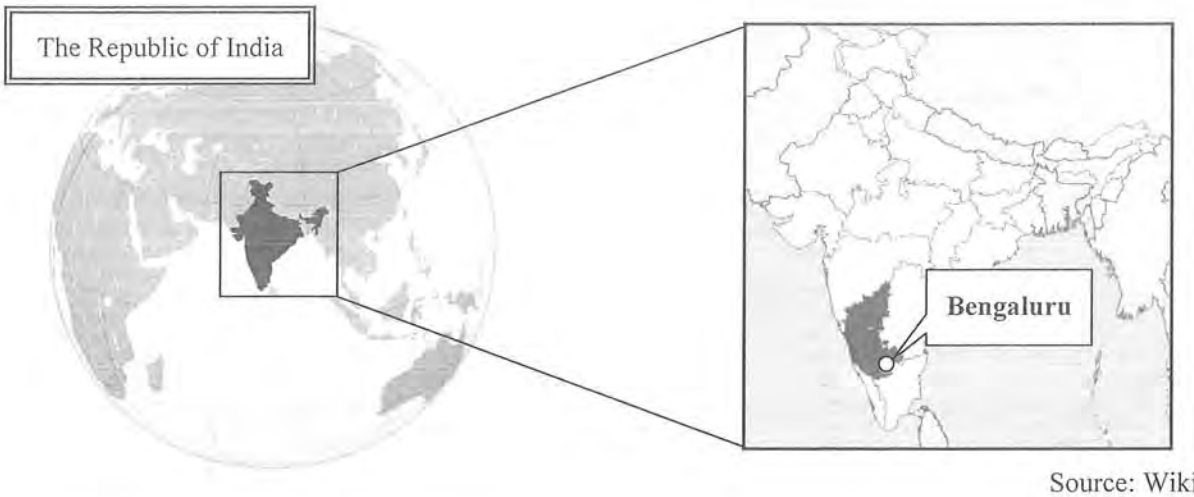
The Indian side stated that the Government of Karnataka had implemented a World Bank assisted project of which loan agreement described tax exemption, and that the India side would review it and explain possible tax treatment and necessary procedure during the second mission of the Team around April 2016.

8-9 Defect liability period

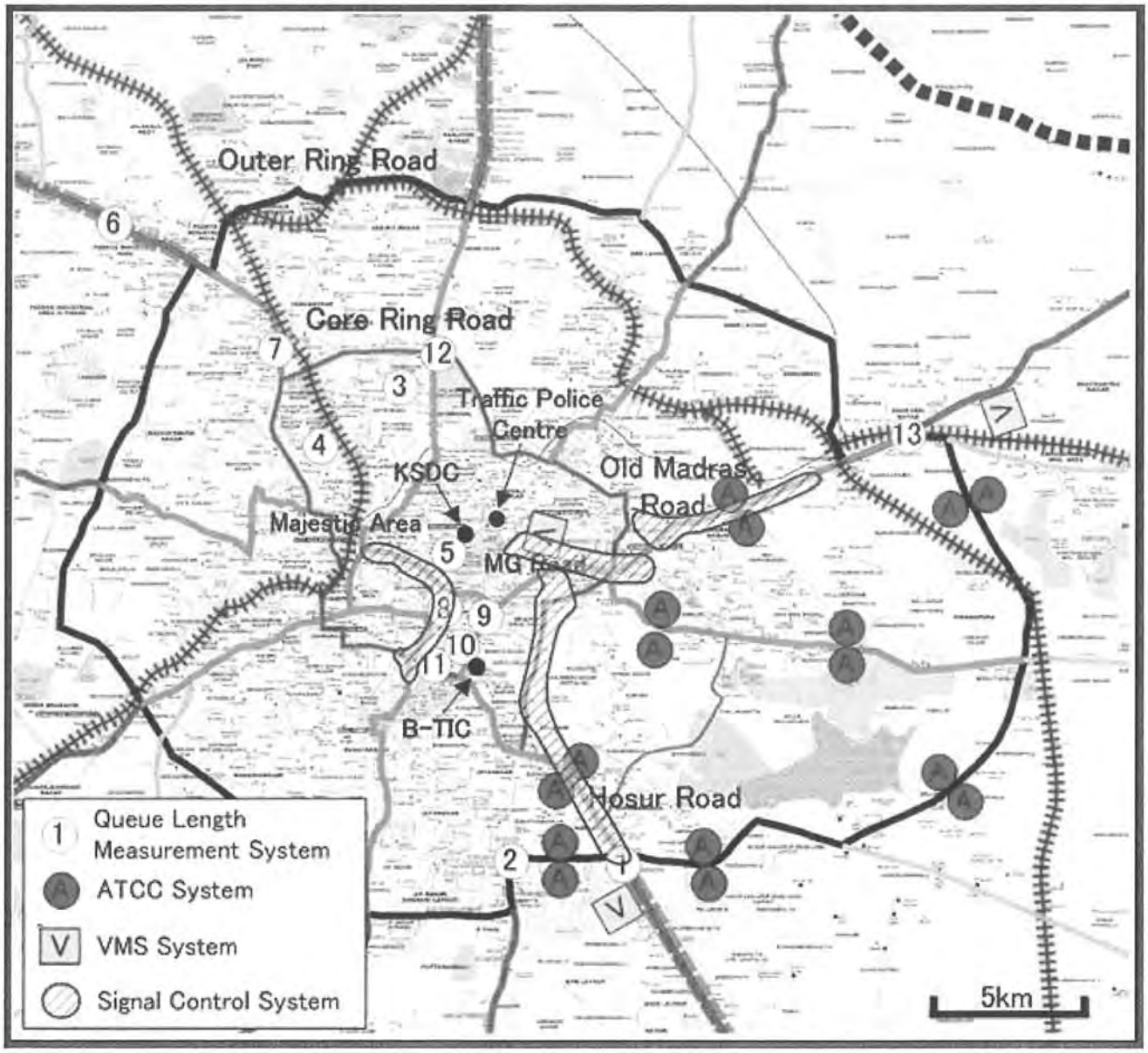
The Team stated that the defect liability period of the Project is expected to be (1) year according to Japanese convention while Indian side explained a defect liability period in India varies from (1) to (3) years depending on a project peculiarity. The defect liability period of the Project should be further discussed in later process.

Annex-1-1 Project Sites
Annex-1-2 Target Intersections
Annex-2 Organization Chart
Annex-3 Japanese Grant
Annex-4 Flow Chart of Japanese Grant Procedures
Annex-5 Financial Flow of Japanese Grant
Annex-6 Project Monitoring Report (template)
Annex-7 Major Undertakings to be taken by Each Government

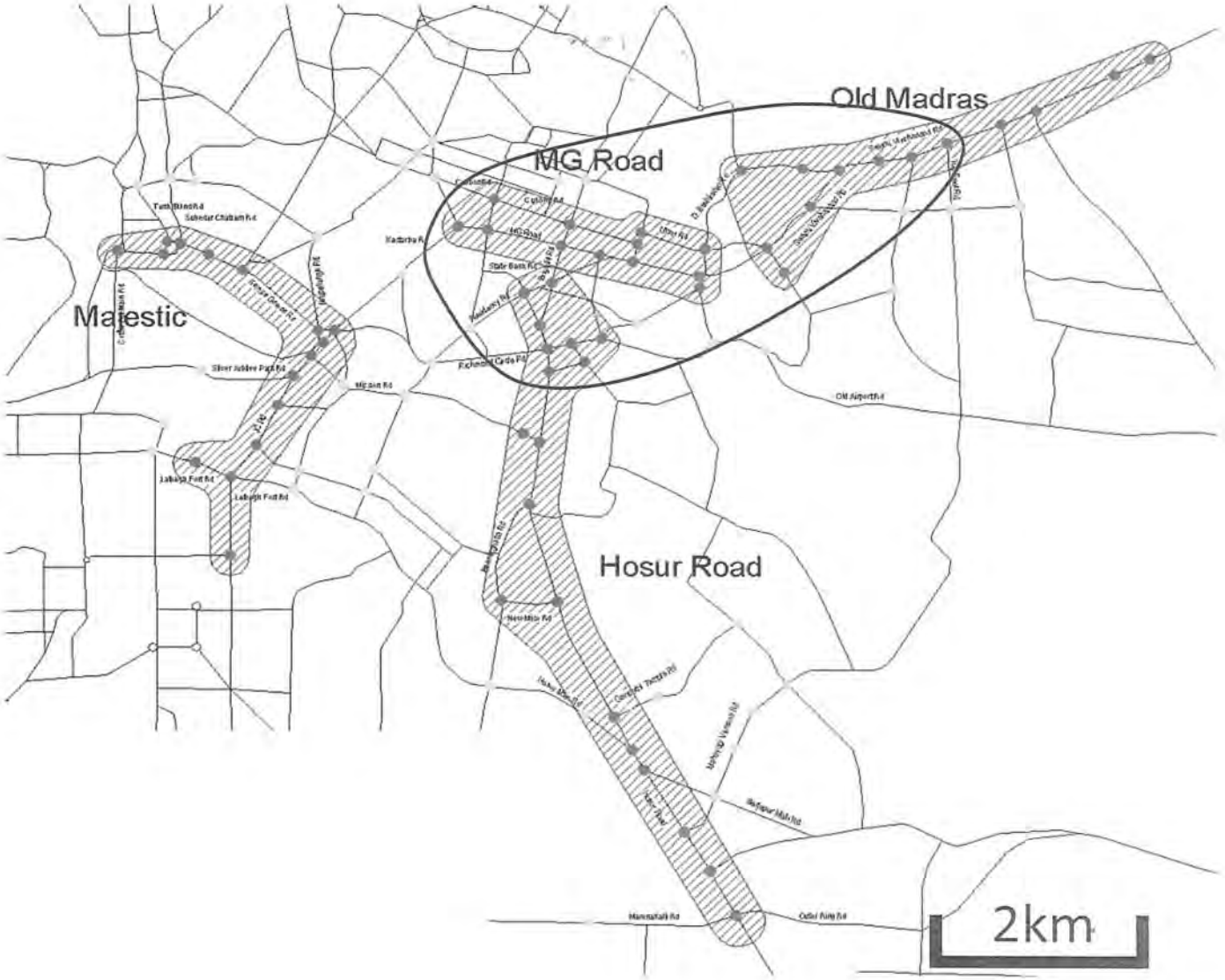
Annex-1-1: Project Sites



Source: Wikipedia

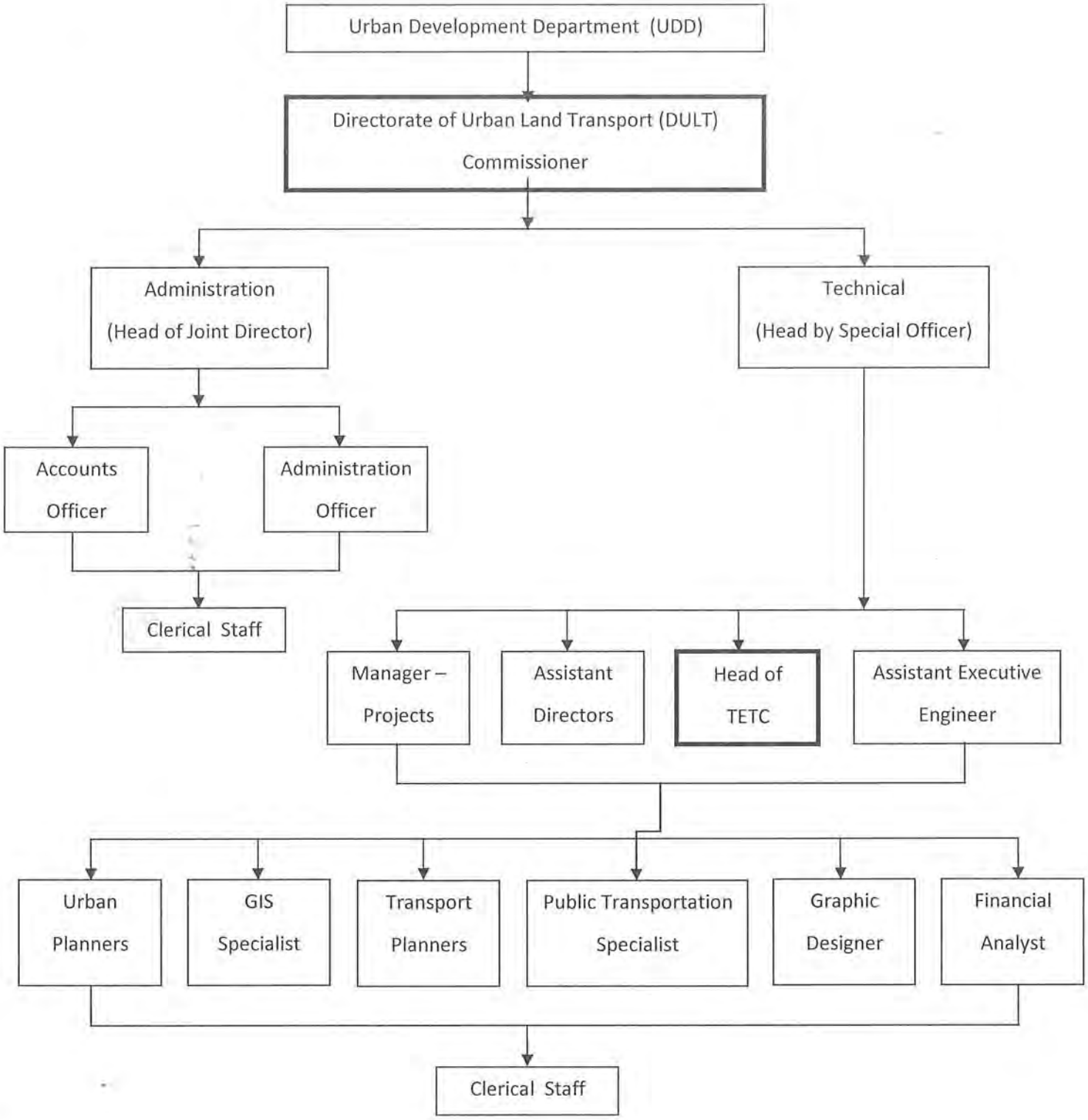


Annex-1-2: Target Intersections

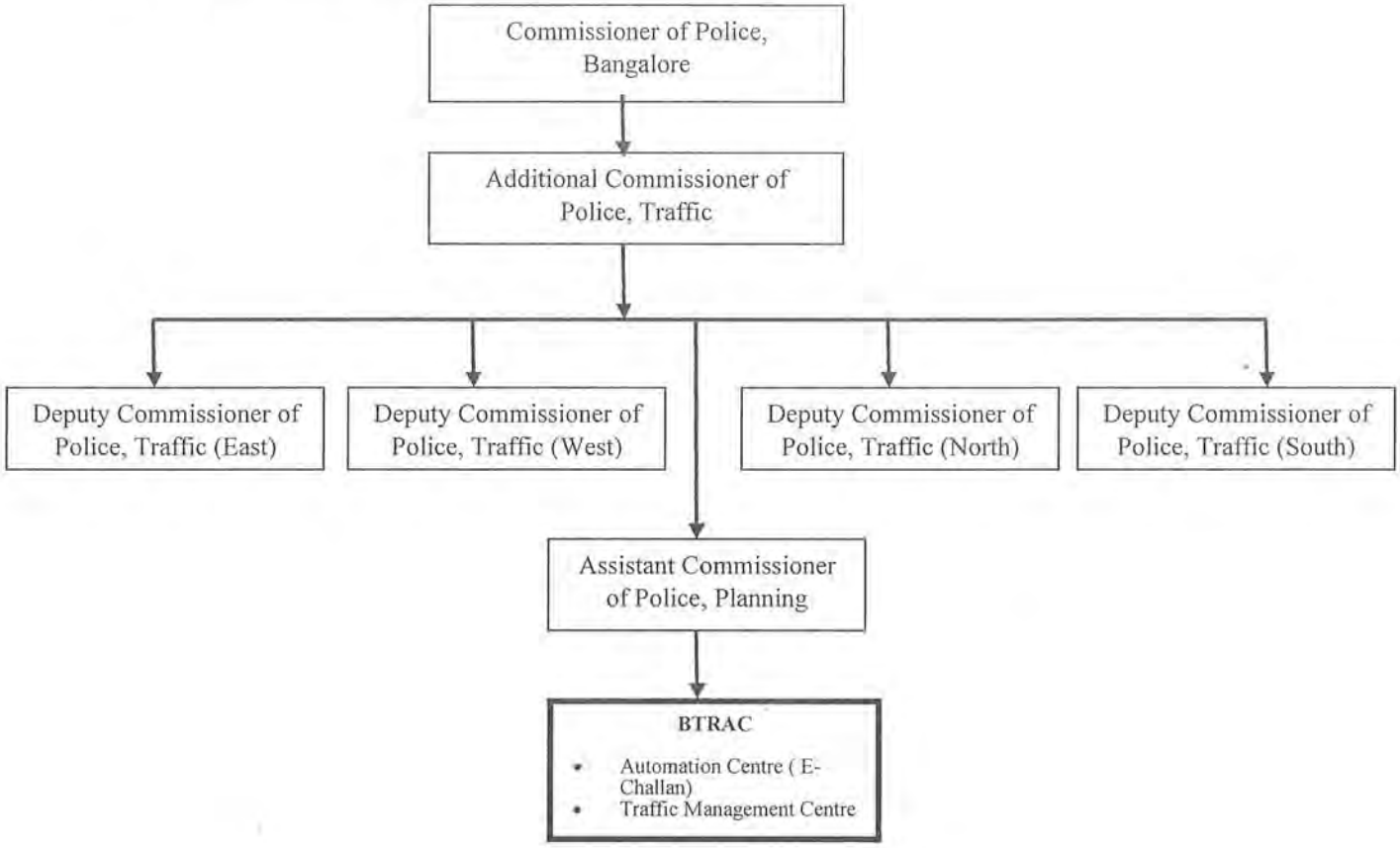


Annex-2: Organization Chart

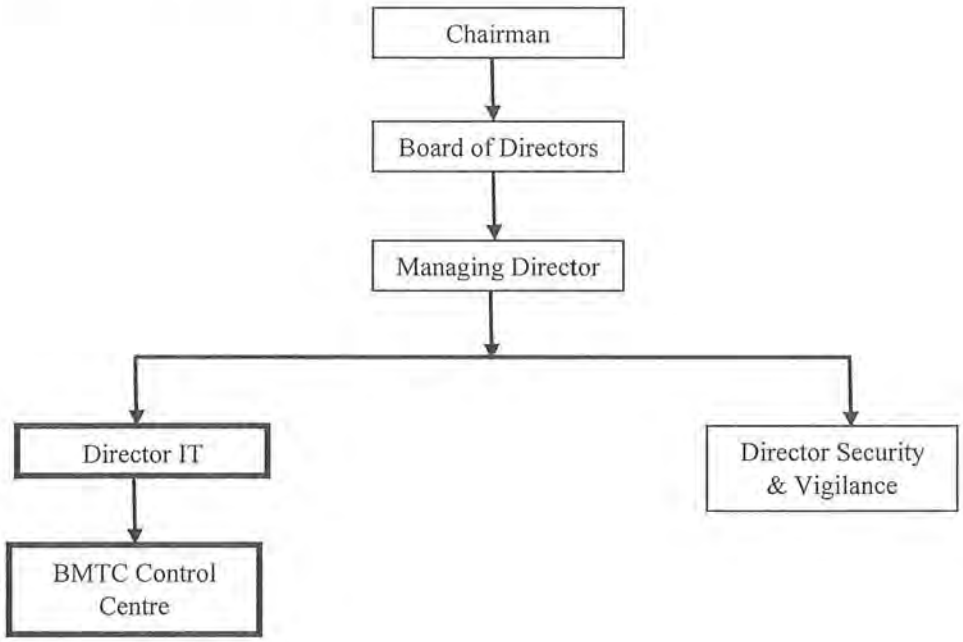
DULT Organization Structure:



Bangalore Traffic Police Organization Structure:



BMTC Organization Structure:

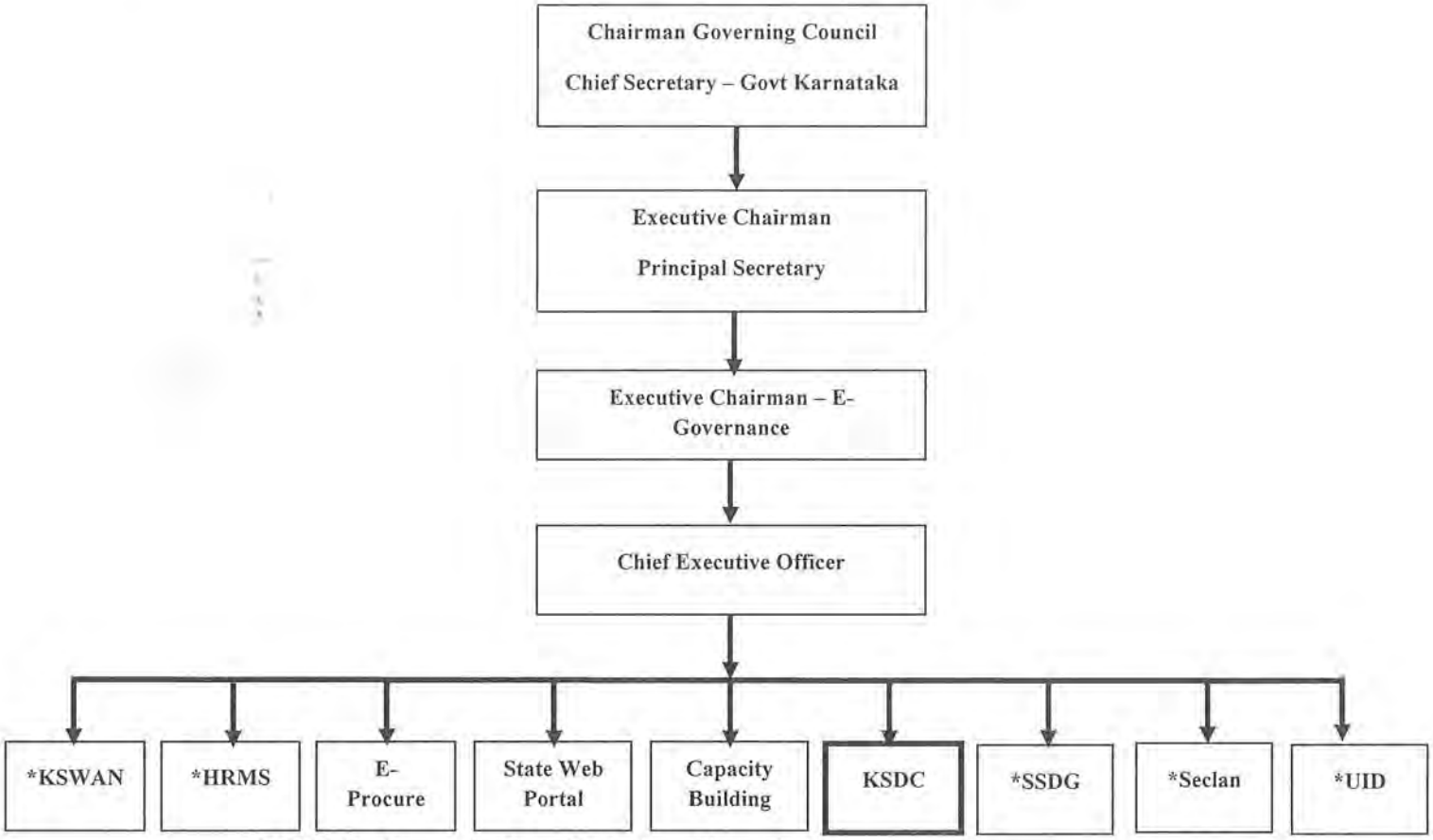


KSDC (Karnataka State Data Centre) Activities and Organization Structure:

Key activities of KSDC are explained below:

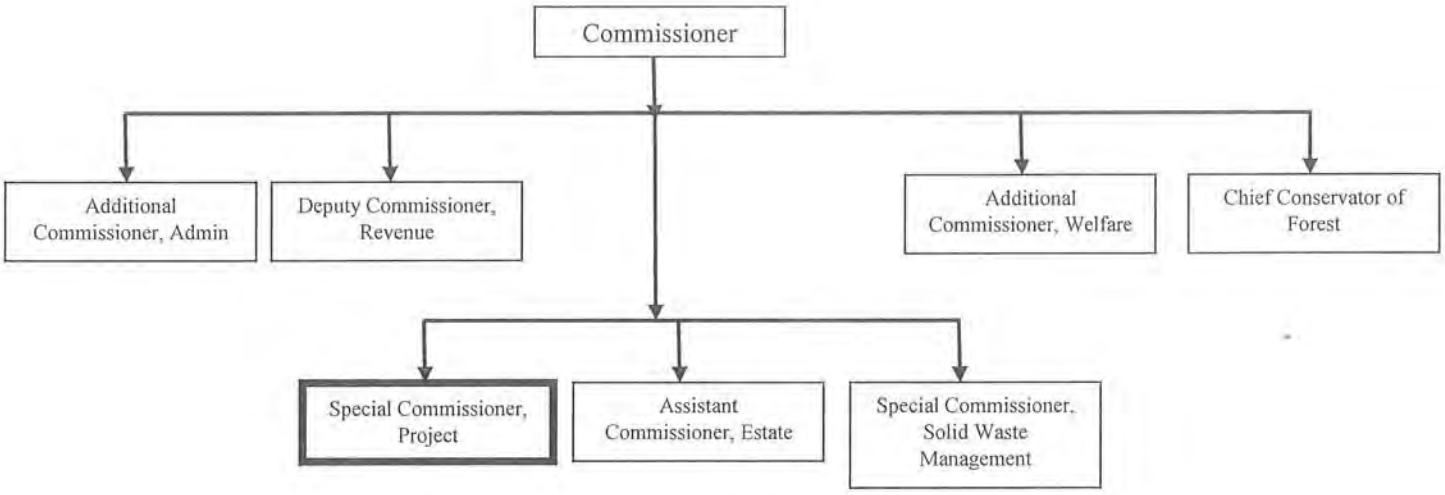
- Installation and upgradeof Servers, Storage and other necessary infrastructure to meet the department requirement for hosting their applications, websites and Databases.
- Virtualized more than 500 numbers of servers.
- Technical Upgrades.
- Implementation of Cloud services for KSDC.
- Procurement of Servers and Storage for Departments.
- Data Management System for Services to Government Department Applications

Organisation Structure of KSDC and Related Departments Under Karnataka State Government E-Governance Project:

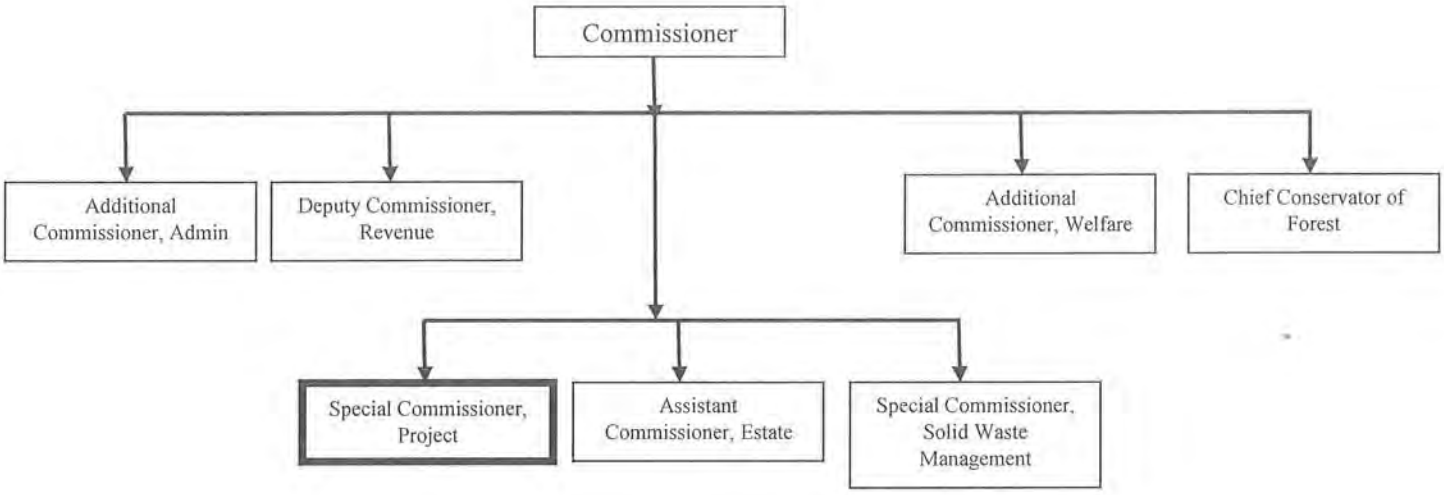


* KSWAN - Karnataka State Wide Area Network
* HTMS - Human Resource Management System
* SSDG – State Secure Delivery Gateway
* Seclan – Secretariat Local Area Network
* UID - Unique Identification Authority

BBMP Organization Structure:



BBMP Organization Structure:



Annex-3: Japan's Grant Aid Scheme

JAPAN'S GRANT AID

Based on a JICA law which was entered into effect on October 1, 2008 and the decision of the GOJ, JICA has become the executing agency of the Grant Aid for Projects for construction of facilities, purchase of equipment, etc.

The Grant Aid is non-reimbursable fund provided to a recipient country to procure the facilities, equipment and services (engineering services and transportation of the products, etc.) for its economic and social development in accordance with the relevant laws and regulations of Japan. The Grant Aid is not supplied through the donation of materials as such.

1. Grant Aid Procedures

The Japanese Grant Aid is supplied through following procedures:

- Preparatory Survey
  - The Survey conducted by JICA
- Appraisal &Approval
  - -Appraisal by the GOJ and JICA, and Approval by the Japanese Cabinet
- Authority for Determining Implementation
  - -The Notes exchanged between the GOJ and a recipient country
- Grant Agreement (hereinafter referred to as "the G/A")
  - -Agreement concluded between JICA and a recipient country
- Implementation
  - -Implementation of the Project on the basis of the G/A

2. Preparatory Survey

(1) Contents of the Survey

The aim of the preparatory Survey is to provide a basic document necessary for the appraisal of the Project made by the GOJ and JICA. The contents of the Survey are as follows:

- Confirmation of the background, objectives, and benefits of the Project and also institutional capacity of relevant agencies of the recipient country necessary for the implementation of the Project.
- Evaluation of the appropriateness of the Project to be implemented under the Grant Aid Scheme from a technical, financial, social and economic point of view.
- Confirmation of items agreed between both parties concerning the basic concept of the Project.
- Preparation of a outline design of the Project.

- Estimation of costs of the Project.

The contents of the original request by the recipient country are not necessarily approved in their initial form as the contents of the Grant Aid project. The Outline Design of the Project is confirmed based on the guidelines of the Japan's Grant Aid scheme.

JICA requests the Government of the recipient country to take whatever measures necessary to achieve its self-reliance in the implementation of the Project. Such measures must be guaranteed even though they may fall outside of the jurisdiction of the organization of the recipient country which actually implements the Project. Therefore, the implementation of the Project is confirmed by all relevant organizations of the recipient country based on the Minutes of Discussions.

(2) Selection of Consultants

For smooth implementation of the Survey, JICA employs (a) registered consulting firm(s). JICA selects (a) firm(s) based on proposals submitted by interested firms.

(3) Result of the Survey

JICA reviews the Report on the results of the Survey and recommends the GOJ to appraise the implementation of the Project after confirming the appropriateness of the Project.

3. Japan's Grant Aid Scheme

(1) The E/N and the G/A

After the Project is approved by the Cabinet of Japan, the Exchange of Notes(hereinafter referred to as "the E/N") will be singed between the GOJ and the Government of the recipient country to make a pledge for assistance, which is followed by the conclusion of the G/A between JICA and the Government of the recipient country to define the necessary articles, in accordance with the E/N, to implement the Project, such as payment conditions, responsibilities of the Government of the recipient country, and procurement conditions.

(2) Selection of Consultants

In order to maintain technical consistency, the consulting firm(s) which conducted the Survey will be recommended by JICA to the recipient country to continue to work on the Project's implementation after the E/N and G/A.

(3) Eligible source country

Under the Japanese Grant Aid, in principle, Japanese products and services including transport or those of the recipient

country are to be purchased. The Grant Aid may be used for the purchase of the products or services of a third country, if necessary, taking into account the quality, competitiveness and economic rationality of products and services necessary for achieving the objective of the Project. However, the prime contractors, namely, constructing and procurement firms, and the prime consulting firm are limited to "Japanese nationals", in principle.

(4) Necessity of "Verification"

The Government of the recipient country or its designated authority will conclude contracts denominated in Japanese yen with Japanese nationals, in principle. Those contracts shall be verified by JICA. This "Verification", is deemed necessary to fulfill accountability to Japanese taxpayers.

(5) Major undertakings to be taken by the Government of the Recipient Country

In the implementation of the Grant Aid Project, the recipient country is required to undertake such necessary measures as Annex-6. The Japanese Government requests the Government of the recipient country to exempt all customs duties, internal taxes and other fiscal levies such as VAT, commercial tax, income tax, corporate tax, resident tax, fuel tax which may be imposed in the recipient country with respect to the supply of the products and services under the verified contract, since the Grant Aid fund comes from the Japanese taxpayers.

(6) "Proper Use"

The Government of the recipient country is required to maintain and use properly and effectively the facilities constructed and the equipment purchased under the Grant Aid, to assign staff necessary for this operation and maintenance and to bear all the expenses other than those covered by the Grant Aid.

(7) "Export and Re-export"

The products purchased under the Grant Aid should not be exported or re-exported from the recipient country.

(8) Banking Arrangements (B/A)

a) The Government of the recipient country or its designated authority should open an account under the name of the Government of the recipient country in a bank in Japan (hereinafter referred to as "the Bank"), in principle. JICA will execute the Grant Aid by making payments in Japanese yen, in principle, to cover the obligations incurred by the Government of the recipient country or its designated authority under the Verified Contracts.

b) The payments will be made when payment requests are presented by the Bank to JICA under an Authorization to Pay (A/P) issued by the Government of the recipient country or its designated authority.

(9) Authorization to Pay (A/P)

The Government of the recipient country should bear an advising commission of an Authorization to Pay and payment

commissions paid to the Bank.

(10) Social and Environmental Considerations

The Government of the recipient country must carefully consider social and environmental impacts by the Project and must comply with the environmental regulations of the recipient country and JICA socio-environmental guidelines.

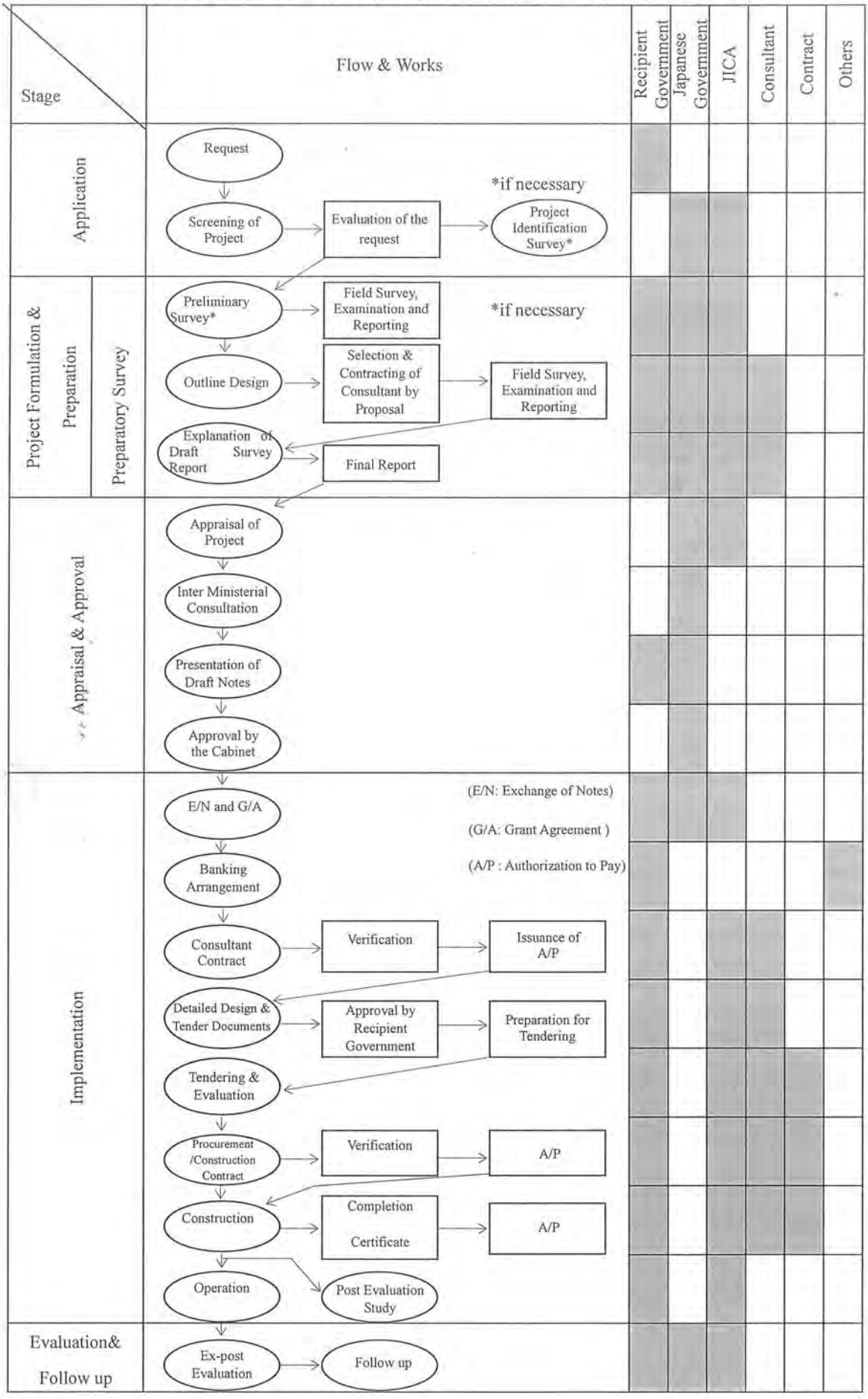
(11) Monitoring

The Government of the recipient country must take their initiative to carefully monitor the progress of the Project in order to ensure its smooth implementation as part of their responsibility in the G/A, and must regularly report to JICA about its status by using the Project Monitoring Report (PMR).

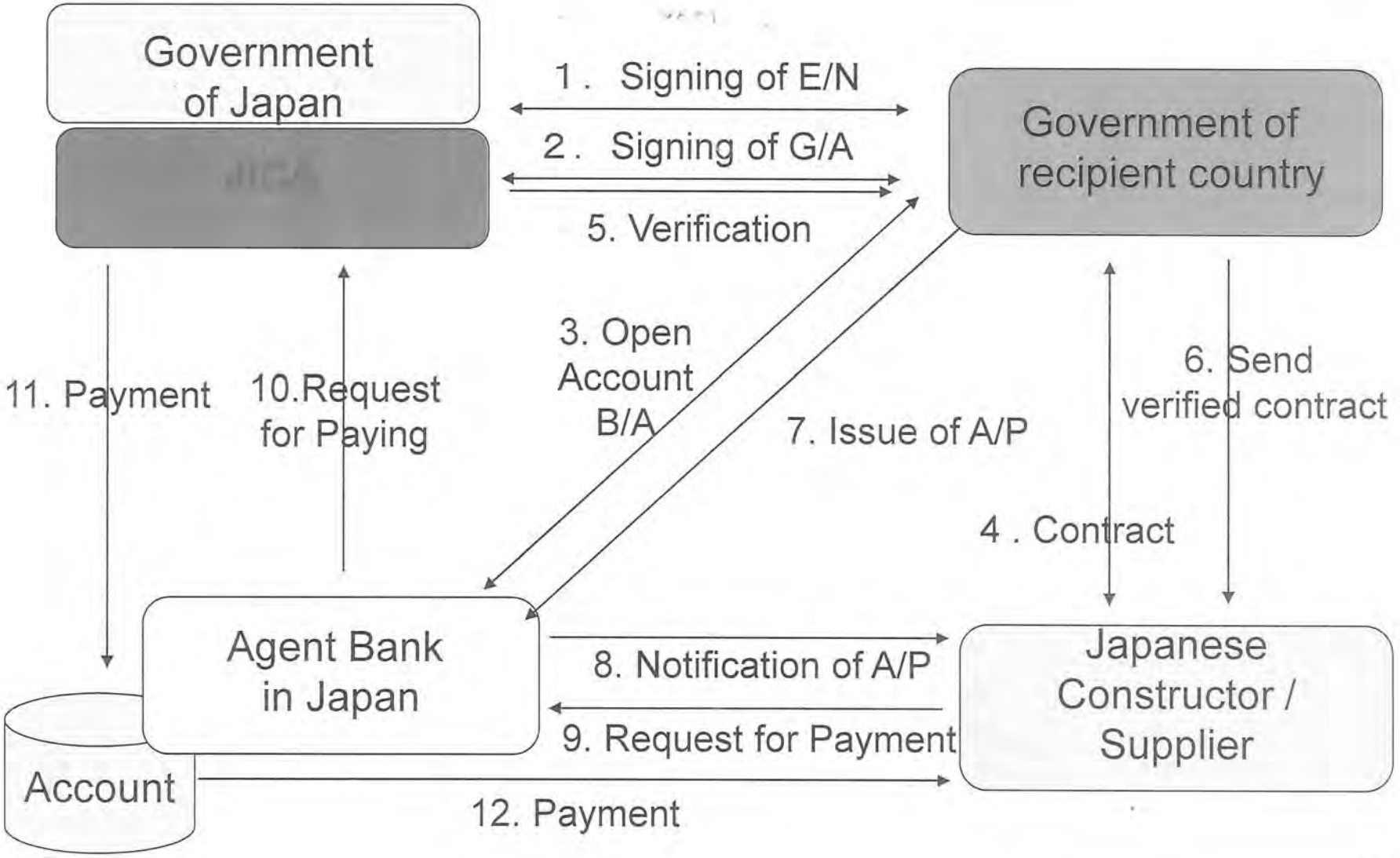
(12) Safety Measures

The Government of the recipient country must ensure that the safety is highly observed during the implementation of the Project.

FLOW CHART OF JAPAN's GRANT AID PROCEDURES



Financial Flow of Grant Aid



Project Monitoring Report
on
Project Name
Grant Agreement No. XXXXXXX

Organization Information

Authority (Signer of the G/A)	_____ Person in Charge _____ (Division) _____ Contacts Address: _____ Phone/FAX: _____ Email: _____
Executing Agency	_____ Person in Charge _____ (Division) _____ Contacts Address: _____ Phone/FAX: _____ Email: _____
Line Ministry	_____ Person in Charge _____ (Division) _____ Contacts Address: _____ Phone/FAX: _____ Email: _____

Outline of Grant Agreement:

Source of Finance	Government of Japan: Not exceeding JPY _____ mil. Government of (_____): _____
Project Title	
E/N	Signed date: Duration:
G/A	Signed date: Duration:

1: Project Description

1-1 Project Objective

1-2 Necessity and Priority of the Project

- Consistency with development policy, sector plan, national/regional development plans and demand of target group and the recipient country.

1-3 Effectiveness and the indicators

- Effectiveness by the project

2: Project Implementation

2-1 Project Scope

Table 2-1-1a: Comparison of Original and Actual Location

Location	**Original:** *(M/D)* **Attachment(s):Map**	**Actual:** *(P/Rand PCR)* **Attachment(s):Map**

Table 2-1-1b: Comparison of Original and Actual Scope

Items	Original	Actual
(M/D)	*(M/D)*	*(P/R and PCR)*

2-1-2 Reason(s) for the modification if there have been any.

(P/R and PCR)

2-2 Implementation Schedule
2-2-1 Implementation Schedule

Table 2-2-1: Comparison of Original and Actual Schedule

Items	Original		Actual
	DOD	G/A	
[M/D]	*(M/D)*		*(P/R, PCR)* As of (Date of Revision)
			Please state not only the most updated schedule but also other past revisions chronologically.
Project Completion Date*			

*Project Completion was defined as _____ at the time of G/A.

2-2-2 Reasons for any changes of the schedule, and their effects on the project.

(P/R and PCR)

2-3 Undertakings by each Government
2-3-1 Major Undertakings
See Attachment 2.

2-3-2 Activities
See Attachment 3.

2-4 Project Cost
2-4-1 Project Cost
Table 2-3-1 Comparison of Original and Actual Cost by the Government of Japan
(Confidential until the Tender)

Items			Cost (Million Yen)	
	Original	Actual	Original	Actual
Construction Facilities (or Equipment)				
Consulting Services	- Detailed design -Procurement Management -Construction Supervision			
Total				

Note: 1) Date of estimation:
2) Exchange rate: 1 US Dollar = Yen

Table 2-3-2 Comparison of Original and Actual Cost by the Government of XX

Items			Cost (Million USD)	
	Original	Actual	Original	Actual
Total				

Note: 1) Date of estimation:
2) Exchange rate: 1 US Dollar = (local currency)

2-4-2 Reason(s) for the wide gap between the original and actual, if there have been any, the remedies you have taken, and their results.

(P/R, PCR)

2-5 **Organizations for Implementation**

2-5-1 **Executing Agency:**

- Organization's role, financial position, capacity, cost recovery etc,
- Organization Chart including the unit in charge of the implementation and number of employees.

Original: *(M/D)*

Actual, if changed: *(P/R and PCR)*

2-6 **Environmental and Social Impacts**

Report based on the agreed environmental checklist and monitoring form (See Attachment 4)

3: Operation and Maintenance (O&M)

3-1 **O&M and Management**

- Organization chart of O&M
- Operational and maintenance system (structure and the number ,qualification and skill of staff or other conditions necessary to maintain the outputs and benefits of the project soundly, such as manuals, facilities and equipment for maintenance, and spare part stocks etc)

Original: *(M/D)*
Actual: *(PCR)*

3-2 O&M Cost and Budget

- The actual annual O&M cost for the duration of the project up to today, as well as the annual O&M budget.

Original: *(M/D)*

4: Precautions (Risk Management)

- Risks and issues, if any, which may affect the project implementation, outcome, sustainability and planned countermeasures to be adapted are below.

Original Issues and Countermeasure(s): *(M/D)*	
Potential Project Risks	Assessment
1.	Probability: H/M/L
(Description of Risk)	Impact: H/M/L
	Analysis of Probability and Impact:
	Mitigation Measures:
	Action during the Implementation:
	Contingency Plan (if applicable):
2.	Probability: H/M/L
(Description of Risk)	Impact: H/M/L
	Analysis of Probability and Impact:
	Mitigation Measures:
	Action during the Implementation:
	Contingency Plan (if applicable):
3.	Probability: H/M/L

(Description of Risk)	Impact: H/M/L
	Analysis of Probability and Impact:
	Mitigation Measures:
	Action during the Implementation:
	Contingency Plan (if applicable):
Actual issues and Countermeasure(s)	
(P/R and PCR)	

5: Evaluation

5-1 Overall evaluation

Please describe your evaluation on the overall outcome of the project.

(PCR)

5-2 Lessons Learnt and Recommendations

Please raise any lessons learned from the project experience, which might be valuable for the future assistance or similar type of projects, as well as any recommendations, which might be beneficial for better realization of the project effect, impact and assurance of sustainability.

(PCR)

Attachment

1. Project Location Map
2. Undertakings to be taken by each Government
3. Monthly Report
4. Monitoring report on environmental and social considerations

Annex-7 Major Undertakings to be taken by Each Government

I. Major Undertakings to be taken by the India Side

1. Before the Tender

No.	Items	Deadline	In charge	Cost	Ref.
1	To open Bank Account (Banking Arrangement (B/A))	within 1 month after G/A	DULT		

2. During the Project Implementation

No.	Items	Deadline	In charge	Cost	Ref.
1	To bear the following commissions to a bank of Japan for the banking services based upon the B/A	-	-	-	-
	1) Advising commission of A/P	within 1 month after the singing of the contract	DULT		
	2) Payment commission for A/P	every payment	DULT		
2	To ensure prompt unloading and customs clearance at the port of disembarkation in recipient country	-	-	-	-
	1) Tax exemption and customs clearance of the products at the port of disembarkation	during the Project	DULT		
3	To accord Japanese nationals and/or physical persons of third countries whose services may be required in connection with the supply of the products and the services under the verified contract such facilities as may be necessary for their entry into the recipient country and stay therein for the performance of their work	during the Project	DULT		
4	To ensure that customs duties, internal taxes and other fiscal levies which may be imposed in the country of the Recipient with respect to the purchase of the Products and/or the Services be exempted and/or borne by its designated authority without using the Grant; Such customs duties, internal taxes and other fiscal levies mentioned above include VAT, commercial tax, income tax and corporate tax of Japanese nationals, resident tax, fuel tax, but not limited, which may be imposed in the recipient country with respect to the supply of the products and services under the verified contract	during the Project	DULT ???		
5	To bear all the expenses, other than those to be borne by the Grant Aid, necessary for construction of the facilities as well as for the transportation and installation of the equipment	during the Project	DULT		
6	Equipment procurement and construction work	-	-	-	-
	1) Providing power supply necessary for the provided equipment at Traffic Information Center(DULT) and Traffic Control Center(BTP)	before equipment at the sites	DULT BTP		
	2) Renovating Centers to accommodate the provided equipment, which includes upgrading of air-conditioning system, replacement of electrical fittings and lighting fixtures, refurbishing of interior finishes, if necessary.	before equipment at the sites	DULT BTP		

3. After the Project

No.	Items	Deadline	In charge	Cost	Ref.
1	To maintain and use properly and effectively the facilities constructed and equipment provided under the Grant Aid 1) Allocation of maintenance cost 2) Operation and maintenance structure 3) Routine check/Periodical inspection	After completion of the construction	DULT BTP		

(B/A: Banking Arrangement, A/P: Authorization to Pay)

II. Major Undertakings to be Covered by the Japanese Grant

No.	Items	Deadline	Cost Estimated (Million Japanese Yen)*
1	To provide equipment	-	-
	1) To ensure prompt unloading and customs clearance at the port of disembarkation in recipient country	-	-
	a) Marine(Air) transportation of the products from Japan to the recipient country	during the Project	
	b) Internal transportation from the port of disembarkation to the project site	during the Project	
	2) To install the equipment including testing, training, and commissioning	during the Project	
	Total		

*: The cost estimates are provisional. This is subject to the approval of the Government of Japan.

III. Major Undertakings to be covered by either side (to be discussed)

No.	Items	Deadline	Cost Estimated (Million Japanese Yen)*
1	1) To improve intersections	during the Project	
2	1) Securing space for unpacking work and installation of the equipment, material storing yard, temporary construction yard and waste disposal	before equipment at the sites	
3	1) Removing designated equipment and obstacles from the Project site	-	-
	a) Relocation of existing traffic signal of target sections		
	b) Relocation of existing utility of target roads and intersections		
	Total		

TECHNICAL NOTE – TRAFFIC POLICE
ON THE PREPARATORY SURVEY FOR
THE PROJECT FOR BENGALURU METROPOLITAN REGION ITS
IN THE REPUBLIC OF INDIA

In response to the request from the Government of India, the Government of Japan decided to conduct a Preparatory Survey for the Project for Bengaluru Metropolitan Region ITS (hereinafter referred to as "the Project"), and entrusted the Preparatory Survey to Japan International Cooperation Agency (hereinafter referred to as "JICA").

JICA sent the Preparatory Survey Team for the Outline Design (hereinafter referred to as "the Team") to India. The Team held a series of discussions with the officials of Bengaluru Traffic Police. In the course of the discussions, both sides have confirmed the main items described in the attachment. The Team will proceed to further works.

Bengaluru, July 05, 2016

奥田真人

Masato OKUDA
Chief Consultant
Preparatory Survey Team
Japan International Cooperation Agency
Japan

V. MANJULA, IAS
Commissioner
Directorate of Urban Land Transport
Government of Karnataka
India

Maintenance part in pending.

R. HITHENDRA, IPS
Additional Commissioner
Bengaluru Traffic Police
Karnataka State Police
India

ATTACHEMENT

1. Objective

The objective of meeting with new Additional Commissioner of Traffic Police, Bengaluru is to explain and confirm the Area Traffic Signal Control System and Variable Message Sign System proposed by Grant project.

2. Agenda

- To explain about the items which were already confirmed with the previous Additional Commissioner
- To explain and confirm on the proposed Area Traffic Control System, concept/function of MODERATO, other required improvement e.g. signal phase, pedestrian signals and etc.

3. Discussed and Confirmed Items

a) Item discussed and confirmed/re-confirmed with Traffic Police
   - VMS system and Signal system will be implemented by DULT but operation and maintenance will be carried out by Bengaluru Traffic police.
   - The new signal will be installed by the grant project. The existing signal will be relocated by Traffic police at their own expense.

4. VMS

- The location of VMS was re-confirmed with Traffic Police. The Traffic Police re-confirmed the location of VMS at MG Road, Hanging Bridge and Silk Board. The approval process from road agencies such as BBMP and NHAI will be initiated by DULT.
- The traffic information will be generated by BTIC and transmitted to BTRAC. The messages such as incident and event will be inputted by Traffic Police as necessary.
- At Silk Board, the existing gantry and sign board will be replaced with new VMS gantry and VMS board. DULT will take care of obtaining approval from NHAI.
- The server equipment of VMS and traffic signal will be installed at Traffic Management Centre of Traffic Police.

5. ATCS

- Twenty nine (29) locations of signal were re-confirmed and approved.
- MODERATO will be introduced with focus on area control and reduction of congestion length.
- Fixed line communication between controller and signals at intersection will be adopted.

6. Other Proposed Improvements Explained to Traffic Police

a) By Grant Project
   - Signal phase improvement will be done for smooth and safety traffic.
   - Pedestrian signal improvement will be done for safe crossing with the introduction of separate display type of pedestrian signal.
   - Intersection improvement such as extending sidewalk, moving the cross location and remove the median strip will be done at 29 intersections where new signal will be installed.

- Change to left-hand traffic by signal indication improvement will be done at Victoria Rd-General KS Thimayya Rd-St Philomena.

b) By Traffic Police

- Publication to notify and let people understand and accustomed to the above improvements will be done by Traffic Police.

7. Others

Maintenance plan for maintenance of system shall be proposed by study team. The maintenance plan shall include aspects such as procuring maintenance contractor, availability of spare parts with local suppliers for all the systems installed by the grant project, cost plan and etc,.

Annex-1 Items Discussed and Confirmed with traffic police in the Past

Annex-2 Area Traffic Control System

Annex-3 Signal Phase Improvement

Annex-4 Pedestrian Signal Improvement

Annex-5 Improvement of Intersections.

Annex-6 Required Organization Structure

Attachment-1

Items Discussed and Confirmed with Traffic Police in the Past

- Area Traffic Signal Control System (ATCS) at selected intersections will be introduced by Japanese Grant Project.
- Variable Message Sing Board at selected locations will be introduced by Japanese Grant Project.

The details are explained hereinafter.

1.1 Area Traffic Signal Control System (ATCS)

The traffic signal which automatically controls optimal signal timing according to the traffic volume measured by roadside sensors will be introduced.

(1) Candidate Corridors Recommended by Traffic Police

The following four candidate corridors were recommended by Traffic Police.

1. Old Madras Road
2. MG Road
3. Hosur Road
4. Majestic

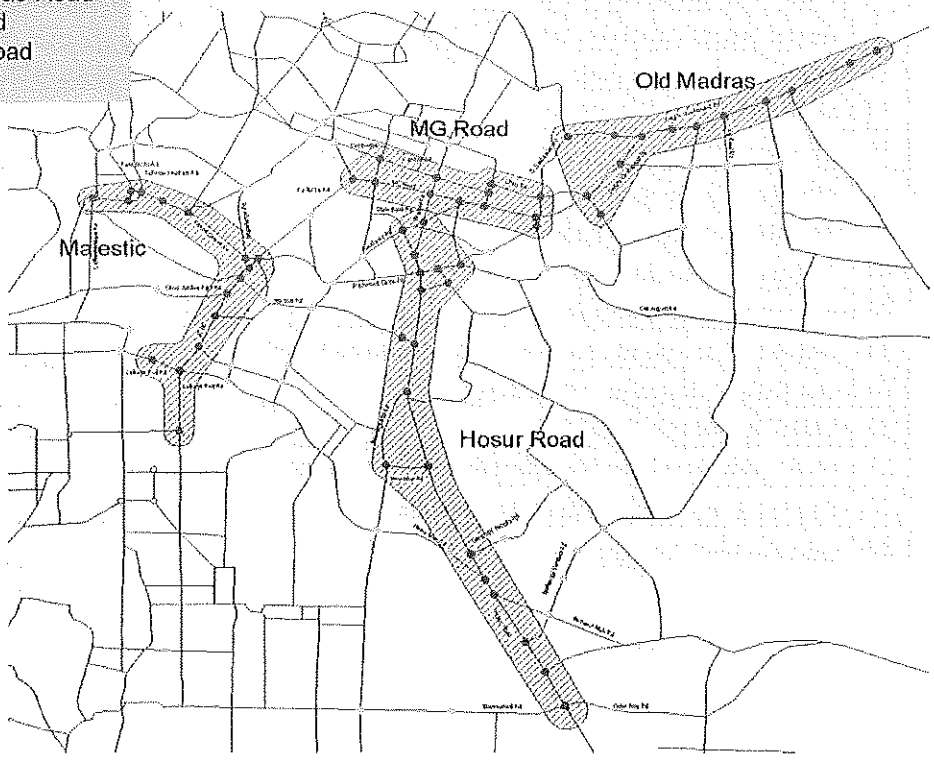


Figure 0-1 Candidate Corridors Recommended by Traffic Police

(2) Intersections Identified by JICA Survey Team

Based on the corridors recommended by Traffic Police, JICA Survey Team selected the following 29 intersections for Traffic Signal Control System.

Table 0-1 Identified Intersection for Traffic Signal Control System

	Intersection Name	Area
1	Queens Statue Circle Junction (Jewels De Paragon)	MG Road
2	Anil Kumble Circle Junction	MG Road
3	Arts & Craft Circle Junction	MG Road
4	Mayo Hall Junction	MG Road
5	Webbs Circle Junction	MG Road
6	Trinity Circle Junction	MG Road
7	General KS Thimayya Road-Trinity-Church Road	MG Road
8	Begum Mahal Junction	MG Road
9	Adigas Junction (Ulsoor Rd Dickenson Rd)	MG Road
10	Manipal Centre Junction	MG Road
11	Kamraj Road Junction	MG Road
12	Shivaji Nagar Intersection Junction (BRV)	MG Road
13	OPERA Junction	Hossur Road
14	Ashirwadam Junction	Hossur Road
15	Old Police Station Junction	Hossur Road
16	Ashok Nagar Junction (Shoolay circle)	Hossur Road
17	Johnson Market Junction	Hossur Road
18	Mother Theresa Junction	Hossur Road
19	Campbell Road Junction	Hossur Road
20	D'Souza Circle Junction	Hossur Road
21	Kensington Oval Junction	Old Madras Road
22	Tamari kannan Junction	Old Madras Road
23	Anjeneya temple Junction	Old Madras Road
24	OM Rd & Double rd Junction (Police Station Junction)	Old Madras Road
25	OM Rd & Indiranagar 100ft Junction	Old Madras Road
26	CMH Rd Adarsh Theater Jn	Old Madras Road
27	Swami Vivekananda Rd-Cambridge Road-Bazaar st	Old Madras Road
28	OM Rd & Indiranagar 80 Ft. Rd. Junction	Old Madras Road
29	Garudal Mall Junction	Hossur Road

The locations of the 29 intersection are shown on the map in the figures below.

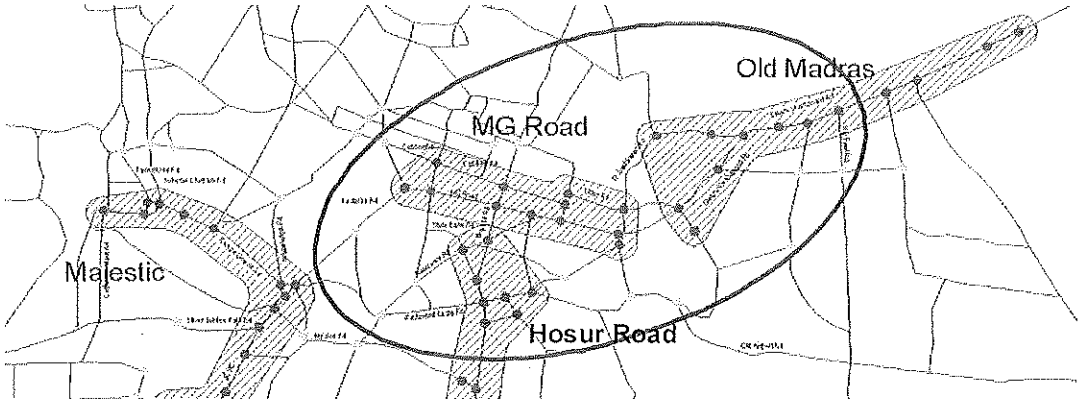


Figure 0-2 Identified 29 Intersections

Figure 0-3 Identified Intersections in MG Road Area

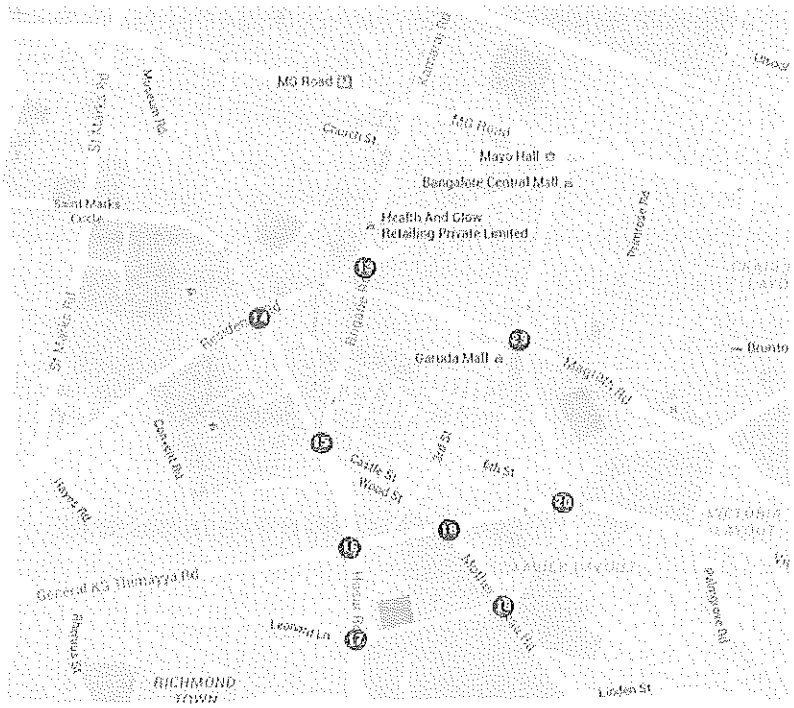


Figure 0-4 Identified Intersections in Hosur Road Area

Figure 0-5 Identified Intersections in Old Madras Road Area

(3) Agreed Items of Traffic Signal with Traffic Police

The following items have been agreed with Traffic Police

- New traffic signals at the target intersection will be installed by the vendors procured in grant project.
- The existing traffic signals at the above intersection will be relocated by Traffic Police at their own expense.
- The operation and maintenance of the new traffic signals will be handled by Traffic Police after handover.

1.2 Variable Message Sign Board (VMS)

(1) Purpose and Function of VMS

- The expected travel time from the location of VMS to the major landmark ahead and congestion level will be displayed.
- The expected travel time and congestion level will be calculated at Bengaluru Traffic Information Centre (B-TIC) and automatically shown on VMS.
- The necessary information e.g. traffic accident, traffic regulation and others will also be manually input by Traffic Police on their own decision as necessary and displayed by the same VMS.

(2) Number and Selected Location of VMS

Three (3) VMS will be installed by the grant project. The following locations were selected by JICA Survey Team:

1) MG Road at Trinity Metro Station

2) KR Puram Junction at Hanging Bridge

3) Silk Board Junction at Silk Board

The locations are mapped in the figure below.

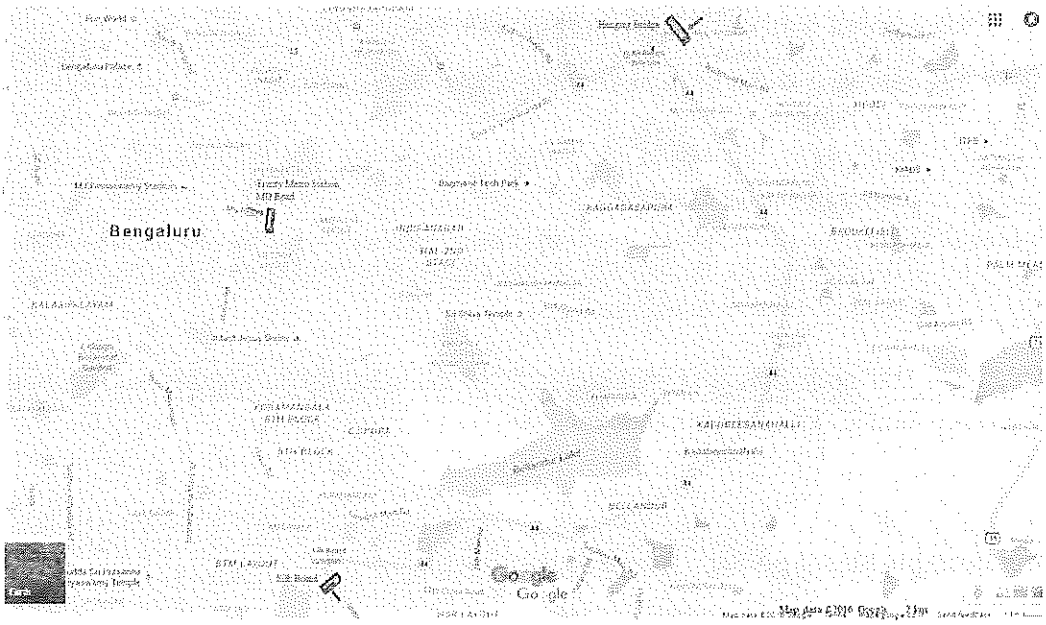


Figure 0-6 Selected Locations of VMS

(3) Image of VMS

The figures below show the images of VMS.

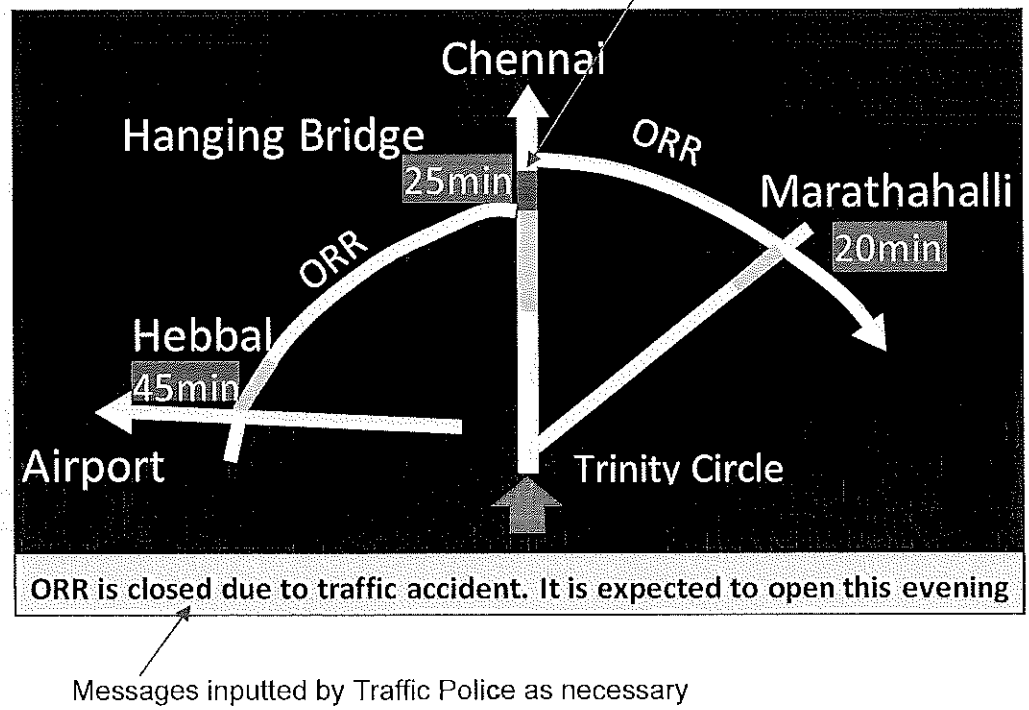


Figure 0-7 Example of VMS (MG Road at Trinity Metro Station)

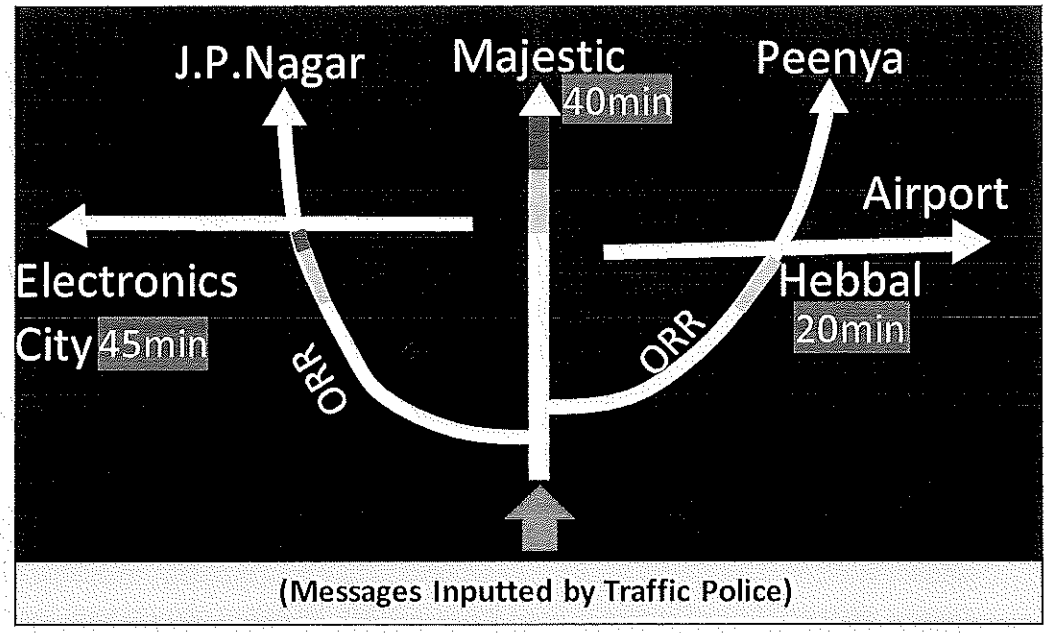


Figure 0-8 Example of VMS (KR Puram Junction at Hanging Bridge)

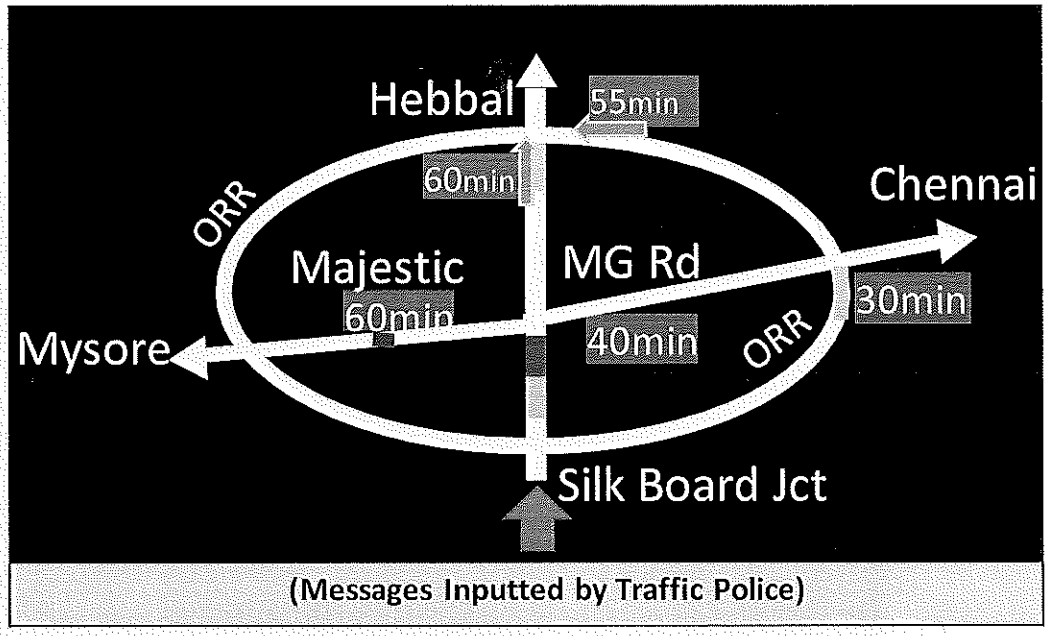


Figure 0-9 Example of VMS (Silk Board Junction at Silk Board)

2 Items to Be Confirmed with Traffic Police

2.1 Installation Location of ATC and VMS Server

Different servers will be installed for various systems prepared by Grant project. It is proposed that ATC and VMS servers are prepared under BTRAC and all other servers are prepared under B-TIC. Based on the discussions with KSDC, it is proposed to install servers in KSDC.

Therefore, Traffic Police require to confirm their acceptance to install ATC and VMS servers in KSDC premises and connect the servers in KSDC to BTRAC control centre through a secure point to point network connection.

2.2 Installation of VMS (MG Road at Trinity Metro Station and Silk Board Junction)

(1) MG Road at Trinity Metro Station

JICA Survey Team carried out the field survey and it was found that the location shown in the picture below is considered best in terms of visibility, available space for gantry, distance from Trinity Circle which is a major diverting point ahead, and etc.

The field survey found that there is no other appropriate location other than below.

It will be installed closed to the Trinity Metro Station building structure.

JICA Survey Team would like to confirm whether there is no particular problems in view of Traffic Police.

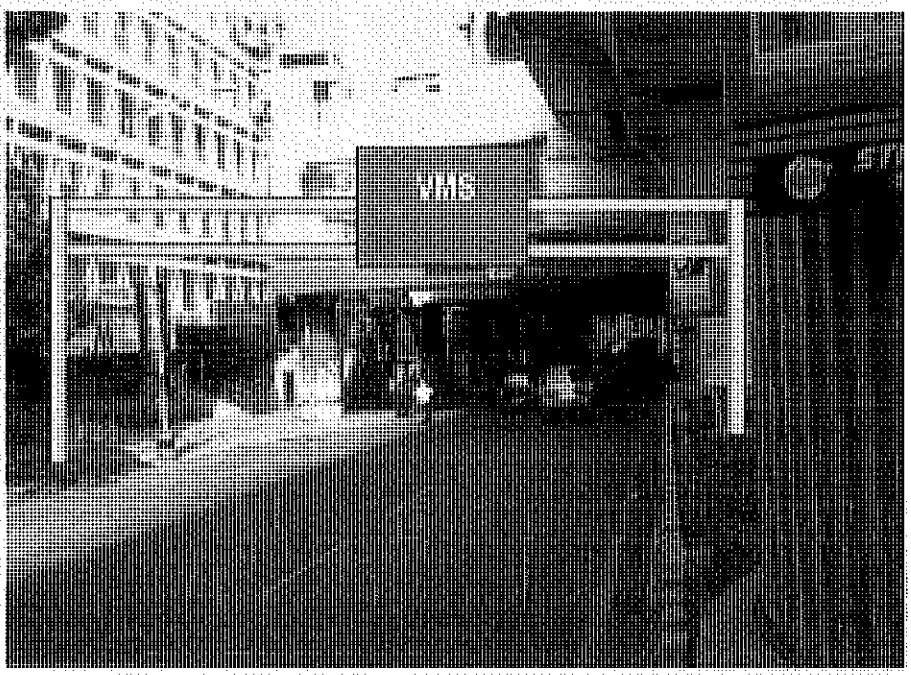


Figure 2-1 Proposed Location of VMS on MG Road at Trinity Metro Station

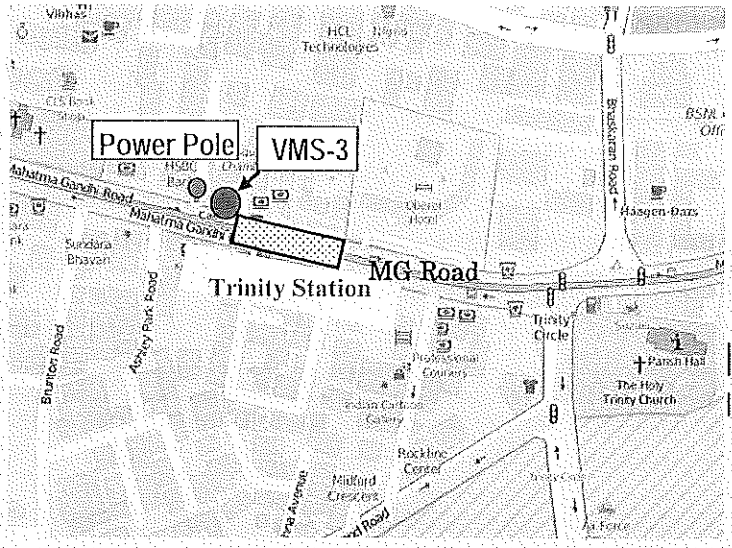


Figure 2-2 Proposed Location on the Map

(2) Silk Board Junction

JICA Survey Team carried out the field survey and it was found that the location shown in the picture below is considered best in terms of visibility, available space for gantry, distance from Silk Board Junction which is a major diverting point ahead, and etc.The field survey found that there is no other appropriate location other than below.

There are existing sign boards on the gantry. However the field survey found that there is no other appropriate location other than here. Thus, it is proposed that

- To remove the existing gantry by the grant project,
- To install new gantry by the grant project,
- To place VMS on the new gantry, and
- To place the existing sign boards on the new gantry as shown below.

JICA Survey Team would like to confirm whether this proposal is acceptable.

Figure 2-3 Existing Sign Boards and Gantry at Silk Board Junction

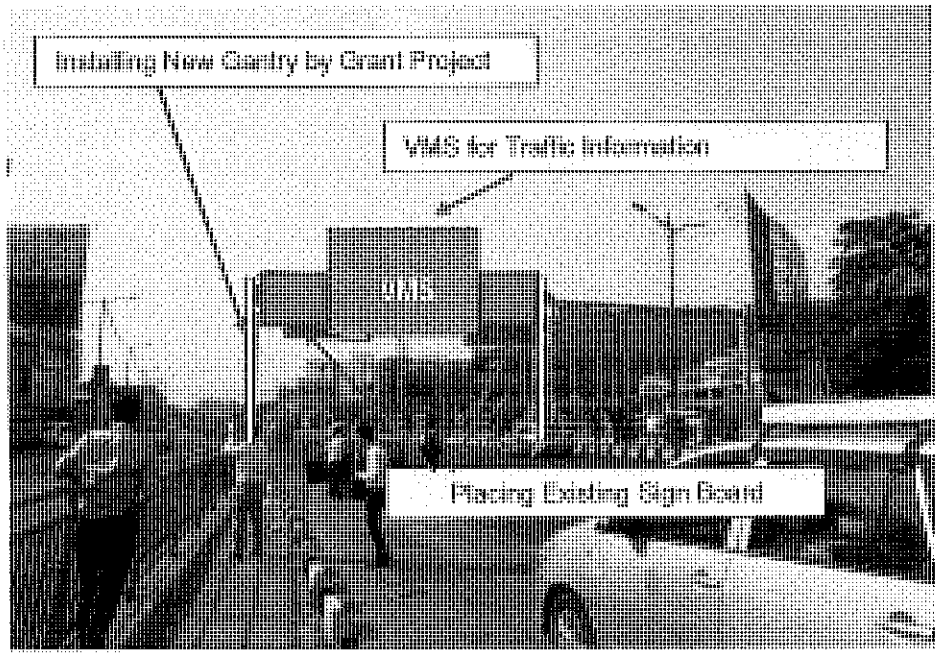


Figure 2-4 Proposed Installation and Arrangement at Silk Board Junction

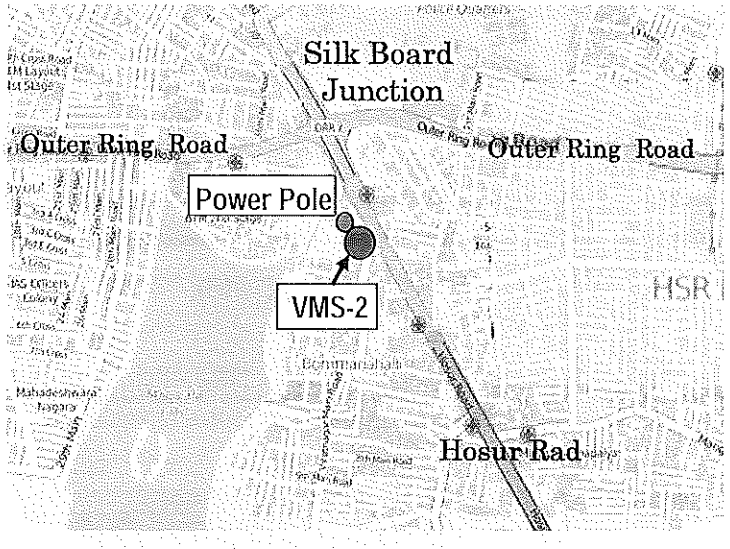


Figure 2-5 Proposed Location on the Map

(3) Hanging Bridge

JICA Survey Team carried out the field survey and it was found that the location shown in the picture below is considered best in terms of visibility, available space for gantry, distance from Hanging Bridge which is a major diverting point ahead, and etc.

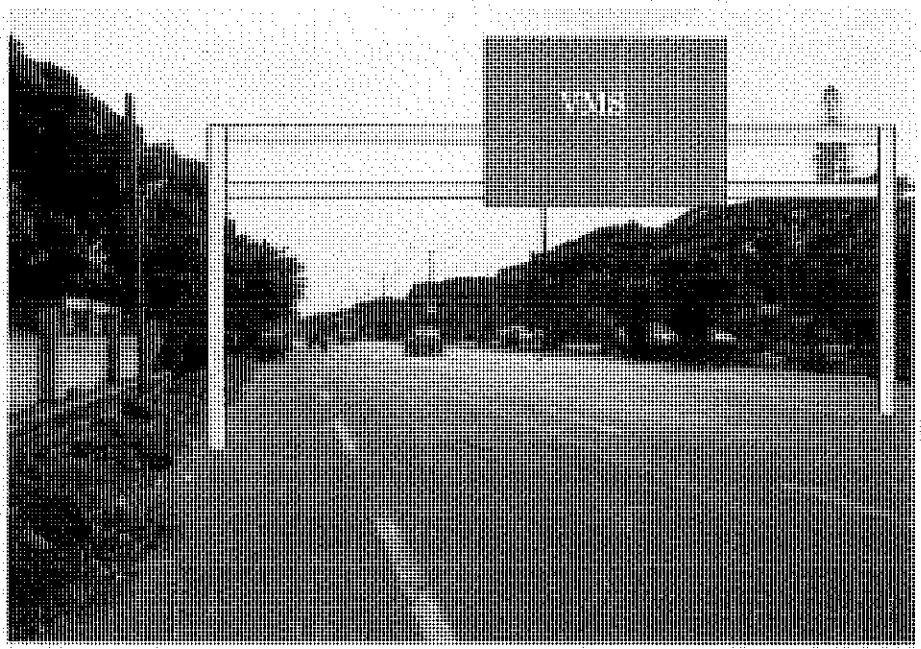


Figure 2-6 Proposed Location of VMS at Hanging Bridge

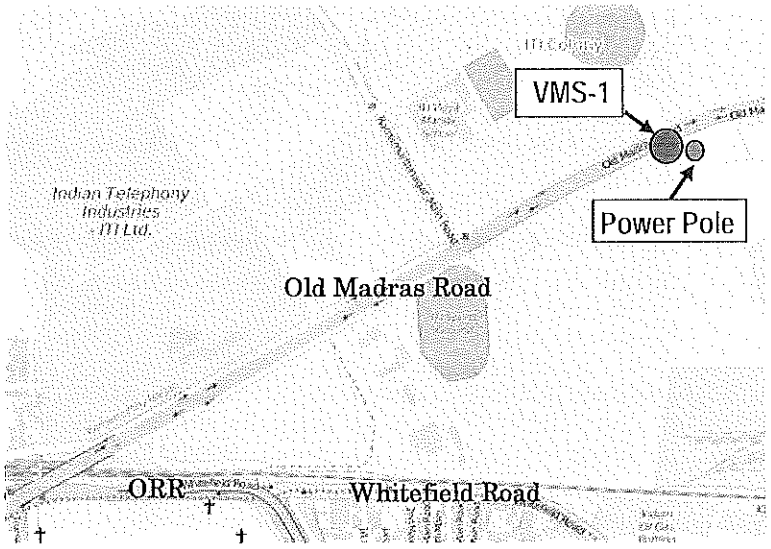


Figure 2-7 Proposed Location on the Map

2.3 B-TIC: Bengaluru Traffic Information Centre

Bengaluru Traffic Information Centre (B-TIC) will be developed by the grant project for the purpose of dynamic traffic information provision and utilization of quantitatively measured data on traffic.

- Major input data: BMTC Bus Probe Data
- Major output information: Congestion information on major road to be provided from VMS and Internet

B-TIC will generate the dynamic traffic information based on the major input data. The generated dynamic traffic information will be provided through VMS and Internet.

B-TIC will be developed and operated under jurisdiction of DULT. VMS will be prepared as one component of B-TIC. VMS will be operated and maintained by **Traffic Police.**

The basic configuration of B-TIC is shown in the figure on the next page.

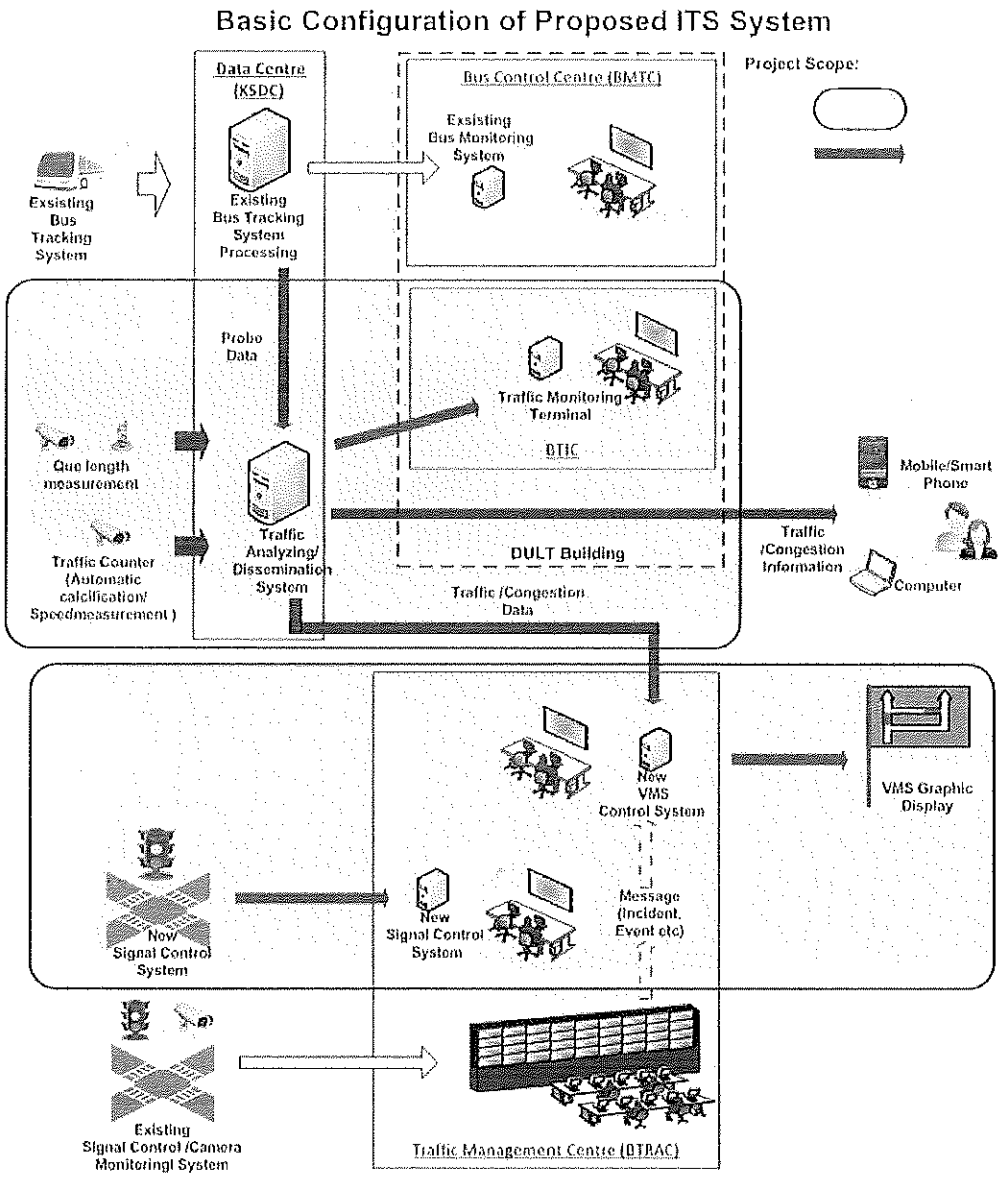


Figure 2-8 Basic Configuration of B-TIC

2.4 Demarcation of Related Agency: Traffic Police and DULT

The demarcation of the related agencies of ITS is summarized below.

Table 2-1 Demarcation of Related Agency for ITS

ITS Component		Implementation (Procurement)	Operation & Maintenance	Equipment Ownership
B-TIC	Centre Other Roadside Equipment	DULT	DULT	DULT
	VMS (*1)	DULT	**Bengaluru Traffic Police**	**Bengaluru Traffic Police**
ATCS (*2)		DULT	**Bengaluru Traffic Police**	**Bengaluru Traffic Police**

*1: Variable Message Sign Board, *2: Area Traffic Control System

Annex-2

Area Traffic Control System

1. Basic Concept of Signal Control

1.1. Basic System Configuration

The traffic condition varies depending on various factors such as time or day (rush-hour, normal-hour, off-hour, holiday, weekday, etc.). In order to alleviate traffic congestion and reduce the number of traffic accidents it is important to optimize the signal control based on the current traffic condition.

The traffic control center gathers the real-time traffic data from the vehicle detectors on the road. Then the central computer analyzes the data and gives the appropriate signal parameters to each signal. There are 3 fundamental parameters of traffic signal: Cycle, Split and Offset shown in Table 1.

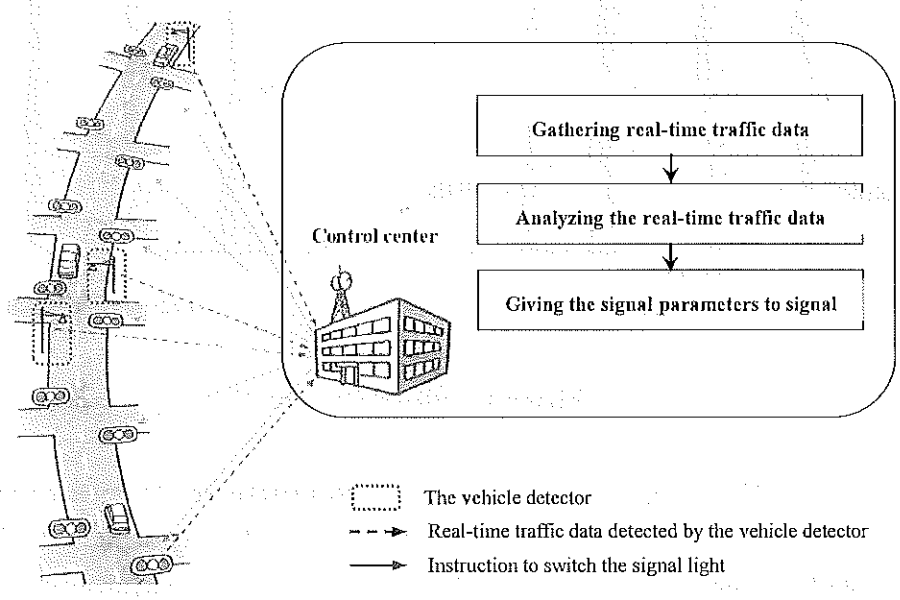
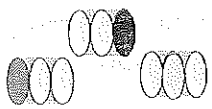
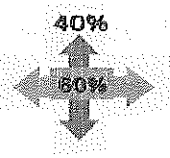
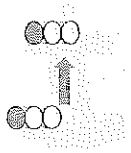


Figure 1 Basic System Configuration

Table 1 Fundamental Signal Parameters

Cycle	Split	Offset
		
Time required for a complete sequence of indications e.g. from green indication to next green indication.	Portion of time allocated to each phase within a cycle at an intersection.	Time difference of coordinated phases between two traffic signals.

1.2. Signal Coordination

Signals installed at short distance need to be coordinated to offer green wave, in which vehicle that has passed an intersection during green will be given green at next signal to allow the vehicle to pass through next intersection without stopping. The reduction of waiting time at signals is illustrated in Figure 2 . To provide green wave, neighboring two signals must operate with the same cycle length and they must be coordinated.

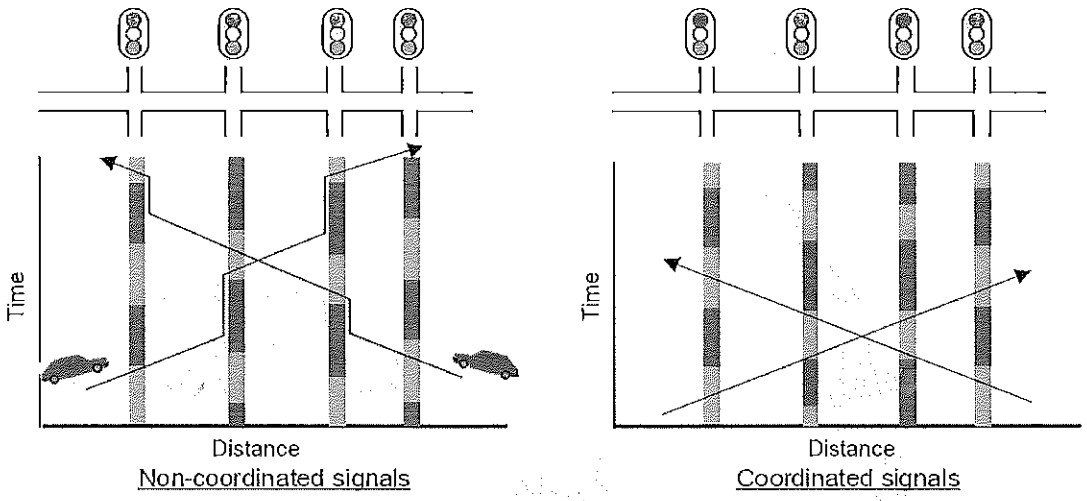


Figure 2 Signal Coordination

2. Required Measures: Reduction of Congestion Length and Area-wise Control

As shown in the previous chapter of technical note, the sections of MG road, Old Madras road and Hosur road in the core area of the city and adjacent areas of these sections are selected as the target area of the traffic single of the grant project.

These roads, MG road, Old Madras road and Hosur road, are major trunk roads in Bengaluru. In particular, the congestion is severe on the sections of these roads in the core area of the city.

It was found by the previously conducted traffic surveys and related existing studies in Bengaluru that it is critical to reduce the congestion length on this target areas.

It is also important that the traffic flow in the adjacent areas with chronic congestion shall be smoothened, synchronizing with these trunk roads by 'area-wise control'. For example, it will be more effective to synchronize the signals on

Gabon road running in parallel with MG road and in the areas in the vicinity of Brigade road.

Therefore, reducing congestion length on these target areas by area-wise control is important.

2.1. Area-wide Signal Control

2.1.1. Area Segmentation

Regarding the wide area (e.g. Bengaluru city), it includes various areas which are in different traffic conditions. For the area-wide signal control it is essential that the signal control is conducted by small area in an analogous the feature of traffic.

The system makes a sub-area and conducts the signal control by the sub-area adapting to the feature of the traffic condition of each area. Figure 3 shows the example of the sub-area (sub-area1~3). The sub-area is composed of key intersections which is on an arterial road and other normal intersections.

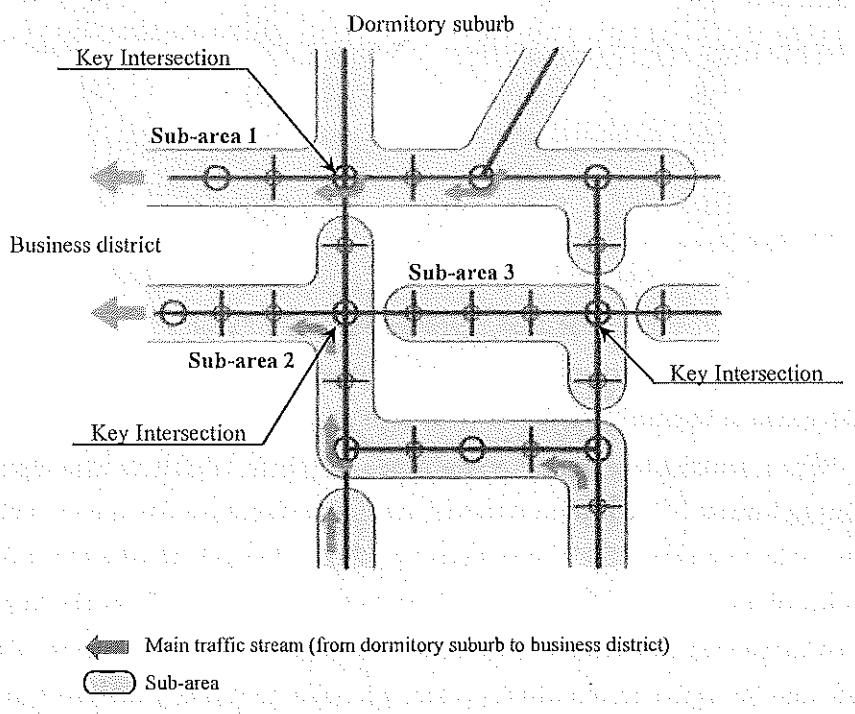


Figure 3 Example of Sub-areas

2.1.2. Dynamic Transition of Sub-area

The traffic condition varies depending on even a period of time in a day. In order to adapt to the temporal variation of traffic condition, the system dynamically changes the conformation of the sub-area by integrating and cutting off sub-areas.

The example of the dynamic transition of the sub-area is shown in Figure 4. Type A is the conformation in a rush hour. In the rush hour neighboring sub-areas are connecting along the main traffic stream (from dormitory suburb to business district). On the other hand, in holiday they are connecting along the main traffic stream (from dormitory suburb to resort area).

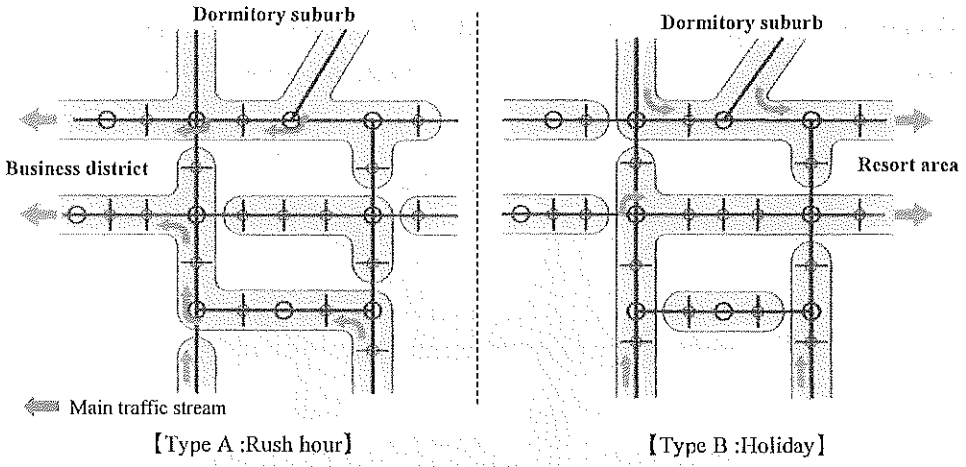


Figure 4 Transition of Sub-area

2.2. Decrease of Queue Length

When congestion occurs the decrease of queue length is also essential for the signal control. The system controls signals to decrease the queue length based on the detection of it. The vehicle detector (Queue Length Measure) is installed at the point of about 150m, 300m, and 500m (maximum) away from the key intersection and measures how long the queue is running. The vehicle detector (Inflow Traffic Volume Measure) is installed at close roadside to the key intersection and detects the inflow volume around the traffic lane 50m away from the key intersection. Figure 5 shows the configuration of queue length measurement.

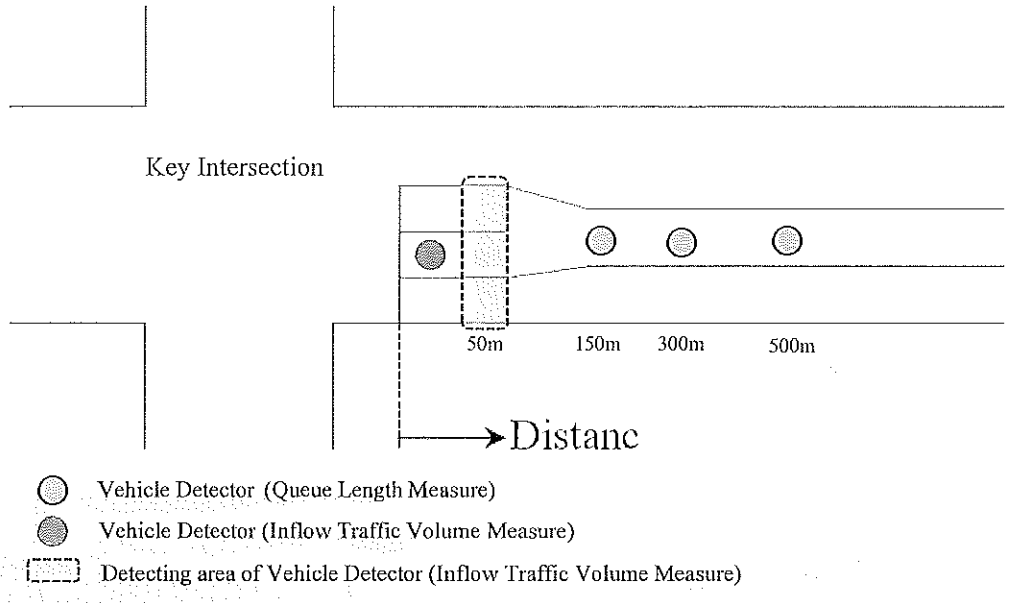


Figure 5 Configuration of Queue Length Measurement

3. Vehicle Detector

3.1. Type of Vehicle Detector

The type of vehicle detector for the real-time vehicle detection is shown in Table 2.

Table 2 The list of Vehicle Detector

Type	Function and Installation
Vehicle Detector (Queue Length Measure)	It measures the queue length heading to the key intersection. It is installed roadside at the point of about 150m, 300m, and 500m (maximum) away from the key intersection.
Vehicle Detector (Inflow Traffic Volume Measure)	It measures the inflow traffic volume at the close roadside to key intersection. It is installed adjacent roadside of Key intersection.
Vehicle Detector (Traffic Volume Measure for Offset)	It measures the traffic volume for the setting of offset time. It is installed at the middle point between two key intersections.

3.2. Configuration

The configuration of vehicle detectors is shown in Figure 6.

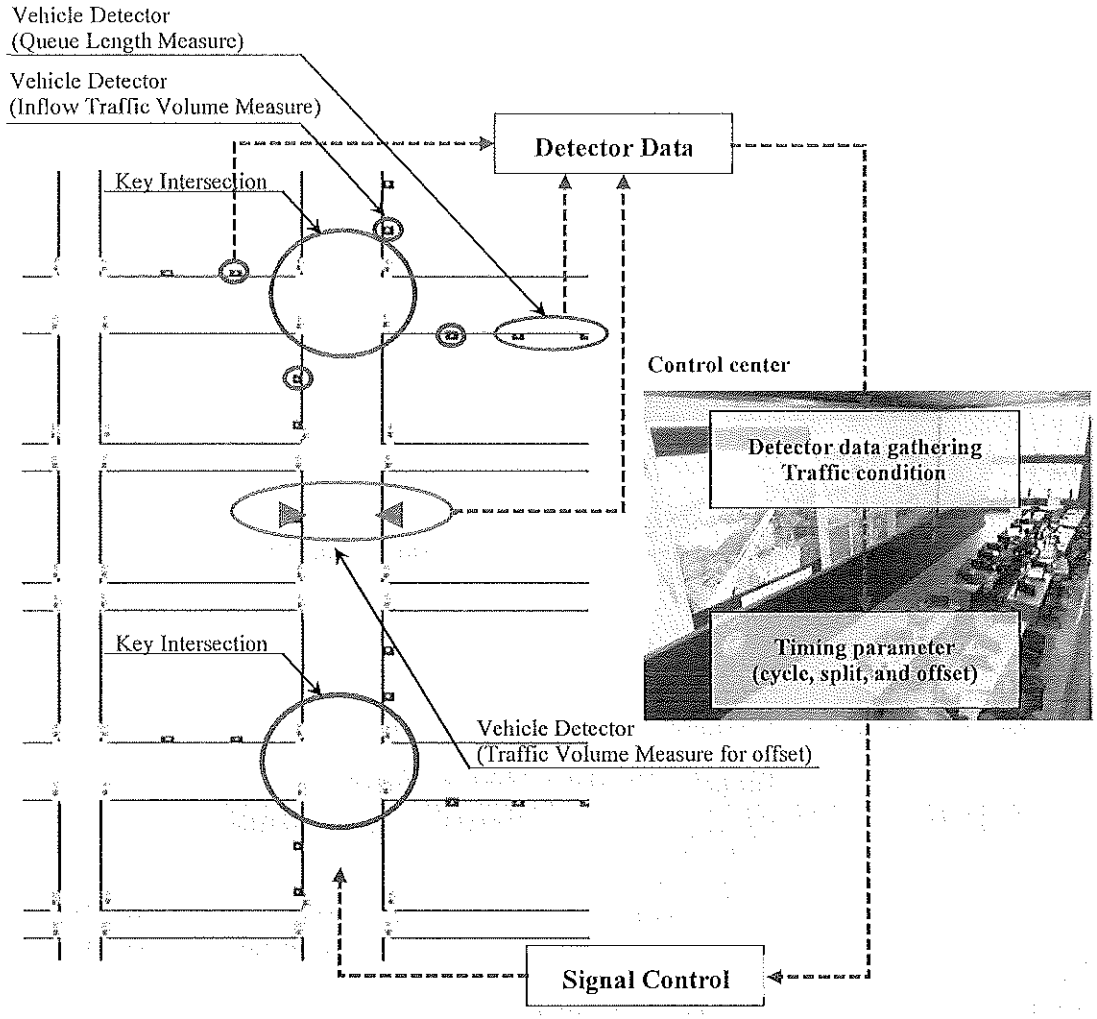
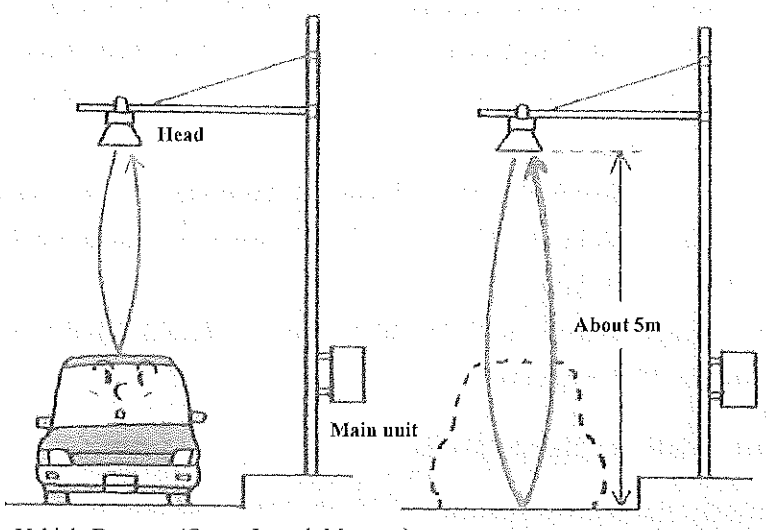


Figure 6 Configuration of vehicle detectors

3.3. Equipment

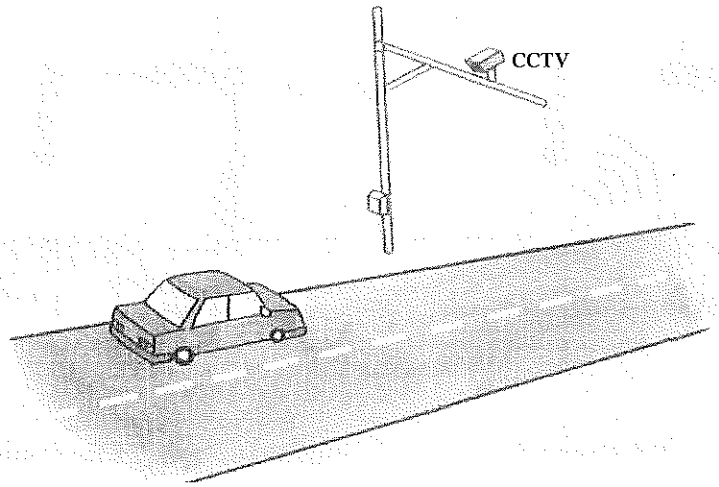
The ultrasonic sensor shown in Figure 7 is used for the vehicle detector (Queue Length Measure) and the vehicle detector (Traffic Volume Measure for offset). It detects the vehicle by calculating the reflecting time of ultrasonic.

The CCTV sensor shown in Figure 8 is used for the vehicle detector (Inflow Traffic Volume Measure). It detects vehicles flowing at intersection by image processing.



・Vehicle Detector (Queue Length Measure)
・Vehicle Detector (Traffic Volume Measure for offset)

Figure 7 Image of Ultrasonic Sensor



・Vehicle Detector (Inflow Traffic Volume Measure)

Figure 8 Image of CCTV Sensor

3.4. Communication Method of Traffic Signal at Intersection

(1) Wifi Communication or Fixed Line Communication

There is a discussion as to which type of communication method, either Wifi connection or fixed line connection, shall be applied to traffic signal at intersection.

The fixed line connection needs to be applied due to the following reasons;

- Critically high reliability and instantaneousness are required for communication between controller and signals at intersection.
- All signals need to be synchronized (Green, Yellow, Red). There is a chance that the delay occurs at any of the signals due to transmission delay by Wifi communication.
- There is a possibility that Green is indicated by all signals due to transmission delay by Wifi connection. (Green will be blinked by fail-safe function in this case)
- The signal is usually controlled by one second. It is difficult to control by one second by Wifi connection.

(2) Aerial Cable or Buried Cable

The buried cable is recommended due to the following reason:

- The aerial cable spoils sight view.
- The aerial cable is exposed to danger of being disconnected.

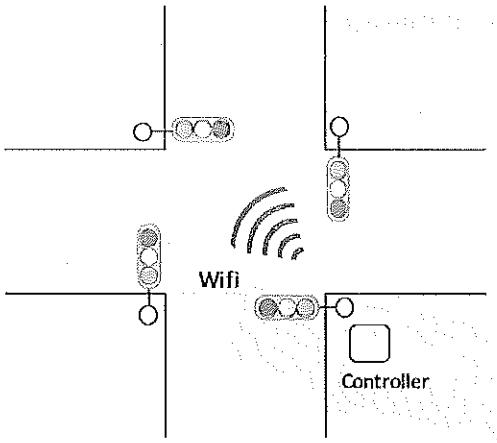


Figure 9 Wifi Connection

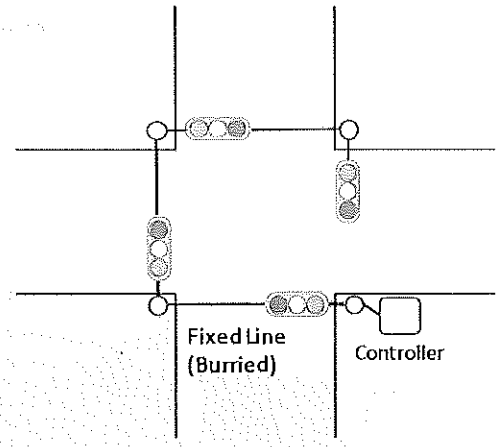
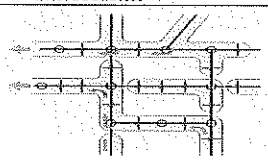
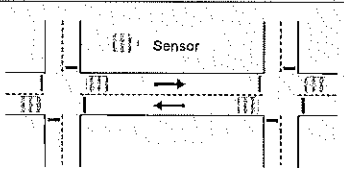
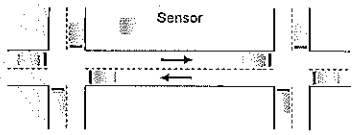


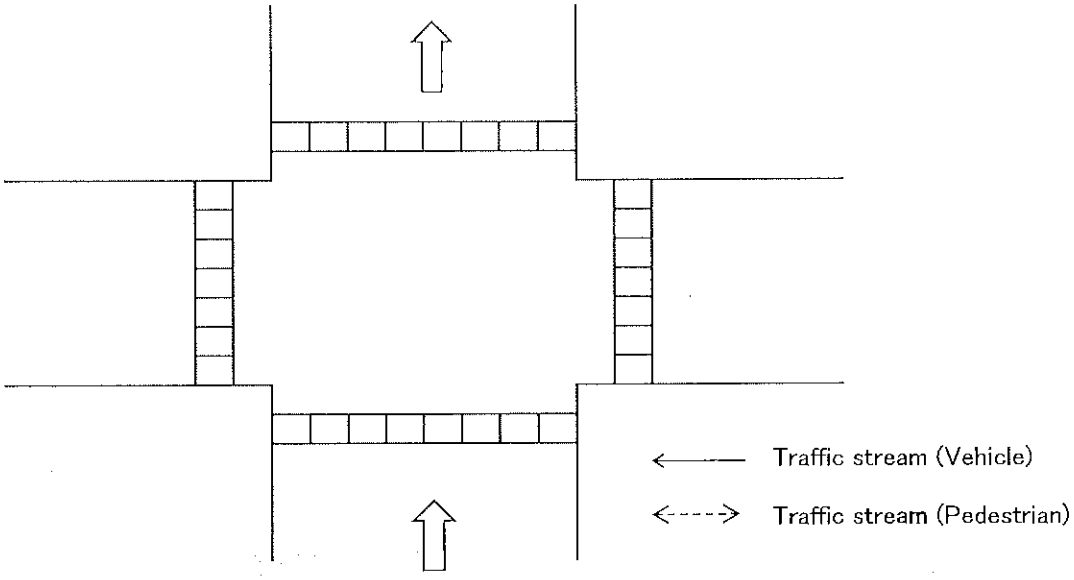
Figure 10 Fixed Line Connection

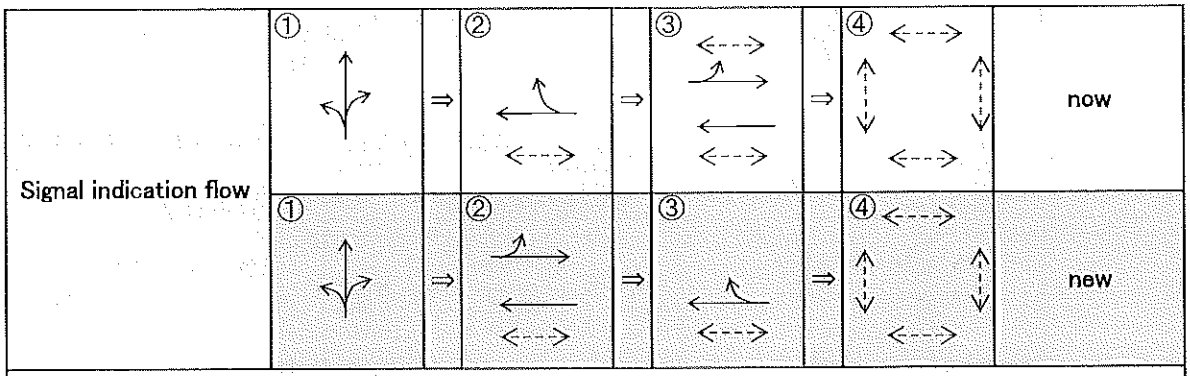
4. Comparison of Signal Control Method

Table 3 Comparison of Signal Control Method

Method	MODERATO	SCOOT	SCATS
Meaning	Management by Origin-DEstination Related Adaptation for Traffic Optimization	Split Cycle Offset Optimization Technique	Sydney Coordinated Adaptive Traffic Systems
Developed Country	Japan	United King dam	Australia
Purpose	1. Decrease of congestion volume and Que length 2. Area wise control based on key intersections.	1. Adjustment of green signal timing by forecasting arrival time of cluster of vehicle. 2. Line wise traffic control	1. Optimize split by degree of saturation and control offset by the pattern depends on the traffic volume 2. Point wise and line wise control
			
Sensor location	1. At entrance of key Intersection 2. Traffic volume sensor at entrance 3. Que length sensor at 150m, 300m and 500m from Intersection	1. At exit of Intersection 2. Traffic volume sensor at 150/200m from Intersection	1. At entrance of intersection 2. Traffic volume sensor at entrance of intersection
Control Index	1. Traffic Volume 2. Que length 3. Travel time	1. Arrival time forecast 2. Congestion or not 3. Traffic volume/duration of Green signal rate	1.Traffic volume/duration of Green signal rate
Sub Area	Subarea is combined and separated automatically based on traffic situation	Fixed	Non
Evaluation	Target area is congested area wise based on MG Road. Area wise control and reducing the que length by MODERAT is most effective for the target area.		

Signal Phase Improvement





【Basic approach for the signal indication】

1. Simplify the signal indication
2. Same signal indication to the same directional road
3. Keep the sequency of the vehicle stream
4. Keep the sequency of the pedestrian stream
5. Eliminate the danger order of the signal indications

Besides, if necessary improvement of intersection (extension/relocation of sidewalk and signals, road marking, etc,.) shall be done.

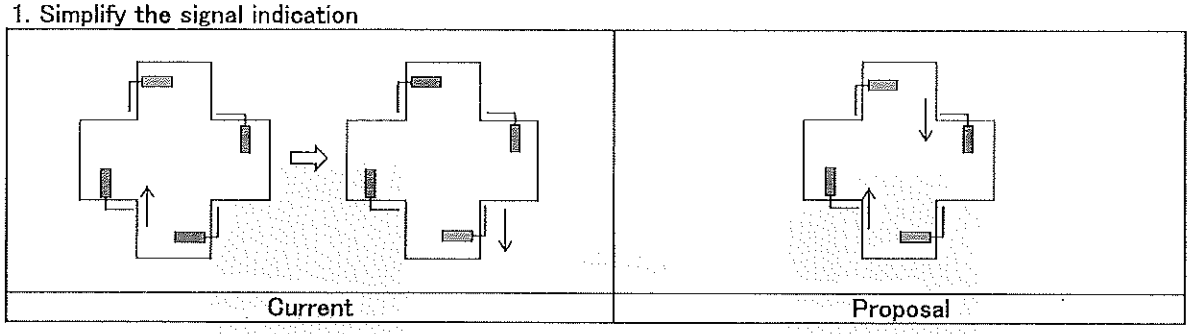
【Proposal signal indication for Anil Kumble Circle Junction】

In order to decrease the following potential dangers in the current signal indication flow, the indication order of ② and ③ is switched in the new flow.

1. In the current flow (②⇒③), right turning vehicle could ignore the signal light induced by the traffic stream of lane for through traffic.
2. If this is the case mentioned above, head on crash could happen between the right turning vehicle and the vehicle coming from opposite side.
3. In order to decrease the danger under the current signal indication flow, Longer cycle time have to be set to keep the clearance between the right turning vehicle and the opposite side vehicle. But, longer cycle time leads to the increase of a waiting time, which could cause further congestion and red light running.

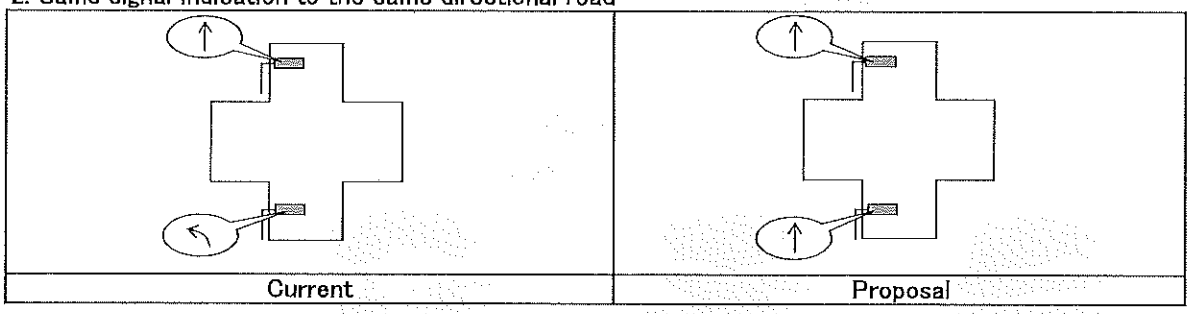
The images of the basic approach for signal indication are shown below.

1. Simplify the signal indication



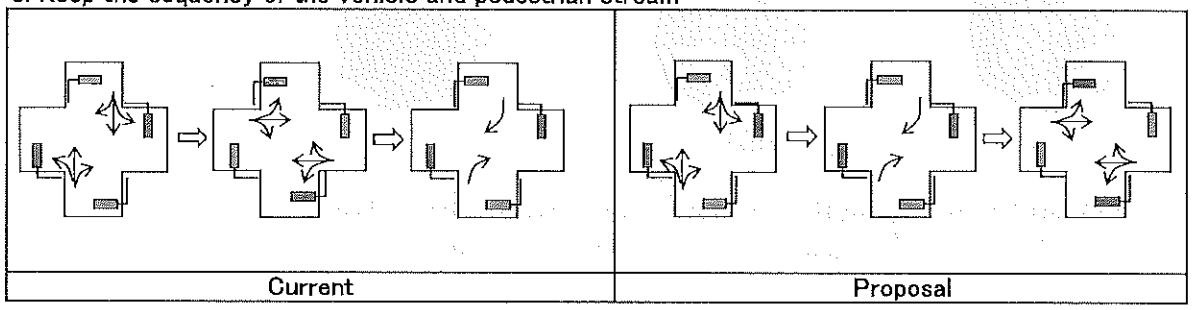
Current	Proposal

2. Same signal indication to the same directional road



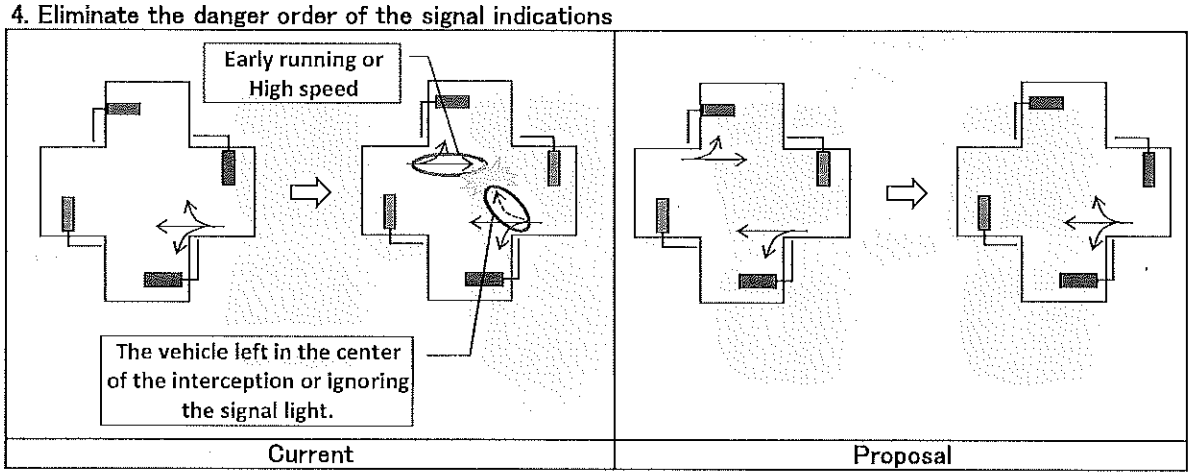
Current	Proposal

3. Keep the sequency of the vehicle and pedestrian stream



Current	Proposal

4. Eliminate the danger order of the signal indications

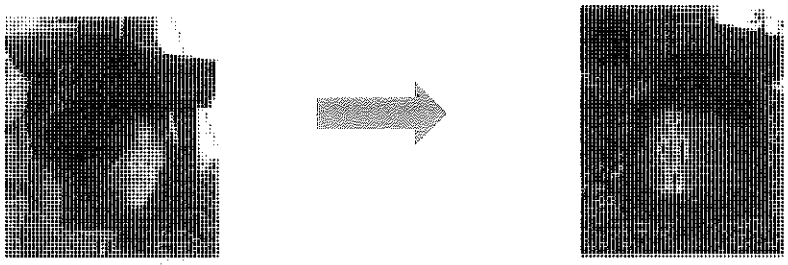


Current	Proposal

←——— Traffic stream (Vehicle)

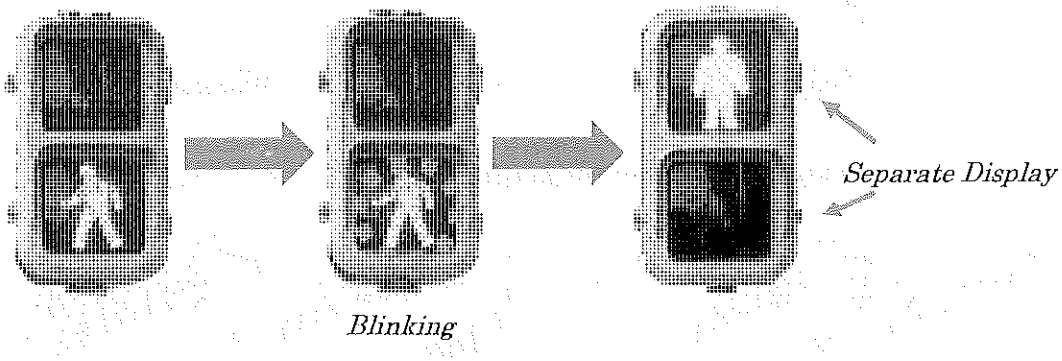
Pedestrian Signal Improvement

<Current Pedestrian Signal>



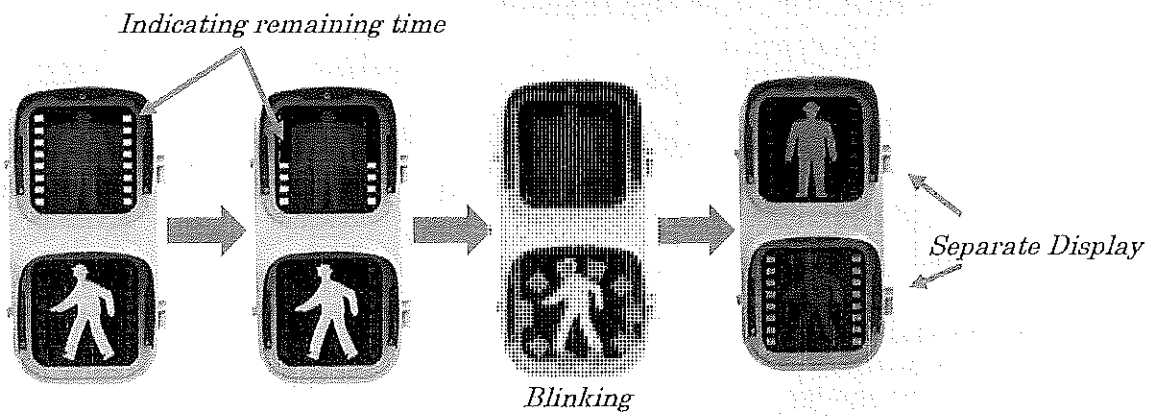
<Proposed Pedestrian Signal>

(Standard Type)



It blinks for duration of time for pedestrian to cross before it becomes red.
Green and red are indicated by separated display for clear recognition.

(Remaining Time Display Type)



It blinks for duration of time for pedestrian to cross before it becomes red.
Green and red are indicated by separated display for clear recognition.
It indicates remaining time for both green and red.

Annex-4

Pedestrian Signal Improvement

Item	Current Pedestrian Signal	Proposed Pedestrian Signal
Light Emitting Device	LED or Light Bulb	LED
Lamp Unit	Single display for green and red	Two separated displays for green and red
Displaying Method	Green → Red (Most signals do not have green blinking function before changing to red.)	Green → Green Blink → Red
Concern/Advantage	<Concern> - Perceptibility of signal indication is limited because both green and red are displayed on single display unit. - Pedestrian does not know when it becomes red due to absence of blinking time resulting in greater danger such as pedestrians being left in the middle of crossing when it becomes red, and etc.	<Advantage> - Green and red are more easily and clearly recognized by pedestrian because they are separately indicated. - Pedestrian knows remaining time before it becomes red so that they can take necessary action such as not start crossing, hurrying up completing crossing and etc. resulting in reduced probability of being left in the middle of crossing and so on. - Long life time of signal (LED)
Remark	In most cases, the green time is set at approx. 10 seconds which is too short to cross. This is considered one of the factors which induce pedestrians to ignore signal.	The required green time will be set according to the distance of pedestrian crossing.
Others		Publication of new display method is necessary.

Pedestrian Signal Improvement

Necessity of Publication of Pedestrian Signal

The indication of the recommended pedestrian signal will be different from the ones which are applied to the current pedestrian signals in Bengaluru.
People are not used to the new one. Thus publication to notify and let people accustomed to is required under the responsibility of Traffic Police.

Annex-5

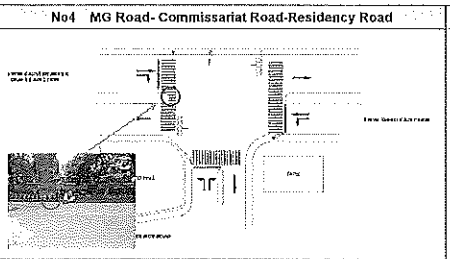
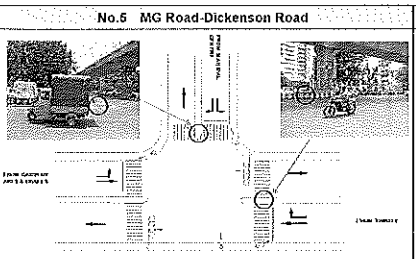
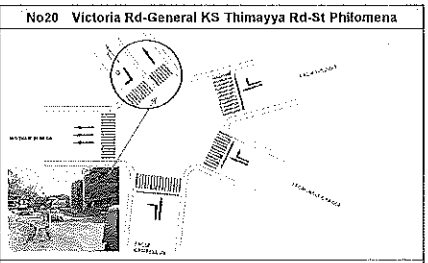
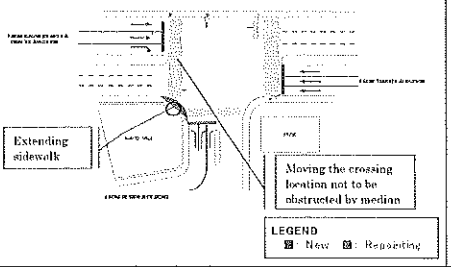
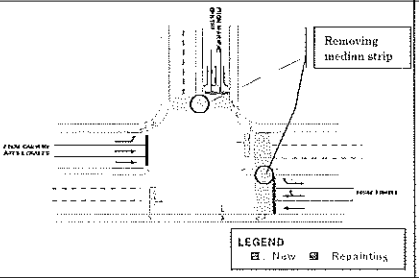
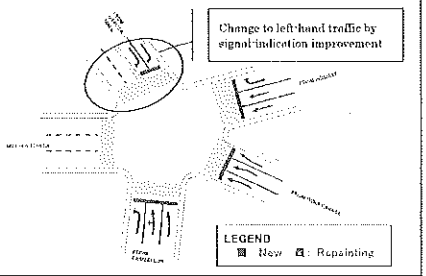
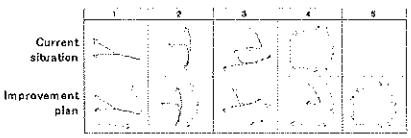
Improvement of Intersection together with Installation of Traffic Signal and Pedestrian Signal (Examples)

<Reason: Improving Intersection together with Installation of Traffic Signal and Pedestrian Signal>

1. To maximize effect of new signals, 2. To assure safety of pedestrian

<Major Improvement Items>

1. Road Marking (Pedestrian Crossing, Lane, Direction Arrow, etc.) 2. Splitting lane, 3. Extending sidewalk, 4. Removing obstacles, 5. Other minor improvements

	No4 MG Road- Commissariat Road-Residency Road	No.5 MG Road-Dickenson Road	No20 Victoria Rd-General KS Thimayya Rd-St Philomena
Current Situation			
Improvement Plan			
Issue	・The pedestrian crossing is blocked by obstacles. ・The crossing time of pedestrial signal is too short to cross. ・The pedestrian signal is almost invisible.	・The pedestrian crossing is blocked by obstacles. ・The crossing time of pedestrial signal is too short to cross. ・The pedestrian signal is almost invisible.	Right-hand traffic causing confustion of driver, thereby higher possibility of accident
Improved items	・Moved crossing: (1) Cleared obstacles to cross (2) Increased intersection capacity by increased road space (compact-sized intersection) ・Extended sidewalk: (1) Assured space for pedestrian (2) Shortened length of pedestrian crossing ・Road marking (Pedestrian crossing, Lane, Stop line, Direction arrow) ・Increased pedestrian crossing time	・Removed median: Cleared obstacles to cross ・Road marking (Pedestrian crossing, Lane, Stop line, Direction arrow) ・Increased pedestrian crossing time	Changed to the left-hand traffic by signal indication improvement (as shown below) 

TECHNICAL NOTE – B-TIC
ON THE PREPARATORY SURVEY FOR
THE PROJECT FOR BENGALURU METROPOLITAN REGION ITS
IN THE REPUBLIC OF INDIA

In response to the request from the Government of India, the Government of Japan decided to conduct a Preparatory Survey for the Project for Bengaluru Metropolitan Region ITS (hereinafter referred to as "the Project"), and entrusted the Preparatory Survey to Japan International Cooperation Agency (hereinafter referred to as "JICA").

JICA sent the Preparatory Survey Team for the Outline Design (hereinafter referred to as "the Team") to India. The Team held a series of discussions with the officials of Department of Urban Land Transport (DULT). In the course of the discussions, both sides have confirmed the main items described in the attachment. The Team will proceed to further works.

Bengaluru, July 05, 2016

奥田真人

Masato OKUDA
Chief Consultant
Preparatory Survey Team
Japan International Cooperation Agency
Japan

V. MANJULA, IAS
Commissioner
Directorate of Urban Land Transport
Government of Karnataka
India

ATTACHEMENT

1 Objective

The objective of meeting with Commissioner of DULT is to discuss and confirm the details of B-TIC to be developed by grant project.

2 Confirmed and Agreed Items by DULT

2.1 Items Confirmed and Agreed with BMTC

There are several aspects of B-TIC which need to be confirmed and agreed with BMTC because the major input data of B-TIC is bus probe data and it will be provided by BMTC. The items described below are agreed with BMTC and they were reported to Commissioner of DULT and confirmed.

a) It was confirmed that B-TIC Probe Server will receive 10 sec probe data from BMTC.
b) It was confirmed that BMTC will push the probe data at every 60 sec interval to B-TIC Probe Server. It means that BMTC will push the last 6 records of probe data at a time every 60 second, which are collected by BMTC server at an interval of 10 sec from GPS devices installed on their city buses.
c) It was agreed that BMTC will provide the bus probe data to B-TIC free of cost.
d) It was also agreed that BMTC will make necessary modification of their systems at their own cost.
e) It was agreed that the communication line between BMTC Server and B-TIC server will be prepared by the grant project. B-TIC will be responsible for the cost of the maintenance of the communication line.

2.2 Items Confirmed and Agreed on B-TIC Function

a) Information Dissemination with VMS and Internet

The following explanations were given to Commissioner of DULT by JICA Survey Team and agreed.

- VMS;

  VMS will comprise multi-coloured display panel which shows schematic road map and message display line. The real time congestion status and expected travel time to the major destinations ahead will be displayed on the schematic road map in the multi-coloured display panel. This information will be automatically generated by B-TIC server. The messages on the traffic event such as accident will be displayed on the message display line. The messages will be manually inputted by Traffic Police at B-TRAC centre as necessary.

- Internet;

  It displays congestion status with different colours according to the level of congestion. The congestion status will be shown on the road network of major arterial roads in Bengaluru metropolitan area.

b) Functions of Roadside Equipment

The details of functions of roadside equipment such as ATCC and Que Length measurement to be installed under B-TIC were explained by JICA Survey Team and they were agreed.

c) Stored Data in B-TIC server
The followings were agreed with Commissioner of DULT.
The probe data collected from BMTC will be saved for 10 years, categorised by road section. The section will comprise group of links (apporx.100m per link) and will be defined as distance between certain points for analysing of traffic data.
ATCC and Queue Length data collected from the roadside equipment will be saved for 10 years.
The saved data in BTIC will be utilised for the purpose of reporting and evaluation by importing into Microsoft excel file and MS-Access file formats.

d) Operation and Maintenance organization
JICA Survey Team proposed the required organisation structure which consists of one director and two operators. The director will be assigned from DULT and the operators will be outsourced.

3 Items Requested by DULT

a) Required Expertise of Staff for Operation and Maintenance of B-TIC
Commissioner of DULT requested JICA Survey Team to mention on the report about the required expertise of staff of each position for operation and maintenance of B-TIC. It was agreed that JICA Survey Team will mention on the report.

b) Required Method for Integration of B-TIC with Other Systems in the Future
B-TIC is intended to play a central role as information centre in Bengaluru metropolitan area in the future as envisaged by ITS Master Plan. Commissioner of DULT requested JICA Survey Team to mention on the report about the required method on how to integrate the systems of the third party agencies with B-TIC. It was agreed that JICA Survey Team will mention on the report.

1 Role and Function of B-TIC

1.1 Objectives of B-TIC

B-TIC will be established to achieve three objectives as described below.

- To disseminate the processed road/traffic information to users on a real-time basis.
- To use stored quantitative data for effective road planning, operation and maintenance.
- To share the information amongst related Gov. agencies.

Each equipment to be developed and their quantity, the following contents will be installed.

Table1 Quantity of ITS Components

ITS Component		Quantity
B-TIC System	Center System	1 set
	Probe Data System	1 set
	Que Length Measurement System	12 locations (72 units)
	Automatic Traffic Counter and Classifier	8 locations (16 units)
	Variable Message Sign	3 units
	Internet System	1 set

1.2 Data Collection and Storage

The B-TIC collects necessary data from the following sub-system components.

1) Automatic Traffic Counter-cum-Classifier System (ATCC):

① ATCC installed at the middle point of major intersections on arterial roads. It collects and process the following data to ATCC server of B-TIC at one-minute interval.

- Traffic volume of large sized/small sized vehicle
- Average speed
- Equipment status

② The ATCC server process the one-minute traffic data collected into five-minute data. Traffic volume will be sum of the latest five one-minute data and speed data will be the arithmetic average of the latest five one-minute data.

Five-minute traffic volume data will be accumulated into one-hour data and one-hour data will be accumulated 24-hour data.

- All processed data will be stored in the ATCC server and the data will be transferred to B-TIC server. B-TIC server stores data for ten years to analyse for future usage.

2) Queue Length Measurement System:

① The Queue Length Measurement System installed distance of 300m, 600m and 900m in principal from the stop line of the chronically congested intersection. It judges the congestion level and determine whether queue has extended to the detector location or not. Measurement duration will be one-minute interval. Following data will be transmitted to the Queue Length Measurement Server one minute interval.

- Vehicle count
- Time occupancy rate
- Equipment status

② The Queue Length Measurement Server estimates the queue length of all approaches where vehicle detectors are installed. The estimation processes are described below.

- Starting from the vehicle detector nearest to the occupancy data needs to be compared against lower and upper limits which have to be settled at each detector location.
- If the occupancy is lower than lower limit, the system judges that no queue exists.
- If occupancy is higher than higher limit, the system judges that queue extends beyond the detector location and the data from the next detector will be processed.
- If the occupancy is between lower and upper limits, queue length needs to be calculated as proportionally.

The Queue Length Measurement Server process the one-minute average occupancy data collected into five-minute data. The Processed five-minute data will be transferred to Probe Server at every five minute interval.

③ All processed data will be stored in the Queue Length Measurement Server and the data will be transferred to B-TIC server. B-TIC server stores data for ten years to analyse for future usage.

④ B-TIC server will have the reporting function which will be generated as a file in portable document file format as per the system operator's request.

3) Probe Car System:

① Probe Car System collects the location data from BMTC buses equipped GPS devices to grasp travel speed of each link※. GPS devices of BMTC buses transmits bus location data, device ID, time, bus route number and etc. to BMTC server every ten seconds. Probe car server of B-TIC receives bus location data from BMTC server at every one-minute interval which composes of six ten-second data.

※Each link: The distance of each link is considered approximately 100 meters. Actually it will be determined by Digital Road Map to use.

② The probe car server process following processes and calculation cycle will be every five minute. Therefore, information will be updated every five minute.

- Data validation
- Map matching
- Determination of moving direction
- Link speed calculation
- Mean link speed and link average travel time
- Congestion level of link
- Section※ travel time

※Section: Section composes of links. It is defined as distance between certain point to major destinations for displaying travel time in sketch map of VMS.

The probe server receives processed data received from the queue length measurement server and combine with processed data of probe server at every five minute.

Although updating time of information is at every five minute, calculation time can be considered utmost fifteen minutes for executing all above processes. Therefore, information provided users is utmost fifteen minutes past information.

③ All data transmitted from BMTC server and processed data of the B-TIC will be transferred to B-TIC server. B-TIC server stored processed location data after map matching for three months, while five-minute link speed, section congestion level and section travel time data will be kept for ten years.

④ B-TIC server will have the reporting function which will be generated as a

file in portable document file format as per the system operator's request.

1.3 ITS Components and Information for Dissemination to Users

The B-TIC disseminates necessary traffic information to users by VMS and Internet.

1) VMS:

It composes of both multi display type of sketch map and message display line. In the sketch map, displaying information is real time traffic status and time to major destination. The displayed information on sketch map will be processed by Probe server of B-TIC and transferred to VMS server in Traffic Police. Operator of Traffic Police enable to display both displayed information on sketch map and any messages on message line in normal usage. If Traffic Police consider to display higher priority information on sketch map such as incident information, operator of Traffic Police enables to add on displayed information on sketch map.

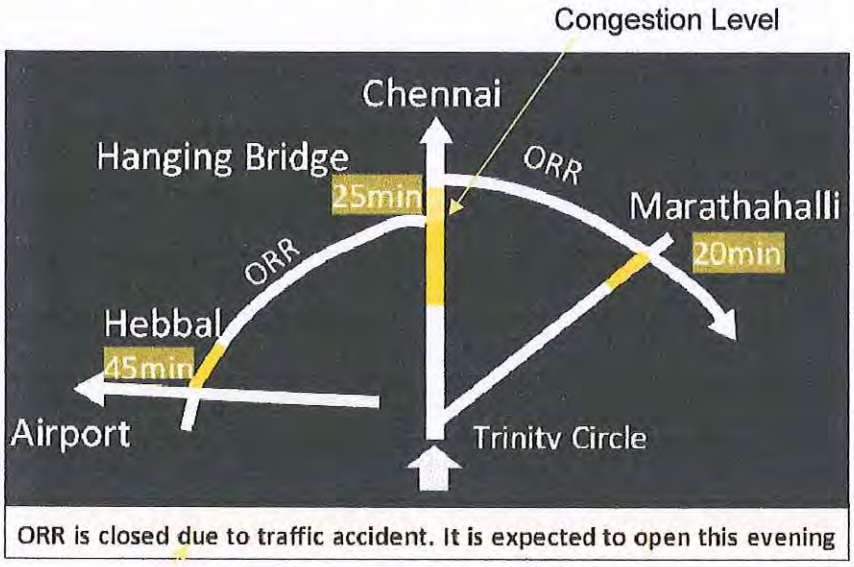


Figure1 Example of VMS (MG Road at Trinity Metro Station)

2) Internet:

It displays traffic status of all arterial roads network in Bengaluru Metropolitan. It also displays incident and event information which may be considered big impact to traffic status such as big accident, road closure etc.

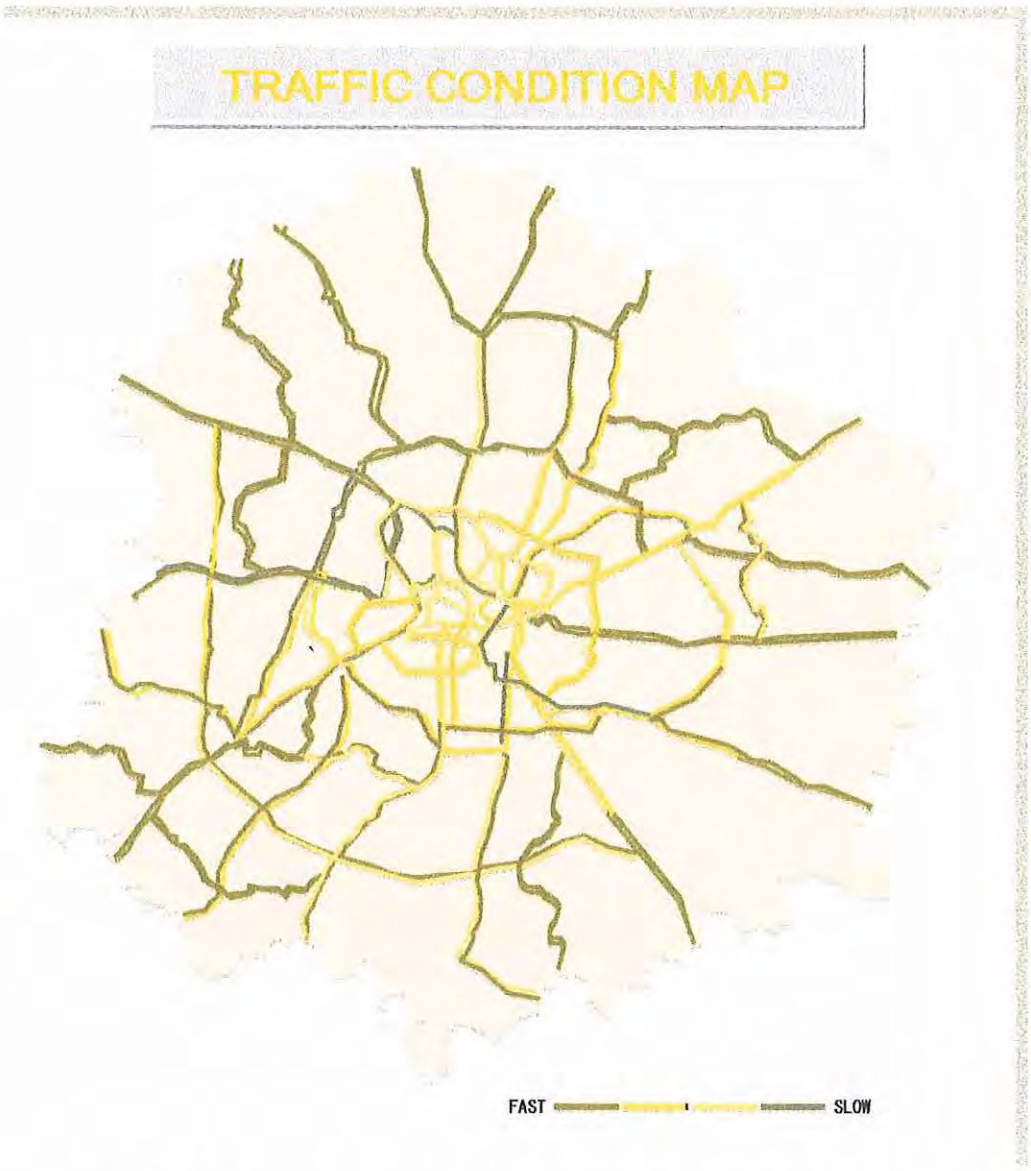


Figure2 Image of Internet (Overall View of Bengaluru city)

1.4 Utilization of stored data

1) Accessibility of BTIC server

B-TIC server will have the reporting function with MS-Access, MS-Excel or equivalent friendly software which will be generated as a file in portable document file format as per the system operator's request.

2) Utilization of store data

The stored data in storage device is used for road planning, operation and maintenance. Proceeded data are stored certain period and these data are compiled in accordance with request of related Gov. agencies. Followings are possible utilization of stored data.

- Finding cause of bottleneck by Identifying starting point of congestion.
- Finding redundancy route by identifying peak hours and transition of queue length of road which is parallel to another route.
- Prospecting the congestion status of arterial road of Bengaluru Metropolitan to encourage users to utilize redundancy route by pre-notice.
- Grasping effectiveness to traffic flow by road/lane closure of road work or adverse weather.
- Grasping correlation between contribution ratio of large sized vehicles and pavement damage.
- Compiling transition and tendency of congestion status by elapsed time.
- Compiling average travel speed and travel time by hourly, daily monthly and seasonal to understand the tendency of changes of peak hours, weekday, holiday and festival season.
- Grasping the effect of construction or extension of road, metro, flyover, etc. by comparing traffic status between before and after.

1.5 Information Sharing among Related Gov. Agencies

Any processed and compiled data/information including above can be provided to related Gov. agencies.

- Traffic Police, Road Administrators (BBMP, PWD, NHAI and BDA) can utilize their traffic/road management and planning.
- Shared information with Traffic Control Centre of BPRR in the case of happening of big incident which may affect each other such as big accident, road closure of BPRR, etc. (In future)
- Provision of parking availability information of off road public parking lot to users. (In future)

1.6 Location of Roadside Equipment

The installation locations of roadside equipment is determined in accordance with the basic policy for installation location selection given below.

Table 2 Installation location selection policy: B-TIC

Roadside unit	Installation location selection policy
Que Length Measurement System Equipment	▪ For measurement of congestion length, vehicle sensors will be installed at 300m, 600m and 900m* from the intersection having significant congestion. ▪ Vehicle sensors will be installed on overtaking lane considering that many obstacles exist on lane on sidewalk side.
Automatic Traffic Counter and Classifier	▪ The installation location will be selected from where the measurement area can be secured using image processing method taking into consideration the traffic situation in India where the trend is not to follow the lane.

(*900m will installed as necessity ; intersection with so heavy traffic.)

1) Que Length Measurement System

Roadside Equipment will be installed on overtaking lane considering that many obstacles exist on lane on sidewalk side.

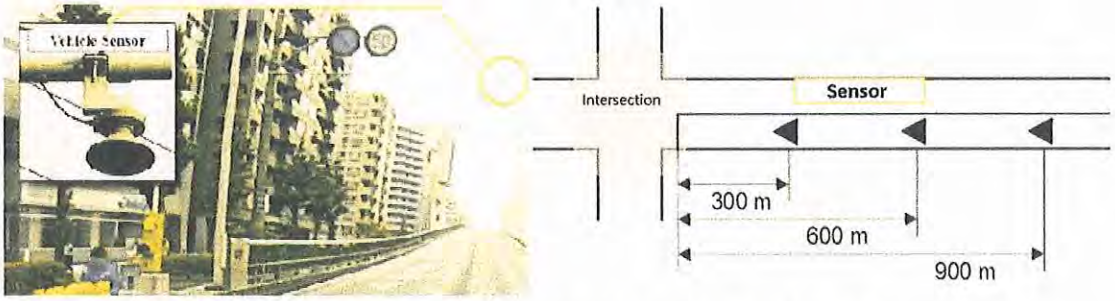


Figure3 Installation image of roadside units (Que Length)

2) Automatic Traffic Counter and Classifier

The installation location will be selected from where the measurement area can be secured using image processing method taking into consideration the traffic situation in site where the trend is not to follow the lane.

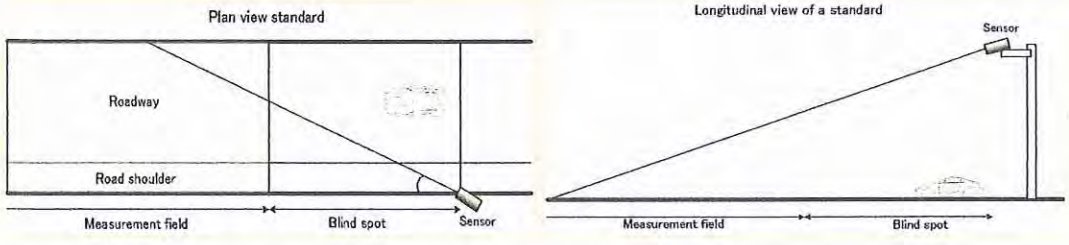


Figure4 Installation policy of roadside units(ATCC)

1.7 System Configuration

System Configuration of all ITS system is shown in below.

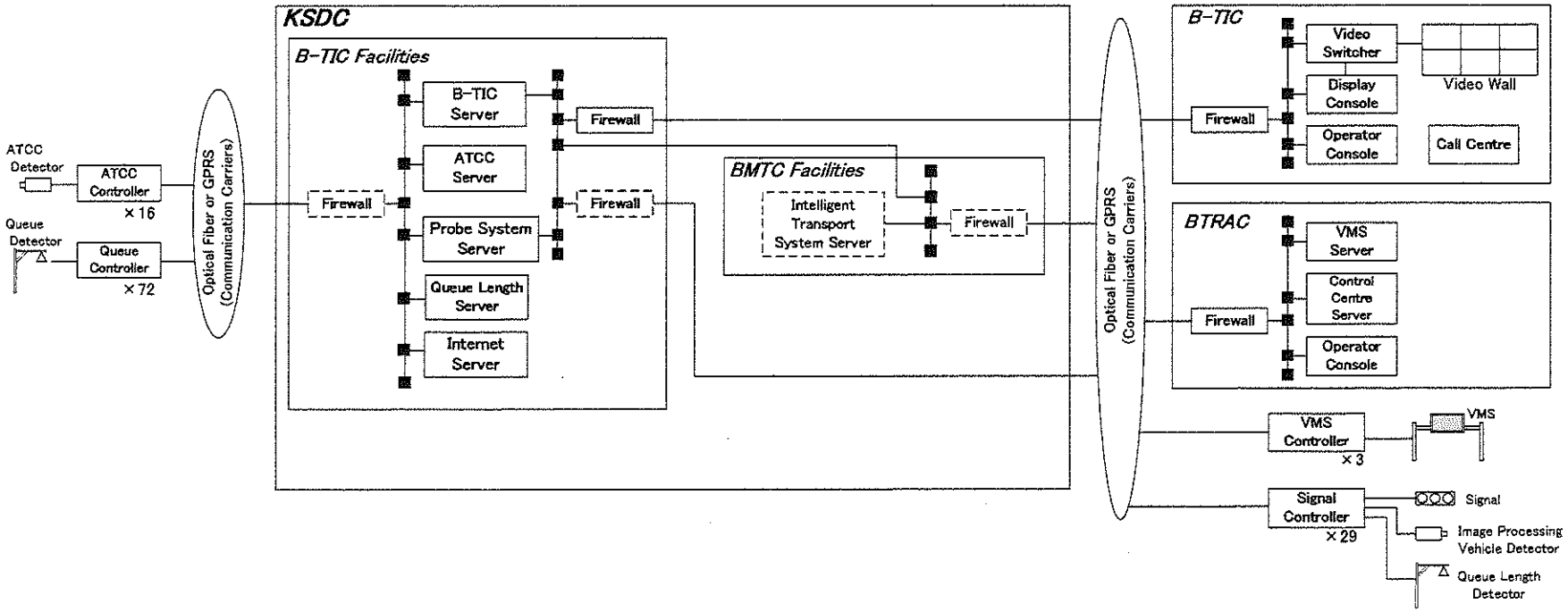


Figure5 System Configuration of all ITS System

2 Required Organization Structure for ITS Pilot Project

In order to sustain the pilot project, posting adequate employee for managing system is required. B-TIC is an organization needs to be newly set up the organization.

2.1 Organization Structure for Operation and Maintenance of B-TIC

B-TIC will be operated and maintained under supervision of DULT. Therefore, one Project Director needs to be posted from DULT. Operators need to be employed under Project Director. As for the maintenance, there is a option for DULT to outsource the maintenance work to the contractor or sub-contraoctor, a company which installs the system. The roles and responsibilities of staff for operation and maintenance of B-TIC are as follows.

Table 3 Roles and Responsibilities

Position	Roles and Responsibilities	Working Hours
Project Director (This position can combine with routine work of DULT)	• Responsible for supervising and controlling all activities of B-TIC • Coordination of all activities between B-TIC and other related Gov. agencies especially Traffic Police. • Checking the report issued by the systems. • Compiling, analysis and providing the processed data/information as per request of related Gov. agencies. • Informing malfunction of ATCC system, Queue Length Measurement system and Prove system to the maintenance company. • Informing the necessity of updating system such as Digital Road Map.to the maintenance company • Checking the spare parts inventory	Daytime only
Operator-1	• Receiving and answering enquiries from general public and the related Gov. agencies • Informing necessary information to the related Gov. agencies. • Request the related Gov. agencies to provide related information if necessary.	Daytime only

	• Checking the storage condition of spare parts. • Taking charge of operator-2's work in his absence.	
Operator-2	• Checking the status of ATCC system and Queue Length Measurement System • Monitoring traffic condition on schematic map of video wall • Informing the malfunction of any systems to Project Director • Carrying out Update or maintenance of the server in KSDC from console. • Checking any discrepancy between the information displaying on VMS by Traffic Police and probe server. • Taking charge of operator-1's work in his absence.	Daytime only

The minimum experience of each position is shown as follows;

Position	Minimum Experience
Project Director (This position can combine with routine work of DULT)	• Education: University graduate • Total Work Experience: 10 years. • As manager of work: three years • Language: Fluent in English
Operator-1	• Education: College graduate or similar • Total Work Experience: 5 years. • In similar size of work: three years • Language: Fluent in English and Local Language
Operator-2	• Education: College graduate or similar • Total Work Experience: 5 years. • In similar size of work: three years • Language: Fluent in English and Local Language

Contracted maintenance company is required following works described below to sustain the B-TIC system.

- Submission of preventive work plan and carrying out it as per plan
- Submission of necessary report after checking or repairing the system
- Carrying out repair works for equipment and retrieving system
- Maintaining spare parts
- Time from receiving notification of failure to completing the permanent or temporary remedial measure for all B-TIC system※ shall be less than 24 hours.

※ B-TIC system: Centre System, ATCC system, Queue Length Measurement system, and Probe system

TECHNICAL NOTE – BMTC
ON THEPREPARATORY SURVEY FOR
THEPROJECTFORBENGALURUMETROPOLITANREGION ITS
INTHE REPUBLIC OF INDIA

In response to the request from the Government ofIndia, the Government of Japan decided to conduct a Preparatory Survey forthe Project for Bengaluru Metropolitan Region ITS (hereinafter referred to as "the Project"), and entrusted the Preparatory Survey to Japan International Cooperation Agency (hereinafter referred to as "JICA").

JICA sent the Preparatory Survey Team for the Outline Design (hereinafter referred to as "the Team") to India.The Team held a series of discussions with the officials of Bengaluru Metropolitan Transport Corporation (BMTC). In the course of the discussions, both sides have confirmed the main items described in the attachment. The Team will proceed to further works.

Bengaluru, July05,2016

奥田真人

MasatoOKUDA
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Directorate of Urban Land Transport
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India

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Corporation
Government of Karnataka
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TABLE OF CONTENTS

1 Items Discussed and Confirmed with BMTC in the Past

- Probe Data transmission by GPS Devices installed on approximately 6400 BMTC city buses at 10 sec interval and collection of probe data by BMTC Server
- BMTC Probe system server configuration setup in KSDC
- Preparation of B-TIC by Japanese Grant Project
- The real time probe data transmission from BMTC to B-TIC
- Sample Probe data provided by BMTC to grant project study team

The details are explained hereinafter.

1.1 Probe Data Transmission by GPS Devices

- The GPS Devices installed on BMTC buses collect and transmit GPS data at every 10 sec interval to the servers.
- The probe data transmitted by GPS devices is collected by the BMTC server
- The BMTC servers are installed in KSDC Data centre

1.2 B-TIC: Bengaluru Traffic Information Centre

Bengaluru Traffic Information Centre (B-TIC) will be developed by the grant project for the purpose of dynamic traffic information provision and utilization of quantitatively measured data on traffic.

- B-TIC will be developed and operated under jurisdiction of DULT.
- Major input data: BMTC Bus Probe Data
- Major output information: Congestion information on major road to be provided from VMS and Internet
- It is proposed to install the B-TIC servers in KSDC

1.3 Transmission of Probe Data from BMTC to B-TIC

BMTC has agreed to provide the real time probe data to B-TIC in a format and at an interval proposed by DULT. The format and interval of probe data requirement by B-TIC is provided in table below.

Table 1-1 Probe Data Transmission from BMTC to B-TIC

Probe Data Transmitting Server	Probe Data Receiving Server	Data Interval of Transmission	Format of Data
BMTC	B-TIC	***At every 60 Sec, 6 packets of real time Probe Data**	GTFS

* The details are elaborated in section 2 below.

1.4 Demarcation of Responsibility for Communication Line Between BMTC and B-TIC

The demarcation of responsibilities for preparation and maintenance of communication line between BMTC and B-TIC for real time probe data transmission is provided in table below.

Table 1-2 Communication Line Between BMTC to B-TIC

Communication Line Preparation	Communication Line Operation & Maintenance	Making the Probe Data available for B-TIC
Grant Project	DULT	**BMTC**

2 Network Communication from BMTC to B-TIC

The network communication configuration for transmission of probe data from BMTC to B-TIC is provided in the figure 2-1 below.

The required probe data transmission related aspects from BMTC to B-TIC are described below.

- B-TIC will prepare the communication line from BMTC to B-TIC.
- BMTC will be responsible to provide the last 6 probe data records to B-TIC at every 60 seconds interval. B-TIC would be responsible to pull the probe data through API or other ways.
- BMTC agreed to provide the probe data to B-TIC free of cost.

3 Probe Data Collection Internal required for B-TIC

BMTC currently collects the data from Buses on every 10 seconds. B-TIC requires the 6 packets of real time data on every 60 Seconds.

4. Confirmation Items Required From BMTC

The following items require confirmation from BMTC to ensure reliable transmission of probe data from BMTC to B-TIC.

- B-TIC would coordinate with BMTC regarding data format to ensure smooth and uninterrupted data transmission flow.
- Based on the sample probe data provided by BMTC to grant study team, data fields mentioned in table below is identified. BMTC need to confirm the data field of probe data.

4.1 Data Format for the Probe Data Provided By BMTC: BMTC will decide the data format for the packet transfer. B-TIC request to include at least below mentioned fields in the data format:

1	Device Serial Number
2	Packet Code
3	GPS Device Date & Time (Time shall be in HH:MM:SS format)
4	Long Lat Information
5	Server Date & Time (Time shall be in HH:MM:SS format)

TECHNICAL NOTE – KSDC
ON THE PREPARATORY SURVEY FOR
THE PROJECT FOR BENGALURU METROPOLITAN REGION ITS
IN THE REPUBLIC OF INDIA

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JICA sent the Preparatory Survey Team for the Outline Design (hereinafter referred to as "the Team") to India. The Team held a series of discussions with the officials of Karnataka State Data Centre (KSDC). In the course of the discussions, both sides have confirmed the main items described in the attachment. The Team will proceed to further works.

Bengaluru, July 05, 2016

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Project Director, KSWAN
Centre for e-Governance

Karnataka State Data Centre
Government of Karnataka
India

TABLE OF CONTENTS

1 Items Discussed and Confirmed with KSDC

- Installation of B-TIC Servers in KSDC
- KSDC provide two types of services: Co-Location and Management Services. Clients can choose one of the services as per their requirement
- Cost of Electricity and Space provision for two types of services provided by KSDC
- Communication network connection from KSDC to B-TIC
- Operation and Maintenance of B-TIC Servers installed in KSDC

The details are explained hereinafter.

1.1 Space for B-TIC Servers in KSDC

- JICA Survey Team discussed with KSDC officials regarding installation of B-TIC Servers in KSDC.
- KSDC agreed to provide required space in their Data Centre.

1.2 Types of Service Offered By KSDC

KSDC offers two types of service for servers in KSDC.They are:

a) Co-Location: KSDC provides space in their data centre for customers to install their hardware (servers) and software (application, database etc). KSDC do not charge. KSDC also provides uninterrupted power supply to the customers'equipment free of charge.

b) Management Services: KSDC preparesall required hardware and software such as servers, database and etc. and installs them in their data centre. The customer develops their own applications and host on the servers prepared by KSDC. KSDC charges the customer. The fee is based on the hardware and software which are prepared by KSDC.

1.3 Type of Service for B-TIC Servers

- It was proposed to install the B-TIC Servers by Co-Location type.
- The grant project will prepare B-TIC Servers, the related hardware and

software in the KSDC premises.

- KSDC will provide the space and the power supply arrangement to the servers free of cost.

1.4 Communication Network from KSDC to B-TIC

- Service providers, BSNL, Reliance and Sify, are providing communication connections between KSDCand customer locations.
- Likewise, the communication connection between KSDC and B-TIC is required to prepare.
- The communication connection between KSDC and B-TIC will be prepared by B-TIC.
- The communication cost and maintenance cost of the communication connection will be responsibility of B-TIC.

1.5 Operation and Maintenance of Servers Installed in KSDC

- B-TIC will be responsible for the operation and maintenance of the servers installed in KSDC.
- B-TIC will prepare the network configuration in B-TIC for remote monitoring, operation and maintenance of the servers installed in KSDC.

1.6 Power Backup in KSDC

- KSDC installedthree Diesel generator sets (total 2000 KVA) to provide power backup in case of primary power failure.
- As a precautionary measure, KSDC installed two separate power connections from two different sub-stations of the power supplier company as primary power supply arrangement.
- The Diesel generator sets can provide continuous power supply for around 18 hours in case of emergency requirement.
- KSDC also installed UPS for secondary backup.
- KSDC will prepare power and UPS sockets to connect B-TIC server.

MINUTES OF DISCUSSIONS
ON THE PREPARATORY SURVEY FOR
THE PROJECT FOR BENGALURU METROPOLITAN REGION ITS
IN THE REPUBLIC OF INDIA

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JICA sent the Preparatory Survey Team for the Outline Design (hereinafter referred to as "the Team") to India. The Team held a series of discussions with the officials of Department of Urban Land Transport (DULT). In the course of the discussions, both sides have confirmed the main items described in the attachment. The Team will proceed to further works.

Bengaluru, July 12, 2016

FOR 高橋 雅人

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Directorate of Urban Land Transport
Government of Karnataka
India

Meeting Record

Topic	Meeting with DULT
Date	07 Jul, 2016
Time	10:30 – 11:30
Venue	DULT Office
Attendees	From DULT: 1. Ms. Manjula IAS - Commissioner - DULT From JICA Survey Team: 1. Mr. Okuda 2. Mr. Totani 3. Mr. Takashi 4. Mr.Narayan 5. Mr. Manohar 6. Mr. Varun

Meeting Record

1. Purpose:

The purposes of the meeting are:

- To explain to the Commissioner of DUT about the conclusion of the discussions held with the related agencies (Traffic Police, BMTC and KSDC), and
- To discuss and confirm on the details of the proposal of B-TIC based on the Technical Note prepared by JICA Survey Team.

2. Traffic Police

JICA Survey Team reported to the Commissioner of DULT that they held the meeting with new Additional Commissioner of Traffic Police on the proposed ATCS (Area Traffic Control System) and VMS and discussed as follows:

2.1 Items Agreed by Additional Commissioner of Traffic Police:

- **Locations of ATCS and VMS:** JICA Survey Team carried out the site survey and identified 29 intersections of ATCS and three (3) locations of VMS. All locations were agreed by the Additional Commissioner of Traffic Police.
- **Method of ATCS:** JICA Survey Team explained about MODERATO as the method of ATCS and it was agreed that MODERATO will be introduced by the grant project.
- **Other improvement:** JICA Survey Team explained about the necessity of the following improvement to be carried out together with introduction of ATCS to maximize the effect.
  - ✓ Improvement of signal phase,
  - ✓ Improvement of pedestrian signals, and
  - ✓ Improvement of intersection.

  Additional Commissioner of Traffic Police agreed the proposals of all above improvement to be carried out.

2.2 Items Raised by Additional Commissioner of Traffic Police:

The following items were raised by Additional Commissioner of Traffic Police:

- **Budget for Maintenance of ATCS and VMS**
  The Traffic Police are responsible for maintenance of ATCS and VMS after handover. Additional Commissioner of Traffic Police requested DULT to explain how the funds will be allocated from State Government budget to Traffic Police for the maintenance costs of the ATCS and VMS systems.
- **Details of Maintenance**
  Additional Commissioner of Traffic Police wished to know how ATCS which is new to them can be sustainably maintained. He requested JICA Survey Team to provide the details of maintenance (called maintenance plan).
  JICA Survey Team agreed that it will be provided. (Question has been submitted to urban Mobility Division)
- **Permission of Relocation of Existing Gantry and Sign Board at Silk Board Junction**
  JICA Survey Team proposed the arrangement of relocation of the existing gantry and sign board for installation of VMS at Silk Board Junction, as detailed on the Technical Note.
  Additional Commissioner of Traffic Police mentioned that the permission of the proposed relocation arrangement needs to be taken from NHAI through DULT.
- **Permission of Installation of Roadside Equipment**
  Additional Commissioner of Traffic Police mentioned that the permission of installation of other roadside equipment needs to be taken from the related road administrators through DULT.
- **Location of Servers of ATCS and VMS**
  JICA Survey Team proposed to install the servers of ATCS and VMS in KSDC (Karnataka State Data Centre), instead of in the centre of B-TRAC, due to such reasons as availability of power supply, assurance of data security and etc.
  Additional Commissioner of Traffic Police mentioned that all components which belong to Traffic Police shall be under direct control of Traffic Police and thus the servers of ATCS and VMS shall be installed in the centre of B-TRAC.

2.3 Items Confirmed with Commissioner of DULT

The items which were raised by Additional Commissioner of Traffic Police mentioned above were confirmed with Commissioner of DULT as follows:

- **Budget for Maintenance of ATCS and VMS**
  Commissioner of DULT confirmed that it will be explained to Traffic Police by DULT.
- **Permission of Relocation of Existing Gantry and Sign Board at Silk Board Junction**
  Commissioner of DULT confirmed that DULT will take care of obtaining approval.
- **Permission of Installation of Roadside Equipment**
  Commissioner of DULT mentioned that the permissions for installation of the roadside equipment from the road administrators shall be taken just prior to tender process due to likeliness that such factors as road conditions at site, officials in charge and etc. will be altered. It was confirmed that the permission will be obtained through DULT.
  It was also confirmed that the design drawings of the roadside equipment will be submitted to BBMP through DULT after completion of the design drawings to be prepared by JICA Survey Team.
- **Location of Servers of ATCS and VMS**

Commissioner of DULT confirmed that she will discuss with Additional Commissioner of Traffic Police.

JICA Survey Team will prepare advantages and disadvantages of installing servers in the centre of B-TRAC and KSDC.

3. B-TIC

JICA Survey Team explained about the proposals of B-TIC as detailed on the Technical Note to Commissioner of DULT. They were conformed and requests were made by Commissioner of DULT as follows:

3.1 Items Agreed with Commissioner of DULT

- **Probe Data Transmission from BMTC to B-TIC**
  It was confirmed that B-TIC will receive 6 records of GPS probe data at a time every 60 seconds from BMTC.
- **Details of Functions of Roadside Equipment**
  The details of functions of roadside equipment to be installed under B-TIC were explained by JICA Survey Team and they were agreed.
- **Period of Data Storage**
  The period of storage of collected and processed data was discussed and it was agreed as ten (10) years.
- **Information to Be Provided from VMS**
  The details of information to be provided from VMS were explained by JICA Survey Team and they were agreed.
- **Operation and Maintenance**
  The organization structure and roles of each position were explained by JICA Survey Team and they were agreed.
- **Permission of Installation of Roadside Equipment**
  Commissioner of DULT mentioned that the permissions for installation of the roadside equipment under B-TIC from the road administrators shall be taken just prior to tender process due to likeliness that such factors as road conditions at site, officials in charge and etc. will be altered. It was confirmed that the permission will be obtained through DULT.
  It was also confirmed that the design drawings of the roadside equipment will be submitted to BBMP through DULT after completion of the design drawings to be prepared by JICA Survey Team.

3.2 Items Requested by Commissioner of DULT

- **Required Expertise of Staff for Operation and Maintenance of B-TIC**
  Commissioner of DULT requested JICA Survey Team to mention on the report about the required expertise of staff of each position for operation and maintenance of B-TIC.
  It was agreed that JICA Survey Team will mention on the report.
- **Required Method for Integration of B-TIC with Other Systems in the Future**
  B-TIC is intended to play a central role as information centre in Bengaluru metropolitan area in the future as envisaged by ITS Master Plan. Commissioner of DULT requested JICA Survey Team to mention on the report about the required method on how to integrate the systems of the third party agencies with B-TIC.
  JICA Survey Team agreed that it will be mentioned on the report.

4. Karnataka State Data Centre (KSDC):

JICA Survey Team reported to the Commissioner of DULT that they held the meeting with the officials of KSDC and items agreed with KSDC as follows:

4.1 Items Agreed with KSDC

- **B-TIC Server and Services to Be Provided by KSDC**
  It was agreed that B-TIC servers will be installed in KSDC by 'Co-Location Method'. The Co-Location Method is a type of service offered by KSDC in which all hardware and software will be prepared by the grant project and spaces of the hardware and power supply will be provided by KSDC.
- **Cost for the Space and Power Supply**
  It was confirmed that the spaces and power supply will be provided free of charge under the co-location method.
- **Communication Line between KSDC and B-TIC**
  It was confirmed that the communication line between KSDC and B-TIC will be prepared by the grant project.

4.2 Comments of Commissioner of DULT

- **Budget for Communication Line**
  Commissioner of DULT mentioned that the budget for the communication line between KSDC and B-TIC will be assured based on the cost provided by JICA Survey Team. She also mentioned that KSWAN could be used for secondary communication line as backup.

5. Bangalore Metropolitan Transport Corporation (BMTC):

JICA Survey Team reported to the Commissioner of DULT that they held the meeting with the officials of BMTC and items agreed with BMTC as follows:

5.1 Items Agreed with BMTC

- **Cost for Providing Probe Data to B-TIC**
  It was agreed that BMTC will provide the bus probe data which they collect to B-TIC free of cost.
- **Communication Line between BMTC Server and B-TIC Server**
  It was agreed that the communication line between BMTC Server and B-TIC server will be prepared by the grant project. B-TIC will be responsible for the cost of the maintenance of the communication line.
- **Probe Data Transmission from BMTC Server to B-TIC Server**
  It was agreed that the probe data will be pushed from BMTC server to B-TIC server. It was also agreed that BMTC will make necessary modification of their systems at their own cost.

6. Action Items by DULT

It was confirmed that the following items will be taken care by DULT.

- **Information about Current Organization of Traffic Police**
  DULT will obtain the information of the current organisation of Traffic Police with number of staff in each section and will share with JICA Survey Team.

- **Information about Budget of Traffic Police**
  DULT will obtain the information of the budget allocated to Traffic Police for the last four (4) years. It will include the cost spent for operation and maintenance of their current system of B-TRAC.
- **Information about Tax Exemption**
  DULT will share the information about tax exemption applied to the projects of World Bank executed in Karnataka State.
- **Obtaining Approval on Trial Digging from BBMP**
  DULT will obtain approval on the trial digging from BBMP as soon as possible.
- **Obtaining Signatures from Related Agencies on Technical Notes**
  DULT will obtain the signatures from Traffic Police, KSDC and BMTC on the technical notes submitted by JICA Survey Team.

MINUTES OF DISCUSSIONS
ON THE PREPARATORY SURVEY FOR
THE PROJECT FOR BENGALURU METROPOLITAN REGION ITS
IN THE REPUBLIC OF INDIA

In response to the request from the Government of India, the Government of Japan decided to conduct a Preparatory Survey for the Project for Bengaluru Metropolitan Region ITS (hereinafter referred to as "the Project"), and entrusted the Preparatory Survey to Japan International Cooperation Agency (hereinafter referred to as "JICA").

JICA sent the Preparatory Survey Team for the Outline Design (hereinafter referred to as "the Team") to India. The Team held a series of discussions with the officials of Department of Urban Land Transport (DULT). In the course of the discussions, both sides have confirmed the main items described in the attachment. The Team will proceed to further works.

Bengaluru, July 12, 2016

高橋雅人

Masahito TAKAHASHI
Roadside Equipment Design Consultant
Preparatory Survey Team
Japan International Cooperation Agency
Japan

SHAMANTH P KUCHANGI
Head Of TETC
Directorate of Urban Land Transport
Government of Karnataka
India

Meeting Record

Topic	Meeting with DULT
Date	12 July,2016
Time	15:30
Venue	DULT Office
Attendees	Representative from DULT: 1. Mr. Shamanth 2. Mr. Siva Representative from JICA Team: 1. Mr. Takahashi 2. Mr. Manohar 3. Mr. Varun

Meeting Record

Agenda:

- Meeting with DULT team to discuss on status update and queries of Study team.

Discussed Items are as below:

1. Explanation of ATCS sensors locations by study team.

DULT team asked for the explanation on the rationale behind selection of the Vehicle Detector locations. Some on the intersections which are part of the ATCS sub-area but does not have any Vehicle detection sensors installed.

Study team has provided the required explanation. Vehicle Detectors (Inflow traffic volume measure) & Vehicle Detectors (Queue Length Measure) are installed only at the key intersections to measure the inflow traffic volume at the close roadside to key intersection and to measure the queue length heading to the key intersection respectively.

Vehicle Detector (Traffic Volume Measure for Offset) are installed at the middle point between two key intersections to measure the traffic volume for calculating/setting the offset time.

The traffic control center will collect all the traffic data in real time from these sensors installed at the key intersections. The central controller will analyze the collected traffic data and send signal parameters (Cycle, Split and offset) to each signal in order to de-congest the key intersections and provide smooth follow in the sub-area. The signal parameters of non-key intersections are changed regularly on the bases of real time traffic data to control the traffic flow towards the key intersection to reduce congestion.

2. QMS & ATCC detailed Location.

The locations finalized for QMS & ATCC were briefed and were accepted by DULT team.

3. Which agency will bear the Cost for relocation of the existing sign board gantry at Silk Board Junction?

According to DULT team, the cost will be bear by either DULT or NHAI. This decision will be taken up during the execution phase only.

4. Languages to be displayed on VMS & Internet.
   - **Internet Website**: Two Languages- Kannada and English. Default Language shall be English.
   - **VMS:** Two languages (Kanada and English) on the VMS proposed on MG Road & Hanging Bridge which are under State Govt (agency) Jurisdiction.
     Three languages (Kanada, Hindi and English) on the VMS proposed on Silk Road which is on National Highway and is under NHAI.

5. Trial digging approval.

DULT has already requested to approving authority (BBMP), the same is in process, DULT team is doing regular follow up with BBMP.

6. Confirming the required process for approval on construction & installation of the roadside equipment.

DULT is responsible for the execution of such projects under the Grant, hence DULT will get all required approvals for construction and installation works.

DULT will obtain the NOCs for concerned agencies once implementation plan is finalized. The tentative time required to obtain all required clearances and approvals is 3 to 4 weeks.

7. Obtaining Signature on technical notes.

The technical notes submitted by the study team are under review by DULT team. Same will be provided latest by mid-next week.

8. Traffic Police questionnaire.

Meeting with the B-TRAC officials is being scheduled for discussion and obtaining required information from Traffic Police. DULT team is doing daily follow up with B-TRAC officials for the meeting schedule.

MINUTES OF DISCUSSIONS
ON THE PREPARATORY SURVEY FOR
THE PROJECT FOR BENGALURU METROPOLITAN REGION ITS
IN THE REPUBLIC OF INDIA

In response to the request from the Government of India, the Government of Japan decided to conduct a Preparatory Survey for the Project for Bengaluru Metropolitan Region ITS (hereinafter referred to as "the Project"), and entrusted the Preparatory Survey to Japan International Cooperation Agency (hereinafter referred to as "JICA").

JICA sent the Preparatory Survey Team for the Outline Design (hereinafter referred to as "the Team") to India. The Team held a series of discussions with the officials of Department of Urban Land Transport (DULT). In the course of the discussions, both sides have confirmed the main items described in the attachment. The Team will proceed to further works.

Bengaluru, August 27, 2016

奥田真人

Masato OKUDA
Chief Consultant
Preparatory Survey Team
Japan International Cooperation Agency
Japan

V. MANJULA, IAS
Commissioner
Directorate of Urban Land Transport
Government of Karnataka
India

ATTACHEMENT

The following items were confirmed between DULT and the Team:

1 Installation of Servers of VMS and Traffic Signal

The Team proposed that the servers of VMS and Traffic Signal be installed in Karnataka State Data Centre (KSDC) because of advantages such as secured environment, continuous power supply and etc.

The Commissioner of DULT tentatively agreed with this idea and will discuss with the Traffic Police.

2 Removal/Relocation of Existing Gantry at Silkboad Junction

The removal/relocation of the existing gantry including information board at Silkboard Junction will be responsible of Indian side (DULT or NHA), including the work and cost.

Minutes of Discussions
on the Preparatory Survey for the Project for
Implementation of Advanced Traffic Information and Management System
In Core Bengaluru
(Explanation on Draft Preparatory Survey Report)

With reference to the minutes of discussions signed between Directorate of Urban Land Transport (hereinafter referred to as "DULT"), Government of Karnataka (hereinafter referred to as " GOK"), Bangalore Traffic Police (hereinafter referred to as "BTP") and the Japan International Cooperation Agency (hereinafter referred to as "JICA") on March 10, 2016 and in response to the request from the Government of India (hereinafter referred to as "GOI") dated November 18, 2015 JICA dispatched the Preparatory Survey Team (hereinafter referred to as "the Team") for the explanation of Draft Preparatory Survey Report (hereinafter referred to as "the Draft Report") for the Project for Implementation of Advanced Traffic Information and Management System in Core Bengaluru (hereinafter referred to as "the Project"), headed by Shuntaro kawahara, Senior Advisor, JICA from January 8 to 13, 2017.

As a result of the discussions, both sides agreed on the main items described in the attached sheets.

Bengaluru, January 16, 2017

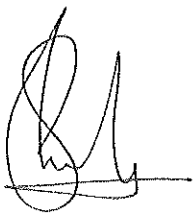
Shuntaro Kawahara
Leader
Preparatory Survey Team
Japan International Cooperation Agency
Japan

Darpan Jain, IAS
Commissioner
Directorate of Urban Land Transport
Government of Karnataka
India

Hitendra, IPS
Additional Commissioner
Bangalore Traffic Police
Karnataka State Police
India

ममता बत्रा/MAMTA BATRA
अवर सचिव/Under Secretary
आवासन और शहरी कार्य मंत्रालय
Ministry of Housing And Urban Affairs
भारत सरकार/Govt. of India
नई दिल्ली/ New Delhi

Ministry of Urban Development
India



के. ए. सिवदास/K. A. SIVADAS
अवर सचिव/Under Secretary
आर्थिक कार्य विभाग/Deptt. of Eco. Affairs
वित्त मंत्रालय/Ministry of Finance
भारत सरकार/Govt. of India
नई दिल्ली/New Delhi

Department of Economic Affairs

Ministry of Finance

India

ATTACHEMENT

1. Project Name

   Both sides confirmed that the Project title would be changed to "the Project for Implementation of Advanced Traffic Information and Management System in Core Bengaluru".

2. Contents of the Draft Report

   After the explanation of the contents of the Draft Report by the Team, the India side agreed to its contents.

3. Cost Estimate

   Both sides confirmed that project cost estimation described in Annex 1 is provisional, and will be examined further by the Government of Japan for its approval.

4. Confidentiality of the Cost Estimate and Technical Specifications

   Both sides confirmed that the cost estimateand technical specifications in the Draft Report should never be duplicated or disclosed to any third parties until all the contractsunderthe Project are awarded.

5. Timeline for the Project Implementation

   The Team explained to theIndia side that the expected timeline for the project implementation is as attached in Annex 2.

6. Expected Outcomes and Indicators

   Both sides agreed that key indicators for expected outcomes and key indicators targeted in year 2022, in which ex-post evaluation by JICA is planned, are as follows. TheIndiasideshall monitor the progress based on those indicators.

   [Quantitative indicators]

   (1) 13% improvement of the average travel speed along trunk roads where signals will be installed by the Grant; and
   (2) 30% reduction of queuelength of main intersections where signals will be installed by the Grant.

[Qualitative indicators]

(1) Long-term vitality of Bengaluru city's regional economy;

(2) Reduction of global warming; and

(3) Reduction of the traffic accidents.

7. Technical Assistance ("Soft Component" of the Project)

Considering the sustainable operation and maintenance of the products and services granted through the Project, technical assistance to instruct initial operation and maintenance is planned under the Project. The India side confirmed to deploy necessary operation and maintenance personnel as described in the Draft Report to effectively acquire benefit from the technical assistance.

8. Undertakings of the Project

Both sides confirmed the undertakings of the Project as described in Annex 3.The India side assured to take the necessary measures and coordination including allocation of the necessary budgetwhich are preconditions of implementation of the Project.

It is further agreed that the costs are indicative, i.e. at Outline Design level. More accurate costs including those to be borne by India side will be calculated at the Detailed Design (D/D) stage. In this connection, cost for "Internal wiring works in the building for the Bnegaluru Traffic Information Center" described in the item 8 of 1. (2) Of Annex 3 will be finalized and confirmed at the stage of D/D.

Both sides also confirmed that necessary expenses will be discussed and confirmed when issues and/or necessity arise regarding "To bear all the expenses, other than those covered by the Grant, necessary for the implementation of the Project" described in the item 10 of 1.(2) of Annex 3.

India side also explained that budget allocation is subject to budget approval of the Cabinet.

Both sides also confirmed that the Annex 3 will be used as an attachment of Grant Agreement (G/A).

8-1 Tax Exemption

With respect to exemption of customs duties, internal taxes and other fiscal levies as stipulated in Annex 3, both sides confirmed as follows in principle:

- Exemption from Custom Duties imposed by GOI ;
- Reimbursement of Service Tax and Excise Tax imposed by GOI;
- Reimbursement of Value Added Tax imposed by GOK; and
- Budget for reimbursement of the taxes imposed by GOI and GOK shall be secured by DULT and/or GOI according to procurement plan of the Project

prepared by the contractor/supplier.

The procedure for reimbursement of Value Added Tax is described in Annex 4.Procedures for other tax treatment including sharing of expenses on tax reimbursement between GOI and GOK shall be clarified byDULT by finalizing Detail Design of the Project. In case of enactmentof new taxation, both sides will consult each other to ensure exemption from new taxes imposed on Japanese nationals engaged in the Project.

8-2Opening B/A and Issuing A/P

(1) The Implementing Agency, Directorate of Urban Land Transport (DULT) of GOK, is expected to open Bank Account (B/A) just after the signing of Grant Agreement (G/A), according to the G/A (Schedule 3). Any other process must follow the completion of B/A (See"Annex 2 Progress Chart"). DULT is expected to clarify necessary procedures of B/a consulting with Department of Finance, GOK and Department of Economic Affairs, Ministry of Finance, GOI in advance, and will take prompt actions accordingly.

(2) After making the Contract with Consultant/Supplier, DULT is expected to issue Authorization to Pay (A/P) under the B/A in order to facilitate payment to Consultant/Supplier based on the Contract.

9. Monitoring during the Implementation

The Project will be monitored by the Executing Agency andreported to JICA by using the form of Project Monitoring Report (PMR) attached as Annex 5.The timing of submission of the PMR is described in Annex 2.

10. Project Completion

Both sides confirmed that the project completes when all the facilities constructed and equipment procured by the grant are in operation. The completion of the Project will be reported to JICA promptly, but in any event not later than six months after completion of the Project.

11. Ex-Post Evaluation

JICA will conduct ex-post evaluation after three (3) years from the project completion, in principle, with respect to five evaluation criteria (Relevance, Effectiveness, Efficiency, Impact, and Sustainability). The result of the evaluation will be publicized. TheIndia side is required to provide necessary support for the data collection.

12. Items and measures to be considered for the smooth implementation of the Project

Both sides confirmed the items and measures to be considered for the smooth implementation of the Project asdescribed in Annex 6.

13. Schedule of the Study

JICA will finalize the Preparatory Survey Report based on the confirmed items.Although the Report excluding the additional study namely drafting contract and specifications for O&M described in "15-4 Issues on Operation and Maintenance" will be finalized around April 2017, it will possibly take a few months in addition for JICA to finalize the additional study. The Team explained that JICA will inform DULT of schedule of the Report delivery as early as possible.

14. Environmental and Social Considerations

The Team explained that 'JICA Guidelines for Environmental and Social Considerations (April 2010)' (hereinafter referred to as "the Guidelines") is applicable for the Project. The Project is categorized as C because the Project is likely to have minimal adverse impact on the environment under the Guidelines.

15. Other Relevant Issues

15-1. Disclosure of Information

Both sides confirmed that the Preparatory Survey Report from which project cost is excluded will be disclosed to the public after completion of the Preparatory Survey. The comprehensive report including the project cost will be disclosed to the public after all the contracts under the Project are concluded.

15-2. Short-term outcomes and indicators

India side requested to set short-term outcomes and indicators to enhance public relations. The Team explained that it will consider proper short-term outcomes and include them into the final Preparatory Survey Report.

15-3. Location of the signal control server

DULT and BTPwill decide location of the signal control server (Traffic Center of BTP or KSDC) by the end of February to be incorporated into the final report of preparatory survey.

15-4. Issues on Operation and Maintenance (O&M)

BTP agreed the O&M structure (see Annex 6) and the 10 Year Maintenance Schedule proposed by the Team in principle.

DULT stated that they would like to go for a single bid (means "*single procurement process but two separate contract will be signed with the same contractor for Implementation and O&M*") where the same contractor shall be incharge for implementation as well as O&M. The funding can be arranged in such a way that implementation is funded through the Japanese grant and O&M shall be borne by GoK and it is requested that the O&M contractor should take care of the system for 5 years so as to secure proper O&M of the equipment and technology transfer including consulting, commissioning, troubleshooting and so on.

The Team stated as follows:

- JICA agreed to the proposed procurement policy for implementation and O&M in principle. The details of the tendering procedures would be discussed and confirmed through the detailed design stage by both sides.
- JICA survey team would prepare a draft of contract and specifications for O&M.

15-5. Interoperability

DULT requested JICA to extend support for interoperability of the system to work with other systems when the India decides to expand ITS services in Bengaluru.

The team replied that JICA will consider possibility of the support according to contents of the request, necessity of support, technical possibility including consent of the systems' manufacturers to open their intellectual properties regarding the systems and so on.

Annex 1 Cost Estimate
Annex 2 Project Implementation Schedule
Annex 3 Major Undertakings to be taken by India side
Annex 4 Procedure for tax exemption and reimbursement
Annex 5 Project Monitoring Report (template)
Annex 6 Maintenance Plan

Annex 1 Cost Estimation

Confidential

1. Japaneseside

This Part is closed due to the confidenciality.

2. Indian side

Item	Unit	Amount	
		Indian Rupee	Japanese yen
Installation of HDPE pipe (32mm/ 2ways) , electricity (power cable) and telecommunication cable (Optical fiber cable)	49 place	3,612,000	5,309,640
Internal wiring works in the building for the Bnegaluru Traffic Information Center	1 place	126,000	185,220
Initial maintenance spare parts (signal pole &sensor pole)	30 pcs	1,013,000	1,489,110
Replacement of existingantry of traffic sign boards	1 place	349,000	513,030
Replacement of existing signal pole	149 pcs	1,345,000	1,977,150
Total		6,445,000	9,474,150

3.Estimation Conditions

(1)Date of Estimation: July 2016

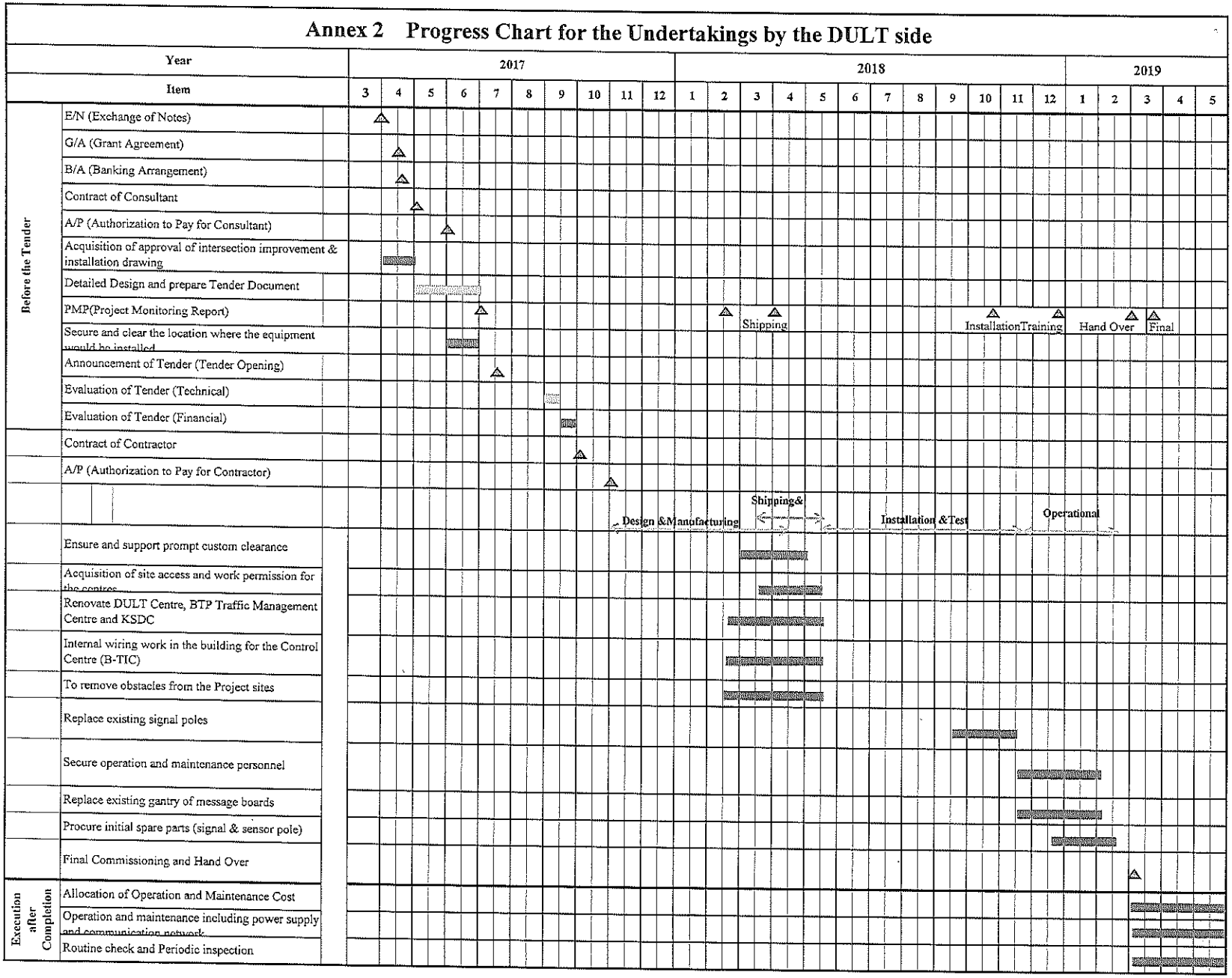
(2)Foreign Exchange Rate: US$1 = JPY 109.04

INR1 = JPY 1.47

(3) During the Project Implementation

NO	Items	Deadline	In charge	Estimated Cost (Thousand India Rupee)	Ref.
1	To issue A/P to a bank in Japan(the Agent Bank) for the payment to the Supplier(s)	within 1 month after the signing of the contract(s)	DULT		
2	To bear the following commissions to a bank in Japan for the banking services based upon the B/A				
	1) Advising commission of A/P	within 1 month after the signing of the contract(s)	DULT		
	2) Payment commission for A/P	every payment	DULT		
3	To ensure prompt unloading and customs clearance at ports of disembarkation in recipient country and to assist the Supplier(s) with internal transportation therein	during the Project	DULT		
4	To facilitate Japanese nationals and/or physical persons of third countries whose services may be required in connection with the supply of the products and the services may be necessary for their entry into the country of the Recipient and stay therein for the performance of their work	during the Project	DULT		
5	To ensure that customs duties, internal taxes and other fiscal levies which may be imposed in India with respect to the purchase of the products and the services be exempted	during the Project	DULT DOF MOF		
6	To renovate DULTCenter, BTPTraffic Management Center and KSDCincluding air conditioning, replacement electrical fittings, lighting fixture and refurbishing if necessary, to accommodate the equipment	before installation of the equipment	DULT BTP		
7	To acquire site access and work permission for the centers	before installation of the equipment	DULT		
8	1) To install HDPE pipe (32mm/ 2ways), electricity (power cable) and telecommunication cable (Optical fiber cable)	before installation of the equipment	DULT	3,612	
	2) To implement internal wiring works in the building for for the Bnegaluru Traffic Information Center	before installation of the equipment	DULT	126	
9	To remove obstacles from the Project sites	before installation of the equipment	DULT BTP		
10	To bear all the expenses, other than those covered by the Grant, necessary for the implementation of the Project	during the Project	DULT		
11	1) To submit Project Monitoring Report after each work under the contract(s) such as shipping, hand over, installation and operational training	within one month after completion of each work	DULT		
	2) To submit Project Monitoring Report (final)	within one month after signing of Certificate of Completion for the works under the contract(s)	DULT		
12	To submit a report concerning completion of the Project	within six months after completion of the Project	DULT		
13	To procure initial maintenance spare parts (signal pole & sensor pole)	Before completion of the equipment installation	DULT,	1,013	

Annex 2 Progress Chart for the Undertakings by the DULT side



Annex 3 Major Undertakings to be taken by India side

B/A: Banking Arrangement

A/P: Authorization to pay, N/A: Not Applicable

DULT: Directorate of Urban Land Transportation, State Government of Karnataka

BTP: Bengaluru Traffic Police

KSDC: Karnataka State Data Center

DOF : Department of Finance, State Government of Karnataka

MOF: Ministry of Finance, Government of India

1. Specific obligations of the Government of India and the Implementing Agency which will not be funded with the Grant

(1) Before the signing of Grant Agreement

NO	Items	Deadline	In charge	Estimated Cost (Thousand Indian Rupee)	Ref.
1	Budget Approval by the Parliament/Cabinet	2 weeks before the signing of Grant Agreement	DULT		

(2) Before the Tender

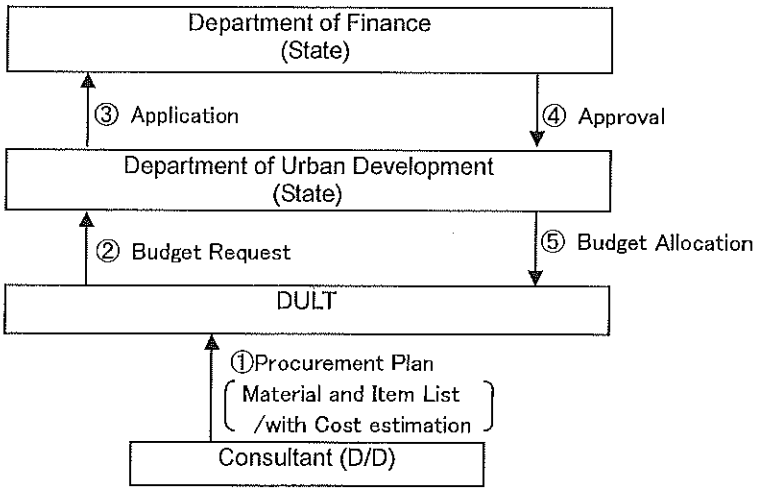
NO	Items	Deadline	In charge	Estimated Cost (Thousand Indian Rupee)	Ref.
1	To open bank account (B/A)	within 1 month after the signing of the G/A	DULT		
2	To issue A/P to a bank in Japan (the Agent Bank) for the payment to the consultant	within 1 month after the signing of the contract	DULT		
3	To acquire approval of intersection improvement and equipment installation drawings from road administrators (National Highway Agency India and Municipal)	before Detail Design	DULT		
4	To secure and clear the location where the equipment would be installed	before notice of the bidding document	DULT		
5	To submit Project Monitoring Report (with the result of Detail Design)	before preparation of bidding documents	DULT		

NO	Items	Deadline	In charge	Estimated Cost (Thousand Indian Rupee)	Ref.
14	To secure operation and maintenance personnel	Before completion of the equipment installation	DULT, BTP		
15	To replace existing gantries oftraffic sign boards	Just after commencement of operational guidance	DULT	349	-
16	To replace existing signal poles	Just after commencement of operational guidance	BTP	1,345	

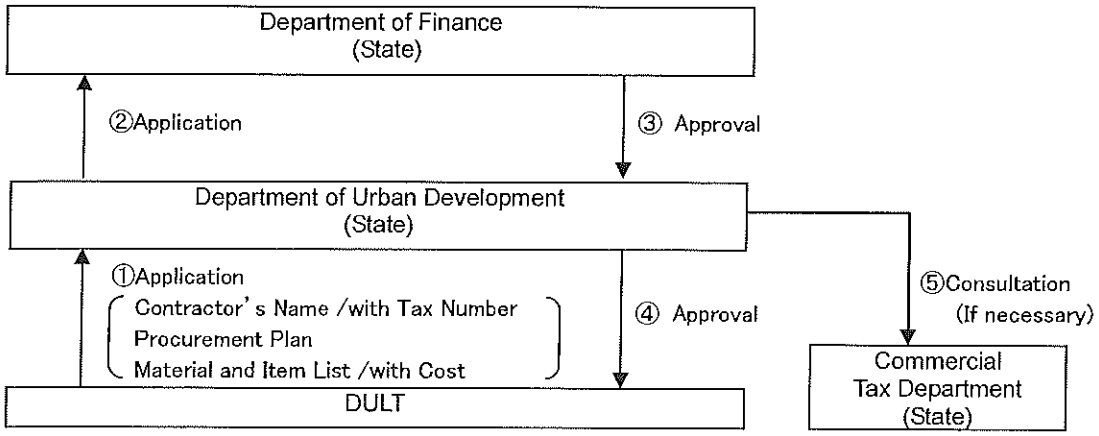
This Part is closed due to the confidenciality.

Annex 4 Basic Procedure for Tax Exemption and Reimbursement (State Tax -VAT-)

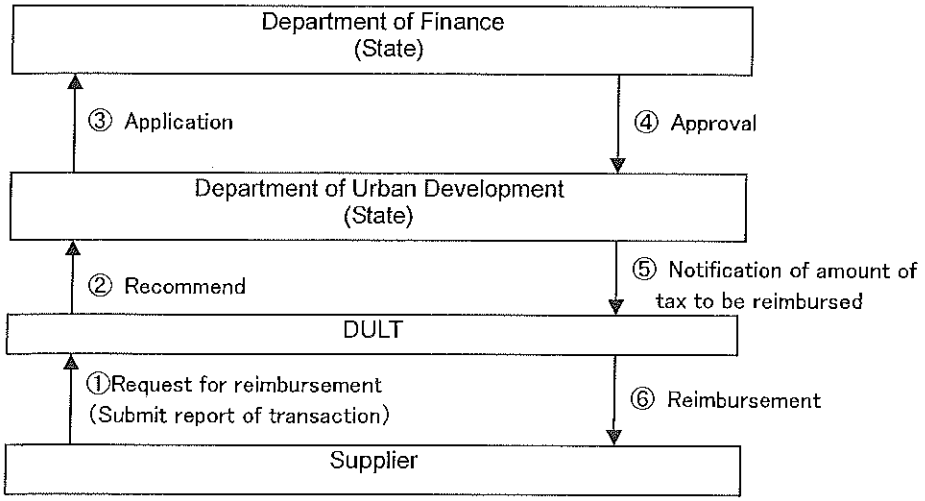
Flow 1 Allocation of Budget for Tax Reimbursement (one time)



Flow 2 Concurrence Procedure for Tax Reimbursement (one time)



Flow 3 Procedure for Tax Reimbursement (quarterly)



Project Monitoring Report
on
Grant Agreement No. XXXXXXX

20XX, Month

Organizational Information

Signer of the G/A (Recipient)	Person in Charge (Designation) _____ Contacts Address: _____ Phone/FAX: _____ Email: _____
Executing Agency	Person in Charge (Designation) _____ Contacts Address: _____ Phone/FAX: _____ Email: _____
Line Ministry	Person in Charge (Designation) _____ Contacts Address: _____ Phone/FAX: _____ Email: _____

General Information:

Project Title	
E/N	Signed date: Duration:
G/A	Signed date: Duration:
Source of Finance	Government of Japan: Not exceeding JPY _____ mil. Government of (_____): _____

1: Project Description

1-1 Project Objective

1-2 Project Rationale

- Higher-level objectives to which the project contributes (national/regional/sectoral policies and strategies)
- Situation of the target groups to which the project addresses

1-3 Indicators for measurement of "Effectiveness"

Quantitative indicators to measure the attainment of project objectives		
Indicators	Original (Yr)	Target (Yr)
Qualitative indicators to measure the attainment of project objectives		

2: Details of the Project

2-1 Location

Components	Original *(proposed in the outline design)*	Actual
1.		

2-2 Scope of the work

Components	Original* *(proposed in the outline design)*	Actual*
1.		

Reasons for modification of scope (if any).

(PMR)

2-3 Implementation Schedule

Items	Original		Actual
	(proposed in the outline design)	*(at the time of signing the Grant Agreement)*	

Reasons for any changes of the schedule, and their effects on the project (if any)

2-4 Obligations by the Recipient

2-4-1 Progress of Specific Obligations

See Attachment 2.

2-4-2 Activities

See Attachment 3.

2-4-3 Report on RD

See Attachment 11.

2-5 Project Cost

2-5-1 Cost borne by the Grant(Confidential until the Bidding)

Components			Cost (Million Yen)	
	Original *(proposed in the outline design)*	Actual *(in case of any modification)*	Original[1),2)] *(proposed in the outline design)*	Actual
	1.			
Total				

Note: 1) Date of estimation:
2) Exchange rate: 1 US Dollar = Yen

2-5-2 Cost borne by the Recipient

Components			Cost (1,000 Taka)	
	Original *(proposed in the outline design)*	Actual *(in case of any modification)*	Original[1),2)] *(proposed in the outline design)*	Actual
	1.			

Note: 1) Date of estimation:
2) Exchange rate: 1 US Dollar =

Reasons for the remarkable gaps between the original and actual cost, and the countermeasures (if any)

(PMR)

2-6 Executing Agency

- Organization's role, financial position, capacity, cost recovery etc,
- Organization Chart including the unit in charge of the implementation and number of employees.

Original *(at the time of outline design)* name: role: financial situation: institutional and organizational arrangement (organogram): human resources (number and ability of staff):
Actual *(PMR)*

2-7 Environmental and Social Impacts

- The results of environmental monitoring based on Attachment 5 (in accordance with Schedule 4 of the Grant Agreement).
- The results of social monitoring based on in Attachment 5 (in accordance with Schedule 4 of the Grant Agreement).
- Disclosed information related to results of environmental and social monitoring to local stakeholders (whenever applicable).

3: Operation and Maintenance (O&M)

3-1 Physical Arrangement

- Plan for O&M (number and skills of the staff in the responsible division or section, availability of manuals and guidelines, availability of spareparts, etc.)

Original *(at the time of outline design)*
Actual *(PMR)*

3-2 Budgetary Arrangement

- Required O&M cost and actual budget allocation for O&M

Original *(at the time of outline design)*

Actual *(PMR)*

4: Potential Risks and Mitigation Measures

- Potential risks which may affect the project implementation, attainment of objectives, sustainability
- Mitigation measures corresponding to the potential risks

Assessment of Potential Risks *(at the time of outline design)*

Potential Risks	Assessment
1. (Description of Risk)	Probability: High/Moderate/Low
	Impact: High/Moderate/Low
	Analysis of Probability and Impact:
	Mitigation Measures:
	Action required during the implementation stage:
	Contingency Plan (if applicable):
2. (Description of Risk)	Probability: High/Moderate/Low
	Impact: High/Moderate/Low
	Analysis of Probability and Impact:
	Mitigation Measures:
	Action required during the implementation stage:
	Contingency Plan (if applicable):
3. (Description of Risk)	Probability: High/Moderate/Low
	Impact: High/Moderate/Low
	Analysis of Probability and Impact:
	Mitigation Measures:
	Action required during the implementation stage:

	Contingency Plan (if applicable):
Actual Situation and Countermeasures	
(PMR)	

5: Evaluation and Monitoring Plan (after the work completion)

5-1 Overall evaluation

Please describe your overall evaluation on the project.

5-2 Lessons Learnt and Recommendations

Please raise any lessons learned from the project experience, which might be valuable for the future assistance or similar type of projects, as well as any recommendations, which might be beneficial for better realization of the project effect, impact and assurance of sustainability.

5-3 Monitoring Plan of the Indicators for Post-Evaluation

Please describe monitoring methods, section(s)/department(s) in charge of monitoring, frequency, the term to monitor the indicators stipulated in 1-3.

Attachment

1. Project Location Map
2. Specific obligations of the Recipient which will not be funded with the Grant
3. Monthly Report submitted by the Consultant

Appendix - Photocopy of Contractor's Progress Report (if any)
- Consultant Member List
- Contractor's Main Staff List

4. Check list for the Contract (including Record of Amendment of the Contract/ Agreement and Schedule of Payment)
5. Environmental Monitoring Form / Social Monitoring Form
6. Monitoring sheet on price of specified materials (Quarterly)
7. Report on Proportion of Procurement (Recipient Country, Japan and Third Countries) (PMR (final)only)
8. Pictures (by JPEG style by CD-R) (PMR (final)only)
9. Equipment List (PMR (final)only)
10. Drawing (PMR (final)only)
11. Report on RD (After project)

Attachment 6

Monitoring sheet on price of specified materials

1. Initial Conditions (Confirmed)

	Items of Specified Materials	Initial Volume A	Initial Unit Price (¥) B	Initial total Price C=A×B	1% of Contract Price D	Condition of payment	
						Price (Decreased) E=C−D	Price (Increased) F=C+D
1	Item 1	●●t	●	●	●	●	●
2	Item 2	●●t	●	●	●		
3	Item 3						
4	Item 4						
5	Item 5						

2. Monitoring of the Unit Price of Specified Materials

(1) Method of Monitoring : ●●

(2) Result of the Monitoring Survey on Unit Price for each specified materials

	Items of Specified Materials	1st ●month, 2015	2nd ●month, 2015	3rd ●month, 2015	4th	5th	6th
1	Item 1						
2	Item 2						
3	Item 3						
4	Item 4						
5	Item 5						

(3) Summary of Discussion with Contractor (if necessary)

-

-

-

Attachment 7

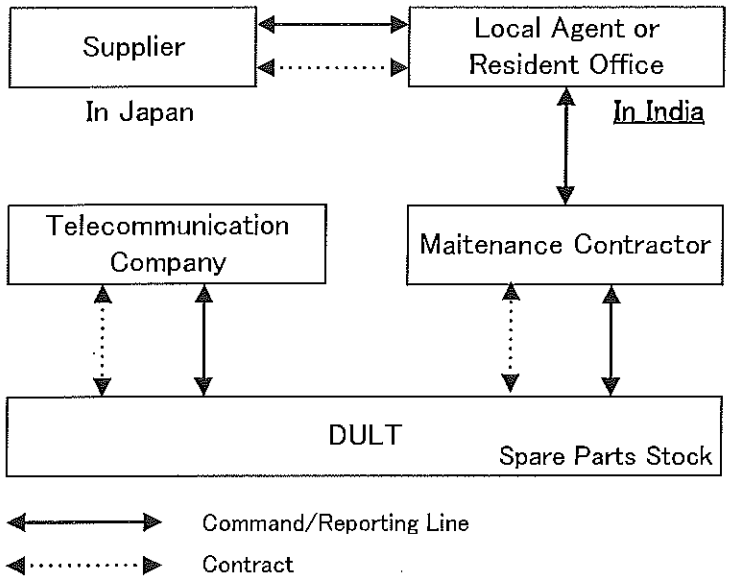
Report on Proportion of Procurement (Recipient Country, Japan and Third Countries)
(Actual Expenditure by Construction and Equipment each)

	Domestic Procurement (Recipient Country) A	Foreign Procurement (Japan) B	Foreign Procurement (Third Countries) C	Total D
Construction Cost	(A/D%)	(B/D%)	(C/D%)	
Direct Construction Cost	(A/D%)	(B/D%)	(C/D%)	
others	(A/D%)	(B/D%)	(C/D%)	
Equipment Cost	(A/D%)	(B/D%)	(C/D%)	
Design and Supervision Cost	(A/D%)	(B/D%)	(C/D%)	
Total	(A/D%)	(B/D%)	(C/D%)	

Annex-6 Maintenance Plan

1) DULT : B-TIC

<Maintenance Structure>



- Technical support/technical consulting
- Purchasing new parts from supplier
- Ordering repair to supplier

- Identifying cause of failure
- System recovery
- Regular inspection

- Daily operation (during normal time)
- Judging origin of failure (Communication/B-TIC/BMTC/BRTRAC)
  → Coordinating with relevant authority

<Assurance of Availability of Spare Parts>

- Stocked spare parts will be used on the occasion of failure or for replacement due to life cycle.
- New spare parts will be purchased before they become out of stock according to spare parts procurement plan under above maintenance structure.
- Broken parts will be repaired by supplier under above maintenance structure.

<Local Agent/Resident Office>

- Supplier must be capable to supply equipment continuously e.g. for 10 years through his resident office or local agent
- Local agent must have experience of handling similar product of the supplier
- Above conditions will be specified in the tender document
- Items to be supplied: All items that are purchased from Japan

<Selection of Maintenance Contractor>

- Timing: Before operation and maintenance guidance to be provided by supplier
- Condition : Contractor must have maintenance experiences of the systems described below.

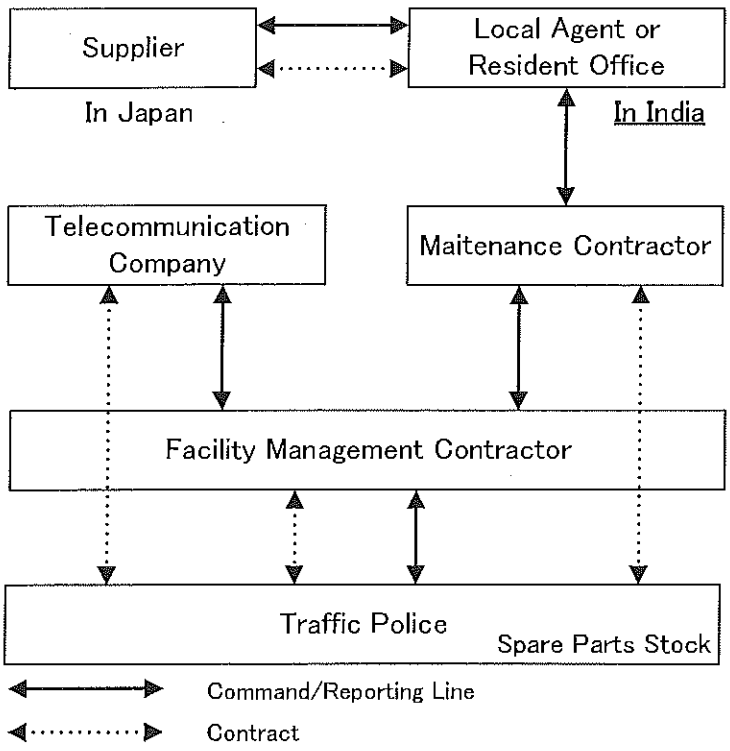
<Requirement of Maintenance Contractor: Maintenance Experience>

(1) Probe System (generating traffic congestion information from probe data) and Internet (providing traffic congestion information)
(2) ATCC System
(3) Queue Length System

Annex-6 Maintenance Plan

2) Traffic Police: ATCS and VMS System

<Maintenance Structure>



- Technical support/technical consulting
- Purchasing new parts from supplier
- Ordering repair to supplier

- Identifying cause of failure
- System recovery
- Regular inspection

- Coordinating with relevant authority (e.g. each maintenance contractor, telecommunication company)
- Keeping record of system recovery
- Reporting to Traffic Police

- Daily operation (during normal time)
- Judging origin of failure (Communication/BTRAC/B-TIC)
  → Coordinating with relevant authority

<Assurance of Availability of Spare Parts>

- Stocked spare parts will be used on the occasion of failure or for replacement due to life cycle.
- New spare parts will be purchased before they become out of stock according to spare parts procurement plan under above maintenance structure.
- Broken parts will be repaired by supplier under above maintenance structure.

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- Supplier must be capable to supply equipment continuously e.g. for 10 years through his resident office or local agent
- Local agent must have experience of handling similar product of the supplier
- Above conditions will be specified in the tender document
- Items to be supplied: All items that are purchased from Japan

<Selection of Maintenance Contractor>

- Timing: Before operation and maintenance guidance to be provided by supplier
- Condition : Contractor must have maintenance experiences of the systems described below.

<Requirement of Maintenance Contractor: Maintenance Experience>

(1) VMS System
(2) Signal System (Dynamic traffic signal control according to traffic condition)

Minutes of Discussions
on the Preparatory Survey for the Project for
Implementation of Advanced Traffic Information and Management System
in Core Bengaluru
(the 5th Site Survey)

With reference to the minutes of discussions signed between Directorate of Urban Land Transport (hereinafter referred to as " DULT "), Government of Karnataka (hereinafter referred to as " GOK"), Bangalore Traffic Police (hereinafter referred to as "BTP") and the Japan International Cooperation Agency (hereinafter referred to as "JICA") on March 10, 2016 and in response to the request from the Government of India (hereinafter referred to as "GOI") dated November 18, 2015 JICA dispatched the Preparatory Survey Team (hereinafter referred to as "the Team") for the explanation of the result of the additional survey on the project for the Project for Implementation of Advanced Traffic Information and Management System in Core Bengaluru (hereinafter referred to as "the Project"), headed by Shuntaro KAWAHARA, Senior Advisor, JICA from June 28 to July 14, 2017.

As a result of the discussions, both sides agreed on the main items described in the attached sheets.

Bengaluru, July 12, 2017

Shuntaro Kawahara
Leader
Preparatory Survey Team
Japan International Cooperation Agency
Japan

Darpan Jain, IAS
Commissioner
Directorate of Urban Land Transport
Government of Karnataka
India

ममता बत्रा/MAMTA BATRA
अवर सचिव/Under Secretary
आवास और शहरी कार्य मंत्रालय
Ministry of Housing And Urban Affairs
भारत सरकार/Govt. of India
नई दिल्ली/ New Delhi

Ministry of Urban Development
India

के. ए. सिवदास/K. A. SIVADAS
अवर सचिव/Under Secretary
आर्थिक कार्य विभाग/Deptt. of Eco. Affairs
वित्त मंत्रालय/Ministry of Finance
भारत सरकार/Govt. of India
नई दिल्ली/New Delhi

Department of Economic Affairs
Ministry of Finance
India

Concerns of MOHUA & the reply of GoK thereto has been made part of this document as Annexure-7

ATTACHMENT

1. Items to be Confirmed in the Additional Survey

After the explanation of the contents of the additional survey by the Team, the India side agreed to its contents. Based on the main points confirmed and the Final Preparatory Survey Report, conditions of contract and specifications for the Project and the Operation and Maintenance (hereinafter referred as "O&M") of it will be prepared at the stage of Detailed Design.

The main points confirmed between both sides are followings:

1-1 Main Points of O&M Specification

The Team submitted the O&M Specification (draft) to DULT. The major conformed items are agreed as follows. The main points of O&M Specification for Bengaluru Traffic Information Center (hereinafter referred to as "BTIC") and those for BTP are shown in Annex 1-1 and Annex 1-2 respectively. And also both sides confirmed about basic concept of service level as shown in Annex 1-3.

(1) Role of the Contractor

Role of the Contractor is shown in Annex 2.

(2) Service Level (DULT and BTP)

- Severity (Critical, Major, Minor) of incidents are defined according to risks to road user.
- Required Response Time and Resolution Time are defined according to the severity.
- System availability is calculated according to down time responsible for the Contractor.
- The Contractor's performance is evaluated based on the difference between target availability and actual availability.
- Payment will be possibly deducted according to the Contractor's performances.

1-2 Form of O&M Contract

The Team submitted the Draft Form of O&M Contract to DULT. The major conformed items are agreed as follows.

(1) General Conditions

- World Bank Management Service Contract is used.

(2) Particular Conditions

- The Employer is DULT.
- DULT will authorize to BTP as Employer's Representative for O&M service within BTP.
- Payment reductions due to failure to meet the requirements are additionally stipulated.
- Independent Expert for dispute resolution who is stipulated in the above general conditions is remained. Remunerations for the Independent Expert will be borne by the Employer and the Contractor on halves.

1-3 O&M Price

The Team submitted the O&M price to DULT. The major conformed items are agreed as follows.

(1) Composition of the O&M Price

O&M price consists of Lump-sum portion and Unit Price portion.

- Lump-sum Portion
  - Operation
  - Primary Response
  - Emergency Response (including resolution cost for damaged facilities)
  - Periodic Inspection and Preventive Maintenance including Update and Debugs of the Installed Software
  - Local Training and Seminar
  - Annual Adjustment of equipment/system including adjustment of parameters of the signal system and necessary survey
  - Minor modifications of the system software (e.g. Improvement of visibilities of system console, web site design of traffic condition information of internet system, etc.) within one (1) year after the completion of the Project according to bilateral negotiations to avoid impartial and excessive burden of the Contractor
- Unit Price Portion

The Contractor can claim invoice of following items according to the unit price prescribed in the O&M Contract

- Purchasing additional equipment/system and supporting facilities for upgrade and expansion according to instructions of the Employer
- Purchasing new equipment and parts if retrieved defective/damaged equipment

and parts is impossible to be repaired

- Notes
  - In case the Employer requests to upgrade software by adding new function, the price for the upgrading is subject to negotiation.

(2) Methodology to Determine the O&M Price

- Both sides confirmed that lump sum portion of O&M price shall be calculated by "Fixed Rate" prescribed in the instructions to bidders. The Team proposed methodology to set the rates as follows;

This Part is closed due to the confidenciality.

- The unit price prescribed in the O&M Contract shall be determined according to the result of the contract negotiation although it should basically meet the unit prices shown in the Bill of Quantities submitted as a bid document by the Contractor.

1-4 Procedures and Evaluation Criteria of the Bidding

The Team explained to DULT procedures and evaluation criteria of the bidding, of which flowchart is shown in Annex-3. The major conformed items are agreed as follows.

1-5 Amount of the Performance Security for the O&M Contract

DULT insisted that sufficient amount of Performance Security should be delivered by the Contractor to ensure proper performance of the Contractor. Both sides agreed that amount of the Performance Security for the O&M Contract would be equal to the amount of 10 percent of the O&M Contract Price in India Rupee.

1-6 Monitoring the Impact of the Project

Both sides agreed that DULT would employ a consulting firm to annually monitor short term impact of the Project, namely reduction of queue length, vehicle stop frequency,

travel time and wasted green signal time, and that terms of reference of the consulting firm would be described in the Final Preparatory Survey Report. Both sides also confirmed that the first monitoring shall be conducted between three to six months after the commencement of the system operation.

2. Respond to the Inquiries from MoUD.

(1) Letter to MoUD by DULT

Both sides confirmed that DULT had replied to the letter from Ministry of Urban Development, the Government of India (hereinafter referred to as "MoUD") dated on May 18, 2017, as shown in Annex-4.

(2) Provision of Necessary Data for DULT Reference

The Team presented an additional explanation to DULT as follows;.

- Interoperability of BTIC and Signal System (Annex 5-1);
  The Team explained that UTMS standard of signal systems has already been incorporated into ISO (International Standard Organization). Communication protocol used internationally, also in India, will be also applied to the BTIC system under the Project; and
- Project Impact (Annex 5-2).

3. Schedule of the Preparatory Survey

JICA will finalize the Preparatory Survey Report based on the confirmed items. The report will be sent to the India side around September 2017.

4. Major Undertakings to be Taken by the India side

The Team explained that major undertakings to be taken by the India side which are discussed in January 2017 has been revised based on the additional survey results as shown in Annex 6.

5. Public Relations for the Project

DULT requested the Japanese side to support public relations during and after the Project to notify local residents, road users and Government entities across the country of new services provided by the Project.

Annex 1-1: Main Points of O&M Specification for BTIC
Annex 1-2: Main Points of O&M Specification for BTP

Annex 1-3: Basic Concept of Service Level

Annex 2: Role of the Contractor

Annex 3: The Procedures and Evaluation Criteria of the Bidding

Annex 4 : A copy of the Letter from DULT to MoUD (dated on July 10, 2017)

Annex 5-1: Interoperability of BTIC and Signal System

Annex 5-2: Project Impact

Annex 6: Major Undertakings to be taken by India side (Revised Information based on the Results of the Additional Survey)

Annex 1-1

Main Points of O&M Specification for BTIC

I. Working Shift and Role of the Contractor

1. The working shift for the Contractor's staffs who will be posted at DULT

- Working hours : 10:00 to 17:30 on weekdays and Saturday except for the 2nd Saturday with 1 shift
- During non-working hours, the Contractor has to respond to accident and/or system failure when the Employer instructs.

2. Reporting

The Contractor submits daily, monthly, quarterly and incident reports of the Contractor's activity to the Employer, who determines reduction amount for payment according to the availability described in a quarterly report.

II. Primary Response and Emergency Response

1. Response and Resolution Time for Incidents

Response and Resolution Time in case of incidents, the Contractor shall perform less than the indicated time period in the table below.

Severity of Incidents	Definitions	Response Time	Resolution Time	
			System Failures	Facility Incident at Site
Critical	Incidents which have high possibility of immediate danger to road users.	< 1 hour	< 6 hours	24 hours
Major	Incidents which may cause danger to road users.	< 1 hour	< 12 hours	
Minor	Failures of control system that does not have any possibility to damage road users' safety	< 2 hours	< 24 hours	

The Contractor is responsible for categorizing severity although the Contractor shall consult with the Employer in case the Contractor finds difficulties to judge it.

Examples of the incidents of each severity are shown in the below table.

Severity	Kinds of Failure
Critical Incident	① Seriously damaged ATCC (Automatic Traffic Counter Classifier) / Que length pole(s) by traffic accident, which has already collapse and/or will probably collapse
Major Incident	② Damaged ATCC / Que length pole(s) by traffic accident, which will not probably collapse immediately
Minor Incident	③ Slight damage on ATCC/Que length pole(s) by traffic accident, which will not collapse; ④ Discommunication among BMTC System/BTIC/Sensors; and ⑤ Sending abnormal data from BTIC to TMC/Internet;.

2. Service Level

Service level is evaluated quarterly based on the availability.

2.1 The Formula of Calculation of Availability

The formula of calculation of availability is shown as follows

$$Availability = (1 - \frac{Downtime - PermissiveDowntime}{Totaltime - PermissiveDowntime}) * 100$$

Downtime (hours): "Total time during which the specified services/components with specified technical and service standards are not available.
Downtime is calculated based on the following unit;
(1) ATCC/Que length sensors: Site basis;
(2) Operator consoles: Console basis; and
(3) Servers: Server basis:

Totaltime (hours): Total time of evaluation period (3 month; 2,160 hours).

Permissive downtime (hours): The time period required for periodic inspection, preventative maintenance, repair works for damages caused by the third parties (e.g. traffic accidents, black out, surge caused by thunder storm, fire, failure of communication lines, vandalism, etc.) and works instructed by the Employer.

2.2 Target Availability

Target availability is 99.00%.

2.3 Payment Reduction

When the availability does not reach the target availability, the Employer can deduct calculated amount from O&M payment. Following is the formula for calculation of the amount for payment reduction.

Payment Reduction = Lump sum portion of O&M payment*(Target availability (%) - Availability (%))/50

This Part is closed due to the confidenciality.

Eg.) Downtime: 110hr, Totaltime: 2160hr (24*90), PermissiveDowntime: 60hr, Target availability: 99%, O&M payment for 3months: INR 80 Lakh

Availability= (1-((110-60)/(2160-60)))*100, Availability = 97.62%

Payment Reduction = 80*(99-97.62)/50,

Payment Reduction = INR 2,88,000

III. Periodic Activities

Periodical Activities by the Contractor is shown in the followings:

1. Periodic Inspection and Preventive Maintenance

Periodic Inspection and Preventive Maintenance shall be carried out by the Contractor.

Frequency	BTIC Server	Roadside Equipment	Participants
Monthly	Visual Check	Visual check from vehicles	Local
Semiannual	Detail Check + Cleaning	Detail Check + Cleaning	Local
Annual	Adjustment of Equipment/System	Adjustment of Equipment/System	Local

<Note>

Preventive Maintenance: Necessary works for preventing system/equipment failures including cleaning, replacing damaged parts, and adjusting position of detecting equipment.

Detail Check: Visual inspection and contact diagnostics.

The Contractor will submit a plan and check sheets for the Periodic Inspection on each equipment and system.

Adjustment of Equipment/System: The Contractor will revise software and/or parameter of the probe system according to results of the monitoring, and incorporate the latest digital road maps into the probe system annually.

2. Seminar

Two days seminar will be hold once in a year by the Contractor. The purpose of seminar is to transfer the ITS technologies and know-how to Police officers, TMC employees, DULT employees, any other Government employees and local private companies of ITS sector including manufactures, operators and maintenance firms. The venue of the seminar shall be provided by DULT. Japanese engineers of the Contractor and knowledgeable local engineers

will be lecturers for the seminar.

3. Adjustment of Equipment/System

The Contractor will adjust the probe system based on actual travel time along major roads detected by probe cars.

Annex 1-2

Main Points of O&M Specification for BTP

I. Working Shift and Reporting

1. The working shift for the Contractor's staffs who will be posted at TMC

- Working hours : 8 : 00 to 20:00 with 2 shifts.
- During non-working hours, the Traffic Police at TMC informs the Contractor of accidents and system failures, the Contractor shall respond to the information.

2. Reporting

The Contractor submits daily, monthly, quarterly and incident reports of the Contractor's activity to a representative of the Employer (Bengaluru Traffic Police). The Employer determines reduction amount for payment according to the availability described in a quarterly report.

II. Primary Response and Emergency Response

1. Response and Resolution Time for Incidents

Response and Resolution Time in case of incidents, the Contractor shall perform less than the indicated time period in the table below.

Severity of Incidents	Definitions	Response Time	Resolution Time	
			System Failures	Facility Incident at Site
Critical	Incidents which have high possibility of immediate danger to road users.	< 1 hour	< 6 hours	24 hours
Major	Incidents which may cause danger to road users.	< 1 hour	< 12 hours	
Minor	Failures of control system that does not have any possibility to damage road users' safety	< 2 hours	< 24 hours	

The Contractor is responsible for categorizing severity although the Contractor shall consult with the Employer in case the Contractor finds difficulties to judge it.

Examples of the incidents of each severity are shown in the below table.

Severity	Examples
Critical Incident	① Green-Green Conflict of signal ② Red and yellow blinking of signal ③ Light out of signal lamp ④ Lighting plural number of signal lamp simultaneously ⑤ Seriously damaged signal pole(s) and/or VMS gantry by traffic accident, which has already collapse and/or will probably collapse
Major Incident	⑥ Damaged signal pole(s) and/or VMS gantry by traffic accident, which will not probably collapse immediately ⑦ Light out of some signal ramp due to halt of signal system, which makes road users have difficulties to identify the signal phase
Minor Incident	⑧ Slight damage on pole(s) or gantry(s) by traffic accident, which will not collapse; ⑨ Discommunication among BTIC/TMC/controller/signal/VMS; ⑩ Sending abnormal data from TMC to signal/VMS; ⑪ Insufficient illuminance of signal ramp/VMS; and ⑫ Light out of VMS screen.

2. Service Level

Service level is evaluated quarterly based on the availability.

2.1 The formula of calculation of availability

The formula of calculation of availability is shown as follows

$$Availability = (1 - \frac{Downtime - PermissiveDowntime}{Totaltime - PermissiveDowntime}) * 100$$

Downtime (hours): "Total time during which the specified services/components with specified technical and service standards are not available.

Downtime is calculated based on the following unit;

(1) Signals: Junction basis;
(2) VMSs: Site basis;
(3) Operator consoles: Console basis; and
(4) Servers: Server basis:

Totaltime (hours): Total time of evaluation period (3 month; 2,160 hours).

Permissive downtime (hours): The time period required for periodic inspection, preventative maintenance, repair works for damages caused by the third parties (e.g. traffic accidents, black out, surge caused by thunder storm, fire, failure of communication lines, vandalism, etc.) and works instructed by the Employer.

2.2 Target Availability

Target availability is 99.00%.

2.3 Payment Reduction

When the availability does not reach the target availability, the Employer can deduct calculated amount from O&M payment. Following is the formula for calculation of the amount for payment reduction.

Payment Reduction = Lump sum portion of O&M payment*(Target availability (%) - Availability (%))/50

This Part is closed due to the confidenciality.

Eg.) Downtime: 110hr, Totaltime: 2160hr (24*90), PermissiveDowntime: 60hr, Target availability: 99%, O&M payment for 3months: INR 80 Lakh

Availability= (1-((110-60)/(2160-60)))*100, Availability = 97.62%

Payment Reduction = 80*(99-97.62)/50,

Payment Reduction = INR 2,88,000

III. Periodic Activities

1. Periodic Inspection and Preventive Maintenance

Periodic Inspection and Preventive Maintenance shall be carried out by the Contractor.

Frequency	TMC System	Roadside Equipment	Participants
Monthly	Visual Check	Visual check from vehicles	Local
Semiannual	Detail Check + Cleaning	Detail Check + Cleaning	Local
Annual	Adjustment of Equipment/System	Adjustment of Equipment/System	Japanese

<Note>

Preventive Maintenance: Necessary works for preventing system/equipment failures including cleaning, replacing damaged parts, and adjusting position of detecting equipment.

Detail Check: Visual inspection and contact diagnostics.

The Contractor will submit a plan and check sheets for the Periodic Inspection on each equipment and system.

Adjustment of Equipment/System: The Contractor will dispatch Japanese engineers annually to review the current traffic condition and adjust each equipment/system accordingly by revising control parameter.

2. Seminar

Two days seminar will be hold once in a year by the Contractor. The purpose of seminar is to transfer the ITS technologies and know-how to Police officers, TMC employees, DULT employees, any other Government employees and local private companies of ITS sector including manufactures, operators and maintenance firms. The venue of the seminar shall be provided by DULT. Japanese engineers of the Contractor and knowledgeable local engineers will be lecturers for the seminar.

3. Adjustment of Equipment/System

The Contractor will, once a year, review the current traffic condition and adjust each equipment/system accordingly by revising control parameter.

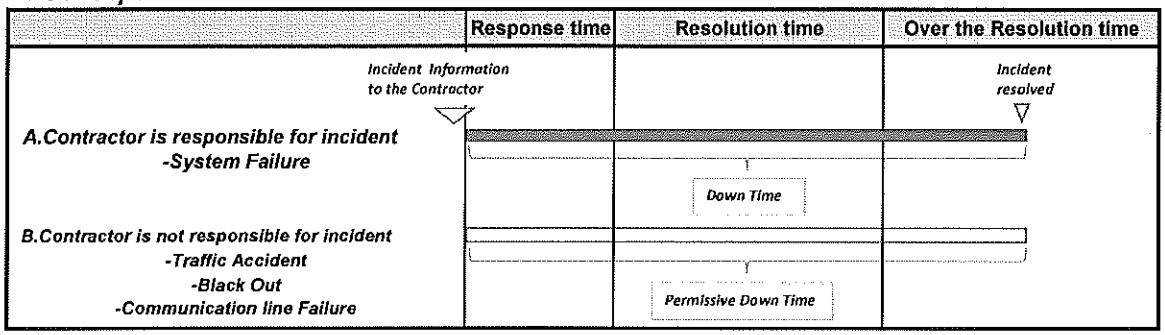
Annex 1-3

Basic Concept of Service Level and Payment Reduction

1. Contents of Service Level

Service Level	PerformanceTarget	Evaluation Method	Payment Reduction
1 Availability	; 99%	$\text{Availability} = (1 - \frac{\text{Downtime} - \text{Permissive Downtime}}{\text{Totaltime} - \text{Permissive Downtime}}) \times 100$	Payment Reduction = Lump sum portion of O&M payment $\times \frac{\text{Target availability(\%)} - \text{Availability (\%)}}{50}$
2.1 Response time	- Critical*;1 Hour - Major*; 1 Hour - Minor*; 2 Hours	Incident Report	NA
2.2 Resolution time	(System Failure) Critical*; 6 Hours Major*; 12 Hours Minor*; 24Hours (Facility Incident at site) ;24Hours	Incident Report	

2. Concept of Down time



Role of the Contractor

I. Role of the Contractor for BTIC

Position	Roles and Responsibilities	Contents
Director and his/her staff @ BTIC	Director: is responsibe for supervising and controlling all activities of BTIC Staff is responsible for data analysis and supporting the director.	- Coordination of all activities between BTIC and other related Gov. agencies especially Traffic Police. - Planning and coordinating system update - Compiling , analysis and providing the proceeded data/information - Responding to enquiries from related Gov. agencies - Requesting related Gov. agencies to provide information for BTIC if necessary. - Checking the report submitted by the Contractor
The Operator (An O&M Contractor's staff @ BTIC)	Operation ***-Lump Sum basis-***	- Responding to enquiries from general public. - Observing operating status of ATCC and Queue Length Measurement System. - Observing traffic status on schematic map of video wall. - Observing operation status of server installed at KSDC from operator console. - Checking the error log of each server and ask according to the instruction of the representative of the Contractor - Comparing the inventory and spare parts periodically. - Establishing supplementary plan for spare part - Preparing and submitting daily, monthly and quarterly reports of the Contractor's activity to the Employer. - Culculation of Availability quarterly based on incident reports.
	Primary Response (at fault) ***-Lump Sum basis-***	- Identifying situations and couses of system malfunctions. - Requesting Maintenance Team of O&M Contractor for responce, in case of failure and incident. - Reporting the status of system/equipment to the Employer in case incidents occurs and are resolved. - Preparing and submitting incident reports to the Employer.
Maintenance Team (O&M Contractor's staffs @ local office) ***To be supported by engineers from Japan as needed.***	Periodic Inspection and Preventive Maintenance ***-Lump Sum basis-***	- Establishing Periodic Inspection and Preventive Maintenance plan and submit to the Employer - Carrying out inspection and preventive maintenance such as cleaning periodically according to a submitted plan. - Conducting of remote diagonostics periodically Confirming operation status of server at KSDC from PC at contractor's office. - Submitting reports of Periodic Inspection and Preventive Maintenance work to the Employer - Maintaining spare parts and inventory and report - Fixing bugs and upgrading software version - Annual Updating of Digital Road Map
	Local Training and Seminor ***-Lump Sum basis-***	- Carrying out trainings for DULT officials annually - Carrying out seminor to transfer the ITS technologies and know-how for public and private sectors in India.
	Adjustment of Equipment/System ***-Lump Sum basis-***	- Detecting actual travel time along major roads by probe cars and adjusting the probe system - Revise software and/or parameter of the probe system according to results of incorporate the latest digital road maps into the probe system annually.
	Emergency Response ***-Lump Sum basis-***	(Remote Service) - Identifying situations and couses of system malfunctions. - Rectifying malfunction remotely. - Providing necessary information about incidentsas per request from BTIC operators. (On-site Service) - Identifying the defective/damaged equipment and parts and replacing defective/damaged equipment and parts with spare parts - Replacement and resolution of damaged facility - Repairing retrieved defective/damaged parts if reparing is possible.
	Purchasing new Equipment and Parts ***-Quotation basis-***	- Additional equipment/system and supporting facilities for upgrade and expansion according to instructions of the Employer - New equipment and parts if retrieved defective/damaged equipment and parts is impossible to be repaired

Role of Operator

Role of Maintenance Team of the Contractor

II. Role of the Contractor for BTP

Position	Roles and Responsibilities	Contents
Traffic Police Director and his/her staff @ Traffic Management Centre (TMC)	Director: is responsibe for supervising and controlling all activities of TMC Staff is responsible for data analysis and supporting the director.	- Coordination of all activities between TMC and other related Gov. agencies especially BTIC. - Planning and coordinating system update - Compiling , analysis and providing the proceeded data/information - Responding to enquiries from related Gov. agencies - Requesting related Gov. agencies to provide information for TMC if necessary. - Instructing to the operator to revise signal parameter (cycle, split, offset) according to monitoring results and requests from local residents. - Instructing manual operations to the operator as required - Inputting necessary messages on VMSs if necessary. - Instructing to the Contractor response and resolution during off-time in case of incidents during off-time. - Checking the report submitted by the Contractor
The Operator (An O&M Contractor's staff @TMC)	Operation ***-Lump Sum basis-***	- Observing operating status of signal and VMS system. - Observing operation status of server installed at KSDC from operator console. - Checking the error log of each server and ask according to the instruction of the representative of the Contractor - Comparing the inventory and spare parts periodically. - Establishing supplementary plan for spare part - Preparing and submitting daily, monthly and quarterly reports of the Contractor's activity to the representative of the Employer. - Culculation of Availability quarterly based on incident reports.
	Primary Response (at Fault) ***-Lump Sum basis-***	- Identifying situations and couses of system malfunctions. - Requesting Maintenance Team of O&M Contractor for responce, in case of failure and incident. - Reporting the status of system/equipment to the Employer in case incidents occurs and are resolved. - Preparing and submitting incident reports to the representative of the Employer.
Maintenance Team (O&M Contractor's staffs @ local office) ***To be supported by engineers from Japan as needed.***	Periodic Inspection and Preventive Maintenance ***-Lump Sum basis-***	- Establishing Periodic Inspection and Preventive Maintenance plan and submit to the representative of the Employer - Carrying out inspection and preventive maintenance such as cleaning periodically according to a submitted plan. - Conducting of remote diagonostics periodically Confirming operation status of server at KSDC from PC at contractor's office. - Submitting reports of Periodic Inspection and Preventive Maintenance work to the representative of the Employer - Maintaining spare parts and inventory and report - Fixing bugs and upgrading software version
	Local Training and Seminor ***-Lump Sum basis-***	- Carrying out trainings for BTP officials annually - Carrying out seminor to transfer the ITS technologies and know-how for public and private sectors in India.
	Adjustment of Equipment/System ***-Lump Sum basis-***	- Review the current traffic condition and adjust each equipment/system accordingly by revising control parameter annually.
	Emergency Response ***-Lump Sum basis-***	(Remote Service) - Identifying situations and couses of system malfunctions. - Rectifying malfunction remotely. - Providing necessary information about incidentsas per request from TMC operators. (On-site Service) - Identifying the defective/damaged equipment and parts and replacing defective/damaged equipment and parts with spare parts - Replacement and resolution of damaged facility - Repairing retrieved defective/damaged parts if reparing is possible.
	Purchasing new Equipment and Parts ***-Unit Price basis-***	- Additional equipment/system and supporting facilities for upgrade and expansion according to instructions of the Employer - New equipment and parts if retrieved defective/damaged equipment and parts is impossible to be repaire.

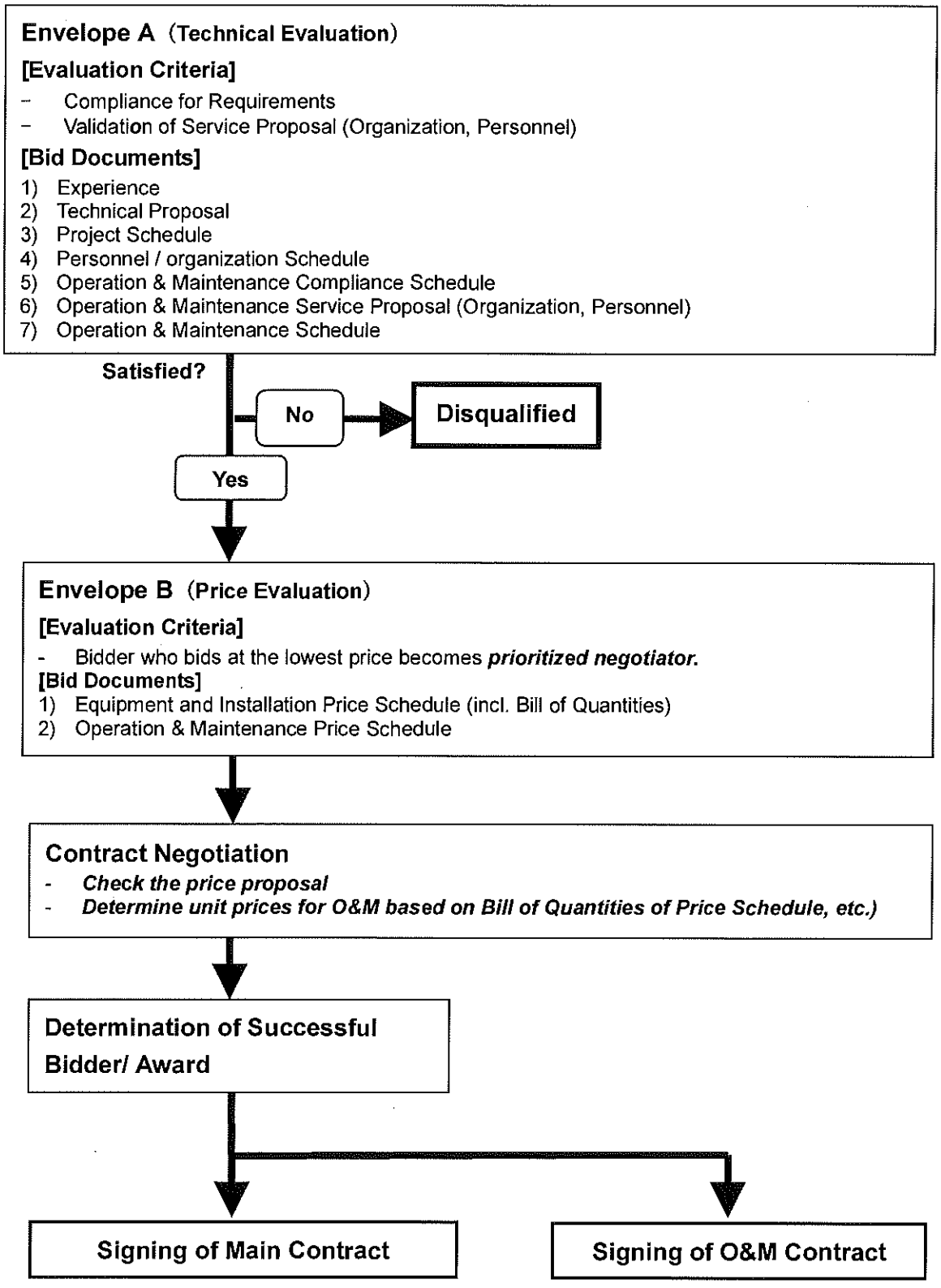
Role of Operator

Role of Maintenance Team of the Contractor

Annex 3

The Procedures and Evaluation Criteria of the Bidding

Note: One Stage / Two Envelope System



Annex 4

MAHENDRA JAIN, I.A.S.,
Additional Chief Secretary to Government
Urban Development Department

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Vikasa Soudha, Dr. Ambedkar Road
Bengaluru-560 001

D.O.No: DULT/33/ITS-Grants/2014-15/188 Date:10-07-2017

Dear Sir,

Sub: Requesting to reconsider the project for implementation of Advance Traffic Information and Management System in core Bengaluru

Ref-1: MoUD Letter K-14011/93/2014-UT-IV dated 17th June 2015
Ref-2: MoUD Letter K-14011/93/2014-UT-IV dated 20th October 2015
Ref-3: DULT Letter DULT/33/ITS-Grant/2014-15/2330 dated 07th February 2017
Ref-4: MoUD Letter K-14011/93/2014-UT-IV/UT-V dated 18th May 2017

***

1. The Directorate of Urban Land Transport with technical assistance from JICA has prepared the ITS Master Plan for Bangalore and Mysore. The Master Plan intends to integrate various technology components that are being planned by different agencies of the state government, such that the traffic and transport issues in the city faced currently and issues expected in the future could be solved in coherent manner using technology interventions.
2. The implementation of the ITS Master Plan in Bengaluru was decided to be taken up with the Peripheral Ring Road project under the JICA ODA loan. A DPR for PRR was prepared, which included City ITS & PRR ITS components and was submitted to MoUD.
3. As City ITS implementation was one of the first city scale deployment being undertaken in India, it was decided to seek grant assistance from Government of Japan for demonstration of some of key components on a pilot basis in Bangalore. It was intended that learnings from the pilot implementation, could be useful for scaling up the ITS deployment to city wide. In this regard, DULT had submitted the grant application for Grant-in-Aid in October 2014 through MoUD. The grant proposal envisages establishing of:
   - Bengaluru Traffic Information Centre (B-TIC)
   - Advance Traffic Control System (ATCS) for 29 locations
   - Variable Message Signs (VMS) for 5 locations.
   - Automatic Traffic Counter and Classifier (ATCC)
   - Queue-length Measurement Sensor (QMS)

Annex 4

4. The application was recommended to DEA by MoUD (Ref 1&2) after obtaining clarification from DULT. Subsequently, after DEA's recommendation, JICA had dispatch a study team to carry out preparatory study for the ITS grant project in Bengaluru. The draft preparatory study includes finalization of location for ITS implementation, technology scooting keeping in view interoperability requirements, setting expected outcomes, preparation of operations and maintenance scope, stakeholder consultations, undertakings from both the governments on responsibilities, implementation plan, and cost estimation, etc.

5. The agreed Minutes of Discussion (M/D) between DULT and JICA was submitted to MoUD (Ref 3) for approval and recommending the ITS grant project for implementation. On 18th May 2017, DULT received official confirmation from MoUD (Ref 4) for not recommending the project for technical assistance and the following reasons were cited for the same:

   i. "The system over a small area compared to the entire city does not yield benefits as traffic moves in a continuum".

   ii. "Expansion of the system will entail the issues pertaining to propriety"

6. With regard to the above concerns, we would like to acknowledge that these were duly deliberated while preparing the grant proposal and also at various stages during the preparatory study.

7. With respect to the concern of MoUD regarding the anticipated benefits of the small scale pilot implementation, it may be noted that grant components of ITS implementation were carved out from the ITS Master Plan for Bengaluru, wherein ITS interventions were planned in a more holistic manner. The Directorate also intends to implement a city wide ITS, and a proposal for which was also put forth to MoUD as sizeable benefits in traffic improvement can be realized at city scale. However, ITS implementations are complex that requires involvement of multiple stakeholders and currently the expertise available within the country is also limited. Hence, it was decided that the pilot ITS implementation is very essential to be taken up, so that the learnings could be utilized before embarking on a city wide implementation.

8. We would like to clarify that in the pilot implementation certain components like establishment of B-TIC (which includes probe system, center console, video wall and servers) would be for city wide operations, and other field components like advance signals

systems (ATCS), ATCC, VMS, etc. are proposed for smaller scale at key locations in Bengaluru. Once the field systems are implemented, calibrated and demonstrated to work well in Indian conditions, these systems would be further scaled to other locations in Bengaluru.

9. The ITS systems that have been proposed for Bengaluru through the Japanese Government grant was considered after careful examination of the benefits that have been measured in implementation in Japan. For example, similar ATCS implementation in Tokyo Metropolitan Area (621 sq. kms.) has helped the city reduce total delays in the area by more than 23% and length of congestion (queuing) by 28%. In terms of economic benefits, the total savings in time and fuel consumptions has been determined as Rs. 5,500 crore per year.

10. Although, as rightly pointed by MoUD the economic benefits of the scale achieved in Tokyo Metropolitan Area would not occur with small scale (pilot) implementation in Bengaluru, localized benefits in traffic improvements is very much anticipated with the proposed pilot implementation. In this regard, JICA has established indicators to objectively measure the impact of pilot implementation. For example, the average queue length at junctions where ATCS would be implemented is anticipated to reduce by 30% post implementation and the average travel speed on the corridor is anticipated to increase by 13%.

11. In the preparatory study for the grant project, it has been measured in an initial survey that at key intersections where ATCS is proposed, that currently the underutilization of green time at signals is averaged for 7 junctions at about 230 minutes in 15 hours of operations and the maximum value of underutilized green time was measured to be 510 minutes, translates to about 57% of time the green time is underutilized. Thus, clearly an opportunity for adaptive traffic signals (ATCS) to minimize the underutilization of green time in real time operations, which would improve the overall operational efficiency at proposed junctions. Further as the proposed ATCS is also required to achieve synchronization of group of signals in the area, number of stops per vehicles is anticipated to reduce there by increasing average journey speeds.

12. MoUD has raised concern that expansion of the system will entail the issues pertaining to propriety. DUTT has in several occasions emphasized that interoperability and scalability of the system should be incorporated in the system design and specification. Japanese

counterpart has agreed to this and the same has been incorporated in the Minutes of Discussion (MFD) submitted to MoUD.

13. It may also be noted that DULT has examined the signal systems implemented in Japan and many cities their ATCS (MODERATO) has been implemented and in operation along with other stand-alone signal systems. For example, in the Tokyo Metropolitan Area MODERATO is operational at 49.8% signalized junctions and remaining junctions are operated by stand-alone signal systems. The proposed ATCS for Bengaluru has capacity to expand upto 128 signals and these ATCS signals can coexist with other ATCS or stand-alone signal systems.

14. DULT has further ensured that in the proposed grant project the contractor would also be responsible for carrying out the operations and maintenance (O&M) for 5 years after commissioning of the systems, so that the anticipated benefits can be demonstrated. DULT, in subsequent discussions with JICA has also laid conditions that in the course of O&M, local technology partners have to be enabled by the project contractor, so that continued spares and skilled manpower would be available locally.

15. Traffic congestion in Bangalore is one of the critical infrastructure bottlenecks and optimal utilisation of existing road infrastructure using intelligent transport system is a part of the strategy to remove these bottlenecks. This project is expected to help in mitigating the traffic issues and provide necessary learnings for further citywide expansion of ITS. Considering the readiness of the project and the leap of progress that has been made, including bringing various stakeholders on-board, securing of space for BTIC, and signals, etc. the proposal may kindly be re-examined by MoUD.

With regards,

Yours sincerely,

Sri Durga Shanker Mishra, IAS
Secretary,
Ministry of Urban Development,
Government of India,
New Delhi.

Copy

1. The Chief Representative, JICA India, New Delhi.

Expansion of Signal System

Annex 5-1

1. Connectivity and Procurement of Equipment for Expansion of Signal System

The signal system consists of a centre server and roadside modules, i.e. signals, controllers and sensors installed at each intersection. The centre server which will be procured by the grant project is capable of controlling a large number of signals. Thus, modification of the software of the centre server is not necessary even if the signals are additionally procured.

The parameter setting is required when the signals are added. Setting the parameter is to be done by operator console terminal. How to set the parameter will be explained by the operation manual which will be prepared under the grant project. A technical guidance on how to set the parameter will also be provided to Bengaluru Traffic Police under the grant project.

The intellectual property rights are not a factor which limits connectivity of the signal system because the communication standard and protocol which will be adopted to the system of the grant project is opened and they are international standard. (The details are explained below on the next page.)

Therefore, expansion of the signal system is possible by procuring and connecting the equipment which fulfils the technical requirement for connecting to the centre server. The functional requirement will be prepared as technical specification and will be attached to the bidding document for the grant project.

Since technical specification and communication protocol between the centre server and roadside modules are opened, additionally procured roadside modules which are compatible with the signal system can be manufactured by any manufactures that have sufficient technical capability. It is considered that technically simple modules, i.e. signal and roadside sensors, can be manufactured by Indian local companies even now. Technically sophisticated modules such as controllers can be locally produced in near future through research & development and/or collaboration with several experienced Japanese companies. For your reference, there is a case in Thailand that the controllers are locally manufactured by local companies through collaboration with a Japanese company.

Therefore, 'competitiveness' for procurement of additional equipment for expansion of the signal system is not impaired by the intellectual property rights.

Expansion of Signal System

The details are explained below.

1) Interface

The following interfaces which will be adopted to the signal system of the grant project are open as they conform to international standards.

- ✓ Centre to Centre
- ✓ Centre to Controller
- ✓ Controller to Signal and Sensor
  (Refer to Attachment for Detail)

2) Equipment Specification

The equipment specifications will be prepared under the grant project and will be disclosed. Therefore, the companies can manufacture the equipment by referring to them (as long as the conditions described on the previous page are met).

3) Centre System

It is possible to add a lot of signals only by changing the parameter setting. The software modification is not required for adding signals.

When adding a new center, it can be connected to the existing center if the interface of the new center conforms to the international standard.

4) Controller

The interface is open because it conforms to the international standard, and the functional requirement is specified by the specification. Therefore, it is possible for many companies to manufacture the controllers.

If additional procurement is necessary in the immediate term, the controllers can be purchased from several different Japanese companies. It is also possible that Japanese companies provide the main parts to the Indian local companies and the controllers will be locally manufactured by OEM (Original Equipment Manufacturing).

The additional controllers can be connected to the centre without modification of the centre system.

5) Signal and Sensor

Expansion of Signal System

The Indian local companies could manufacture the signals and sensors by themselves because the interface (controller to signals and sensor) conforms to the international standard, and the signals and sensors can be connected to the controllers.

2. Area of Signal System

The signal system to be introduced by the grant project realizes effective signal control by Area Control.

The area control is effective in the area of continuous signals having their interval of 300 meters to 400 meter or less. If the distance is more than these intervals, the effect will be reduced.

Therefore, standalone signals are sufficient and the area control is not required in these areas.

It is necessary to consider the area to be expanded once the effect is confirmed after introducing the area control signal system by the grant project.

Attachment-1 : "Relation of UTMS Standard and International Standard"
Attachment-2 : "ISO TC204 Working Group of Standardization of Traffic Management"

Attachment - 1 : "Relation of UTMS Standard and International Standard"

Layer of OSI Model	UTMS Standard	Applicable International Standard
(7) End Application Layer	Traffic Signal DATEX-ASN Message Standard	---
(7) Application Layer	DATEX-ASN Communication Application Standard	ISO 14827- 1,2 ISO 15784
(6) Presentation Layer	UD Type Encording Standard	ISO/IEC 8824-1, 8825-1, 10646-1, NTCIP1102v01.06
(4/3) Transport/Network Laye	UD Type Transporting Standard	IP : IAB, STD51, RFC791 UDP : RFC768
(2) Data Link Layer	UD Type Interface Standard	PPP : IAB, STD51, RFC1661
	S9 Interface Standard	PPP : IAB, STD51, RFC1661
(1) Physical Layer	UD Type Interface Standard	V.32
	S9 Interface Standard	EIA-422-A

UTMS	Universal Traffic Management Society of Japan
IEC	International Electrotechnical Commission
NTCIP	The National Transportation Communications for Intelligent Transportation Systems (ITS) Protocol
IAB STD	Interactive Advertising Bureau Standard
RFC	Request for Comments
V.32	Transfer protcol of ITU-T(International Telecommunication Union Telecommunication Standardization Sector)
EIA	Electronic Industries Alliance

ISO/TC204 Working Group of Standardization of Traffic Management

WG 9 Integrated Transport Information, Management and Control

WG 9 is working on the standardization of traffic management (traffic information and control, etc.). Specifically, it is working on the systematization of information and standardization of communication systems between traffic management centers, between centers and roadside modules, and between roadside modules, to enable efficient data exchange and to provide information to outside organizations.

List of WG 9 work items

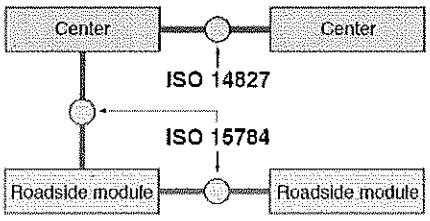
	Standardization themes	ISO number	Contents
1	Data Interfaces between Centres for Transport Information and Control Systems - Part 1: Message Definition Requirement	ISO 14827-1	Definition of message forms between centers for transport information and control systems
2	Data Interfaces between Centres for Transport Information and Control Systems - Part 2: DATEX-ASN Application	ISO 14827-2	Definition of a DATEX-ASN-based communication protocol between centers for transport information and control systems
3	Data Interfaces between Centres for Transport Information and Control Systems Part 3 : Data interfaces between centres for Intelligent Transport Systems (ITS) using XML	DIS 14827-3	Definition of an XML-based communication protocol between centers for transport information and control systems
4	Data exchange involving roadside modules communication - Part 1: General principles and documentation framework of application profiles	ISO 15784-1	Principles underlying application profiles and framework for documentation regarding communication between centers and roadside modules
5	Data exchange involving roadside modules communication - Part 2: Application profile-data exchange (AP-DATEX)	ISO 15784-2	Application profile based on TMP of communication between roadside modules (NTCIP 1103)
6	Data exchange involving roadside modules communication-Part 3: Application profile-data exchange (AP-DATEX)	ISO 15784-3	Application profile based on DATEX-ASN (ISO 14827) for communication between centers and roadside modules
7	Integrated Transport Information, Management and Control - Data quality in ITS Systems	TR 21707	Definition of data quality for ITS
8	Interface Protocol and Message Set Definition between Traffic Signal Controllers and Detectors (IPMSTSCD)	NP 10711	Definition of interface and message set between vehicle detectors and traffic signal controllers
9	The use of simulation models for evalution of traffic management systems: Input parameters and reporting template for simulation of traffic signal control systems	TR 16786	Specification of input parameters and report templates in evaluating signal control systems through simulation
10	Definition of data elements and data frames between roadside units and signal controllers for cooperative signal control	WD 19082	The definition of a use-case, requirements and data concepts for traffic signal control, incorporating probe data
11	Data interfaces between centres for transport information and control systems — Platform independent model specifications for data exchange protocols for transport information and control systems	PWI 19468	Platform independent model specifications for data exchange protocols for transport information and control systems
12	Intelligent transport systems - Roadside modules data interface Part 1 - Generalized field device	PWI 20684-1	Definition of interface between general roadside modules and the center
13	Intelligent transport systems - Roadside modules data interface Part 2 - Variable message signs	WD 20684-2	Definition of interface between the information display board and the center

Activities

The scope (center-to-center, centers-to-roadside) of standardization being worked on by WG 9 is shown in the figure. Centers refer to transport management centers. Roadside modules include signal control devices, information boards and sensors installed along roads.

Ensuring interconnectivity is one advantage of promoting the standardization of information and communication between centers as well as centers and roadside modules. It also reduces the risks involved in purchasing modules for procurers, and in development for module suppliers.

Scope of standardization



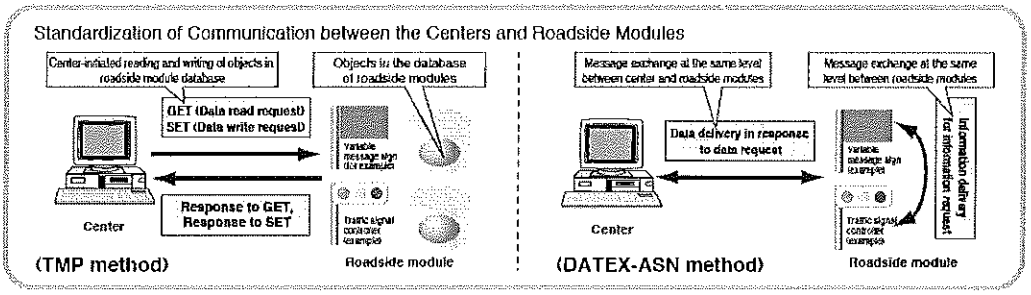
Definition of data elements and data frames between roadside units and signal controllers for cooperative signal control (WD 19082)

Recently, in addition to vehicle detectors, road-to-vehicle communications are making it possible to collect traffic information (probe data) directly. Therefore, through the presentation of a reference model, Japan made a new proposal to help develop a platform to utilize probe data for signal control. This item was approved as NP in 2016. Currently CD voting is being prepared.

Communication between Centers and Roadside Modules (ISO 15784)

Communication between centers and roadside modules refers to the exchange of information between the central modules of a transport management center and modules installed along roads, as well as between different roadside modules. WG 9 plans to prescribe this communication in the form of an application profile. The application profile will specify a set of base standards for the three upper OSI layers to meet the requirements for communication between centers and roadside modules. It will also prescribe how to use the base standards. As initial versions, the Transportation Management Protocol (TMP), from the U.S. National Transportation Communication for ITS Protocol (NTCIP), was adopted for Part 2, while DATEX-ASN from the ISO 14827-2 international standard for communications between transport management centers, was adopted as Part 3.

This item has been promoted under Japan's leadership. Part 1 and 3 were issued in October 2008 and Part 2 in November 2015 as ISO publications.



(Source: ITS Standardization Activities of ISO/TC 204, 2016)

Annex-5-2

■ Quantitative Effect

Indicator		Baseline Value in 2016	Estimated Value After Introducing ATCS (*3)
1. Queue Length			
	(1) Maximum Queue Length amongst Key Intersections (*1)	550 meters	385 meters (-30%)
	(2) Average Queue Length of Key Intersections (*1)	400 meters	280meters (-30%)
2. Average Travel Speed (*2)		13km/h	15km/h (+13%) (*4)

(*1) Key Intersections = 7 intersections where traffic congestion mostly occurs amongst 29 intersections

(*2) Average travel speed on target corridor in morning peak hour

(*3) For the period of 3 years after commencement of operation

(*4) It was found by traffic survey that the delay time waiting for signals is one of the causes of current travel speed on the target corridor. It was also observed that long cycle time is applied to many current signals.
Approximately 150 second is considered to be applied to the cycle time of the signal system which will be introduced in the project. Based on this, it is assumed that maximum waiting time for the signal is approximately 100 seconds (approx. 70% of 150 seconds). The average travel speed after the project was estimated by setting approx. 100 seconds for signal waiting time for the intersections currently taking more than 100 seconds.

■ Result of Signal Survey

◆ Outline of carried out survey

- Surveyed Intersections: 7 Key Intersections
- Survey Contents: The following surveys for one cycle every half an hour for all day were carried out.
  - ✓ Signal Phase Time (to understand actual operation situation)
  - ✓ Passing Vehicle Counting by 10 Seconds During Green Time (to identify degree of inefficiencies if any)
  - ✓ Wasted Green/Dead Green Phenomena (supplementally carried out to confirm the situation)

◆ Observations

- It was found that there are inefficiencies in signal operation at key intersections.
- The major inefficiencies are:
  - The signal cycle time is generally too long.
  - The time for pedestrian signal is generally too short.
  - The signal phase patterns at some intersections are not configured for traffic flow.
  - Thus, there are wasted green time during the traffic signal operation.

◆ Quantified inefficiencies

The inefficiencies in terms of wasted green time are quantified by key intersection as follows:

	Junction Name	Signal Operating Time (Min.)	Wasted Green Time	
			Min.	Ratio
01	Queens Statue Junction	930	281	30%
02	Cauvery Arts and Craft Junction	960	179	19%
03	Trinity Circle Junction	960	329	34%
04	Kamraj and Cubbon Road Junction	870	127	15%
05	Opera Road Junction	930	144	15%
06	Vellera Road Junction	240 (*)	81	34%
07	Vivekananda/Bhaskaran Junction	900	510	57%

(*) Note: The survey time was limited to this time.

- **Improvement that can be made**
  - The optimal signal indications (i.e. green time, red time) according to traffic demand can be given.
  - The inefficiencies of signal operation can be more optimized.
  - The group of passing vehicles will be accordingly formed by optimizing signal time.
  - Then, the traffic flow will be more smoothened allowing the group of passing vehicles to pass next intersections by coordinating signals.

■ Example of Effect in Japan

The Advanced Traffic Control System (MODERATO) of Tokyo Metropolitan Police Department was completed and started operation in February, 1995. The following tables show the effect of MODERATO when it was implemented.

Table1: Results of Control

Index	Before Implementation (1994)	After Implementation (1995)	Effect in Ratio (%)
Total Travel Time [1,000 veh・hour]	1,194	1,086	9.1
Total Delay [1,000 veh・hour]	448	343	23.4
Congestion Length-time [km・hour]	8,423	6,066	28.0

Table1: Benefit in Economic Terms

Items	Benefit	
	(billion yen/year)	(crore INR/year)
Saving in Time (TM)	107.2	5,360
Saving in Fuel Consumption (FM)	2.9	1,450
Total	110.1	5,500

The conditions of above implementation are:

- Implemented Year: 1995
- Implemented Area: Tokyo Metropolitan Area (approx. 621km2)
- Implemented Road Length: 1,515km of Major Road
- Implemented Number of Key Intersection: 308
- Implemented Total Number of Intersection: 6,800

Annex-6

Annex 3 Major Undertakings to be taken by India side

(Revised Information based on the Results of the Additional Survey)

1. Specific obligations of the Government of India and the Implementing Agency which will not be funded with the Grant

(1) Before the Tender

NO	Items	Deadline	In charge	Estimated Cost*	Ref.
1	To open bank account (B/A)	within 1 month after the signing of the G/A	DULT		
2	To issue A/P to a bank in Japan (the Agent Bank) for the payment to the consultant	within 1 month after the signing of the contract	DULT		
3	To acquire approval of intersection improvement and equipment installation drawings from road administrators (National Highway Agency India and Municipal)	before Detail Design	DULT		
4	To secure and clear the location where the equipment would be installed	before notice of the bidding document	DULT		
5	To submit Project Monitoring Report (with the result of Detail Design)	before preparation of bidding documents	DULT		

B/A: Banking Arrangement

A/P: Authorization to pay, N/A: Not Applicable

DULT: Directorate of Urban Land Transportation, State Government of Karnataka

BTP: Bengaluru Traffic Police

KSDC: Karnataka State Data Center

DOF : Department of Finance, State Government of Karnataka

MOF: Ministry of Finance, Government of India

(2) During the Project Implementation

NO	Items	Deadline	In charge	Estimated Cost*	Ref.
1	To issue A/P to a bank in Japan (the Agent Bank) for the payment to the Supplier(s)	within 1 month after the signing of the contract(s)	DULT		
2	To bear the following commissions to a bank in Japan for the banking services based upon the B/A				
	1) Advising commission of A/P	within 1 month after the signing of the contract(s)	DULT		
	2) Payment commission for A/P	every payment	DULT		
3	To ensure prompt unloading and customs clearance at ports of disembarkation in recipient country and to assist the Supplier(s) with internal transportation therein	during the Project	DULT		
4	To accord Japanese nationals and/or physical persons of third countries whose services may be required in connection with the supply of the products and the services such facilities as may be necessary for their entry into the country of the Recipient and stay therein for the performance of their work	during the Project	DULT		
5	To ensure that customs duties, internal taxes and other fiscal levies which may be imposed in India with respect to the purchase of the products and the services be reimbursed	during the Project	DULT DOF MOF	**9,274**	
6	To renovate DULT Center, BTP Traffic Management Center and KSDC including air conditioning, replacement electrical fittings, lighting fixture and refurbishing if necessary, to accommodate the equipment	before installation of the equipment	DULT BTP		
7	To acquire site access and work permission for the centers	before installation of the equipment	DULT		
8	Internal wiring works in the building for the Control Center (B-TIC)	before installation of the equipment	DULT	3,738	-
9	To remove obstacles from the Project sites	before installation of the equipment	DULT BTP		
10	To bear all the expenses, other than those covered by the Grant, necessary for the implementation of the Project	during the Project	DULT		
11	1) To submit Project Monitoring Report after each work under the contract(s) such as shipping, hand over, installation and operational training	within one month after completion of each work	DULT		
	2) To submit Project Monitoring Report (final)	within one month after signing of Certificate of Completion for the works under the contract(s)	DULT		
12	To submit a report concerning completion of the Project	within six months after completion of the Project	DULT		
13	To procure initial spare parts (signal pole & sensor pole)	Before completion of the equipment installation	DULT,	1,013	

NO	Items	Deadline	In charge	Estimated Cost*	Ref.
14	To secure operation and maintenance personnel	Before completion of the equipment installation	DULT, BTP		
15	To replace existing gantries of traffic sign boards	Just after commencement of operational guidance	DULT	349	-
16	To replace existing signal poles	Just after commencement of operational guidance	BTP	1,345	

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Annex-7

K-14011/93/2014-UT-IV/UT-V
Government of India
Ministry of Urban Development
Urban Transport Wing

Nirman Bhawan, New Delhi
Dated: 18th May, 2017.

To,

The Commissioner and E/O Principal Secretary to Govt.,
Directorate of Urban Land Transport,
Urban Development Department,
Shanthinagar, Bangalore - 560027.

Subject: Project for Implementation of Advanced Traffic Information and Management System in Core Bengaluru.- reg.

Sir,

I am directed to refer to your letter No. DULT/33/ITS-GRANT/2014-15/2330 dated 07.02.2017 on the above cited subject vide which "Minutes of Discussion" was furnished to this Ministry. The proposal for implementation of Advanced Traffic Information and Management System in core Bengaluru was examined in detail. The system over a small area compared to the entire city does not yield benefits as traffic moves in a continuum. Also, any expansion of the system will entail the issues pertaining to propriety. Therefore, the same not recommended for Technical Assistance.

Yours faithfully,

(Mamta Batra)
Under Secretary to the Government of India
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MAHENDRA JAIN, I.A.S.,
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D.O.No: DULT/33/ITS-Grants/2014-15/188 Date:10-07-2017

OFFICE OF SECRETARY (UD)
14 JUL 2017
Dy. No. 877196

Dear Sir,

Sub: Requesting to reconsider the project for implementation of Advance Traffic Information and Management System in core Bengaluru

Ref-1: MoUD Letter K-14011/93/2014-UT-IV dated 17th June 2015
Ref-2: MoUD Letter K-14011/93/2014-UT-IV dated 20th October 2015
Ref-3: DULT Letter DULT/33/ITS-Grant/2014-15/2330 dated 07th February 2017
Ref-4: MoUD Letter K- 14011 / 93/2014-UT-IV/UT-V dated 18th May 2017

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1. The Directorate of Urban Land Transport with technical assistance from JICA has prepared the ITS Master Plan for Bangalore and Mysore. The Master Plan intends to integrate various technology components that are being planned by different agencies of the state government, such that the traffic and transport issues in the city faced currently and issues expected in the future could be solved in coherent manner using technology interventions.
2. The implementation of the ITS Master Plan in Bengaluru was decided to be taken up with the Peripheral Ring Road project under the JICA ODA loan. A DPR for PRR was prepared, which included City ITS & PRR ITS components and was submitted to MoUD.
3. As City ITS implementation was one of the first city scale deployment being undertaken in India, it was decided to seek grant assistance from Government of Japan for demonstration of some of key components on a pilot basis in Bangalore. It was intended that learnings from the pilot implementation, could be useful for scaling up the ITS deployment to city wide. In this regard, DULT had submitted the grant application for Grant-in-Aid in October 2014 through MoUD. The grant proposal envisages establishing of:

- Bengaluru Traffic Information Centre (B-TIC)
- Advance Traffic Control System (ATCS) for 29 locations
- Variable Message Signs (VMS) for 3 locations.
- Automatic Traffic Counter and Classifier (ATCC)
- Queue-length Measurement Sensor (QMS)

4. The application was recommended to DEA by MoUD (Ref 1&2) after obtaining clarification from DULT. Subsequently, after DEA's recommendation, JICA had dispatch a study team to carry out preparatory study for the ITS grant project in Bengaluru. The draft preparatory study includes finalization of location for ITS implementation, technology scooting keeping in view interoperability requirements, setting expected outcomes, preparation of operations and maintenance scope, stakeholder consultations, undertakings from both the governments on responsibilities, implementation plan, and cost estimation, etc.
5. The agreed Minutes of Discussion (M/D) between DULT and JICA was submitted to MoUD (Ref 3) for approval and recommending the ITS grant project for implementation. On 18th May 2017, DULT received official confirmation from MoUD (Ref 4) for not recommending the project for technical assistance and the following reasons were cited for the same:
    i. "The system over a small area compared to the entire city does not yield benefits as traffic moves in a continuum".
    ii. "Expansion of the system will entail the issues pertaining to propriety"
6. With regard to the above concerns, we would like to acknowledge that these were duly deliberated while preparing the grant proposal and also at various stages during the preparatory study.
7. With respect to the concern of MoUD regarding the anticipated benefits of the small scale pilot implementation, it may be noted that grant components of ITS implementation were carved out from the ITS Master Plan for Bengaluru, wherein ITS interventions were planned in a more holistic manner. The Directorate also intends to implement a city wide ITS, and a proposal for which was also put forth to MoUD as sizeable benefits in traffic improvement can be realized at city scale. However, ITS implementations are complex that requires involvement of multiple stakeholders and currently the expertise available within the country is also limited. Hence, it was decided that the pilot ITS implementation is very essential to be taken up, so that the learnings could be utilized before embarking on a city wide implementation.
8. We would like to clarify that in the pilot implementation certain components like establishment of B-TIC (which includes probe system, center console, video wall and servers) would be for city wide operations, and other field components like advance signals

systems (ATCS), ATCC, VMS, etc. are proposed for smaller scale at key locations in Bengaluru. Once the field systems are implemented, calibrated and demonstrated to work well in Indian conditions, these systems would be further scaled to other locations in Bengaluru.

9. The ITS systems that have been proposed for Bengaluru through the Japanese Government grant was considered after careful examination of the benefits that have been measured in implementation in Japan. For example, similar ATCS implementation in Tokyo Metropolitan Area (621 sq. kms.) has helped the city reduce total delays in the area by more than 23% and length of congestion (queuing) by 28%. In terms of economic benefits, the total savings in time and fuel consumptions has been determined as Rs. 5,500 crore per year.

10. Although, as rightly pointed by MoUD the economic benefits of the scale achieved in Tokyo Metropolitan Area would not occur with small scale (pilot) implementation in Bengaluru, localized benefits in traffic improvements is very much anticipated with the proposed pilot implementation. In this regard, JICA has established indicators to objectively measure the impact of pilot implementation. For example, the average queue length at junctions where ATCS would be implemented is anticipated to reduce by 30% post implementation and the average travel speed on the corridor is anticipated to increase by 13%.

11. In the preparatory study for the grant project, it has been measured in an initial survey that at key intersections where ATCS is proposed, that currently the underutilization of green time at signals is averaged for 7 junctions at about 236 minutes in 15 hours of operations and the maximum value of underutilized green time was measured to be 510 minutes, translates to about 57% of time the green time is underutilized. Thus, clearly an opportunity for adaptive traffic signals (ATCS) to minimize the underutilization of green time in real-time operations, which would improve the overall operational efficiency at proposed junctions. Further as the proposed ATCS is also required to achieve synchronization of group of signals in the area, number of stops per vehicles is anticipated to reduce there by increasing average journey speeds.

12. MoUD has raised concern that expansion of the system will entail the issues pertaining to propriety. DULT has in several occasions emphasized that interoperability and scalability of the system should be incorporated in the system design and specification. Japanese

counterpart has agreed to this and the same has been incorporated in the Minutes of Discussion (M/D) submitted to MoUD.

13. It may also be noted that DULT has examined the signal systems implemented in Japan and many cities their ATCS (MODERATO) has been implemented and in operation along with other stand-alone signal systems. For example, in the Tokyo Metropolitan Area MODERATO is operational at 49.8% signalized junctions and remaining junctions are operated by stand-alone signal systems. The proposed ATCS for Bengaluru has capacity to expand upto 128 signals and these ATCS signals can coexist with other ATCS or stand-alone signal systems.

14. DULT has further ensured that in the proposed grant project the contractor would also be responsible for carrying out the operations and maintenance (O&M) for 5 years after commissioning of the systems, so that the anticipated benefits can be demonstrated. DULT, in subsequent discussions with JICA has also laid conditions that in the course of O&M, local technology partners have to be enabled by the project contractor, so that continued spares and skilled manpower would be available locally.

15. Traffic congestion in Bangalore is one of the critical infrastructure bottlenecks and optimal utilisation of existing road infrastructure using intelligent transport system is a part of the strategy to remove these bottlenecks. This project is expected to help in mitigating the traffic issues and provide necessary learnings for further citywide expansion of ITS. Considering the readiness of the project and the leap of progress that has been made, including bringing various stakeholders on-board, securing of space for BTIC, and signals, etc. the proposal may kindly be re-examined by MoUD.

With regards,

Yours sincerely,

Sri Durga Shanker Mishra, IAS
Secretary,
Ministry of Urban Development,
Government of India,
New Delhi.

K-14011/93/2014-UT-IV/UT-V
Government of India
Ministry of Housing and Urban Affairs
Urban Transport Wing

Nirman Bhawan, New Delhi
Dated: 10th August, 2017.

To,
The Chief Secretary
Government of Karnataka,
Vidhan Soudha
Bangaluru - 560027.

Subject: Project for Implementation of Advance Traffic Information and Management System in Bengaluru- regarding

Sir,

I am directed to refer to your letter No. DULT/33/ITSGRANT/2014-15 dated 20.7.2017 on the above cited subject.

The above mentioned proposal has been re-examined in the light of clarifications received vide GoK's letter dated 10.7.2017. This Ministry supports the proposal for implementation of Intelligent Transport System (ITS) on pilot basis in Bangaluru with grant assistance from JICA. GoK may take further necessary action in this regard.

Yours faithfully

(Mamta Batra)
Under Secretary to the Government of India
Telefax: 011-23062285

資料　5

ソフトコンポーネント計画書

インド国
ベンガルール都市圏 ITS 機器供与計画準備調査

ソフトコンポーネント計画書

平成 28 年 12 月

１．背景

(1)プロジェクトの背景

ベンガルール都市圏では交通需要の増加に対応すべく、ハード対策として道路交通インフラの整備が進められている。しかし、渋滞が特に深刻な中心部では道路拡幅余地の制約もあり緊急なソフト対策が必要となっている。

高度道路交通システム（Intelligent Transport Systems、以下「ITS」とする）は、情報技術を道路交通分野に適用した重要なソフト対策であり、短期間での効果発現が期待される施策である。

こうした背景の下、技術協力の一環として貴機構による「インド国ベンガルール及びマイソール都市圏 ITS マスタープラン策定調査プロジェクト（2014 年 1 月～2015 年 6 月)」（以下「マスタープラン調査」とする）が実施された。マスタープラン調査では、ベンガルール都市圏における様々な ITS を短期・中期・長期に分け段階的に整備することが提唱されている。

係る状況の中、上記に掲げる短期整備が緊急な課題と判断され、カルナタカ州都市交通局（Directorate of Urban Land Transport、以下「DULT」とする）より日本政府に対して無償資金協力事業による以下の整備のための要請書が提出された。

・交通情報システム：リアルタイムな交通情報を提供し渋滞緩和を図る
・信号システム：渋滞緩和と交通安全のため、交通流の整流化を図る

本プロジェクトは、上記「交通情報システム」と「信号システム」が効果的に機能し、ベンガルール市の交通渋滞が緩和されることを目的とするものである。

(2) ソフトコンポーネントの背景

今回整備されるシステムは、以下に挙げる点が大きな特徴である。

1) BTIC システム

BTIC システムは、センターシステム、プローブシステム、渋滞長計測システム、交通量計測システム及びインターネットシステムから構成され、DULT にて運用管理される。BTIC システムは、市内の交通状況をリアルタイムに提供する機能と収集した交通情報を蓄積管理する機能がある。交通情報のリアルタイム情報提供機能はほぼ自動的に実施される機能であるが、交通情報の蓄積管理機能については、詳細で膨大な交通情報を一定の管理情報に変換し長期間蓄積したうえで、その後解析し交通計画等に役立てる必要がある。

DULT は、交通情報システムの運営管理を行った経験がなく、調達業者による操作・維持管理の指導だけでは、円滑な立ち上がりに問題があり、また交通情報解析方法についても知識は十分でなく、持続的、発展的な情報利用に課題がある。そのため、システムの運用・維持管理マニュアルを作成し立ち上がりに必要な運用・維持管理能力を指導するとともに、交通情報の解析方法と計画への利用方法、および解析の目的と

方法に合わせ、情報を適切に管理する方法について、ソフトコンポーネントにて指導することが必要である。

2) TMC システム

TMC システムは信号システム及び可変情報システムから構成され、交通警察(Bengaluru Traffic Police、以下「BTP」とする)にて運用管理される。信号システムは、渋滞長削減とエリア制御を主目的に各信号を制御するシステムであり、交通状況に敏感にそして適切に対応できるよう各種パラメータの設定が必要である。しかし、そのパラメータも周辺施設の整備状況や社会状況の変動に伴い、刻々と変わる変化する交通状況に対応して定期的に見直していく必要がある。

BTP では、すでに信号システムを運用しているが、交通状況情報の把握や適切なパラメータ等の設定などにより、変化していく交通状況に対応し信号システムの制御機能を持続させていく経験や能力は不足している。また、信号設置の交差点についても、信号機能を効果的に発揮させるための交差点施設の設計・維持管理や警察職員の交通安全指導等の方法にも課題がある。

そのため、パラメータ見直しのための交通状況の調査方法、パラメータ設定や交通状況情報の管理方法を中心に既存運用・維持管理マニュアルの修正を含め、ソフトコンポーネントによる技術指導が必要である。また、信号制御の効果を高めるための交差点の改良方法、運転者、住民そして警察官への啓発事項等についてもソフトコンポーネントにて指導する必要がある。

VMS (Variable Message Sign) システムは、交通情報システムの１コンポーネントであり、交通情報システムにて収集、提供されるリアルタイムの情報を大型表示板にて運転者や歩行者に情報提供するとともに、事故や道路工事などの情報、安全啓啓発やイベント情報などを BTP 職員によって設定し情報提供するシステムである。

BTP では、すでに VMS システムを運用しているが、交通情報システムによる交通情報を把握したうえで、必要な提供情報を VMS に設定する運用の経験がない。

そのため、交通情報システムによる交通情報の把握、事故などの提供情報の収集管理、情報提供決定の方法を中心にソフトコンポーネントにて指導する必要がある。

(3)ソフトコンポーネントの位置付け

本プロジェクトにより整備するシステムを適切かつ効果的に運用していくためには、上記の特徴に考慮した運用管理方法に熟知していく必要があり、さらにシステムの効果を上げプロジェクト目標を達成するためには、以下の(a)から(g)に示す活動を実施する必要がある。

(a) 各システムの基本的な操作・維持管理

(b) 各システムの総合的・効率的な運用・管理

(c) 交通情報システムにおける交通情報の管理

(d) 信号システムにおける各種パラメータ設定に関する運用・管理

(e) VMS システムにおける情報提供方法に関する運用管理

(f) 交通情報システムを活用した交通状況の解析と交通計画の策定

(g) 交通誘導や交通マナー向上のための運転者、市民への啓発活動の実施

これらの項目の中で、

(a)に関しては、調達業者により施設建設・機材調達の一環として実施される。

(b)～(e)に関しては、システムの運用が円滑に立ち上がりと持続性を最低限確保するために必要であり、実システムを使用した無償資金協力の本ソフトコンポーネントによる技術支援の実施が必要と判断される。(上記アンダーラインの活動)

(f)～(g)に関しては、システムを稼働させるための必要条件ではなく、導入するシステムの効果を上げるために必要な活動である。そこで、ソフトコンポーネントによる技術支援では、方法の提示に留め、実際の活動は、現地実施機関独自により実施することとする。

2．ソフトコンポーネントの目標

無償資金協力のソフトコンポーネントによる技術支援の目標は、システム機材の運用・維持管理を適切、効果的、そして継続的に実施できる状況である。

表-2 ソフトコンポーネントの具体的な目標

機関	対象者	目　　標
DULT	交通情報システムの運用管理と交通計画を行う技術者	交通情報システムの情報が安定的に提供され、かつ蓄積・解析する情報が関係機関や交通計画立案等で効果的に利活用できる状況。
BTP	信号システム・VMS システムの運用管理と交差点設計を行う技術者	信号システムとVMSシステムが安定的に運用され、かつ信号システムのパラメータ設定など運用の見直しが継続的に実施できる状況。
市役所	交通計画と交差点設計を行う技術者	DULT や BTP と連携し効果的な交通計画や交差点設計ができる状況。

３．ソフトコンポーネントの成果

本ソフトコンポーネントによる指導の成果を DULT 管轄の BTIC システムと BTP 管轄の TMC システムに分け以下に示す。

BTIC システムの成果

(1) 市内交通に関係する各関連組織の役割と活動内容が明確になるとともに、効果的な交通情報活動となるために必要な情報の提供方法や連携方法が明確になることにより、システムの運用、道路管理そして道路計画において関連機関の総合的かつ効果的な協力関係が確認できる。

(2) システムの運用・維持管理マニュアルを作成し、基本的な運用維持管理を実施できる技術力と判断力が育成される。

(3) 交通情報の効果的管理と有効活用の方法が習得できる。

TMC システムの成果

(1) 信号システムおよび VMS システムの運用・維持管理マニュアルを改訂または作成し、基本的な運用維持管理を実施できる技術力と判断力が育成される。

(2) 地域の施設整備の変化や交通状況の変化に対応して継続的に信号パラメータ等運用の見直しをする必要があるため、交通状況調査実施および交通状況の把握そして運用見直しに関する能力が育成される。

(3) 信号システムの効果を高めるための交差点改良および維持管理の方法や交通誘導および交通マナー向上のための啓発活動の方法が習得できる。

４．成果達成度の確認方法

成果達成度の評価は、技術支援の実施中にその都度把握していく必要があるが、定量的には、技術支援担当者が期待できる成果をチェックシートに整理し、その評価表によって確認し結果をとりまとめる。成果達成度の評価表の事例を表-3 に示す。

表-3　成果達成度の評価表の事例

評価項目	評価
<u>BTIC システム運用管理技術面の評価</u> 1.組織・体制 ・各関連組織の役割と活動内容を理解しているか ・必要な情報の提供方法や連携方法が明確になっているか 2. システムの運営・維持管理マニュアルの策定 ・運用維持管理方法が理解されているか 3. 情報の管理方法 ・基本的な交通情報の管理方法が理解されているか（リンク、セクションの管理含む） ・データベースの構成について理解しているか 4. 情報の解析方法と利用方法 ・情報解析方法について理解しているか ・情報利用方法について理解しているか	
<u>TMC システム運用管理技術面の評価</u> 1. システムの運営・維持管理マニュアルの修正 ・運用維持管理方法が理解されているか 2. 情報の管理方法 ・交通情報の管理方法を理解しているか ・データベース構成を理解しているか 3. 交通調査・分析と信号設計への適用 ・交通調査方法を理解しているか ・調査結果と交通情報の分析を理解しているか ・信号設計への適用方法を理解しているか？ 4. 信号機運用の見直し方法 ・適正なパラメータ（現示とタイミング）の計算方法を理解しているか ・サブエリア設定の見直し方法を理解しているか 5. 交差点設計、維持管理 ・交差点の形状設計を理解しているか ・交差点のマーキング設計を理解しているか 6. 信号システムの効果的な使用 ・交通誘導方法を理解しているか ・交通マナー向上のための啓発活動方法を理解しているか	

５．活動と投入計画

(1) 専門別受講者対象者

各技術支援に対し最低必要と判断される専門別受講対象者数を表-4 にしめす。

ソフトコンポーネント教育は、DULT と BTP の各システムの運用管理技術を設定し、DULT と BTP の技術者を中心に実施するが、運用管理技術の一部においては、市役所の技術者も対象に実施する。

表-4　技術支援の専門別受講対象者数とグループ

機関	担当業務	人数		受講者グループ
		責任者	担当	
DULT	運用担当	1名	2名	A
	交通計画担当	1名	6名	B
BTP	運用担当	1名	6名	C
	パラメータ設定担当	1名	6名	D
	交差点設計担当	1名	6名	E
市役所	交通計画担当	1名	4名	F
	交差点設計担当	1名	4名	G

(2) 技術支援の活動内容

DULT に設置される BTIC システムと BTP に設置される TMC システムに関する技術支援の活動内容を表-5 に列記する。

表-5　技術支援の活動内容

BTIC システム：1ヶ月

活動内容	受講者グループ	必要期間(週)
1.関連組織と連携方法 交通情報共有における各機関の担当部門と役割分担を確認し、各機関および職員の責任体制を明確にするとともに、効果的な活動となるために必要な情報の提供方法や連携方法を提示する。 ・機関との役割分担の確認 ・各機関との連携方法の確認 ・各機関と交換する情報とタイミングの説明と確認	A-F (責任者)	0.5
2. システムの運営・維持管理マニュアルの策定 システムの運営・維持管理マニュアルの策定を行う。 効果的な運用活動となるよう、システムの運営・維持管理マニュアルを策定し、基本的な運営維持管理を実施できる技術力と判断力を育成する。 ・運用維持管理方法の説明 ・運用維持管理マニュアルの策定作業	A	1.5
3. 情報の管理方法 運用のために必要な情報の種類、精度、収集タイミングを整理するとともに情報の管理方法を明確にする。 ・交通情報の管理方法の説明(リンク、セクションの管理含む) ・データベースの説明	A	0.5
4. 情報の解析方法と利用方法 交通情報の解析方法を紹介するとともに、交通計画等に役立つ交通情報の利用方法ついても紹介する。 ・交通情報の解析方法の説明 ・交通情報の利用方法の説明	B,F	1.0
5. 今後の交通情報システムの説明 将来、多様な機関との情報連携や共有が可能となることを想	A,B,F	0.5

定し、今後の交通情報管理体制と交通情報システムについて説明する。 ・今後の交通情報体制と交通情報システムの説明		
6. 評価 本技術支援の評価を行う。 ・ペーパによる確認 ・操作運用による確認	A,B,F	-

TMC システム：1ヶ月

活動内容	受講者グループ	必要期間(週)
1. システムの運営・維持管理マニュアルの修正 信号システムおよびVMSシステムの運営・維持管理マニュアルの修正を行う。 効果的な運用活動となるよう、システムの運営・維持管理マニュアルを修正し、基本的な運営維持管理を実施できる技術力と判断力を育成する。 ・運用維持管理方法の説明(0.25週) ・運用維持管理マニュアルの修正作業(0.75週)	C	1.5
2. 情報の管理方法 運用のために必要な情報の種類、精度、収集タイミングを整理するとともに情報の管理方法を明確にする。 ・交通情報の管理方法の説明 ・データベースの説明	D	0.5
3. 交通調査・分析と信号設計への適用 定期的な交通調査方法を説明するとともに、収集情報の分析方法と信号設計への適用方法について説明する ・交通調査方法の説明 ・調査結果、交通情報の分析方法の説明 ・信号設計への適用	D	0.5
4. 信号機運用の見直し方法 パラメータやサブエリアに関する設定の見直し方法について説明する。 ・適正なパラメータ（現示とタイミング）の計算 ・サブエリア設定の見直し方法	D	0.5
5. 交差点設計・維持管理 交差点の形状設計やマーキング等、交差点に関する設計および維持管理方法を説明する。 ・交差点の形状設計・維持管理 ・交差点のマーキング	E,G	0.5
6. 信号システムの効果的な使用 信号システムをより効果的に運用していくための交通誘導方法や住民・運転者の安全マナー向上のための啓発活動方法などについて説明する。 ・交通誘導方法 ・住民、運転者への啓発活動方法	C,D,E	0.5
7. 評価 本技術支援の評価を行う。 ・ペーパによる確認 ・操作運用による確認	C,D,E,G	-

(3) 日本側からの投入

技術支援を遂行するために必要な日本側からの投入は、DULT のシステムを中心に指導する技師１名（国内 0.5 ヵ月、現地 1.0 ヶ月）および BTP のシステムを中心に指導する技師１名（国内 0.5 ヵ月、現地 1.0 ヶ月）とする。

６．実施リソースの調達方法

本ソフトコンポーネントは以下の理由により本邦コンサルタント直接支援型により実施することが最も有効である。

本プロジェクトの技術支援に投入される技術者は以下のとおりである。

BTIC システムの技術支援

- BTIC システムは、情報収集、情報蓄積、情報提供など日本で実施されている交通情報システムの処理技術を基に構築され、さらに蓄積された交通情報は情報解析を通じ効果的な交通計画への利用など日本で実施されている技術的知見が反映できる機能となっている。
- 日本で実施されている交通情報システムの技術に詳しく、さらに交通解析や交通計画への反映などの知見を有する技術者が望ましい。

TMC システムの技術支援

- TMC システムの信号システムは、日本の警察庁標準仕様に基づいた技術仕様となっており、渋滞長に着目した制御やサブエリア制御など日本での運用管理技術を基に運用されるべくシステムが構築されている。また、交差点改良など信号制御の効果を高める方策も施行する。
- 日本の警察庁標準仕様と日本での運用方法に詳しく、さらに信号制御の効果を高める包括的な対策および知見を有する技術者が望ましい。

７．実施工程

実施期間は、調達業者による操作説明が終了後、2019 年１月～2019 年２月に、現地にて実施する。

表-6　ソフトコンポーネント実施工程表

活動内容	2019 年		合計
	1 月	2 月	(週)
１．BTIC システム			
(1)国内準備			2
(2)関連組織と連携方法			0.5
(3)システムの運営・維持管理マニュアルの策定			1.5
(4)情報の管理方法			0.5
(5)情報の解析方法と利用方法			1.0
(6)今後の交通情報システムの説明			0.5
２．TMC システム			
(1)国内準備			2
(2)システムの運営・維持管理マニュアルの修正			1.5
(3)情報の管理方法			0.5
(4)交通調査・分析と信号設計への適用			0.5
(5)信号機運用の見直し方法			0.5
(6)交差点設計・維持管理			0.5
(7)信号システムの効果的な使用			0.5

国内準備；　　現地指導；

８．成果品

ソフトコンポーネント業務の成果品は、以下のとおりである。

(1)　インド政府へ提出する完了報告書（Final Report）

(2)　JICA へ提出する完了報告書

(3)　本技術支援において作成する“運営・維持管理マニュアル”

９．相手国実施機関の責務

ソフトコンポーネントの目標達成のためには、ソフトコンポーネント投入による成果に加え、先方実施機関やBTPによる運営維持管理活動等の継続的な実施が必要である。以下に、先方実施機関やBTPの責務となる継続的な取り組みについて記載する。

交通情報システムを活用した交通状況の解析と交通計画の策定

・DULTは、交通情報システムに基づく交通状況の解析および交通計画を継続的に実施するとともに、関係者機関と連携し、問題点の共有と優先的計画を定期的、継続的に協議していく。

信号システム活用に向けたBTP職員、住民および運転者への啓蒙活動の実施

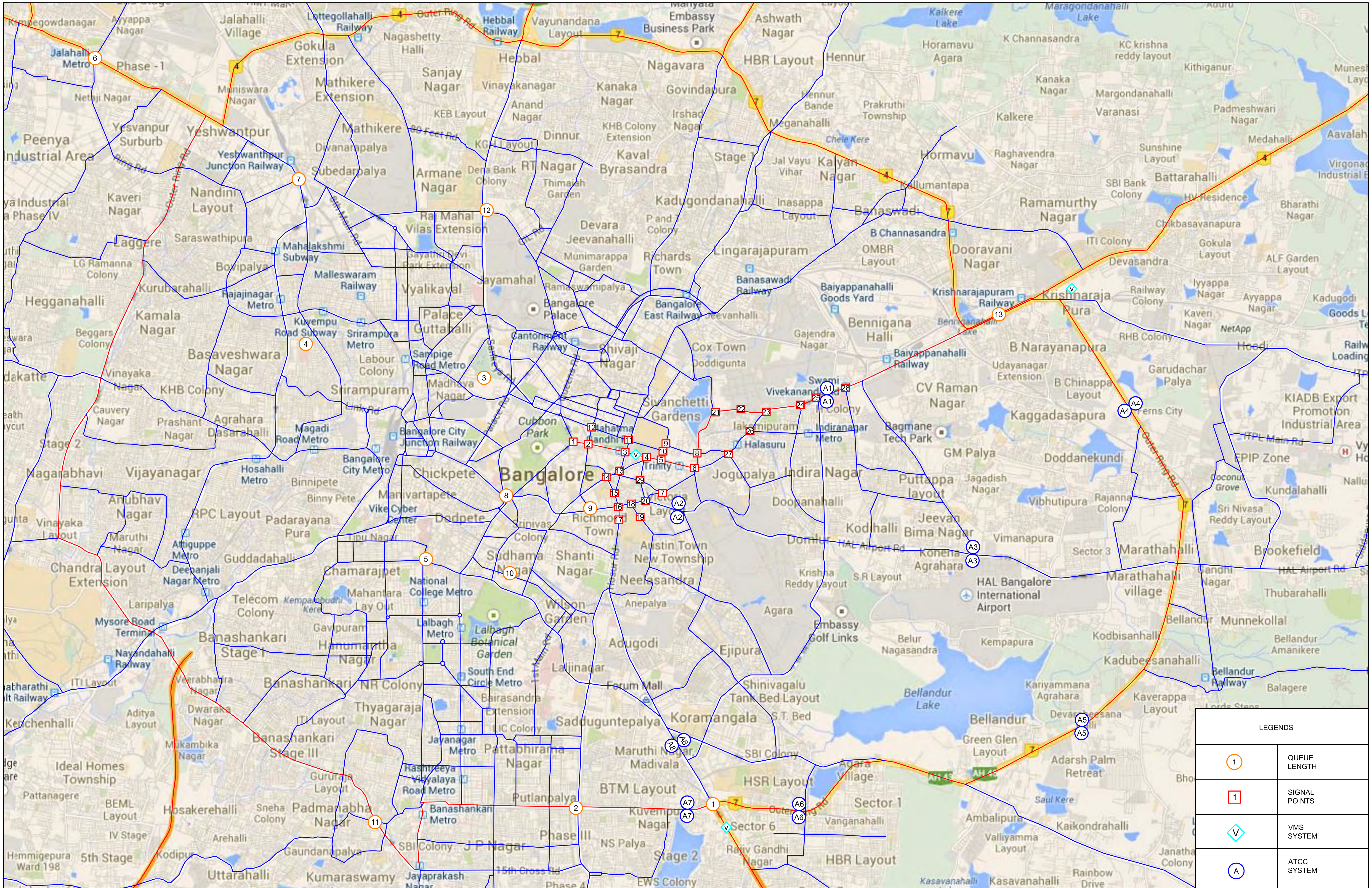
・BTPは、交差点での信号システムが効果的に機能するよう、現場のBTP管の交通誘導等の方法を継続的に指導していく
・BTPは、歩行者マナー、運転者マナーなどを住民および運転者に周知させ、交通マナー向上のための啓蒙活動を推進していく。
・DULTは、BTPの啓蒙活動の推進に協力していく。

交通情報システムによる提供方法・提供情報の改良

・DULTは、関係機関と定期的、継続的に協議を行い、公共の交通情報システムとして必用な提供情報の収集につとめニーズを意識した情報提供方法や提供情報を検討し今後、改良をしていく必要がある。

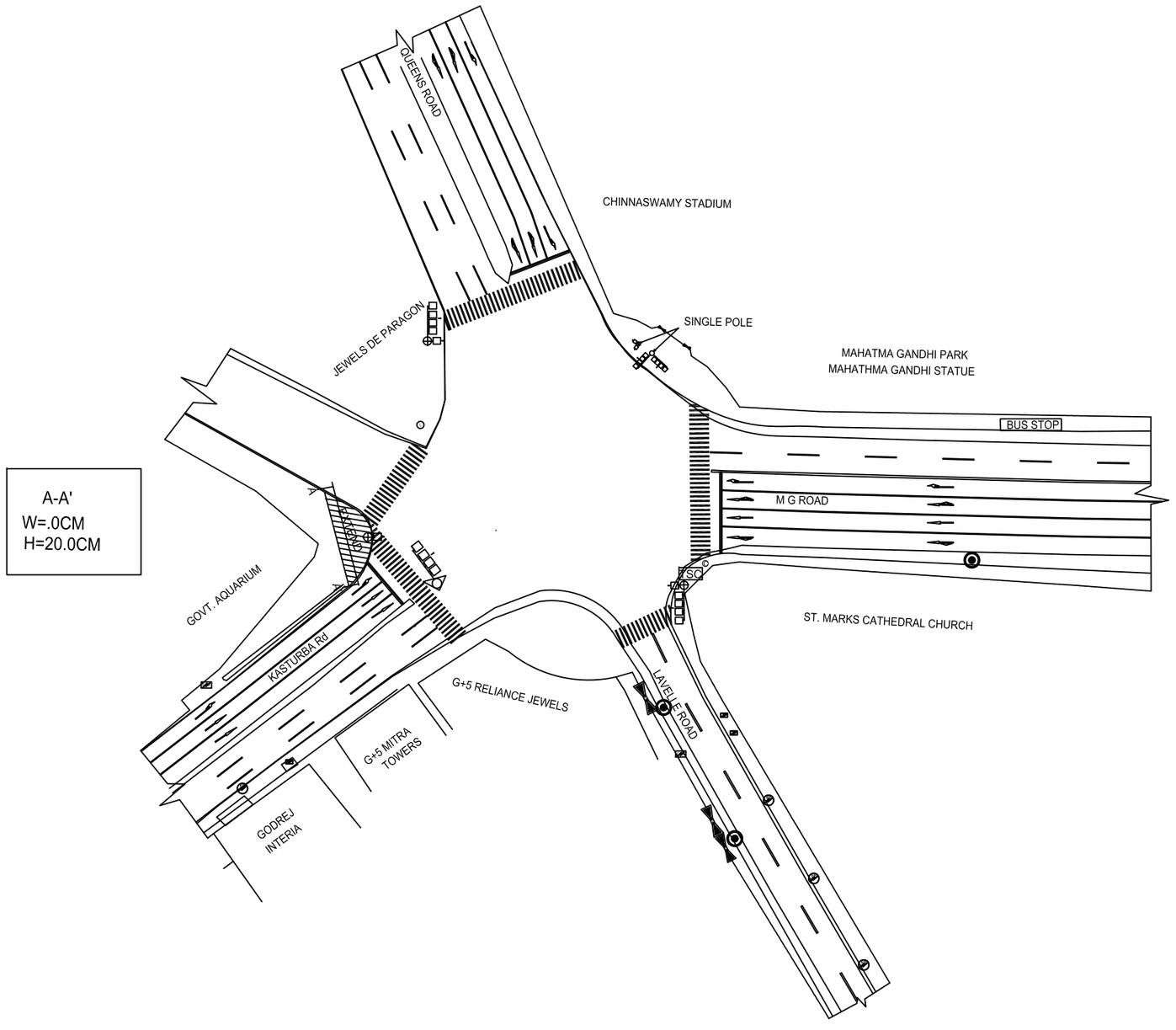
資料　6

参考資料（基本図面）



JAPAN INTERNATIONAL COOPERATION AGENCY	PREPARATORY SURVEY ON THE PROJECT FOR BENGALURU METROPOLITAN REGION ITS IN THE REPUBLIC OF INDIA	DRAWING TITLE	DRAW. NO.	NIPPON KOEI CO.,LTD
		LOCATION OF ROADSIDE EQUIPMENTS	CMM-2	EAST NIPPON EXPRESSWAY CO.,LTD

1 QUEENS Rd-KASTURBA Rd-M G Rd

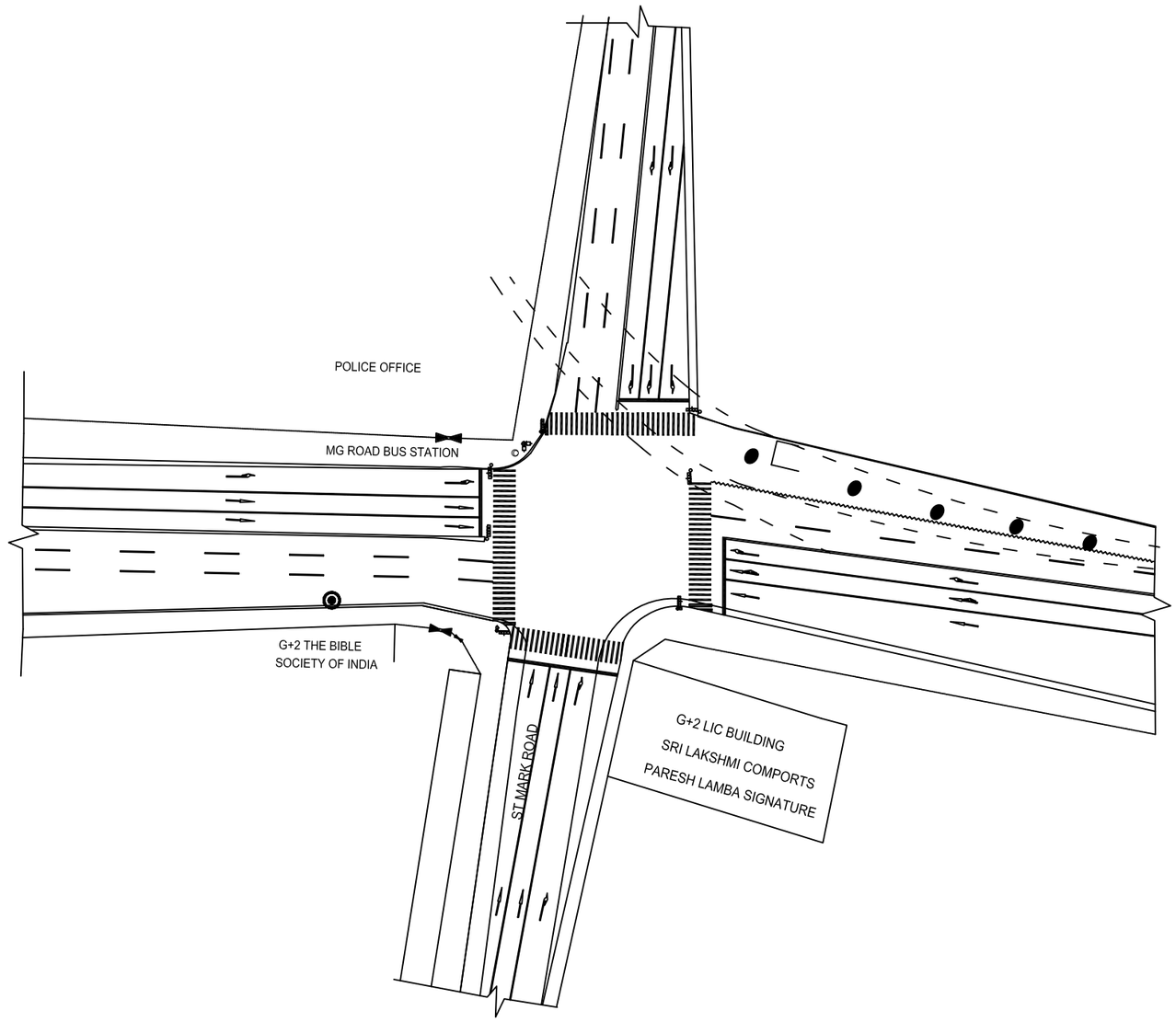


LEGENDS	
DISCRPITION	SYMBOL
2 CAR SIGNALS	
CAR SIGNAL	
PEDESTRIANS	
CAR AND PEDESTRAIN SIGNAL	
2 PEDESTRIANS	
MEDIAN	
MAN HOLE	
GATE	
TRAFFIC SIGNAL CONTROLLER	TSC
TRAFFIC CC CAMERA	C
CHANGE OF LOCATION	
NEW LOCATION	
SIGNAL REMOVED	

SCALE = 1:1000

JAPAN INTERNATIONAL COOPERATION AGENCY	PREPARATORY SURVEY ON THE PROJECT FOR BENGALURU METROPOLITAN REGION ITS IN THE REPUBLIC OF INDIA	DRAWING TITLE: DETAIL LOCATION OF TRAFFIC SIGNAL 1	DRAW. NO.: TS-1	NIPPON KOEI CO.,LTD. EAST NIPPON EXPRESSWAY CO.,LTD

2 Mg Road- St Marks Rd

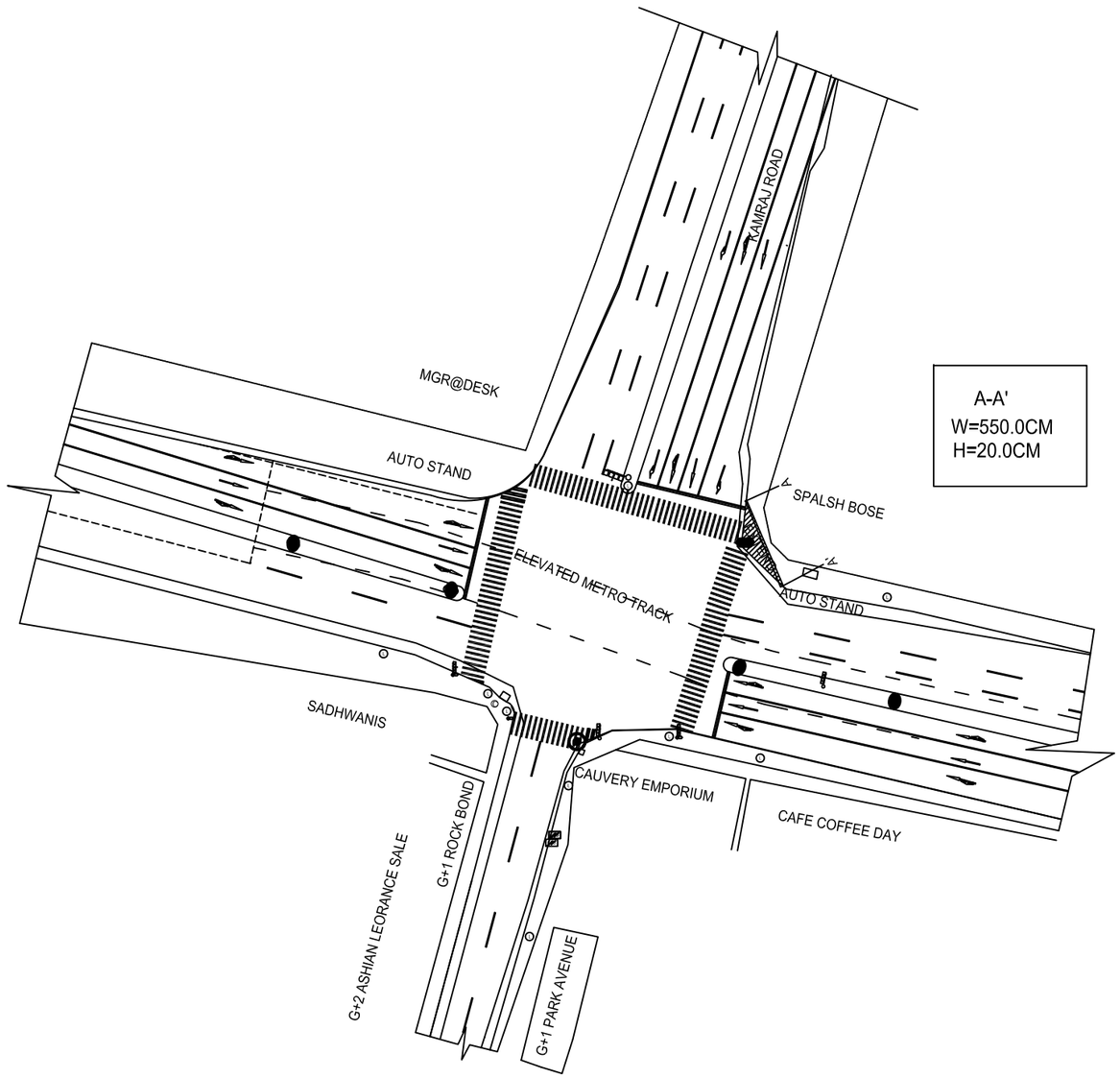


LEGENDS	
DISCRPITION	SYMBOL
2 CAR SIGNALS	
CAR SIGNAL	
PEDESTRIANS	
CAR AND PEDESTRAIN SIGNAL	
2 PEDESTRIANS	
MEDIAN	
MAN HOLE	
GATE	
TRAFFIC SIGNAL CONTROLLER	TSC
TRAFFIC CC CAMERA	C
CHANGE OF LOCATION	
NEW LOCATION	
SIGNAL REMOVED	

SCALE = 1:1000

JAPAN INTERNATIONAL COOPERATION AGENCY	PREPARATORY SURVEY ON THE PROJECT FOR BENGALURU METROPOLITAN REGION ITS IN THE REPUBLIC OF INDIA	DRAWING TITLE	DRAW. NO.	NIPPON KOEI CO.,LTD. EAST NIPPON EXPRESSWAY CO.,LTD
		DETAIL LOCATION OF TRAFFIC SIGNAL 2	TS-2	

3 Mg Road and Kamaraj Rd Jn



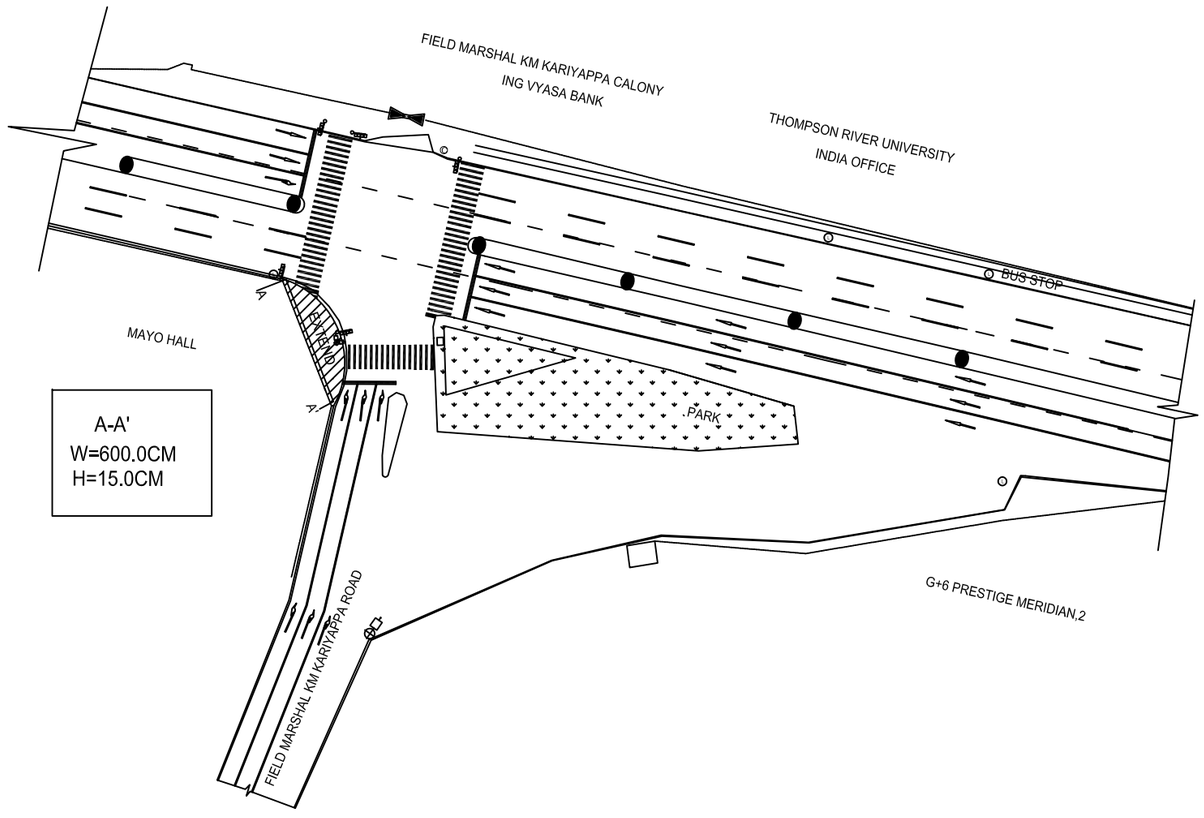
A-A'
W=550.0CM
H=20.0CM

LEGENDS	
DISCRPITION	SYMBOL
2 CAR SIGNALS	
CAR SIGNAL	
PEDESTRIANS	
CAR AND PEDESTRAIN SIGNAL	
2 PEDESTRIANS	
MEDIAN	
MAN HOLE	
GATE	
TRAFFIC SIGNAL CONTROLLER	TSC
TRAFFIC CC CAMERA	C
CHANGE OF LOCATION	
NEW LOCATION	
SIGNAL REMOVED	

SCALE = 1:1000

JAPAN INTERNATIONAL COOPERATION AGENCY	PREPARATORY SURVEY ON THE PROJECT FOR BENGALURU METROPOLITAN REGION ITS IN THE REPUBLIC OF INDIA	DRAWING TITLE	DRAW. NO.	NIPPON KOEI CO.,LTD. EAST NIPPON EXPRESSWAY CO.,LTD
		DETAIL LOCATION OF TRAFFIC SIGNAL 3	TS-3	

4 MG Rd and Residency Rd

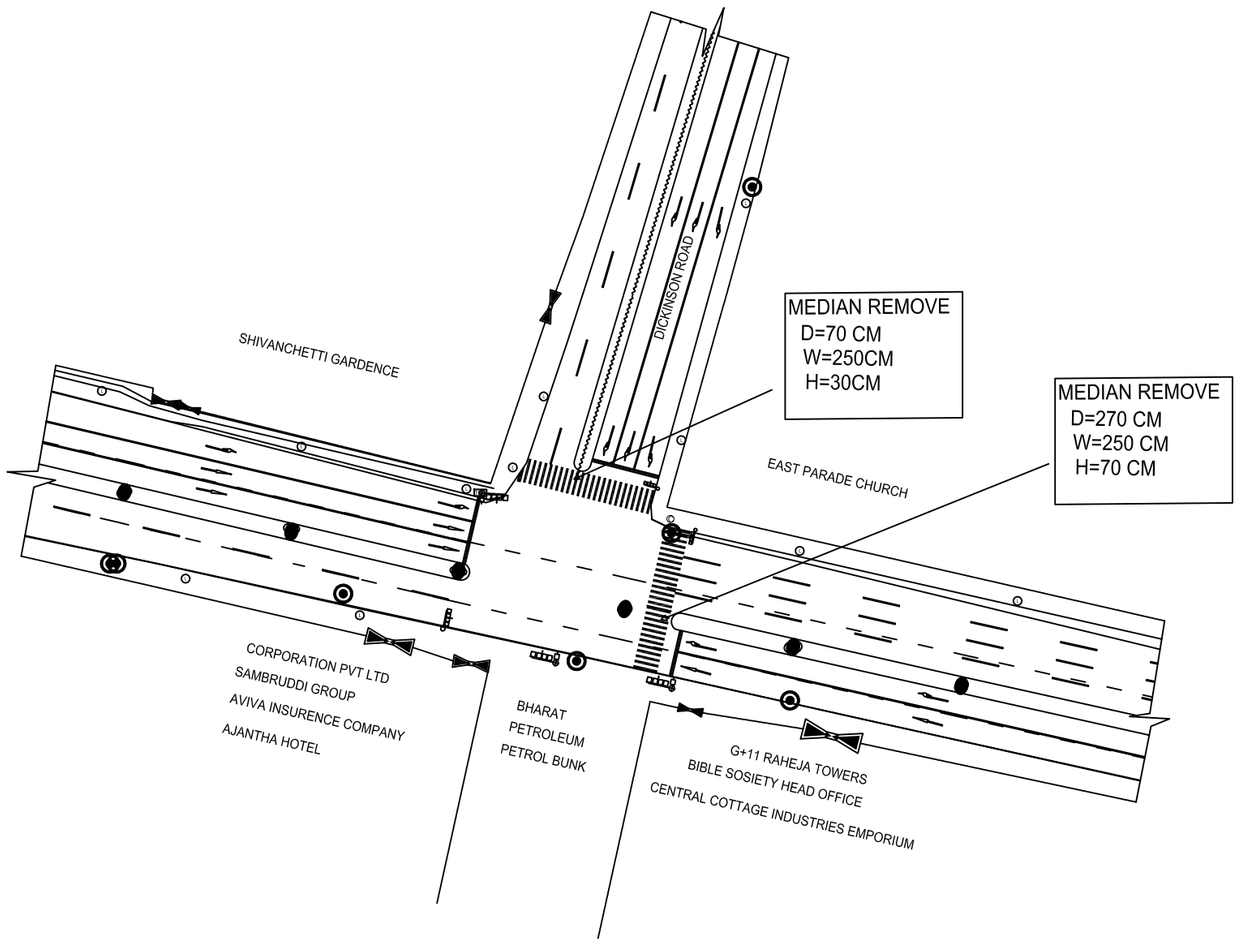


LEGENDS	
DISCRPITION	SYMBOL
2 CAR SIGNALS	
CAR SIGNAL	
PEDESTRIANS	
CAR AND PEDESTRAIN SIGNAL	
2 PEDESTRIANS	
MEDIAN	
MAN HOLE	
GATE	
TRAFFIC SIGNAL CONTROLLER	TSC
TRAFFIC CC CAMERA	C
CHANGE OF LOCATION	
NEW LOCATION	
SIGNAL REMOVED	

SCALE = 1:1000

JAPAN INTERNATIONAL COOPERATION AGENCY	PREPARATORY SURVEY ON THE PROJECT FOR BENGALURU METROPOLITAN REGION ITS IN THE REPUBLIC OF INDIA	DRAWING TITLE	DRAW. NO.	NIPPON KOEI CO.,LTD. EAST NIPPON EXPRESSWAY CO.,LTD
		DETAIL LOCATION OF TRAFFIC SIGNAL 4	TS-4	

5 MG Road and Dickenson Rd Jn

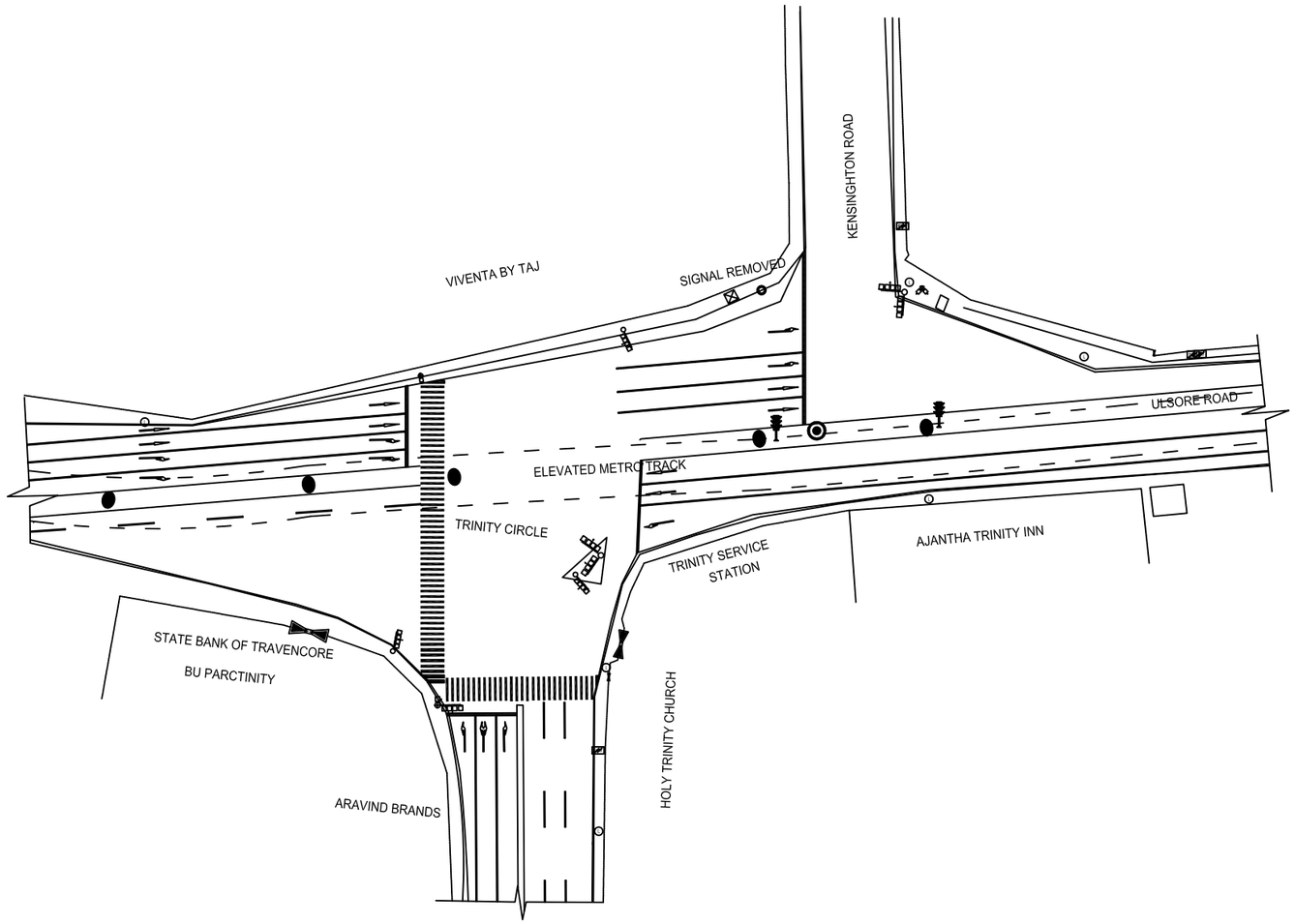


LEGENDS	
DISCRPITION	SYMBOL
2 CAR SIGNALS	
CAR SIGNAL	
PEDESTRIANS	
CAR AND PEDESTRAIN SIGNAL	
2 PEDESTRIANS	
MEDIAN	
MAN HOLE	
GATE	
TRAFFIC SIGNAL CONTROLLER	TSC
TRAFFIC CC CAMERA	C
CHANGE OF LOCATION	
NEW LOCATION	
SIGNAL REMOVED	

SCALE = 1:1000

JAPAN INTERNATIONAL COOPERATION AGENCY	PREPARATORY SURVEY ON THE PROJECT FOR BENGALURU METROPOLITAN REGION ITS IN THE REPUBLIC OF INDIA	DRAWING TITLE	DRAW. NO.	NIPPON KOEI CO.,LTD. EAST NIPPON EXPRESSWAY CO.,LTD
		DETAIL LOCATION OF TRAFFIC SIGNAL 5	TS-5	

6 Trinity Circle

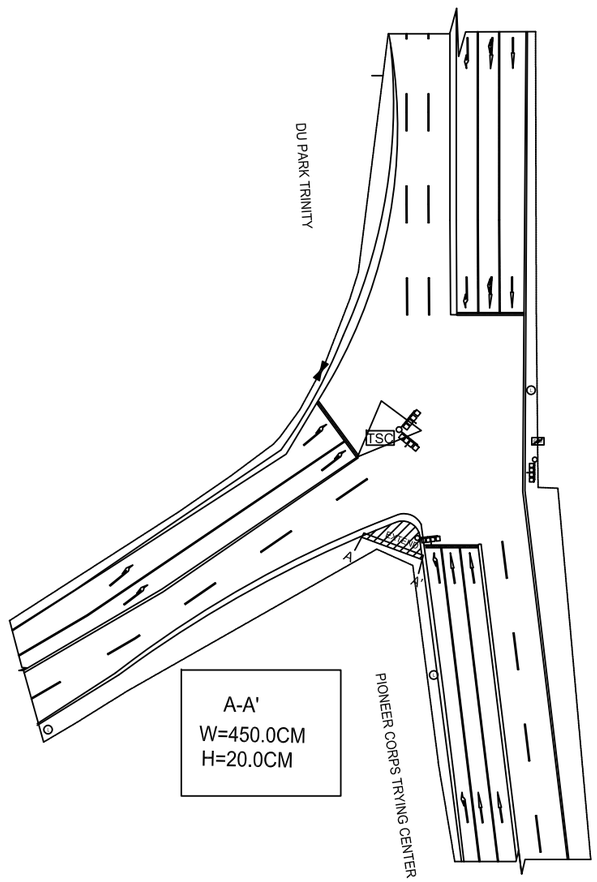


LEGENDS	
DISCRPITION	SYMBOL
2 CAR SIGNALS	
CAR SIGNAL	
PEDESTRIANS	
CAR AND PEDESTRAIN SIGNAL	
2 PEDESTRIANS	
MEDIAN	
MAN HOLE	
GATE	
TRAFFIC SIGNAL CONTROLLER	TSC
TRAFFIC CC CAMERA	C
CHANGE OF LOCATION	
NEW LOCATION	
SIGNAL REMOVED	

SCALE = 1:1000

JAPAN INTERNATIONAL COOPERATION AGENCY	PREPARATORY SURVEY ON THE PROJECT FOR BENGALURU METROPOLITAN REGION ITS IN THE REPUBLIC OF INDIA	DRAWING TITLE: DETAIL LOCATION OF TRAFFIC SIGNAL 6	DRAW. NO.: TS-6	NIPPON KOEI CO.,LTD. EAST NIPPON EXPRESSWAY CO.,LTD

7 Trinity Bus Stop

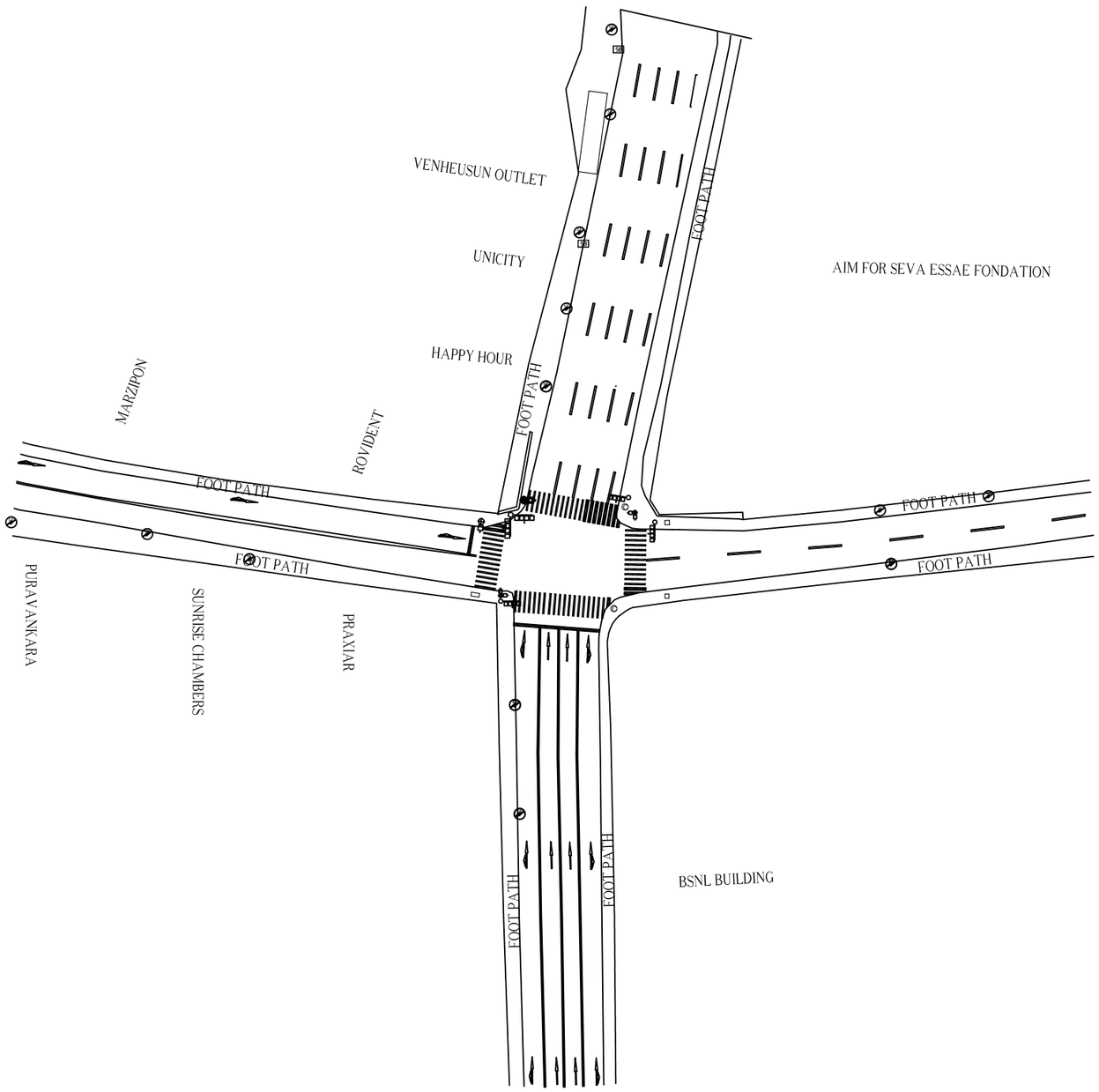


LEGENDS	
DISCRPITION	SYMBOL
2 CAR SIGNALS	
CAR SIGNAL	
PEDESTRIANS	
CAR AND PEDESTRAIN SIGNAL	
2 PEDESTRIANS	
MEDIAN	
MAN HOLE	
GATE	
TRAFFIC SIGNAL CONTROLLER	TSC
TRAFFIC CC CAMERA	C
CHANGE OF LOCATION	
NEW LOCATION	
SIGNAL REMOVED	

SCALE = 1:1000

JAPAN INTERNATIONAL COOPERATION AGENCY	PREPARATORY SURVEY ON THE PROJECT FOR BENGALURU METROPOLITAN REGION ITS IN THE REPUBLIC OF INDIA	DRAWING TITLE	DRAW. NO.	NIPPON KOEI CO.,LTD. EAST NIPPON EXPRESSWAY CO.,LTD
		DETAIL LOCATION OF TRAFFIC SIGNAL 7	TS-7	

8 Ulsoor Rd Kensington Rd Jn

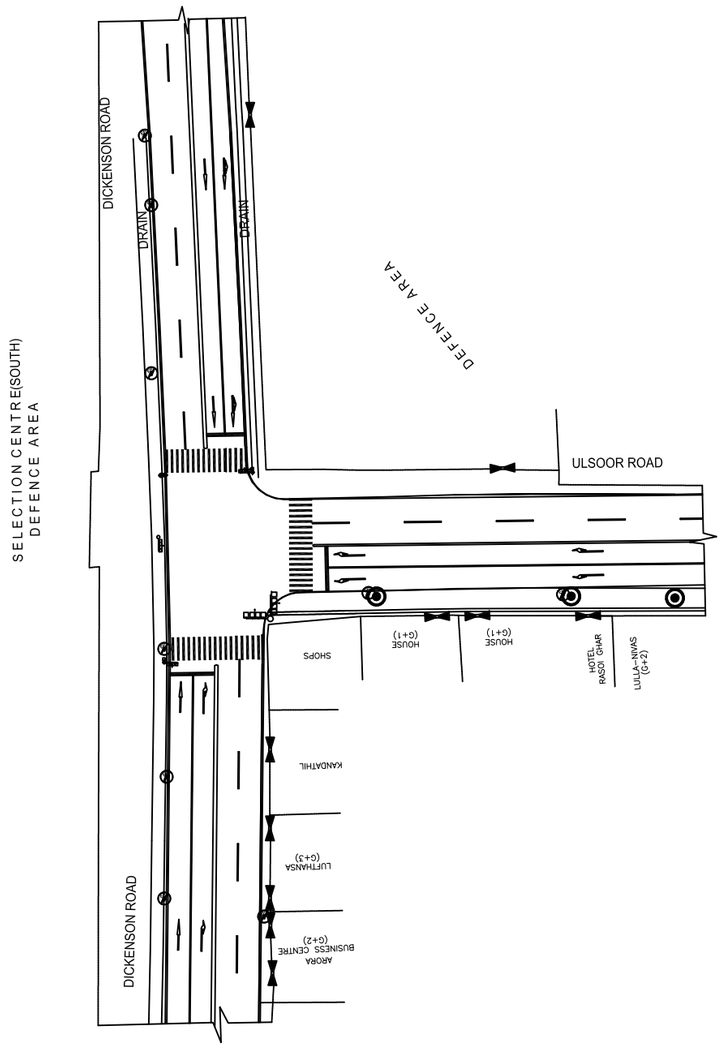


LEGENDS	
DISCRPITION	SYMBOL
2 CAR SIGNALS	
CAR SIGNAL	
PEDESTRIANS	
CAR AND PEDESTRAIN SIGNAL	
2 PEDESTRIANS	
MEDIAN	
MAN HOLE	
GATE	
TRAFFIC SIGNAL CONTROLLER	TSC
TRAFFIC CC CAMERA	C
CHANGE OF LOCATION	
NEW LOCATION	
SIGNAL REMOVED	

SCALE = 1:1000

JAPAN INTERNATIONAL COOPERATION AGENCY	PREPARATORY SURVEY ON THE PROJECT FOR BENGALURU METROPOLITAN REGION ITS IN THE REPUBLIC OF INDIA	DRAWING TITLE	DRAW. NO.	NIPPON KOEI CO.,LTD. EAST NIPPON EXPRESSWAY CO.,LTD
		DETAIL LOCATION OF TRAFFIC SIGNAL 8	TS-8	

9 Ulsoor Road Dickenson Rd Jn

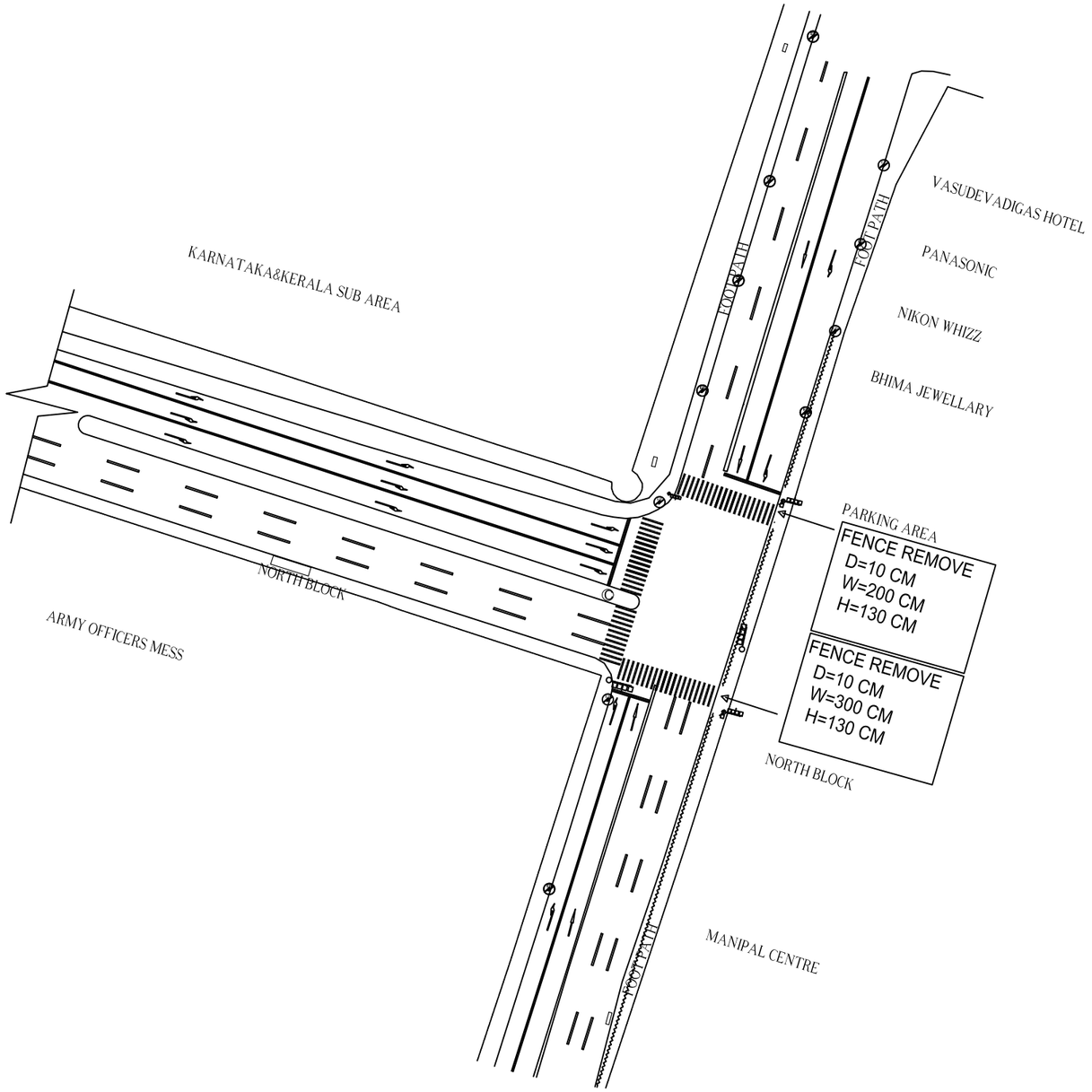


LEGENDS	
DISCRPITION	SYMBOL
2 CAR SIGNALS	
CAR SIGNAL	
PEDESTRIANS	
CAR AND PEDESTRAIN SIGNAL	
2 PEDESTRIANS	
MEDIAN	
MAN HOLE	
GATE	
TRAFFIC SIGNAL CONTROLLER	TSC
TRAFFIC CC CAMERA	C
CHANGE OF LOCATION	
NEW LOCATION	
SIGNAL REMOVED	

SCALE = 1:1000

JAPAN INTERNATIONAL COOPERATION AGENCY	PREPARATORY SURVEY ON THE PROJECT FOR BENGALURU METROPOLITAN REGION ITS IN THE REPUBLIC OF INDIA	DRAWING TITLE	DRAW. NO.	NIPPON KOEI CO.,LTD. EAST NIPPON EXPRESSWAY CO.,LTD
		DETAIL LOCATION OF TRAFFIC SIGNAL 9	TS-9	

10 Cubbon Rd Dickenson Rd Jn



LEGENDS	
DISCRPITION	SYMBOL
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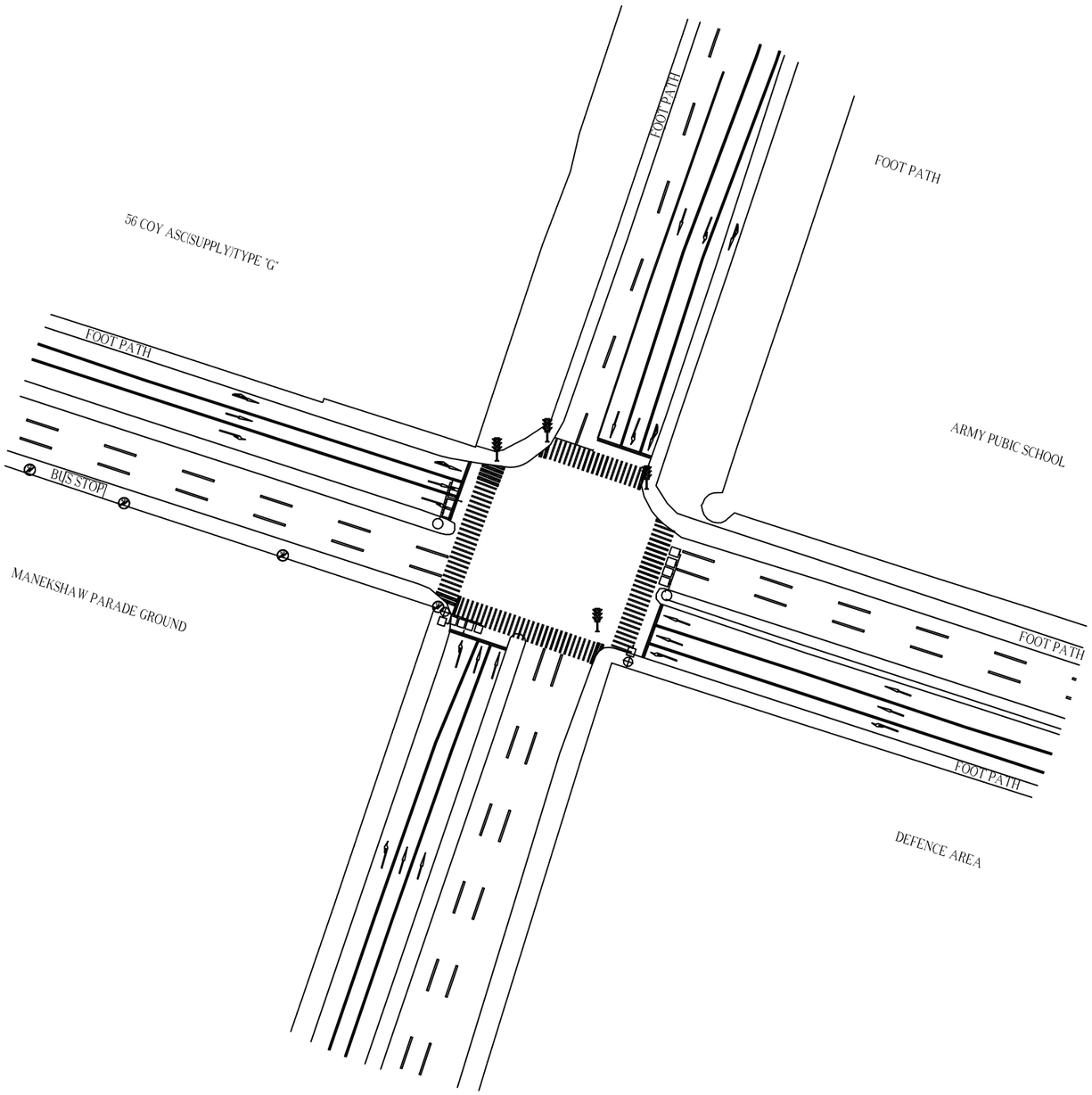
CAR SIGNAL	
PEDESTRIANS	
CAR AND PEDESTRAIN SIGNAL	
2 PEDESTRIANS	
MEDIAN	
MAN HOLE	
GATE	
TRAFFIC SIGNAL CONTROLLER	TSC
TRAFFIC CC CAMERA	C
CHANGE OF LOCATION	
NEW LOCATION	
SIGNAL REMOVED	

SCALE = 1:1000

JAPAN INTERNATIONAL COOPERATION AGENCY	PREPARATORY SURVEY ON THE PROJECT FOR BENGALURU METROPOLITAN REGION ITS IN THE REPUBLIC OF INDIA	DRAWING TITLE	DRAW. NO.	NIPPON KOEI CO.,LTD. EAST NIPPON EXPRESSWAY CO.,LTD
		DETAIL LOCATION OF TRAFFIC SIGNAL 10	TS-10	

11 Cubbon Rd Kamaraj Rd Jn

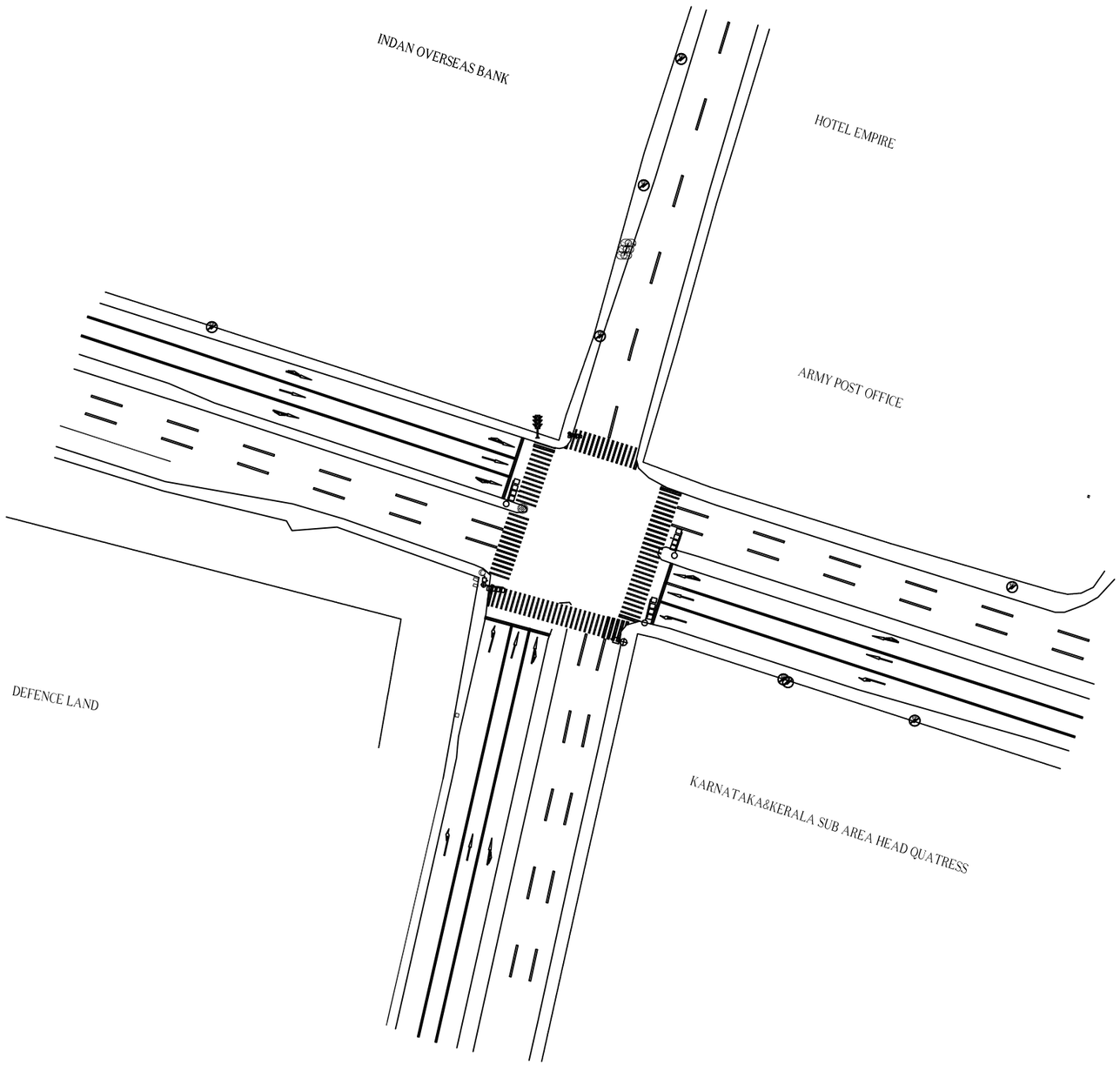


LEGENDS	
DISCRPITION	SYMBOL
2 CAR SIGNALS	
CAR SIGNAL	
PEDESTRIANS	
CAR AND PEDESTRAIN SIGNAL	
2 PEDESTRIANS	
MEDIAN	
MAN HOLE	
GATE	
TRAFFIC SIGNAL CONTROLLER	TSC
TRAFFIC CC CAMERA	C
CHANGE OF LOCATION	
NEW LOCATION	
SIGNAL REMOVED	

SCALE = 1:1000

JAPAN INTERNATIONAL COOPERATION AGENCY	PREPARATORY SURVEY ON THE PROJECT FOR BENGALURU METROPOLITAN REGION ITS IN THE REPUBLIC OF INDIA	DRAWING TITLE	DRAW. NO.	NIPPON KOEI CO.,LTD. EAST NIPPON EXPRESSWAY CO.,LTD
		DETAIL LOCATION OF TRAFFIC SIGNAL 11	TS-11	

12Cubbon Rd St Marks Rd Jn

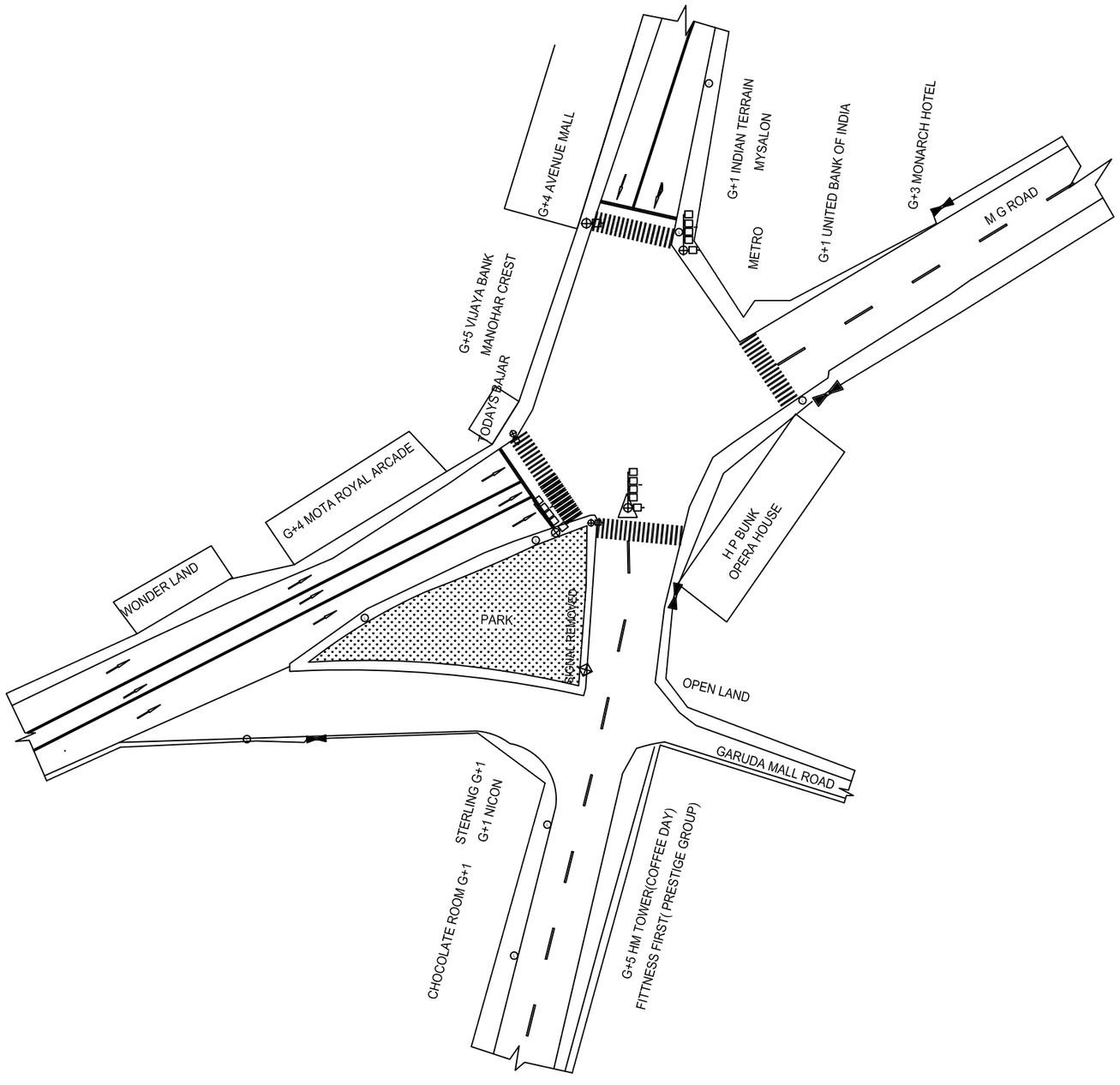


LEGENDS	
DISCRPITION	SYMBOL
2 CAR SIGNALS	
CAR SIGNAL	
PEDESTRIANS	
CAR AND PEDESTRAIN SIGNAL	
2 PEDESTRIANS	
MEDIAN	
MAN HOLE	
GATE	
TRAFFIC SIGNAL CONTROLLER	TSC
TRAFFIC CC CAMERA	C
CHANGE OF LOCATION	
NEW LOCATION	
SIGNAL REMOVED	

SCALE = 1:1000

JAPAN INTERNATIONAL COOPERATION AGENCY	PREPARATORY SURVEY ON THE PROJECT FOR BENGALURU METROPOLITAN REGION ITS IN THE REPUBLIC OF INDIA	DRAWING TITLE	DRAW. NO.	NIPPON KOEI CO.,LTD. EAST NIPPON EXPRESSWAY CO.,LTD
		DETAIL LOCATION OF TRAFFIC SIGNAL 12	TS-12	

13 Recidency Rd Brigade Rd Jn

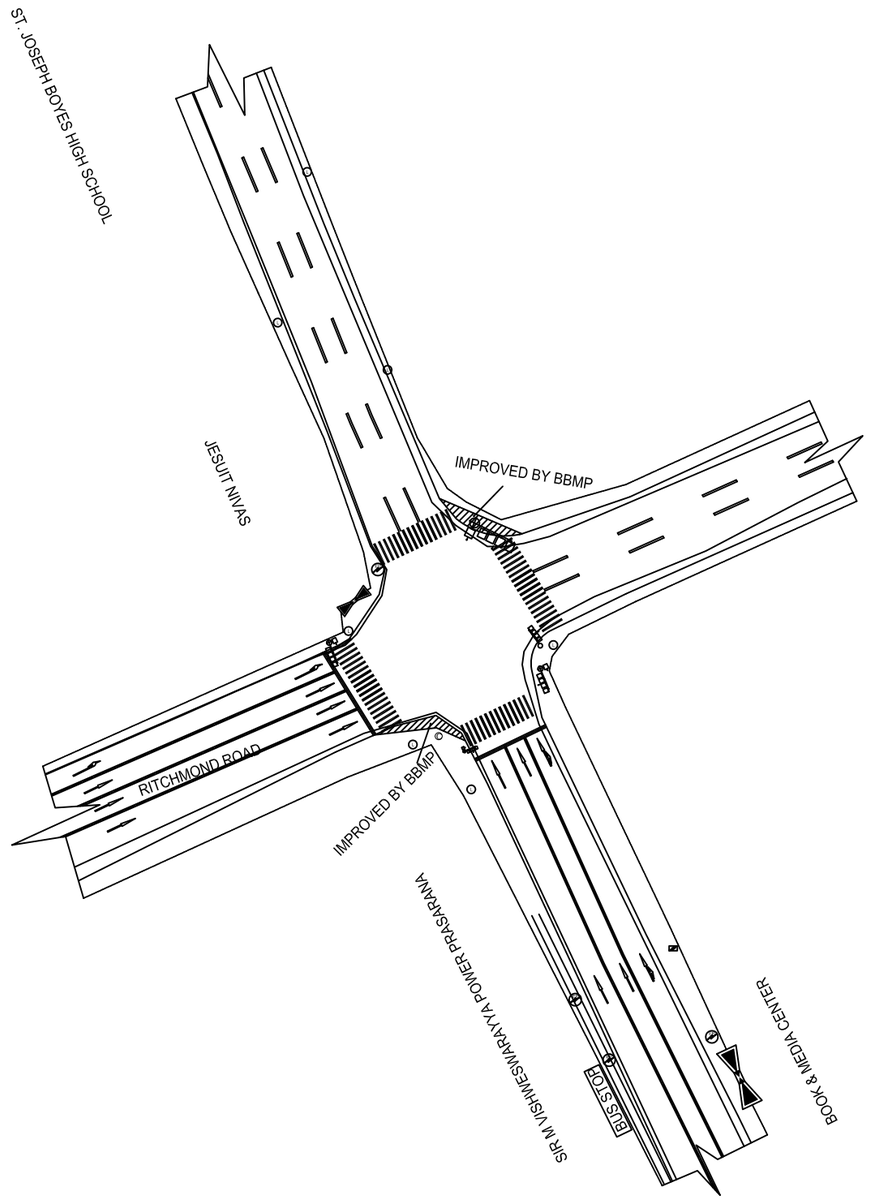


LEGENDS	
DISCRPITION	SYMBOL
2 CAR SIGNALS	
CAR SIGNAL	
PEDESTRIANS	
CAR AND PEDESTRAIN SIGNAL	
2 PEDESTRIANS	
MEDIAN	
MAN HOLE	
GATE	
TRAFFIC SIGNAL CONTROLLER	TSC
TRAFFIC CC CAMERA	C
CHANGE OF LOCATION	
NEW LOCATION	
SIGNAL REMOVED	

SCALE = 1:1000

JAPAN INTERNATIONAL COOPERATION AGENCY	PREPARATORY SURVEY ON THE PROJECT FOR BENGALURU METROPOLITAN REGION ITS IN THE REPUBLIC OF INDIA	DRAWING TITLE	DRAW. NO.	NIPPON KOEI CO.,LTD. EAST NIPPON EXPRESSWAY CO.,LTD
		DETAIL LOCATION OF TRAFFIC SIGNAL 13	TS-13	

14 Residency Rd Museum Rd Jn

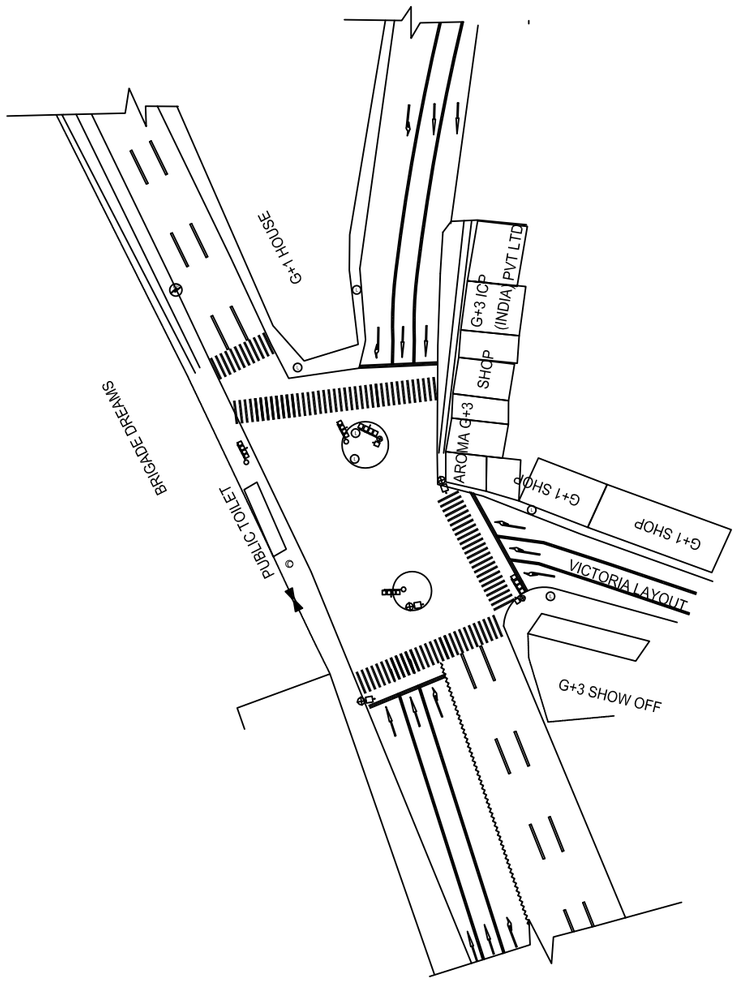


LEGENDS	
DISCRPITION	SYMBOL
2 CAR SIGNALS	
CAR SIGNAL	
PEDESTRIANS	
CAR AND PEDESTRAIN SIGNAL	
2 PEDESTRIANS	
MEDIAN	
MAN HOLE	
GATE	
TRAFFIC SIGNAL CONTROLLER	TSC
TRAFFIC CC CAMERA	C
CHANGE OF LOCATION	
NEW LOCATION	
SIGNAL REMOVED	

SCALE = 1:1000

JAPAN INTERNATIONAL COOPERATION AGENCY	PREPARATORY SURVEY ON THE PROJECT FOR BENGALURU METROPOLITAN REGION ITS IN THE REPUBLIC OF INDIA	DRAWING TITLE	DRAW. NO.	NIPPON KOEI CO.,LTD. EAST NIPPON EXPRESSWAY CO.,LTD
		DETAIL LOCATION OF TRAFFIC SIGNAL 14	TS-14	

15 Museum Rd Castle Rd Jn

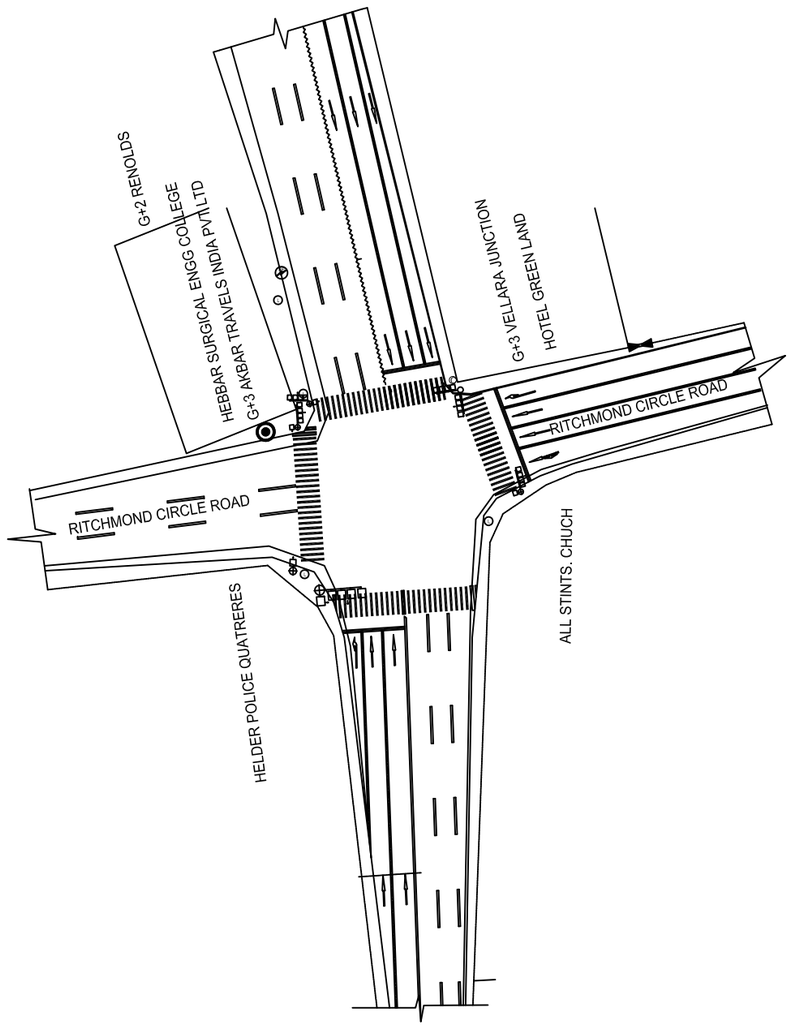


LEGENDS	
DISCRPITION	SYMBOL
2 CAR SIGNALS	
CAR SIGNAL	
PEDESTRIANS	
CAR AND PEDESTRAIN SIGNAL	
2 PEDESTRIANS	
MEDIAN	
MAN HOLE	
GATE	
TRAFFIC SIGNAL CONTROLLER	TSC
TRAFFIC CC CAMERA	C
CHANGE OF LOCATION	
NEW LOCATION	
SIGNAL REMOVED	

SCALE = 1:1000

JAPAN INTERNATIONAL COOPERATION AGENCY	PREPARATORY SURVEY ON THE PROJECT FOR BENGALURU METROPOLITAN REGION ITS IN THE REPUBLIC OF INDIA	DRAWING TITLE	DRAW. NO.	NIPPON KOEI CO.,LTD. EAST NIPPON EXPRESSWAY CO.,LTD
		DETAIL LOCATION OF TRAFFIC SIGNAL 15	TS-15	

16 General KS Thimaya Rd Hosur Rd Jn

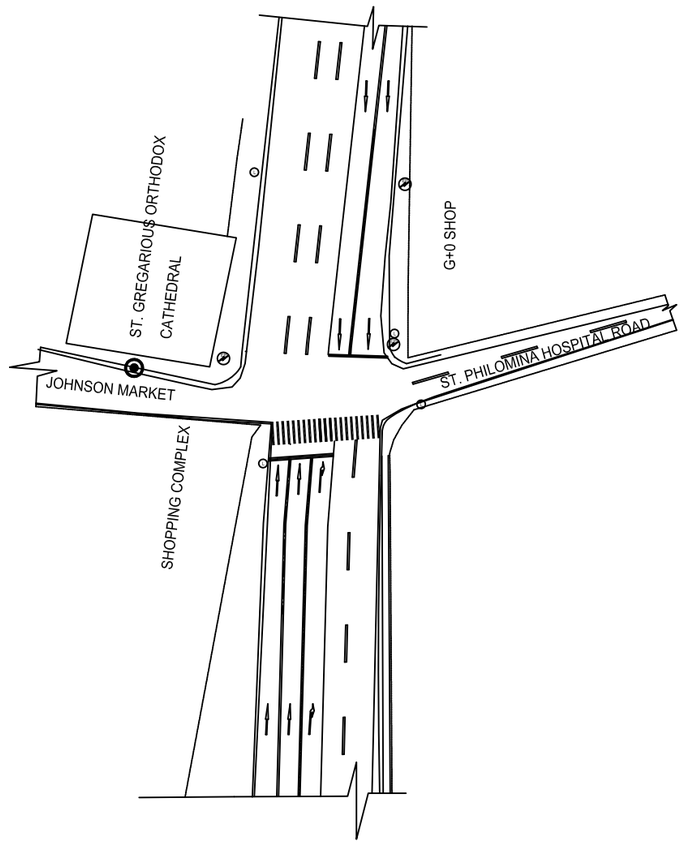


LEGENDS	
DISCRPITION	SYMBOL
2 CAR SIGNALS	
CAR SIGNAL	
PEDESTRIANS	
CAR AND PEDESTRAIN SIGNAL	
2 PEDESTRIANS	
MEDIAN	
MAN HOLE	
GATE	
TRAFFIC SIGNAL CONTROLLER	TSC
TRAFFIC CC CAMERA	C
CHANGE OF LOCATION	
NEW LOCATION	
SIGNAL REMOVED	

SCALE = 1:1000

JAPAN INTERNATIONAL COOPERATION AGENCY	PREPARATORY SURVEY ON THE PROJECT FOR BENGALURU METROPOLITAN REGION ITS IN THE REPUBLIC OF INDIA	DRAWING TITLE	DRAW. NO.	NIPPON KOEI CO.,LTD. EAST NIPPON EXPRESSWAY CO.,LTD
		DETAIL LOCATION OF TRAFFIC SIGNAL 16	TS-16	

17 Campbell Rd Hosur Rd Jn

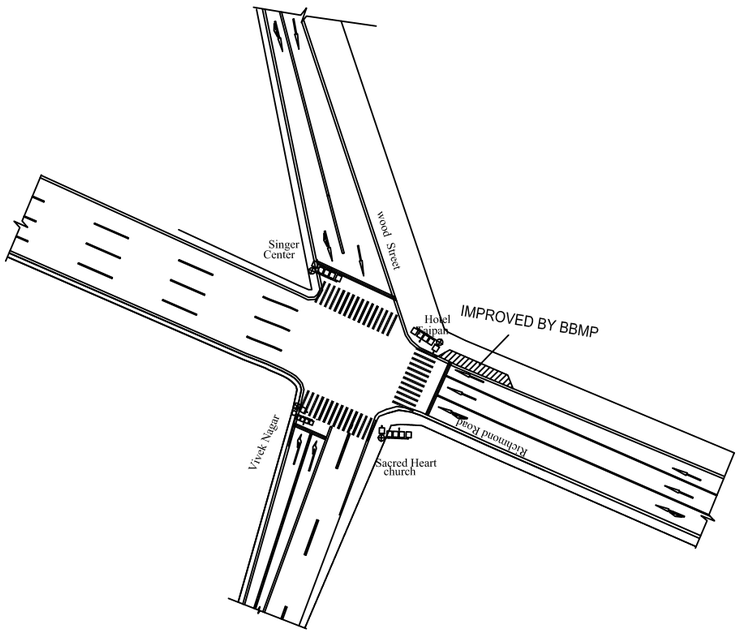


LEGENDS	
DISCRPITION	SYMBOL
2 CAR SIGNALS	
CAR SIGNAL	
PEDESTRIANS	
CAR AND PEDESTRAIN SIGNAL	
2 PEDESTRIANS	
MEDIAN	
MAN HOLE	
GATE	
TRAFFIC SIGNAL CONTROLLER	TSC
TRAFFIC CC CAMERA	C
CHANGE OF LOCATION	
NEW LOCATION	
SIGNAL REMOVED	

SCALE = 1:1000

JAPAN INTERNATIONAL COOPERATION AGENCY	PREPARATORY SURVEY ON THE PROJECT FOR BENGALURU METROPOLITAN REGION ITS IN THE REPUBLIC OF INDIA	DRAWING TITLE	DRAW. NO.	NIPPON KOEI CO.,LTD. EAST NIPPON EXPRESSWAY CO.,LTD
		DETAIL LOCATION OF TRAFFIC SIGNAL 17	TS-17	

18 General K S Thimayya Rd Mother Teresa Rd Jn

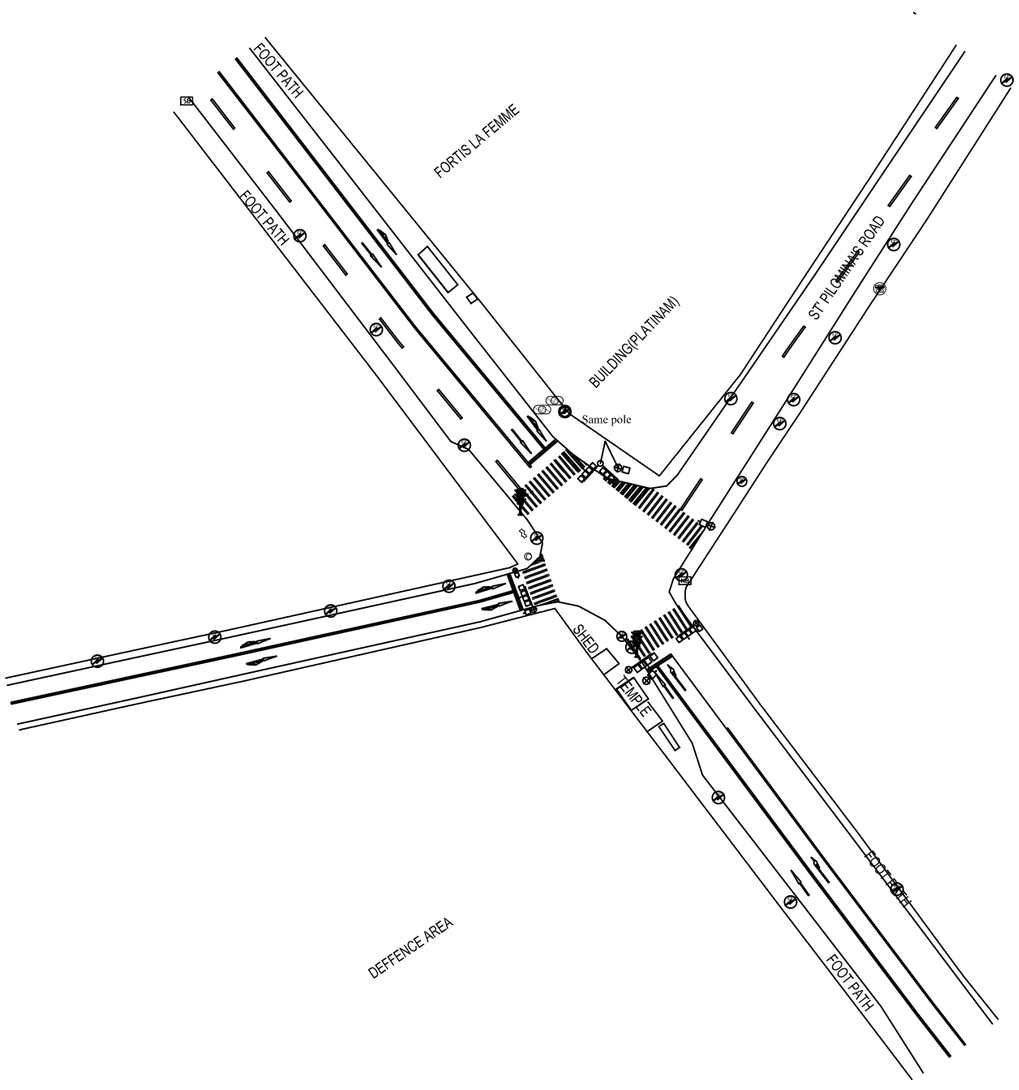


LEGENDS	
DISCRPITION	SYMBOL
2 CAR SIGNALS	
CAR SIGNAL	
PEDESTRIANS	
CAR AND PEDESTRAIN SIGNAL	
2 PEDESTRIANS	
MEDIAN	
MAN HOLE	
GATE	
TRAFFIC SIGNAL CONTROLLER	TSC
TRAFFIC CC CAMERA	C
CHANGE OF LOCATION	
NEW LOCATION	
SIGNAL REMOVED	

SCALE = 1:1000

JAPAN INTERNATIONAL COOPERATION AGENCY	PREPARATORY SURVEY ON THE PROJECT FOR BENGALURU METROPOLITAN REGION ITS IN THE REPUBLIC OF INDIA	DRAWING TITLE	DRAW. NO.	NIPPON KOEI CO.,LTD. EAST NIPPON EXPRESSWAY CO.,LTD
		DETAIL LOCATION OF TRAFFIC SIGNAL 18	TS-18	

19 St Philomena Rd Mother Teresa Rd Jn

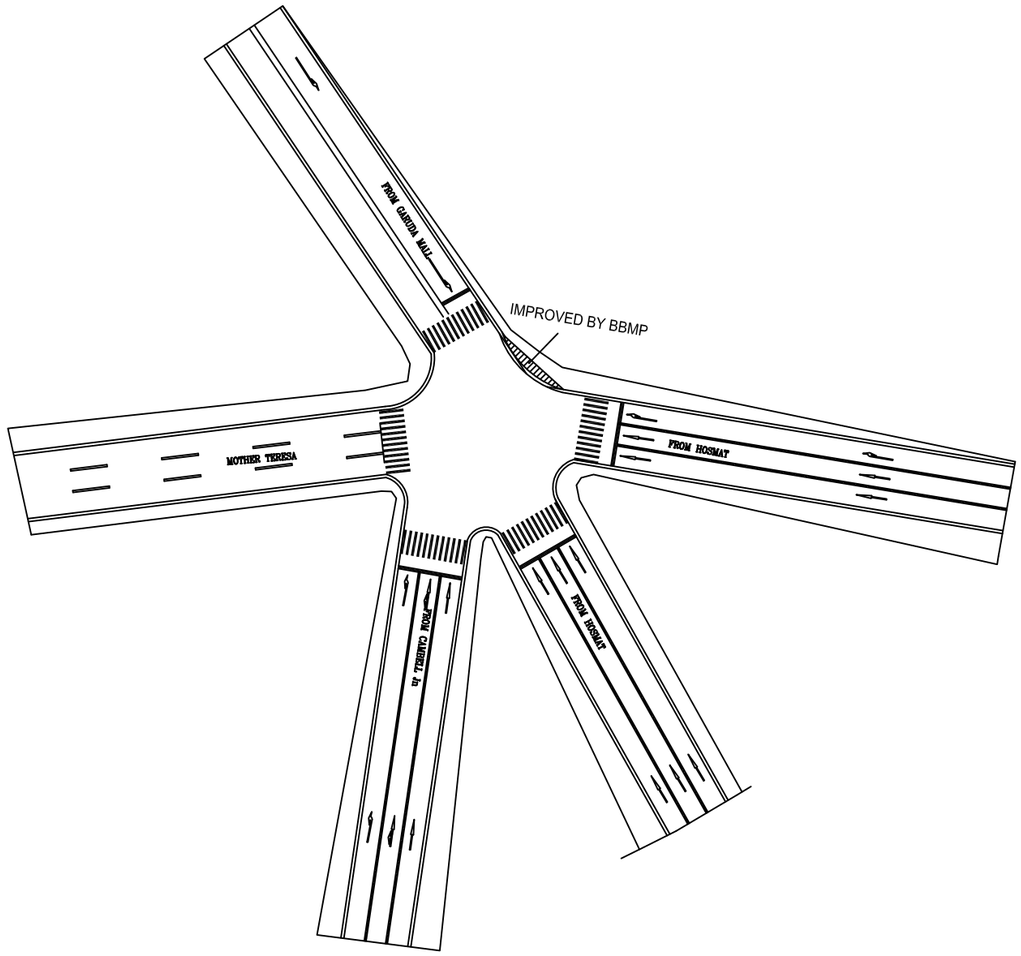


LEGENDS	
DISCRPITION	SYMBOL
2 CAR SIGNALS	
CAR SIGNAL	
PEDESTRIANS	
CAR AND PEDESTRAIN SIGNAL	
2 PEDESTRIANS	
MEDIAN	
MAN HOLE	
GATE	
TRAFFIC SIGNAL CONTROLLER	TSC
TRAFFIC CC CAMERA	C
CHANGE OF LOCATION	
NEW LOCATION	
SIGNAL REMOVED	

SCALE = 1:1000

JAPAN INTERNATIONAL COOPERATION AGENCY	PREPARATORY SURVEY ON THE PROJECT FOR BENGALURU METROPOLITAN REGION ITS IN THE REPUBLIC OF INDIA	DRAWING TITLE	DRAW. NO.	NIPPON KOEI CO.,LTD. EAST NIPPON EXPRESSWAY CO.,LTD
		DETAIL LOCATION OF TRAFFIC SIGNAL 19	TS-19	

20 Victoria Rd General K S Thimayya Rd

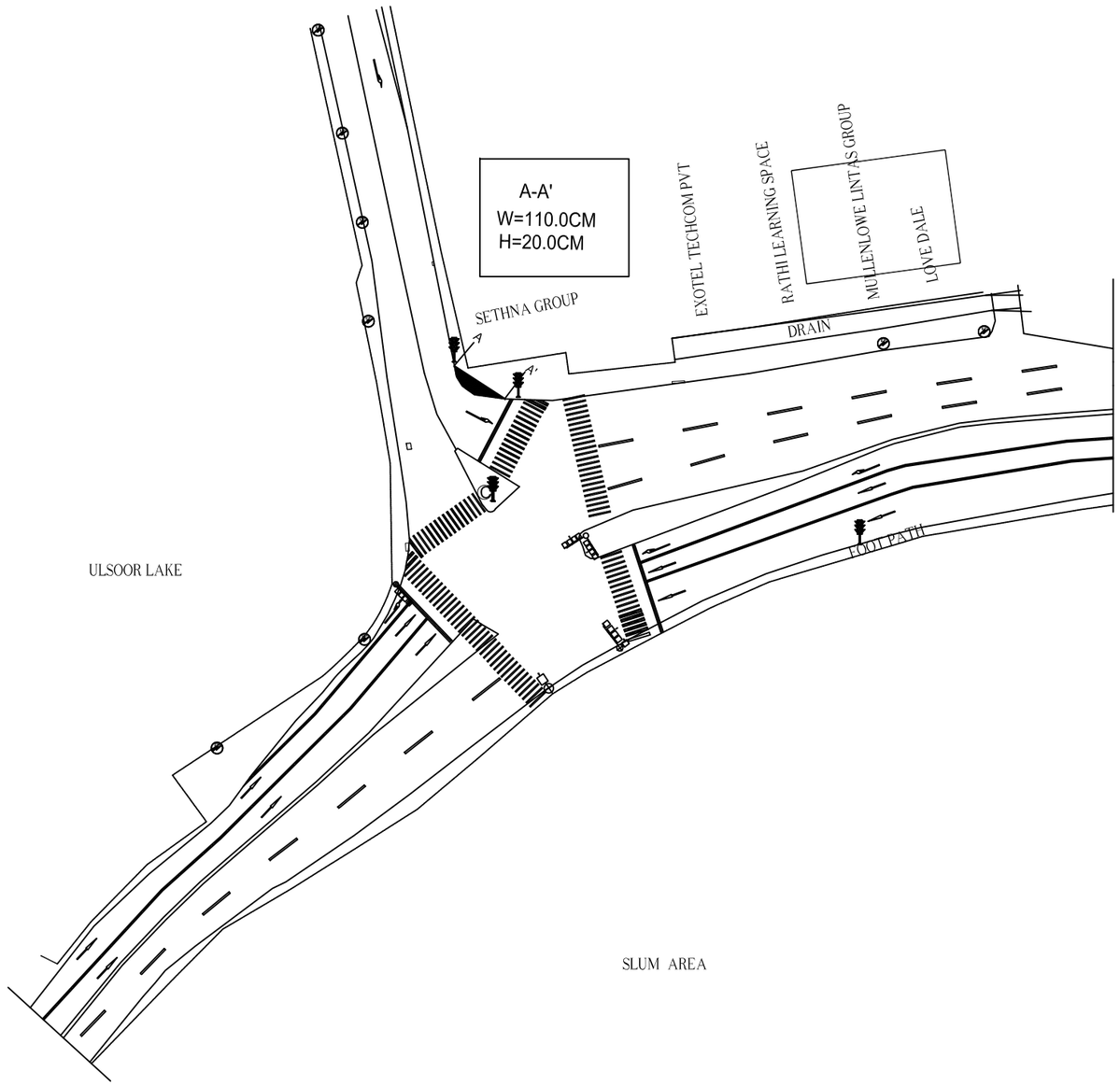


LEGENDS	
DISCRPITION	SYMBOL
2 CAR SIGNALS	
CAR SIGNAL	
PEDESTRIANS	
CAR AND PEDESTRAIN SIGNAL	
2 PEDESTRIANS	
MEDIAN	
MAN HOLE	
GATE	
TRAFFIC SIGNAL CONTROLLER	TSC
TRAFFIC CC CAMERA	C
CHANGE OF LOCATION	
NEW LOCATION	
SIGNAL REMOVED	

SCALE = 1:1000

JAPAN INTERNATIONAL COOPERATION AGENCY	PREPARATORY SURVEY ON THE PROJECT FOR BENGALURU METROPOLITAN REGION ITS IN THE REPUBLIC OF INDIA	DRAWING TITLE	DRAW. NO.	NIPPON KOEI CO.,LTD. EAST NIPPON EXPRESSWAY CO.,LTD
		DETAIL LOCATION OF TRAFFIC SIGNAL 20	TS-20	

21 Kensigton &Oval Junction

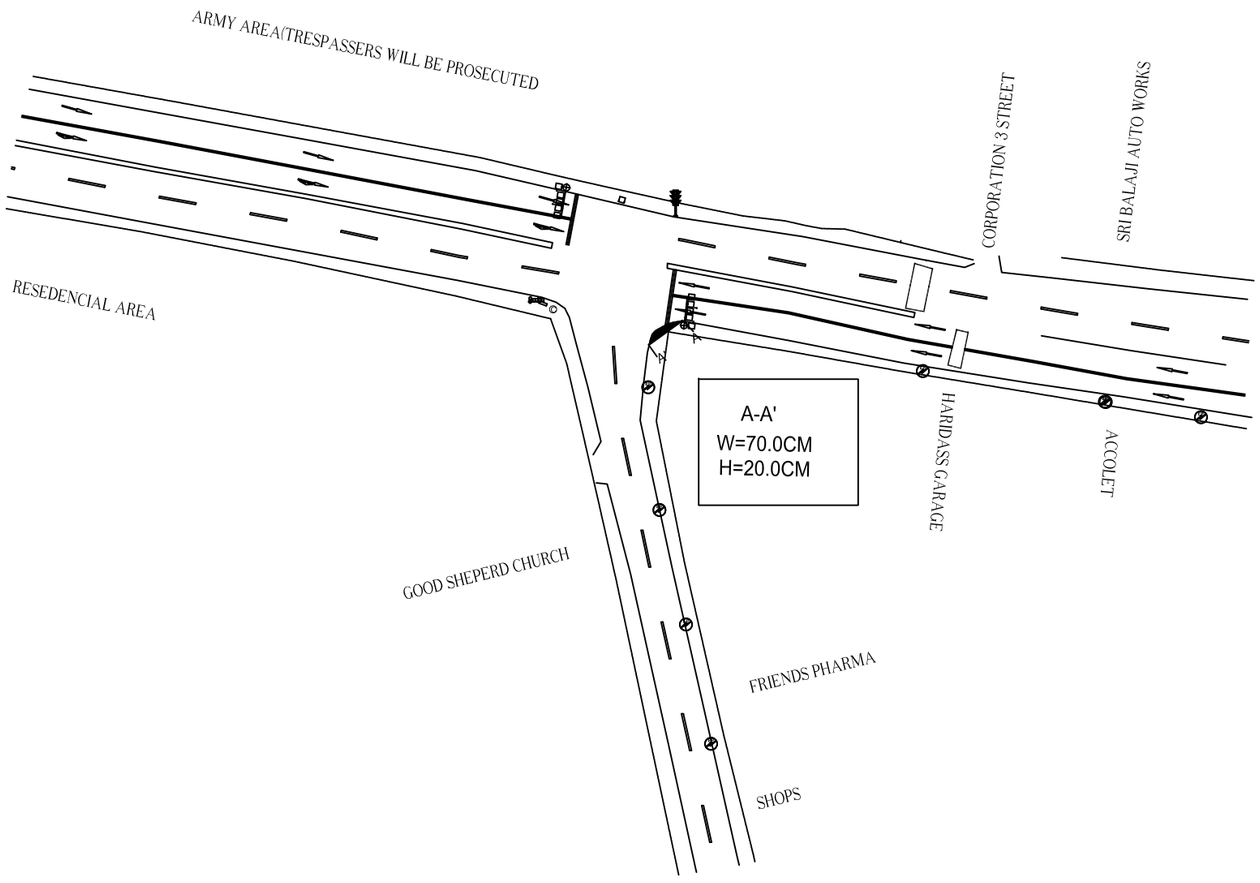


LEGENDS	
DISCRPITION	SYMBOL
2 CAR SIGNALS	
CAR SIGNAL	
PEDESTRIANS	
CAR AND PEDESTRAIN SIGNAL	
2 PEDESTRIANS	
MEDIAN	
MAN HOLE	
GATE	
TRAFFIC SIGNAL CONTROLLER	TSC
TRAFFIC CC CAMERA	C
CHANGE OF LOCATION	
NEW LOCATION	
SIGNAL REMOVED	

SCALE = 1:1000

JAPAN INTERNATIONAL COOPERATION AGENCY	PREPARATORY SURVEY ON THE PROJECT FOR BENGALURU METROPOLITAN REGION ITS IN THE REPUBLIC OF INDIA	DRAWING TITLE	DRAW. NO.	NIPPON KOEI CO.,LTD. EAST NIPPON EXPRESSWAY CO.,LTD
		DETAIL LOCATION OF TRAFFIC SIGNAL 21	TS-21	

22 Murphy Rd Corp colony Rd Jn

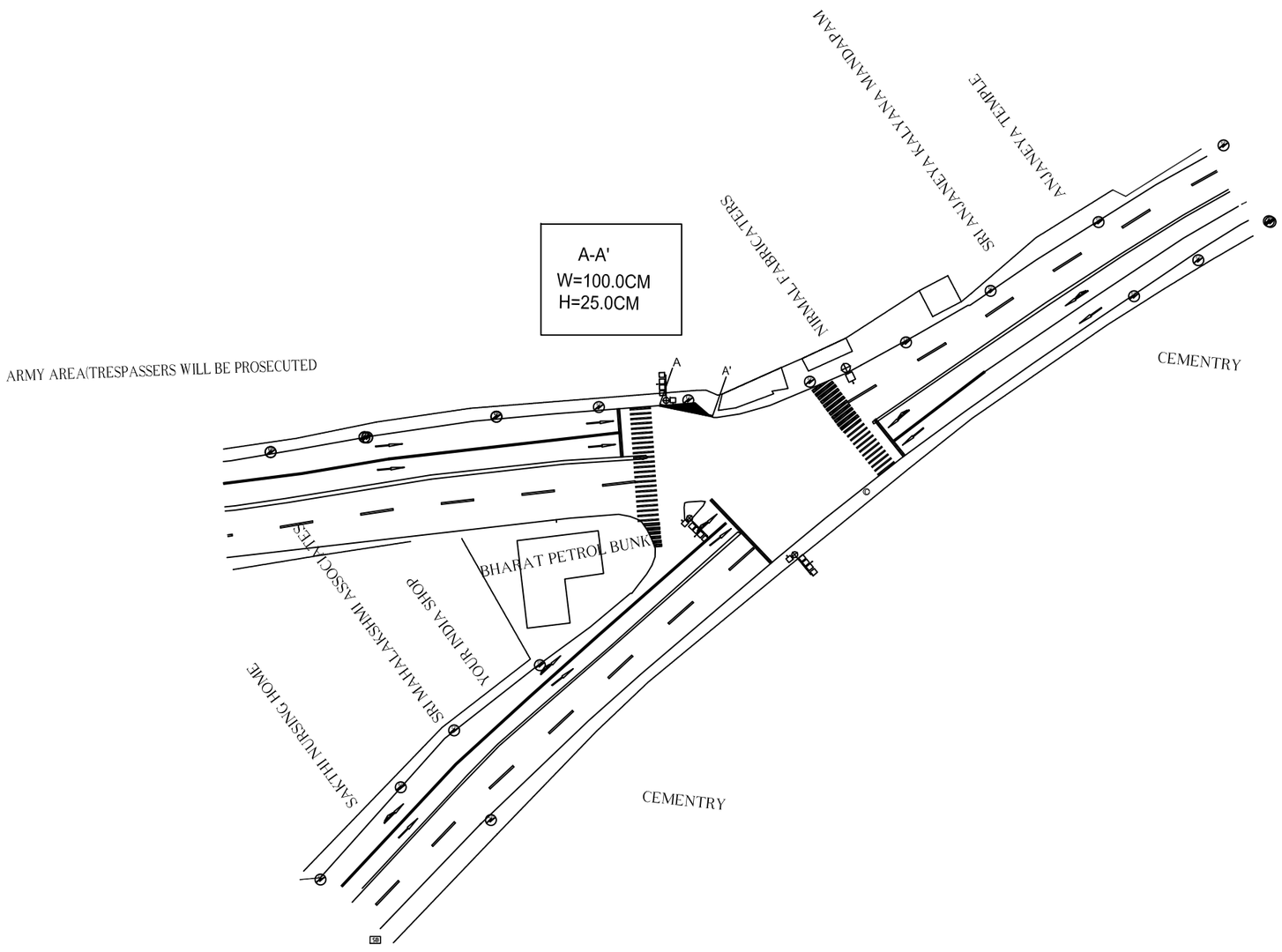


LEGENDS	
DISCRPITION	SYMBOL
2 CAR SIGNALS	
CAR SIGNAL	
PEDESTRIANS	
CAR AND PEDESTRAIN SIGNAL	
2 PEDESTRIANS	
MEDIAN	
MAN HOLE	
GATE	
TRAFFIC SIGNAL CONTROLLER	TSC
TRAFFIC CC CAMERA	C
CHANGE OF LOCATION	
NEW LOCATION	
SIGNAL REMOVED	

SCALE = 1:1000

JAPAN INTERNATIONAL COOPERATION AGENCY	PREPARATORY SURVEY ON THE PROJECT FOR BENGALURU METROPOLITAN REGION ITS IN THE REPUBLIC OF INDIA	DRAWING TITLE	DRAW. NO.	NIPPON KOEI CO.,LTD. EAST NIPPON EXPRESSWAY CO.,LTD
		DETAIL LOCATION OF TRAFFIC SIGNAL 22	TS-22	

23 Murphy Rd and Swami Vivekananda Rd Jn

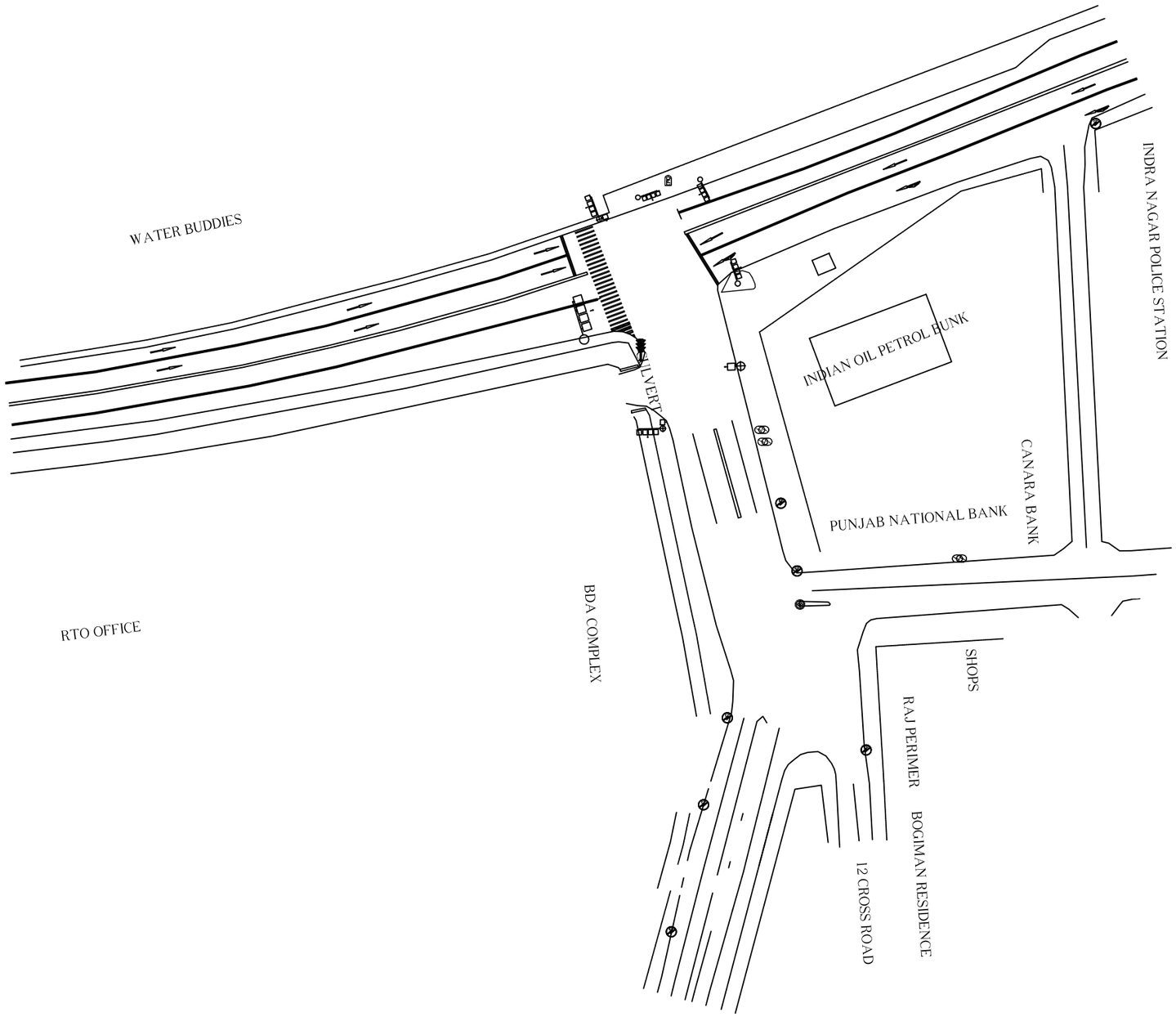


LEGENDS	
DISCRPITION	SYMBOL
2 CAR SIGNALS	
CAR SIGNAL	
PEDESTRIANS	
CAR AND PEDESTRAIN SIGNAL	
2 PEDESTRIANS	
MEDIAN	
MAN HOLE	
GATE	
TRAFFIC SIGNAL CONTROLLER	TSC
TRAFFIC CC CAMERA	C
CHANGE OF LOCATION	
NEW LOCATION	
SIGNAL REMOVED	

SCALE = 1:1000

JAPAN INTERNATIONAL COOPERATION AGENCY	PREPARATORY SURVEY ON THE PROJECT FOR BENGALURU METROPOLITAN REGION ITS IN THE REPUBLIC OF INDIA	DRAWING TITLE	DRAW. NO.	NIPPON KOEI CO.,LTD. EAST NIPPON EXPRESSWAY CO.,LTD
		DETAIL LOCATION OF TRAFFIC SIGNAL 23	TS-23	

24 Swami Vivekananda Rd and Indiranagar Double Rd Jn

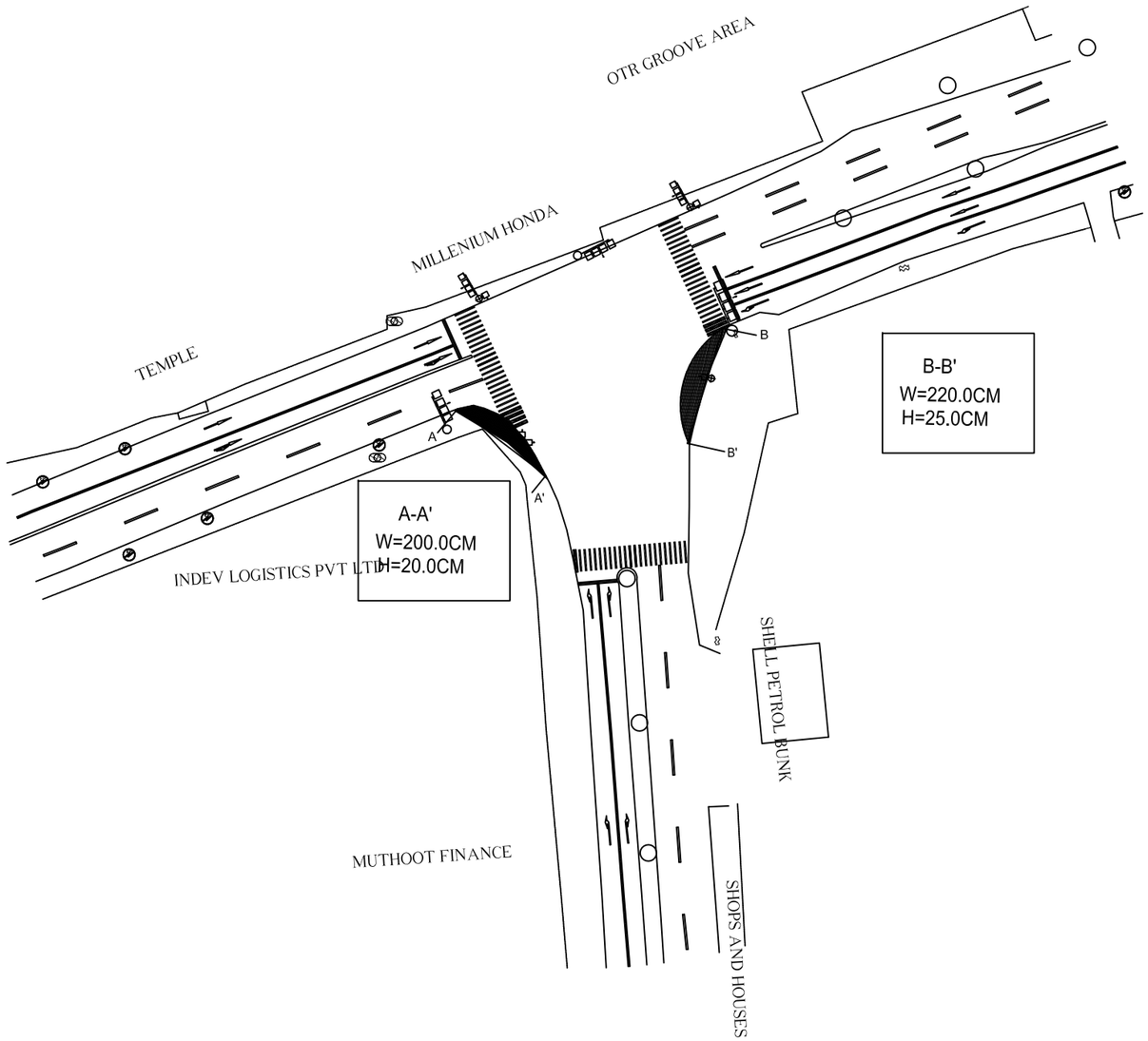


LEGENDS	
DISCRPITION	SYMBOL
2 CAR SIGNALS	
CAR SIGNAL	
PEDESTRIANS	
CAR AND PEDESTRAIN SIGNAL	
2 PEDESTRIANS	
MEDIAN	
MAN HOLE	
GATE	
TRAFFIC SIGNAL CONTROLLER	TSC
TRAFFIC CC CAMERA	C
CHANGE OF LOCATION	
NEW LOCATION	
SIGNAL REMOVED	

SCALE = 1:1000

JAPAN INTERNATIONAL COOPERATION AGENCY	PREPARATORY SURVEY ON THE PROJECT FOR BENGALURU METROPOLITAN REGION ITS IN THE REPUBLIC OF INDIA	DRAWING TITLE	DRAW. NO.	NIPPON KOEI CO.,LTD. EAST NIPPON EXPRESSWAY CO.,LTD
		DETAIL LOCATION OF TRAFFIC SIGNAL 24	TS-24	

25 Swami Vivekananda Rd and Indiranagar 100 ft Rd Jn

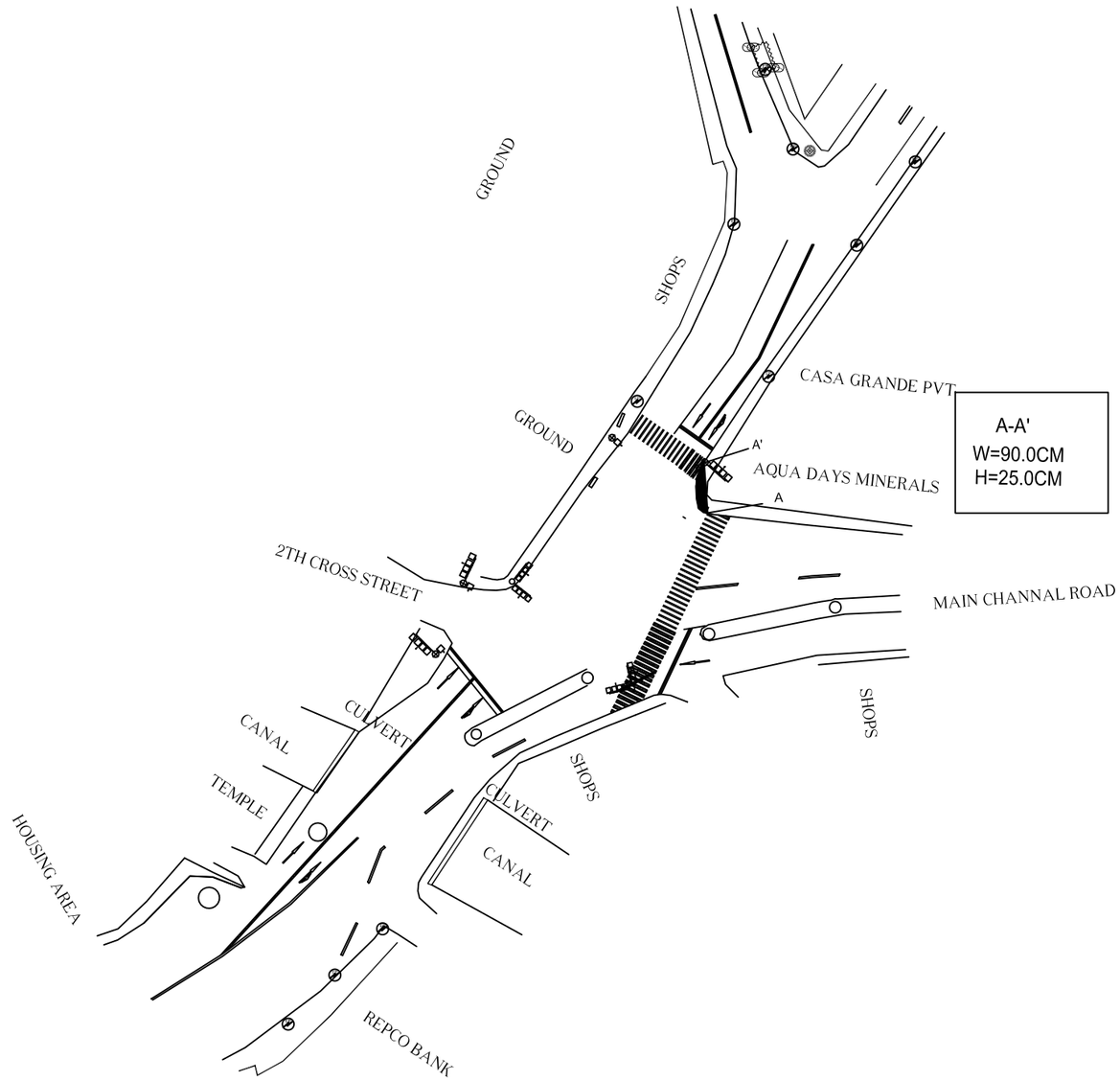


LEGENDS	
DISCRPITION	SYMBOL
2 CAR SIGNALS	
CAR SIGNAL	
PEDESTRIANS	
CAR AND PEDESTRAIN SIGNAL	
2 PEDESTRIANS	
MEDIAN	
MAN HOLE	
GATE	
TRAFFIC SIGNAL CONTROLLER	TSC
TRAFFIC CC CAMERA	C
CHANGE OF LOCATION	
NEW LOCATION	
SIGNAL REMOVED	

SCALE = 1:1000

JAPAN INTERNATIONAL COOPERATION AGENCY	PREPARATORY SURVEY ON THE PROJECT FOR BENGALURU METROPOLITAN REGION ITS IN THE REPUBLIC OF INDIA	DRAWING TITLE	DRAW. NO.	NIPPON KOEI CO.,LTD. EAST NIPPON EXPRESSWAY CO.,LTD
		DETAIL LOCATION OF TRAFFIC SIGNAL 25	TS-25	

26 A Nanjappa Circle

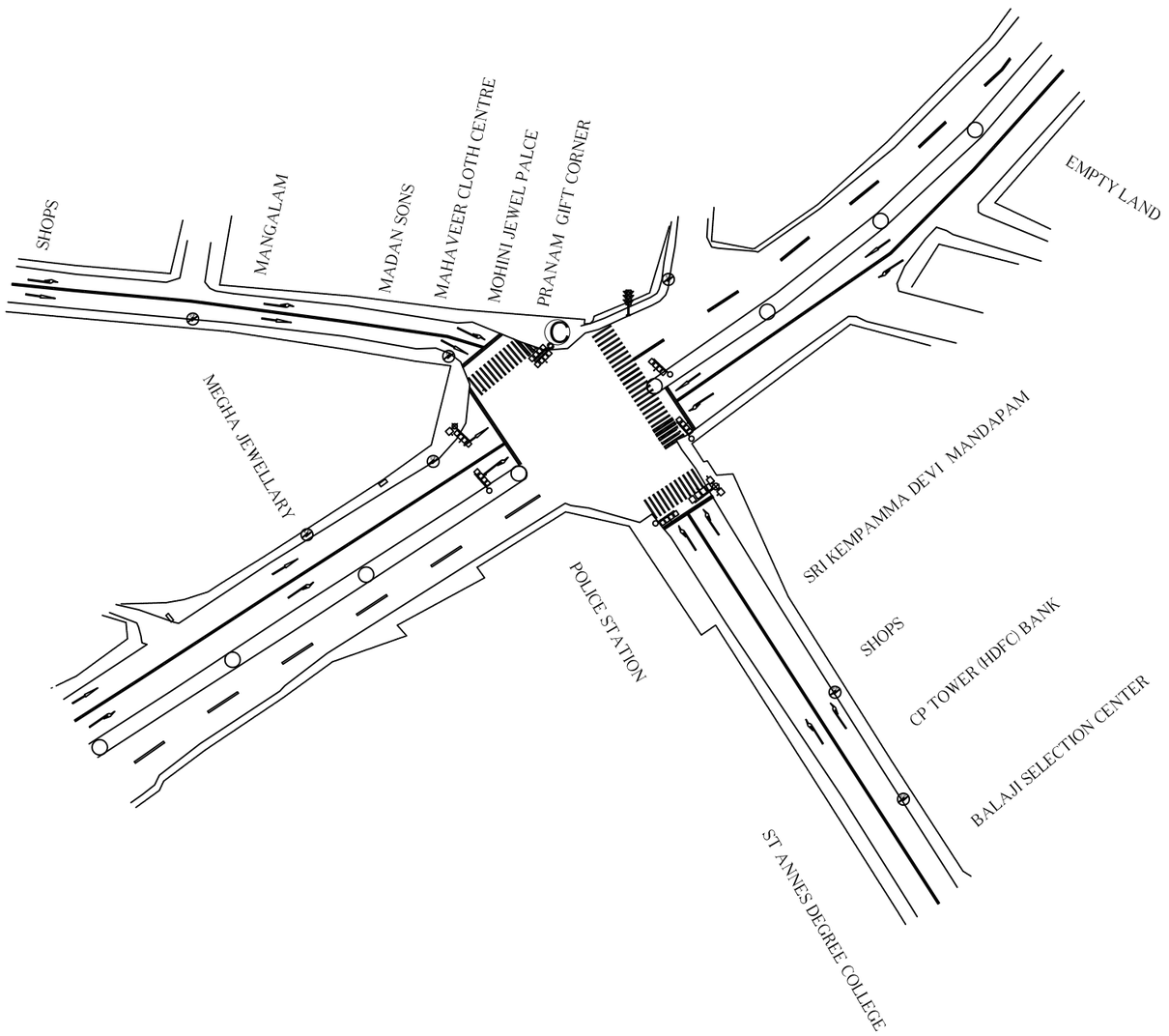


LEGENDS	
DISCRPITION	SYMBOL
2 CAR SIGNALS	
CAR SIGNAL	
PEDESTRIANS	
CAR AND PEDESTRAIN SIGNAL	
2 PEDESTRIANS	
MEDIAN	
MAN HOLE	
GATE	
TRAFFIC SIGNAL CONTROLLER	TSC
TRAFFIC CC CAMERA	C
CHANGE OF LOCATION	
NEW LOCATION	
SIGNAL REMOVED	

SCALE = 1:1000

JAPAN INTERNATIONAL COOPERATION AGENCY	PREPARATORY SURVEY ON THE PROJECT FOR BENGALURU METROPOLITAN REGION ITS IN THE REPUBLIC OF INDIA	DRAWING TITLE	DRAW. NO.	NIPPON KOEI CO.,LTD. EAST NIPPON EXPRESSWAY CO.,LTD
		DETAIL LOCATION OF TRAFFIC SIGNAL 26	TS-26	

27 Swami vivekanand Rd -Cambridge Rd-Bazaar st

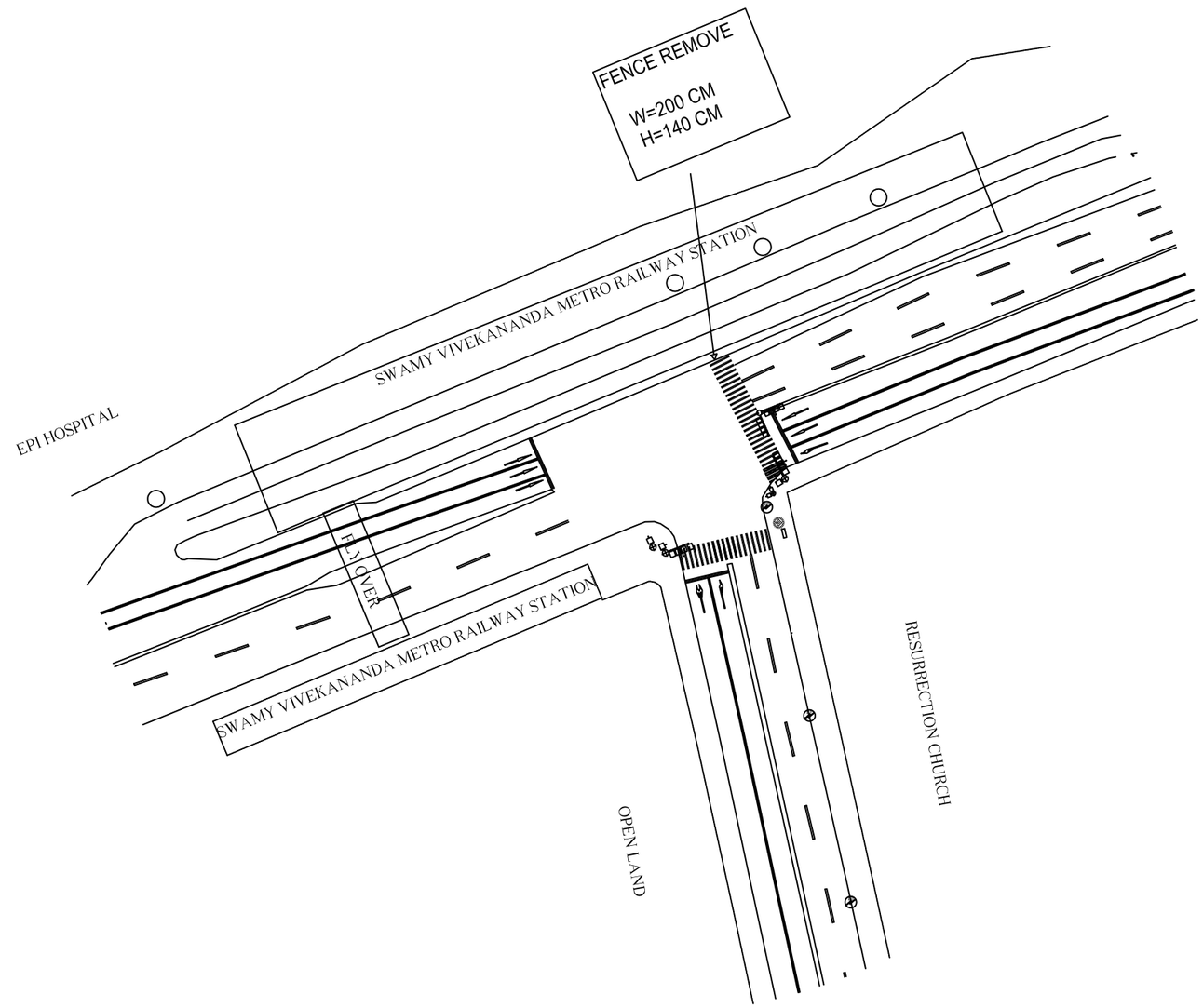


LEGENDS	
DISCRPITION	SYMBOL
2 CAR SIGNALS	
CAR SIGNAL	
PEDESTRIANS	
CAR AND PEDESTRAIN SIGNAL	
2 PEDESTRIANS	
MEDIAN	
MAN HOLE	
GATE	
TRAFFIC SIGNAL CONTROLLER	TSC
TRAFFIC CC CAMERA	C
CHANGE OF LOCATION	
NEW LOCATION	
SIGNAL REMOVED	

SCALE = 1:1000

JAPAN INTERNATIONAL COOPERATION AGENCY	PREPARATORY SURVEY ON THE PROJECT FOR BENGALURU METROPOLITAN REGION ITS IN THE REPUBLIC OF INDIA	DRAWING TITLE	DRAW. NO.	NIPPON KOEI CO.,LTD. EAST NIPPON EXPRESSWAY CO.,LTD
		DETAIL LOCATION OF TRAFFIC SIGNAL 27	TS-27	

28 Swami vivekanand Station

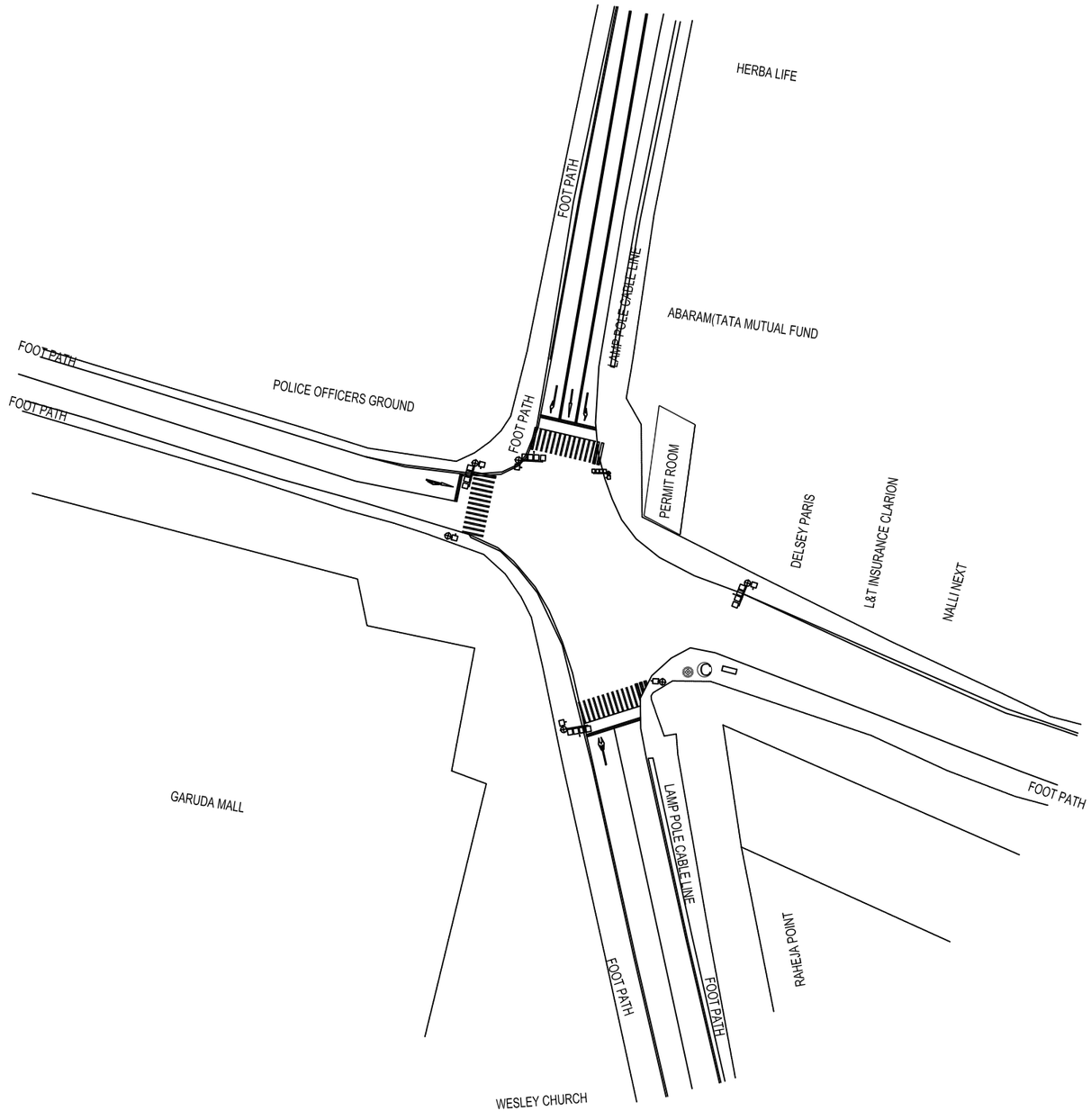


LEGENDS	
DISCRPITION	SYMBOL
2 CAR SIGNALS	
CAR SIGNAL	
PEDESTRIANS	
CAR AND PEDESTRAIN SIGNAL	
2 PEDESTRIANS	
MEDIAN	
MAN HOLE	
GATE	
TRAFFIC SIGNAL CONTROLLER	TSC
TRAFFIC CC CAMERA	C
CHANGE OF LOCATION	
NEW LOCATION	
SIGNAL REMOVED	

SCALE = 1:1000

JAPAN INTERNATIONAL COOPERATION AGENCY	PREPARATORY SURVEY ON THE PROJECT FOR BENGALURU METROPOLITAN REGION ITS IN THE REPUBLIC OF INDIA	DRAWING TITLE	DRAW. NO.	NIPPON KOEI CO.,LTD. EAST NIPPON EXPRESSWAY CO.,LTD
		DETAIL LOCATION OF TRAFFIC SIGNAL 28	TS-28	

29 Garuda Mall Jn

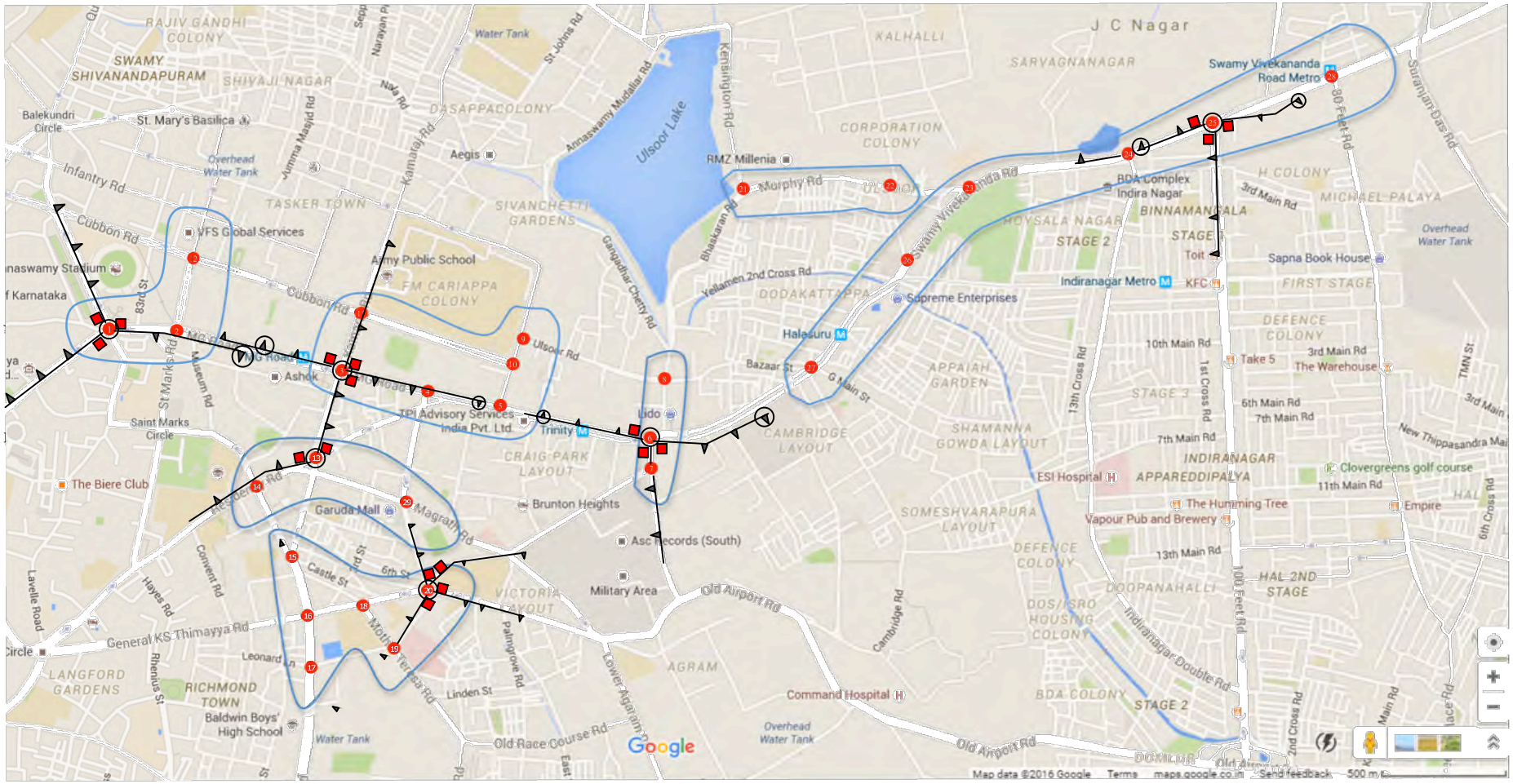


LEGENDS	
DISCRPITION	SYMBOL
2 CAR SIGNALS	
CAR SIGNAL	
PEDESTRIANS	
CAR AND PEDESTRAIN SIGNAL	
2 PEDESTRIANS	
MEDIAN	
MAN HOLE	
GATE	
TRAFFIC SIGNAL CONTROLLER	TSC
TRAFFIC CC CAMERA	C
CHANGE OF LOCATION	
NEW LOCATION	
SIGNAL REMOVED	

SCALE = 1:1000

JAPAN INTERNATIONAL COOPERATION AGENCY	PREPARATORY SURVEY ON THE PROJECT FOR BENGALURU METROPOLITAN REGION ITS IN THE REPUBLIC OF INDIA	DRAWING TITLE	DRAW. NO.	NIPPON KOEI CO.,LTD. EAST NIPPON EXPRESSWAY CO.,LTD
		DETAIL LOCATION OF TRAFFIC SIGNAL 29	TS-29	

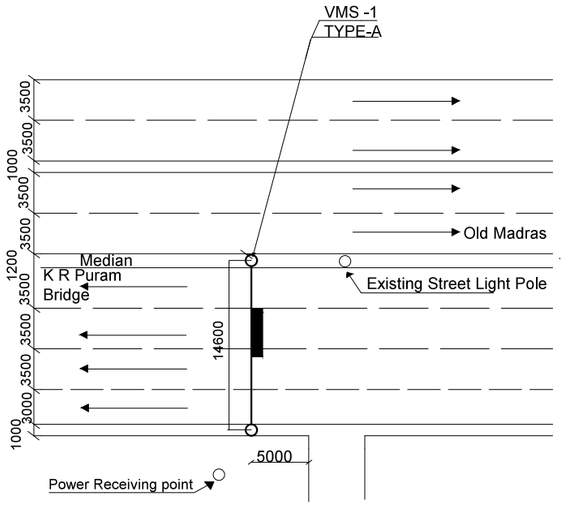
SUB AREA AND VEHICLE DETECTOR LAYOUT



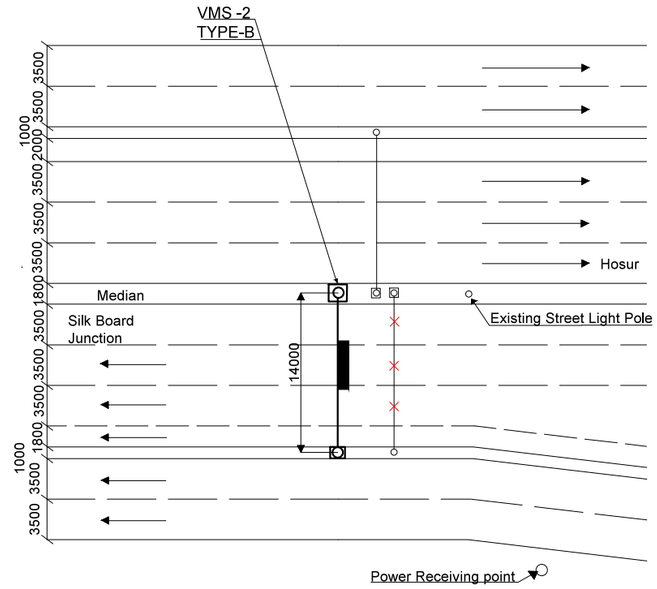
500 m

LEGENDS

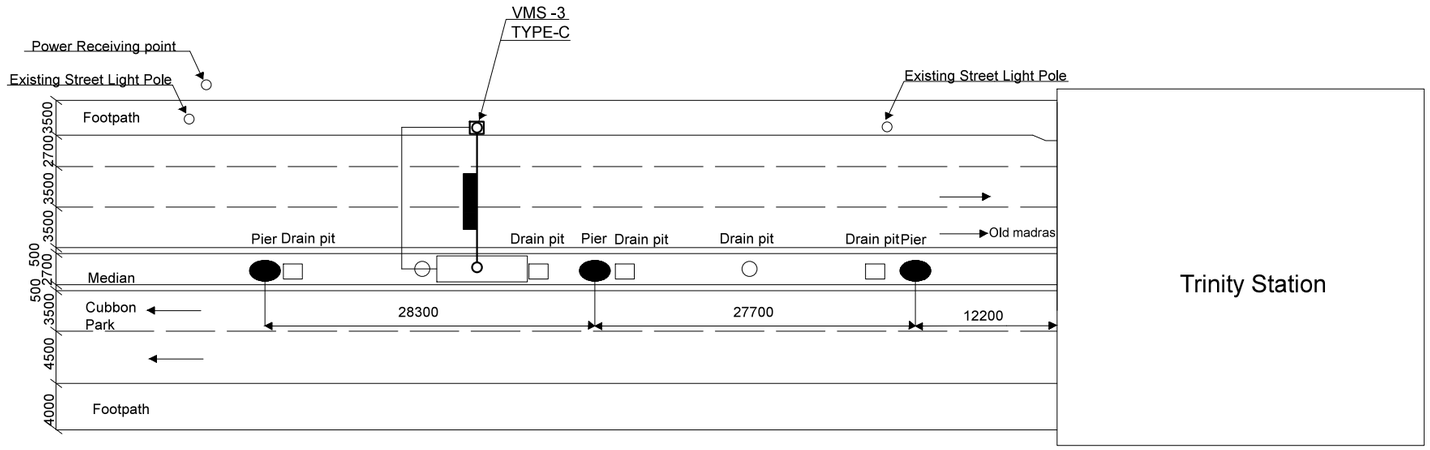
	SUB AREA	▲	VEHICLE DETECTOR (QUEUE LENGTH MEASUREMENT
		■	VEHICLE DETECTOR (INFLOW TRAFFIC VOLUME MEASUREMENT)
●	KEY INTERSECTION	○	VEHICLE DETECTOR (TRAFFIC VOLUME MEASURE FOR OFFSET)



VMS -1

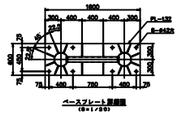


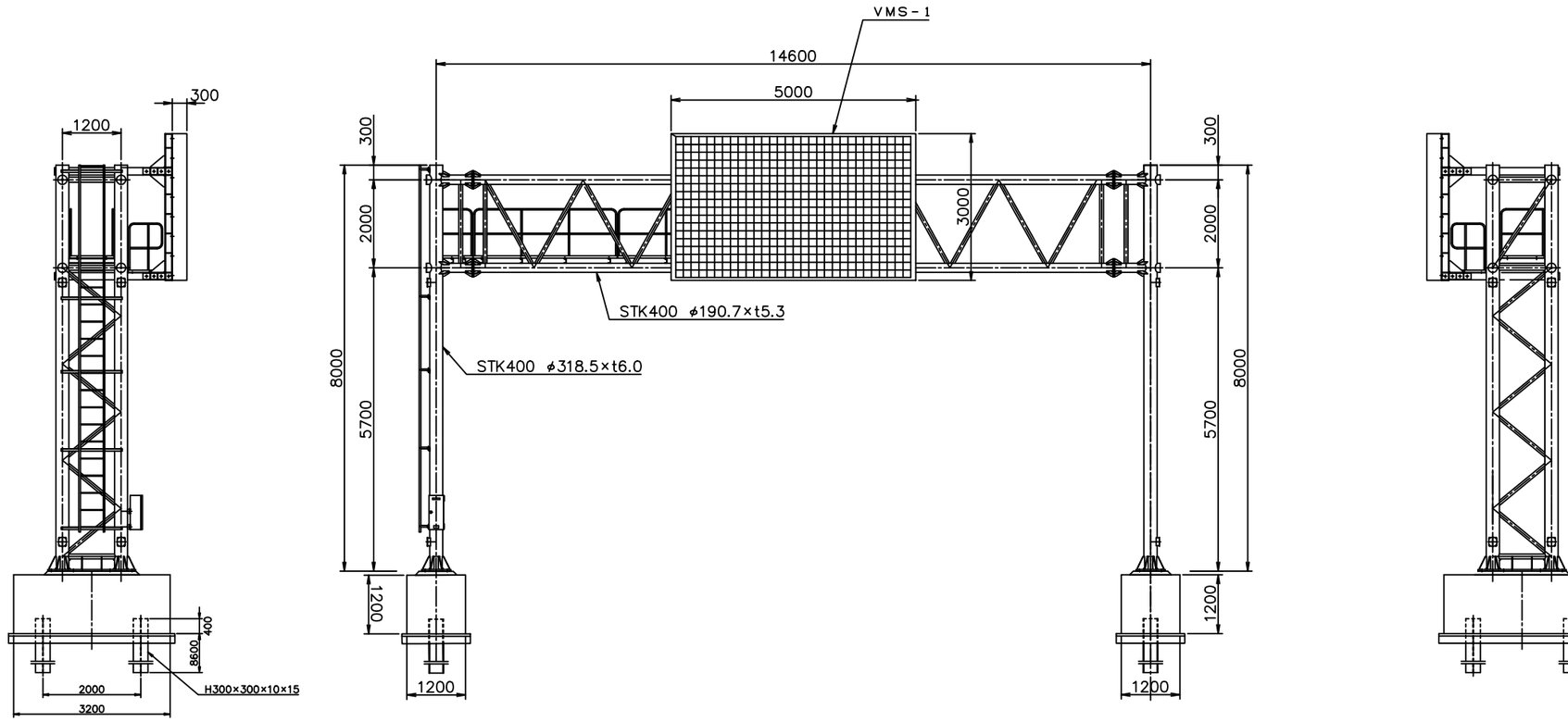
VMS -2



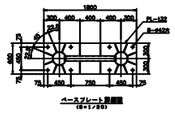
VMS -3

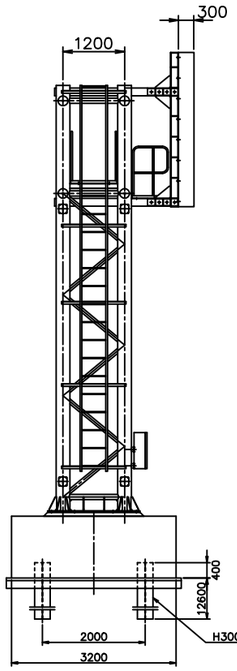
JAPAN INTERNATIONAL COOPERATION AGENCY	PREPARTORY SURVEY ON THE PROJECT FOR BENGALURU METROPOLITAN REGION ITS IN THE REPUBLIC OF INDIA	DRAWING TITLE LAYOUT OF PLAN VMS	DRAW.NO.	NIPPON KOEI CO.,LTD.

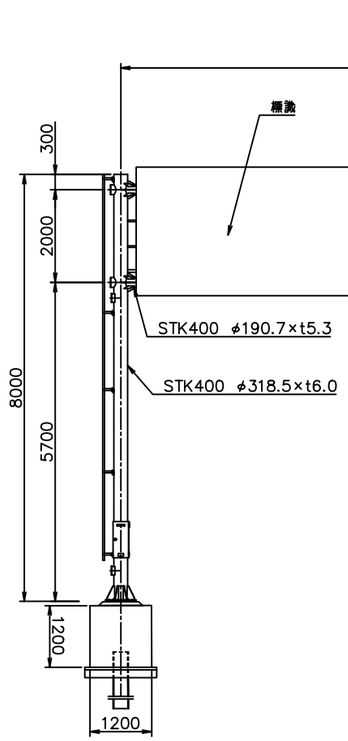


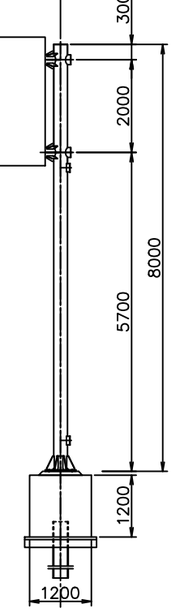


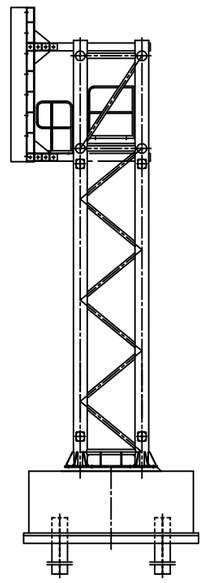
JAPAN INTERNATIONAL COOPERATION AGENCY	PREPARATORY SURVEY ON THE PROJECT FOR BENGALURU METROPOLITAN REGION ITS IN THE REPUBLIC OF INDIA	DRAWING TITLE	DRAW. NO.	NIPPON KOEI CO.,LTD EAST NIPPON EXRESSWAY CO.,LTD
		VARIABLE MESSAGE SIGN	VMS-1	



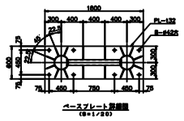


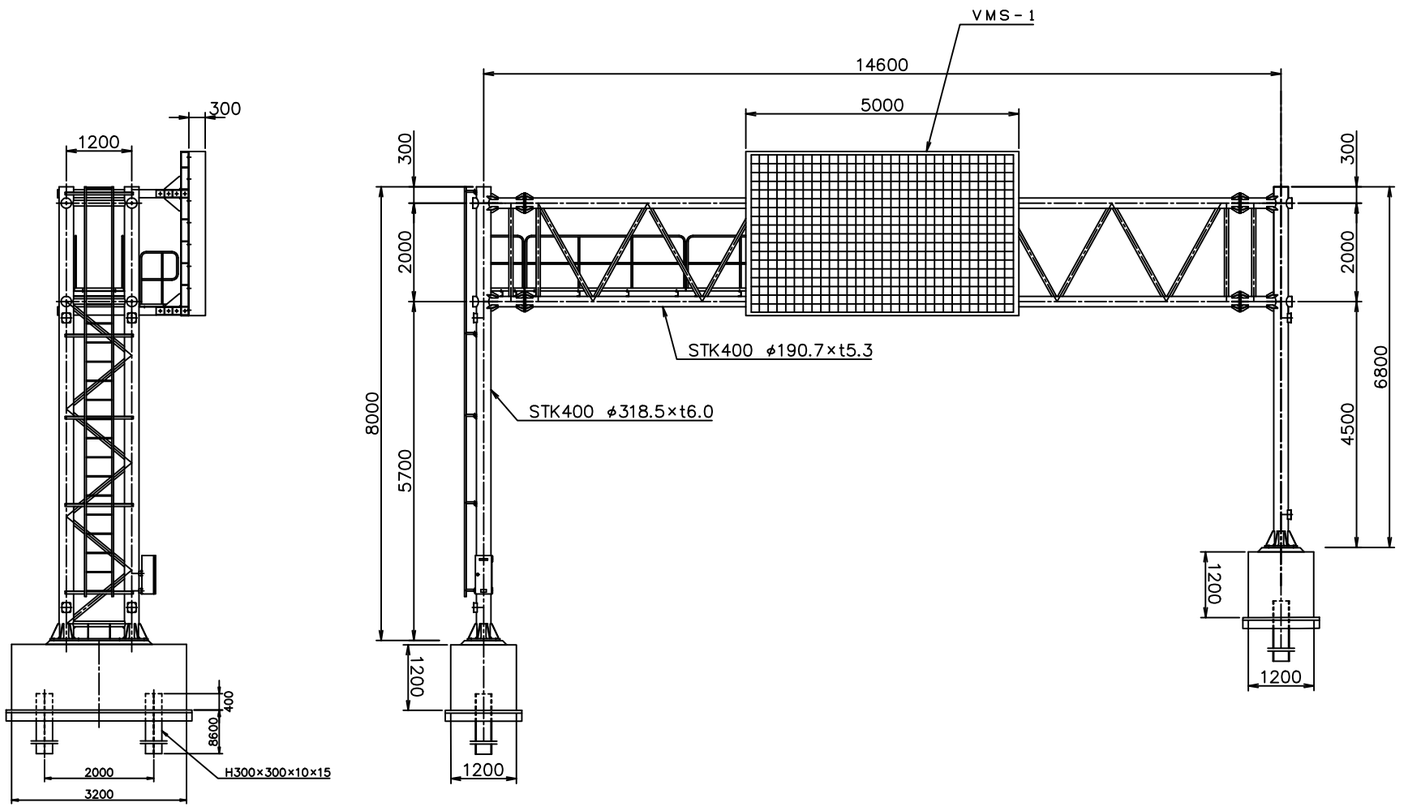






JAPAN INTERNATIONAL COOPERATION AGENCY	PREPARATORY SURVEY ON THE PROJECT FOR BENGALURU METROPOLITAN REGION ITS IN THE REPUBLIC OF INDIA	DRAWING TITLE	DRAW. NO.	NIPPON KOEI CO.,LTD EAST NIPPON EXRESSWAY CO.,LTD
		VARIABLE MESSAGE SIGN	VMS-2	





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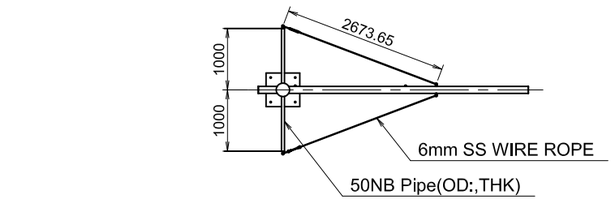
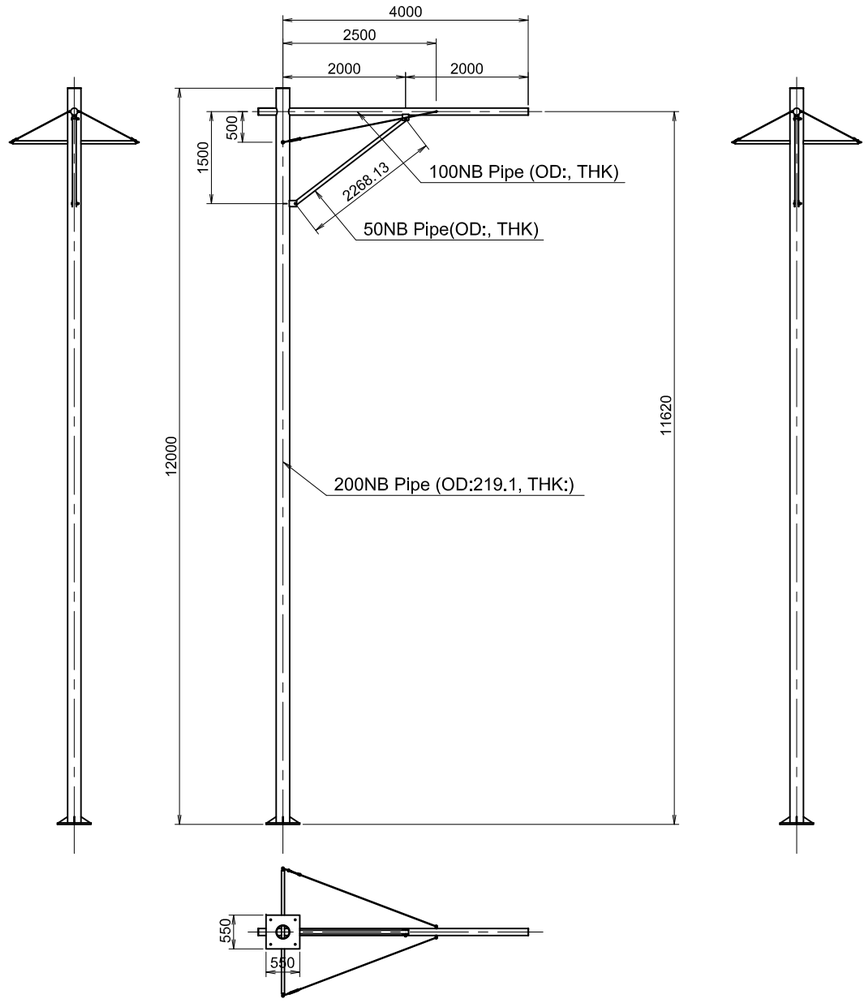
For Referrence）





JAPAN INTERNATIONAL COOPERATION AGENCY	PREPARATORY SURVEY ON THE PROJECT FOR BENGALURU METROPOLITAN REGION ITS IN THE REPUBLIC OF INDIA	DRAWING TITLE	DRAW. NO.	NIPPON KOEI CO.,LTD EAST NIPPON EXPRESSWAY CO.,LTD
		POLE OF SENSOR For Referrence）	SSP-1	

資料　7 - 1

交通量調査報告書

PREPARATORY SURVEY
ON THE PROJECT
FOR
BENGALURU METROPOLITAN REGION ITS
IN
THE REPUBLIC OF INDIA

TRAFFIC SURVEY REPORT

JUNE 2016

JAPAN INTERNATIONAL COOPERATION AGENCY

NIPPON KOEI CO., LTD.

EAST NIPPON EXPRESSWAY COMPANY LIMITED

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1. INTRODUCTION

The scope of the work is to perform and analyze a preparatory traffic survey for the project for 'Bengaluru Metropolitan Region ITS in India'. A detailed framework of the intended study has been specified by the client. The survey locations, the days and duration of the survey, turning movements to be considered, vehicle categories to be counted etc. are listed in depth in the Terms of Reference (TOR).

As per the requirement of the TOR, we have carried out three major surveys

- Intersection Traffic Volume Survey
- Travel Time Survey
- Intersection Delay Survey

This report presents the details of all the three surveys, including the data collection procedure and the analysis. The data was entered in excel sheet in the required format as suggested by the client. A detailed analysis was carried out and the results were presented graphically using pie charts and line graphs. The photographs showing the video camera on site and the enumerators on field are presented in the appendix.

2. INTERSECTION TRAFFIC VOLUME SURVEY

The traffic volume surveys were carried out at seven major intersections. The intersection names are listed in Table 1 and a snapshot of the location map is shown in Figure 1.

Table 1: Traffic Volume Survey Intersection Locations

No.	Name of the Intersection
1	Queen's Statue Junction
2	Cauvery Arts & Craft Junction
3	Trinity Circle
4	Kamraj & Cubbon Road Junction
5	Opera Junction
6	Vellara Junction
7	Dr. Bhaskaran Road & Swami Vivekanadha Junction

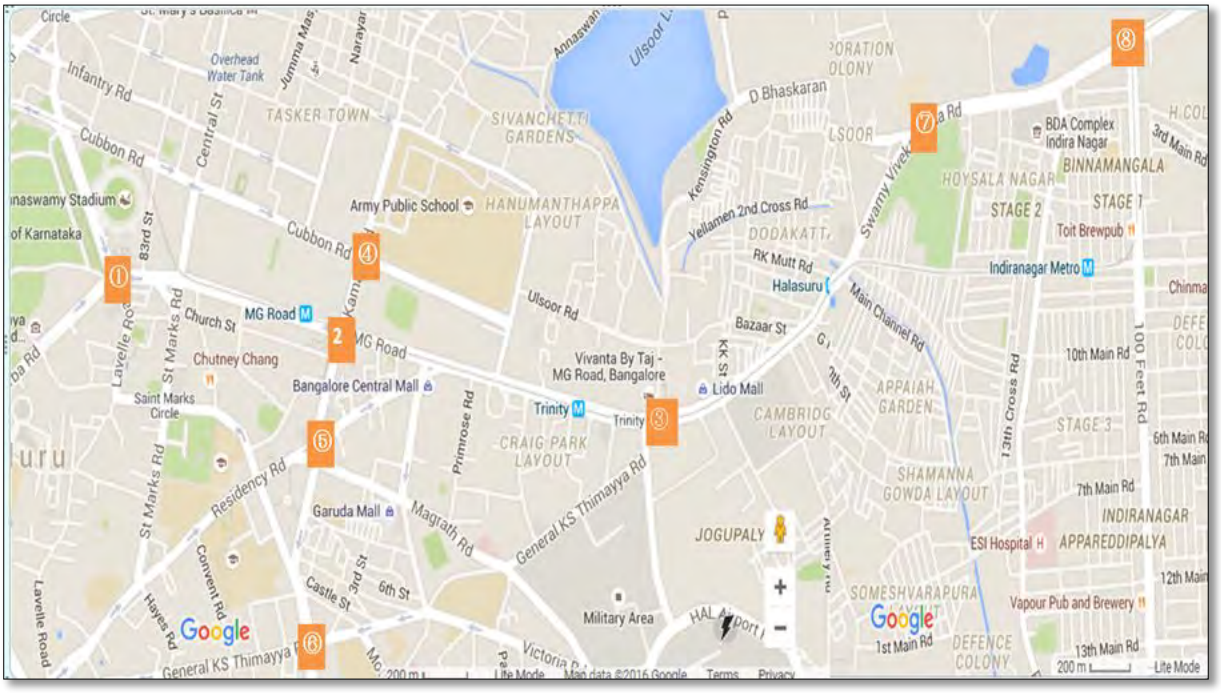


Figure 1: Map of Traffic Volume Survey Locations

In the present study, the traffic volume survey was carried out using a video camera installed at each intersection location. The live traffic was captured for a continuous period of 16 hours, starting from 6:00 am to 22:00 pm. The survey was performed on two week days which were essentially normal government working days with no rain and were not affected with any major incidents.

The traffic volume data was counted by viewing the recorded videotapes. Trained enumerators were deployed to extract the data at every 15 minute intervals. The possible turning movements such as left, right, through and U- turn movements; including grade separated movements (legal and illegal) at each intersection is considered. Each turning movement volume is classified into the following vehicle classes as follows:

- Two wheeler
- Auto rickshaw
- Car/Jeep/Van
- Bus
- LCV/HCV
- Containers
- Others (military vehicles)
- Bicycle
- Emergency vehicles (Ambulance /Fire services)

The classified vehicle turning movement volume is counted and entered into the excel format at every 15 minute intervals. The classified vehicle count is then converted to equivalent Passenger Car Unit (PCU). The PCU factors recommended by Indian Road Congress in "Guidelines for Capacity of Urban Roads in Plain Areas" (IRC: 106-1990) were used. The hourly traffic volume in PCU is then calculated for each turning movement. Figure 2 presents the values of Passenger Car Unit factors for different vehicle categories as recommended in IRC.

Vehicle Type	Equivalent PCU Factors	
	Percentage composition of Vehicle type in traffic stream	
	5%	10% and above
Fast Vehicles		
1. Two wheelers Motor cycle or scooter etc.	0.5	0.75
2. Passenger car, pick-up van	1.0	1.0
3. Auto-rickshaw	1.2	2.0
4. Light commercial vehicle	1.4	2.0
5. Truck or Bus	2.2	3.7
6. Agricultural Tractor Trailer	4.0	5.0
Slow Vehicles		
7. Cycle	0.4	0.5
8. Cycle rickshaw	1.5	2.0
9. Tonga (Horse drawn vehicle)	1.5	2.0
10. Hand cart	2.0	3.0

Figure 2: PCU Conversion Factors, IRC 106-1990

For each intersection the total traffic volume is calculated and reported at hourly intervals. The Peak Hour Volume is also identified and reported for both morning and evening time peak period. The proportions of different vehicles at Peak Hours were also plotted with the help of pie-charts.

The Peak Hour and the Peak Hour Volume (morning and evening) for each intersection is analyzed and is summarized in Table 2.

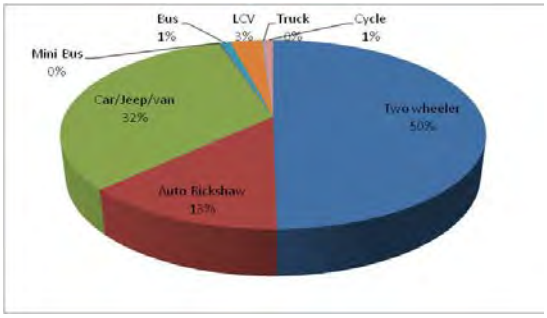
Table 2: Details of Peak Hour Traffic Volume for Survey Intersections

No.	Junction Name	Day	Peak Hour		Peak Hour Volume	
			Morning	Evening	Morning	Evening

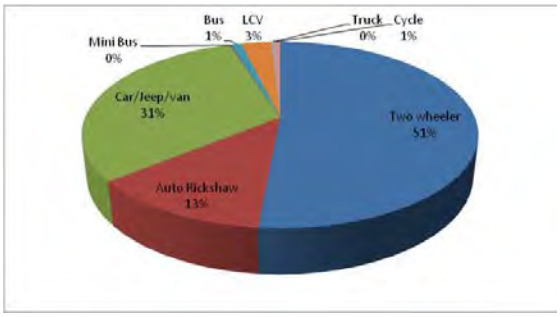
1	Queen's Statue Junction	24/03/2016	10.00-11.00	5.00-6.00	12011	10769
		29/03/2016	10.00-11.00	6.00-7.00	13161	11599
2	Cauvery Arts & Craft Junction	24/03/2016	10.00-11.00	6.00-7.00	10798	10297
		29/03/2016	10.00-11.00	6.00-7.00	11842	10296
3	Trinity Circle	24/03/2016	9.00-10.00	6.00-7.00	12843	11865
		31/03/2016	9.00-10.00	6.00-7.00	13688	12664
4	Kamraj & Cubbon Road Junction	17/03/2016	9.00-10.00	5.00-6.00	13105	10354
		22/03/2016	9.00-10.00	6.00-7.00	13030	10831
5	Opera Junction	17/03/2016	9.00-10.00	6.00-7.00	11666	8293
		22/03/2016	9.00-10.00	6.00-7.00	10212	8153
6	Vellara Junction	17/03/2016	9.00-10.00	5.00-6.00	13017	11420
		22/03/2016	9.00-10.00	6.00-7.00	13456	11252
7	Dr. Bhaskaran & Swami Vivekanadha Junction	24/03/2016	9.00-10.00	6.00-7.00	9136	8611
		29/03/2016	9.00-10.00	6.00-7.00	9686	8711

The proportion of different category of vehicles contributing to the total traffic volume is graphically analyzed with pie charts for each intersection and is presented in Table 3.

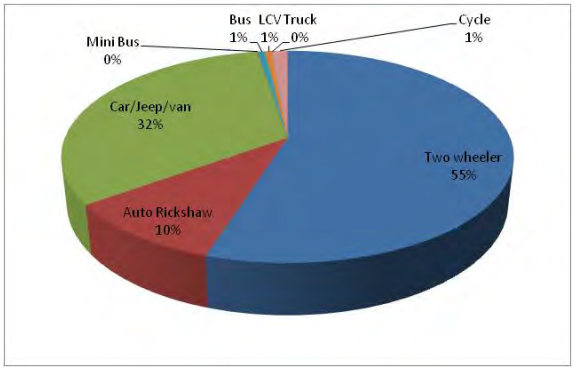
Table 3: Total Traffic Volume at Each Intersection with Proportion of Different Vehicle Categories



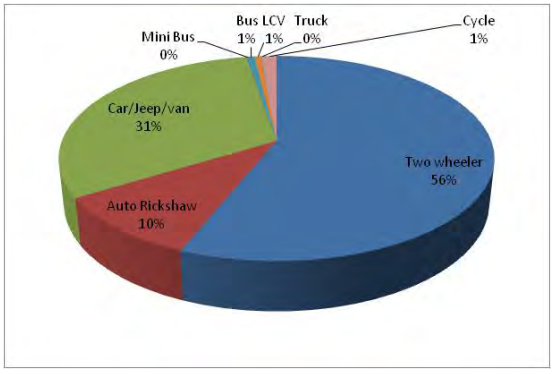
Queen's Statue Junction (24/03/2016)



Queen's Statue Junction (29/03/2016)



Cauvery Arts & Craft Junction (24/03/2016)



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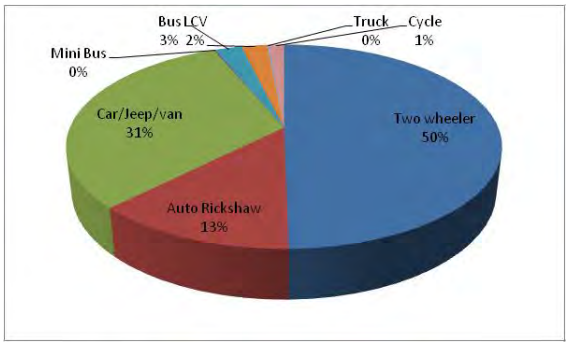

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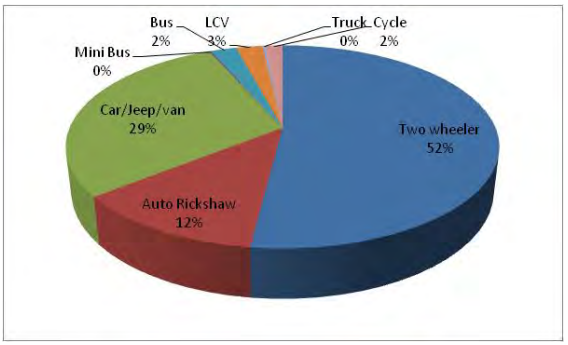
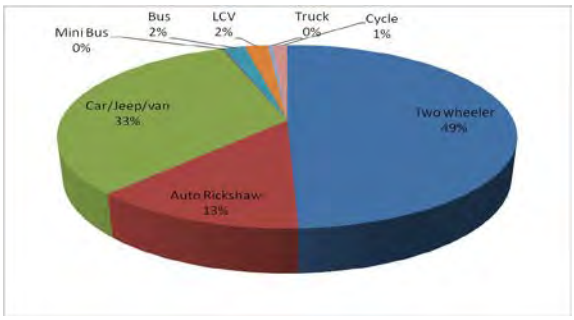
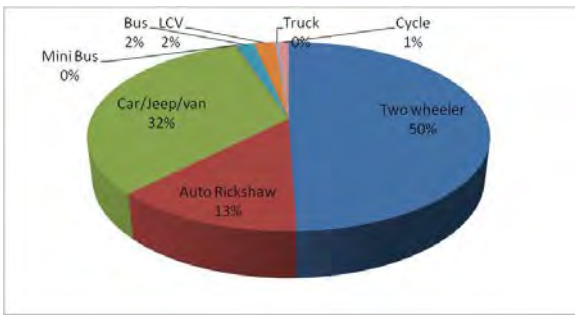


Trinity Circle (31/03/2016)



Kamraj & Cubbon Road Junction (17/03/2016)



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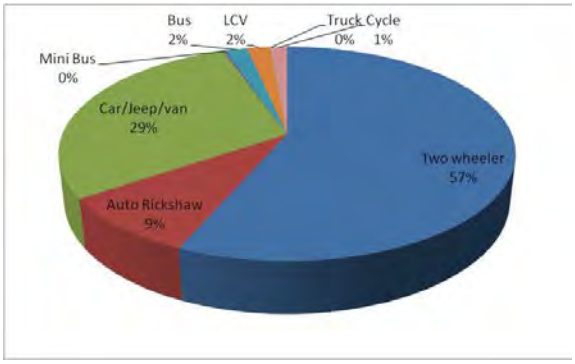
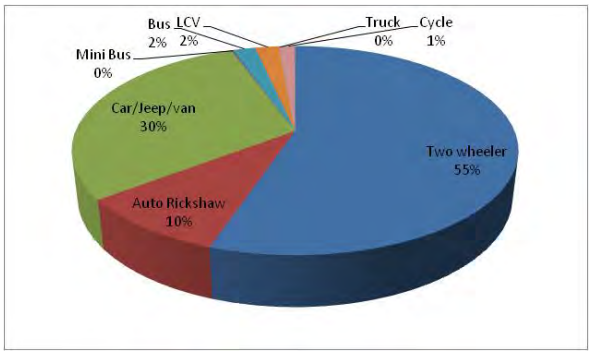


Opera Junction (17/03/2016)



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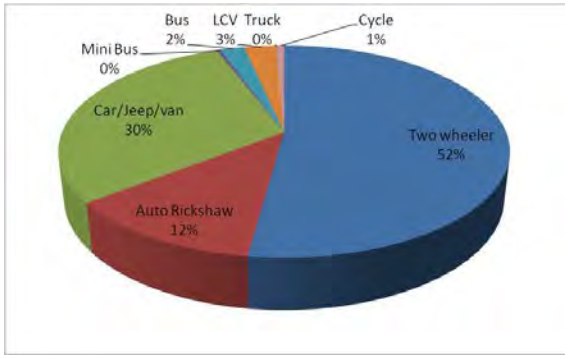
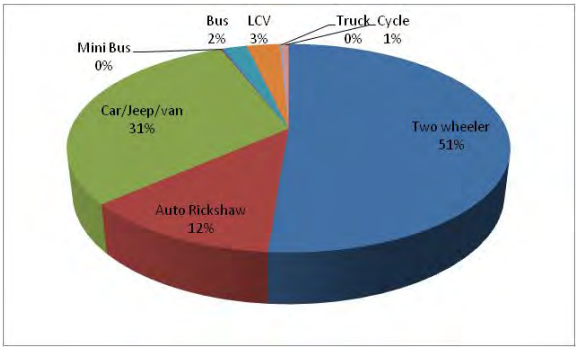
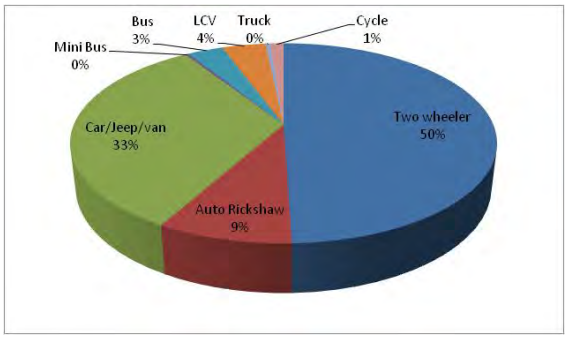


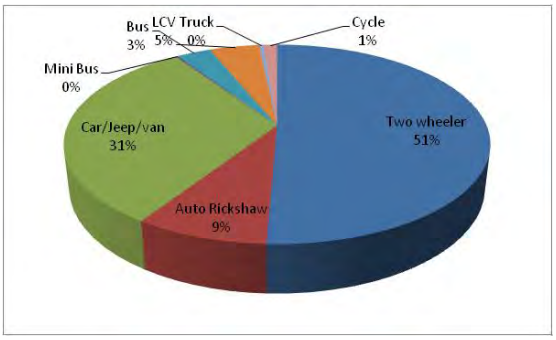
Vellara Junction (17/03/2016)



Vellara Junction (22/03/2016)



Dr. Bhaskaran Road & Swami Vivekanadha Junction (24/03/2016)



Dr. Bhaskaran Road & Swami Vivekanadha Junction (29/03/2016)

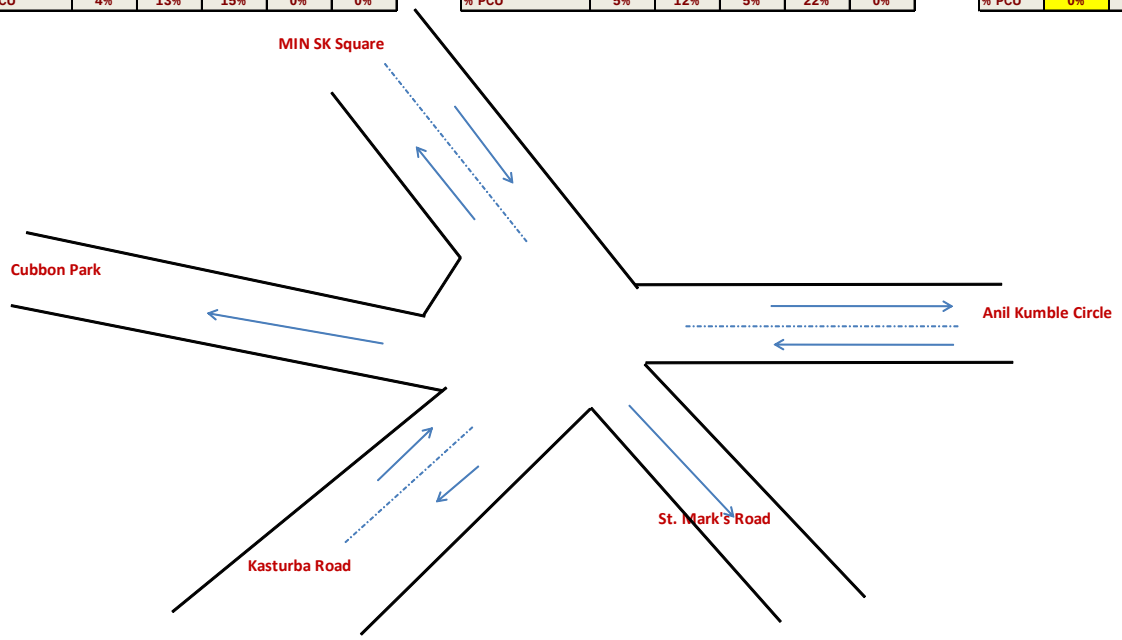
Figure 3-9 presents detailed analysis of each intersection showing the peak hour traffic volume. The intersection diagram is drawn (not to scale) and the traffic volume in each turning movement is also presented. The movements which are illegal are highlighted in yellow color.

Figure 3: Queen's Statue Junction Morning Peak Hour Volume (24/03/2016)

From MIN SK Square	Anil Kumble Circle	St. Mark's Rd	Kasturba Road	Cubbon park	U-Turn
Two Wheelers	303	841	843	17	1
Auto Rickshaws	16	328	267	3	4
Cars / Jeep / Van	174	400	356	11	3
Mini Bus	0	0	3	0	0
Bus	0	1	60	0	0
LCV	3	20	81	0	0
HCV	0	0	0	0	0
Containers	0	0	0	0	0
Military Vehicles	0	0	0	0	0
Emergency Vehi	0	0	0	0	0
Cycle	0	12	6	0	2
Total Vehicles	496	1602	1616	31	10
Total PCUs	349	1249	1352	23	9
% PCU	**4%**	**13%**	**15%**	**0%**	**0%**

From Anil Kumble Circle	St. Mark's Rd	Kasturba Road	Cubbon park	Minssk Square	U-Turn
Two Wheelers	259	766	533	1074	16
Auto Rickshaws	109	217	1	481	6
Cars / Jeep / Van	182	375	212	843	11
Mini Bus	0	0	0	0	0
Bus	0	5	0	5	0
LCV	9	27	1	32	0
HCV	3	3	0	2	0
Containers	0	0	0	0	0
Military Vehicles	0	0	0	0	0
Emergency Vehicles	0	1	1	0	0
Cycle	22	18	12	13	0
Total Vehicles	584	1412	760	2450	33
Total PCUs	470	1082	487	2023	26
% PCU	**5%**	**12%**	**5%**	**22%**	**0%**

From St. Mark's Road	Kasturba Road	Cubbon park	Minssk Square	Anil Kumble Circle	U-Turn
Two Wheelers	6	0	1	0	0
Auto Ricks	0	0	0	0	0
Cars / Jeep	0	0	0	0	0
Mini Bus	0	0	0	0	0
Bus	0	0	0	0	0
LCV	0	0	0	0	0
HCV	0	0	0	0	0
Containers	0	0	0	0	0
Military Ve	0	0	0	0	0
Emergency	0	0	0	0	0
Cycle	12	0	13	0	0
Total Vehicles	18	0	14	0	0
Total PCUs	8	0	6	0	0
% PCU	**0%**	**0%**	**0%**	**0%**	**0%**



From Kasturba Road	Minssk Square	Anil Kumble	St. Mark's Rd	U-Turn	Cubbon park
Two Wheelers	185	1516	9	92	49
Auto Rickshaws	135	213	1	17	2
Cars / Jeep / Van	98	455	3	19	13
Mini Bus	1	2	0	0	0
Bus	7	27	0	0	2
LCV	21	56	0	2	0
HCV	2	0	0	0	0
Containers	0	0	0	0	0
Military Vehicles	0	0	0	0	0
Emergency Vehi	0	1	0	0	0
Cycle	12	8	7	2	2
Total Vehicles	461	2278	20	132	68
Total PCUs	409	1615	12	89	45
% PCU	**4%**	**17%**	**0%**	**1%**	**0%**

From Cubbon Park	Minssk Square	Anil Kumble Circle	St. Mark's Rd	Kasturba Road	U-Turn
Two Wheelers	0	11	1	7	0
Auto Rickshaws	0	1	0	0	0
Cars / Jeep / Van	0	1	0	0	0
Mini Bus	0	0	0	0	0
Bus	0	0	0	0	0
LCV	0	0	0	0	0
HCV	0	0	0	0	0
Containers	0	0	0	0	0
Military Vehicles	0	0	0	0	0
Emergency Vehicles	0	0	0	0	0
Cycle	0	0	5	0	0
Total Vehicles	0	13	6	7	0
Total PCUs	0	8	3	4	0
% PCU	**0%**	**0%**	**0%**	**0%**	**0%**

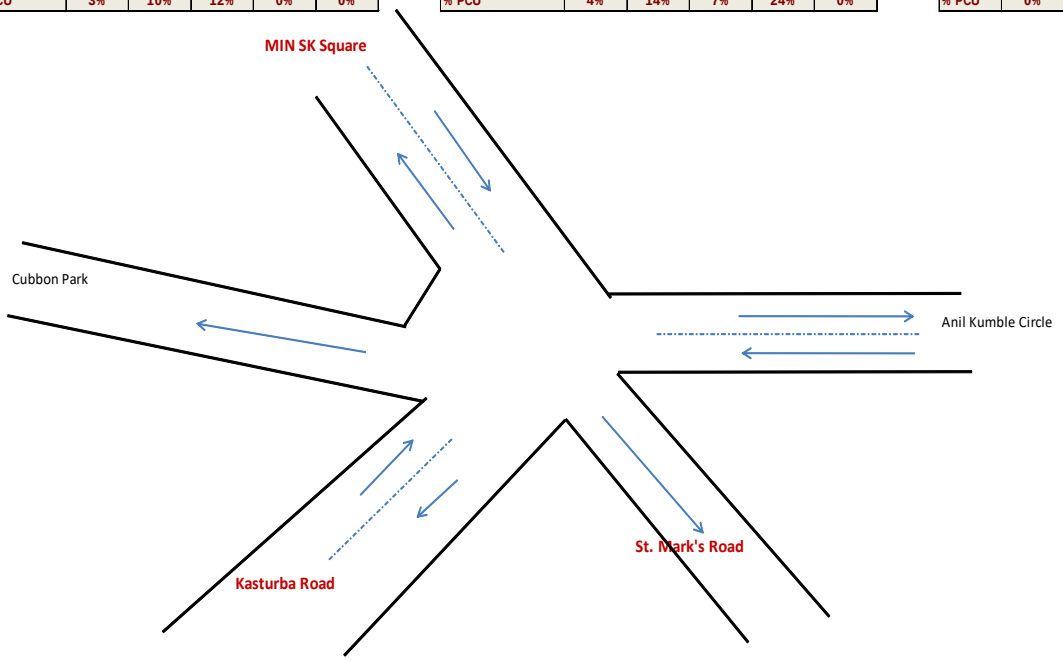
Peak Hour	**10. 00-11.00**
Peak Hour Volume	**12011**
Peak Volume (PCUs)	**9267**

Figure 4: Queen's Statue Junction Evening Peak Hour Volume (24/03/2016)

From MIN SK Square	Anil Kumble Circle	St. Mark's Rd	Kasturba Road	Cubbon park	U-Turn
Two Wheelers	195	416	469	16	4
Auto Rickshaws	5	215	194	0	5
Cars/Jeep/Van	174	397	374	17	7
Mini Bus	0	4	2	0	0
Bus	0	0	38	0	0
LCV	2	15	87	0	2
HCV	0	0	1	0	0
Containers	0	0	0	0	0
Military Vehicles	0	0	0	0	0
Emergency Vehi	2	0	1	0	0
Cycle	3	12	3	0	1
Total Vehicles	381	1059	1169	33	19
Total PCUs	284	898	1056	25	18
% PCU	**3%**	**10%**	**12%**	**0%**	**0%**

From Anil Kumble Circle	St. Mark's Rd	Kasturba Road	Cubbon park	Minssk Square	U-Turn
Two Wheelers	202	751	729	934	3
Auto Rickshaws	64	212	0	380	1
Cars/Jeep/Van	152	449	221	1057	4
Mini Bus	0	7	0	1	0
Bus	0	3	0	13	0
LCV	1	59	1	29	0
HCV	0	4	0	1	0
Containers	0	0	0	0	0
Military Vehicles	0	0	0	0	0
Emergency Vehicles	0	1	0	0	0
Cycle	3	3	0	1	0
Total Vehicles	422	1489	951	2416	8
Total PCUs	332	1195	587	2054	7
% PCU	**4%**	**14%**	**7%**	**24%**	**0%**

From St. Mark's Rd	Kasturba Road	Cubbon park	Minssk Square	Anil Kumble Circle	U-Turn
Two Wheelers	2	0	7	0	0
Auto Ricks	0	0	0	0	0
Cars/Jeep	0	0	0	0	0
Mini Bus	0	0	0	0	0
Bus	0	0	0	0	0
LCV	0	0	0	0	0
HCV	0	0	0	0	0
Containers	0	0	0	0	0
Military Ve	0	0	0	0	0
Emergency	0	0	0	0	0
Cycle	1	0	4	0	0
Total Vehicles	3	0	11	0	0
Total PCUs	1	0	5	0	0
% PCU	**0%**	**0%**	**0%**	**0%**	**0%**



From Kasturba Road	Minssk Square	Kumble Circle	St. Mark's Rd	U-Turn	Cubbon park
Two Wheelers	218	1133	8	35	42
Auto Rickshaws	112	228	1	9	0
Cars/Jeep/Van	128	597	6	47	36
Mini Bus	0	1	0	0	0
Bus	1	37	0	0	0
LCV	22	93	2	2	1
HCV	0	1	0	0	0
Containers	0	0	0	0	0
Military Vehicles	0	0	0	0	0
Emergency Vehi	0	2	0	0	0
Cycle	1	8	0	0	0
Total Vehicles	482	2100	17	93	79
Total PCUs	405	1658	14	78	58
% PCU	**5%**	**19%**	**0%**	**1%**	**1%**

From Cubbon Park	Minssk Square	Kumble Circle	St. Mark's Rd	Kasturba Road	U-Turn
Two Wheelers	1	15	4	6	0
Auto Rickshaws	0	0	0	0	0
Cars/Jeep/Van	1	4	4	0	0
Mini Bus	0	0	0	0	0
Bus	0	0	0	0	0
LCV	1	0	0	0	0
HCV	0	0	0	0	0
Containers	0	0	0	0	0
Military Vehicles	0	0	0	0	0
Emergency Vehicles	0	0	0	0	0
Cycle	0	0	0	1	0
Total Vehicles	3	19	8	7	0
Total PCUs	3	12	6	3	0
% PCU	**0%**	**0%**	**0%**	**0%**	**0%**

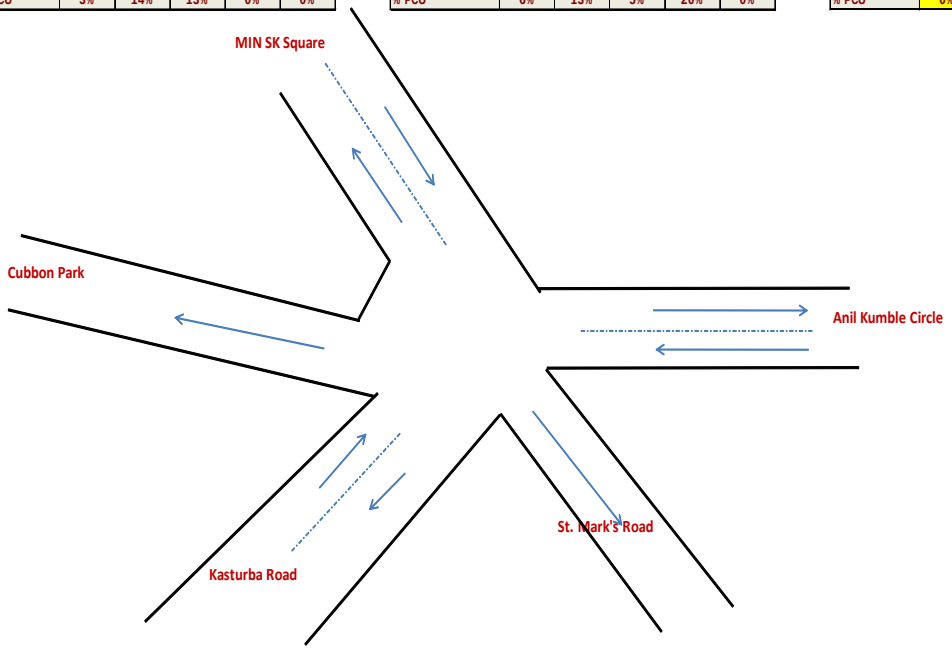
Peak Hour	**5.00-6.00 PM**
Peak Hour Volume	**10769**
Peak Volume (PCUs)	**8698**

Figure 5: Queen's Statue Junction Morning Peak Hour Volume (29/03/2016)

From MIN SK Square	Anil Kumble Circle	St. Mark's Rd	Kasturba Road	Cubbon park	U-Turn
Two Wheelers	339	1017	956	13	6
Auto Rickshaws	12	345	221	3	1
Cars/Jeep/Van	155	440	309	12	4
Mini Bus	0	2	1	0	0
Bus	0	0	53	0	0
LCV	1	25	64	0	1
HCV	0	0	0	0	0
Containers	0	0	0	0	0
Military Vehicles	0	0	0	0	0
Emergency Vehi	0	0	0	0	0
Cycle	2	15	5	0	0
Total Vehicles	509	1844	1609	28	12
Total PCUs	341	1408	1263	22	10
% PCU	**3%**	**14%**	**13%**	**0%**	**0%**

From Anil Kumble Circle	St. Mark's Rd	Kasturba Road	Cubbon park	Minssk Square	U-Turn
Two Wheelers	309	912	477	1150	21
Auto Rickshaws	136	293	0	501	4
Cars/Jeep/Van	224	382	201	769	12
Mini Bus	0	0	1	0	0
Bus	0	6	2	3	0
LCV	8	30	6	25	0
HCV	0	3	0	0	0
Containers	0	0	0	0	0
Military Vehicles	0	0	0	0	0
Emergency Vehicles	0	0	1	0	0
Cycle	13	16	10	12	0
Total Vehicles	690	1642	698	2460	37
Total PCUs	558	1258	460	1992	27
% PCU	**6%**	**13%**	**5%**	**20%**	**0%**

From St. Mark's Road	Kasturba Road	Cubbon park	Minssk Square	Anil Kumble Circle	U-Turn
Two Wheelers	6	1	2	0	0
Auto Rickshaws	0	0	0	0	0
Cars/Jeep/Van	0	0	0	0	0
Mini Bus	0	0	0	0	0
Bus	0	0	0	0	0
LCV	0	0	0	0	0
HCV	0	0	0	0	0
Containers	0	0	0	0	0
Military Vehicles	0	0	0	0	0
Emergency Vehicl	0	0	0	0	0
Cycle	3	5	9	0	0
Total Vehicles	9	6	11	0	0
Total PCUs	4	3	5	0	0
% PCU	**0%**	**0%**	**0%**	**0%**	**0%**



From Kasturba Road	Minssk Square	Anil Kumble Circle	St. Mark's Rd	U-Turn	Cubbon park
Two Wheelers	224	1907	12	126	31
Auto Rickshaws	154	214	0	23	1
Cars/Jeep/Van	95	583	2	28	26
Mini Bus	0	2	0	0	3
Bus	7	35	0	0	1
LCV	23	78	0	3	0
HCV	2	2	0	0	0
Containers	0	0	0	0	0
Military Vehicles	0	0	0	0	0
Emergency Vehi	0	0	0	0	0
Cycle	6	10	1	0	1
Total Vehicles	511	2831	15	180	63
Total PCUs	446	1992	8	123	51
% PCU	**4%**	**20%**	**0%**	**1%**	**1%**

From Cubbon Park	Minssk Square	Anil Kumble Circle	St. Mark's Rd	Kasturba Road	U-Turn
Two Wheelers	0	0	0	8	0
Auto Rickshaws	0	0	0	0	0
Cars/Jeep/Van	0	0	0	0	0
Mini Bus	0	0	0	0	0
Bus	0	0	0	0	0
LCV	0	0	0	0	0
HCV	0	0	0	0	0
Containers	0	0	0	0	0
Military Vehicles	0	0	0	0	0
Emergency Vehicles	0	0	0	0	0
Cycle	0	0	0	0	0
Total Vehicles	0	0	0	8	0
Total PCUs	0	0	0	4	0
% PCU	**0%**	**0%**	**0%**	**0%**	**0%**

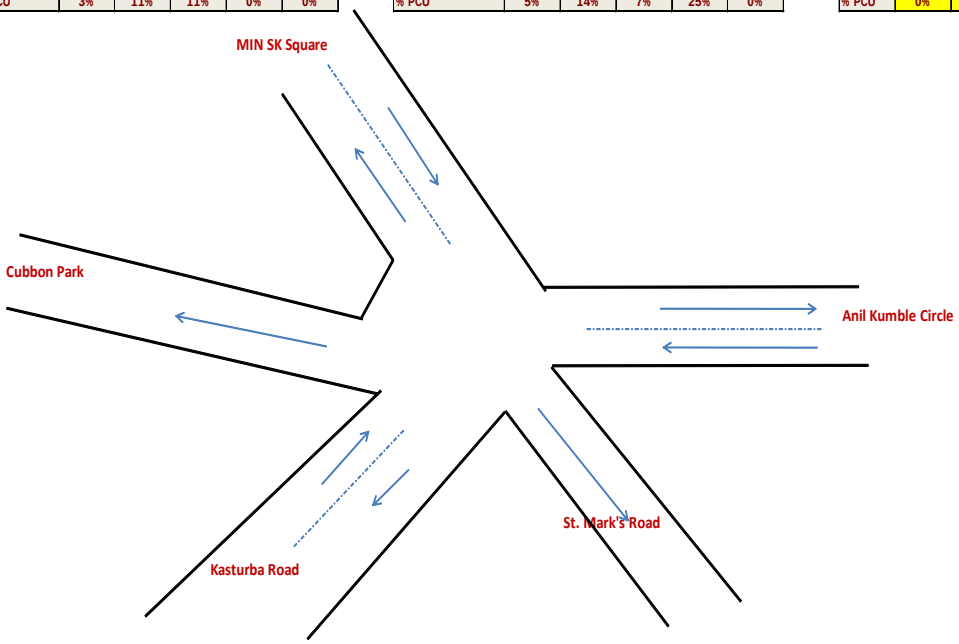
Peak Hour	**10. 00-11.00**
Peak Hour Volume	**13161**
Peak Volume (PCUs)	**9973**

Figure 6: Queen's Statue Junction Evening Peak Hour Volume (29/03/2016)

From MIN SK Square	Anil Kumble Circle	St. Mark's Rd	Kasturba Road	Cubbon park	U-Turn
Two Wheelers	166	541	477	18	8
Auto Rickshaws	11	197	170	0	4
Cars/Jeep/Van	156	434	308	7	8
Mini Bus	0	2	0	0	0
Bus	0	3	47	0	0
LCV	3	22	83	0	1
HCV	2	0	2	0	0
Containers	0	0	0	0	0
Military Vehicles	0	0	0	0	0
Emergency Vehi	0	0	0	0	0
Cycle	5	10	1	1	0
Total Vehicles	343	1209	1088	26	21
Total PCUs	263	987	975	16	18
% PCU	**3%**	**11%**	**11%**	**0%**	**0%**

From Anil Kumble Circle	St. Mark's Rd	Kasturba Road	Cubbon park	Minssk Square	U-Turn
Two Wheelers	237	927	782	1267	9
Auto Rickshaws	72	213	0	350	1
Cars/Jeep/Van	225	450	240	1074	20
Mini Bus	0	2	0	5	0
Bus	0	2	0	14	0
LCV	8	50	4	38	0
HCV	1	2	0	1	0
Containers	0	0	0	0	0
Military Vehicles	0	0	0	0	0
Emergency Vehicles	0	0	0	0	0
Cycle	9	13	2	9	0
Total Vehicles	552	1659	1028	2758	30
Total PCUs	447	1258	637	2228	26
% PCU	**5%**	**14%**	**7%**	**25%**	**0%**

From St. Mark's Road	Kasturba Road	Cubbon park	Minssk Square	Anil Kumble Circle	U-Turn
Two Wheelers	7	2	6	0	0
Auto Ricks	0	0	0	0	0
Cars/Jeep	0	0	0	0	0
Mini Bus	0	0	0	0	0
Bus	0	0	0	0	0
LCV	0	0	0	0	0
HCV	0	0	0	0	0
Containers	0	0	0	0	0
Military Ve	0	0	0	0	0
Emergency	0	0	0	0	0
Cycle	0	0	6	0	0
Total Vehicles	7	2	12	0	0
Total PCUs	4	1	5	0	0
% PCU	**0%**	**0%**	**0%**	**0%**	**0%**

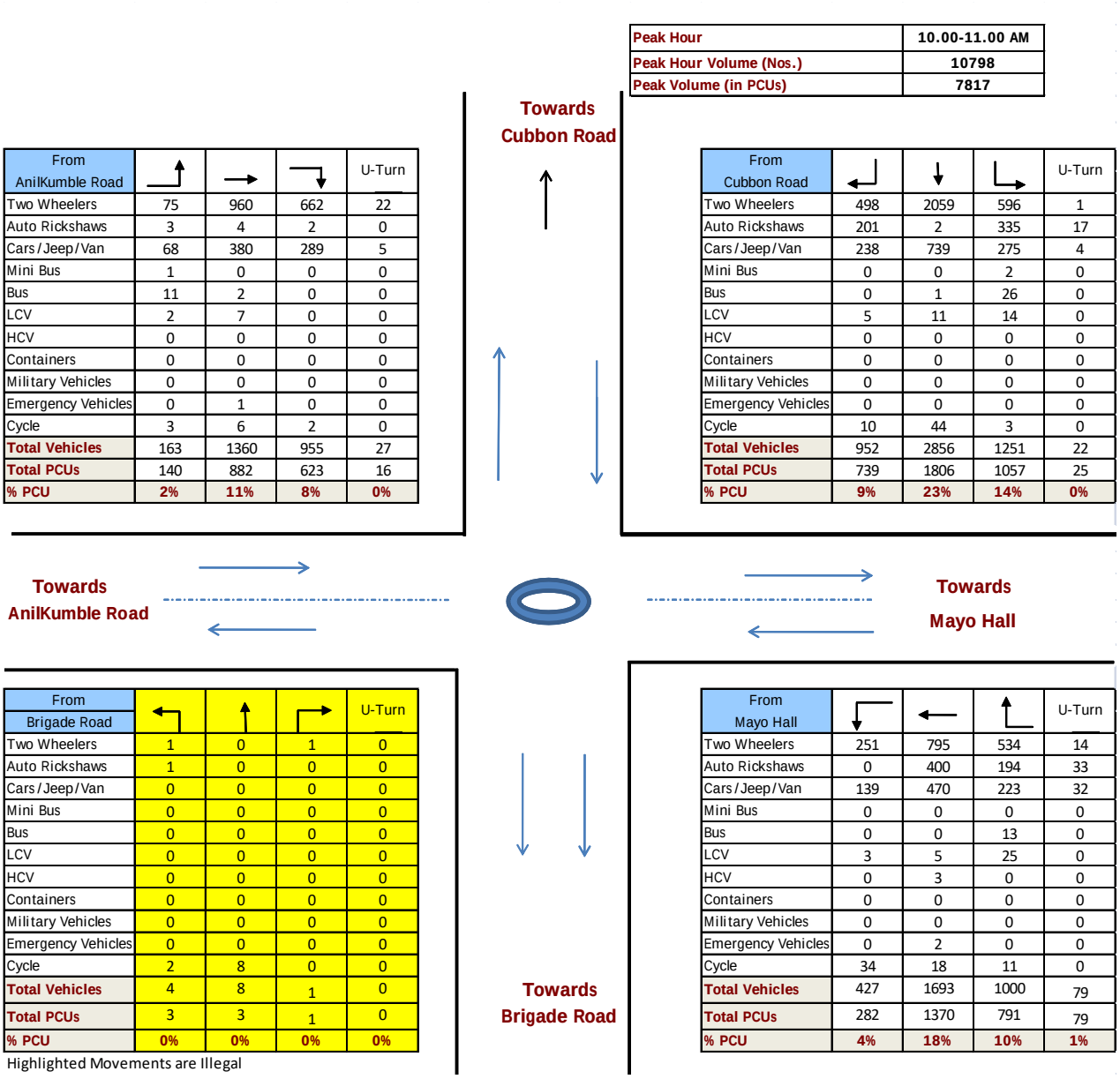


From Kasturba Road	Minssk Square	Anil Kumble Circle	St. Mark's Rd	U-Turn	Cubbon park
Two Wheelers	217	1355	9	52	34
Auto Rickshaws	100	241	2	9	0
Cars/Jeep/Van	100	326	1	19	25
Mini Bus	1	3	0	0	0
Bus	1	30	0	0	0
LCV	26	85	0	1	0
HCV	0	1	0	0	0
Containers	0	0	0	0	0
Military Vehicles	0	0	0	0	0
Emergency Vehi	0	1	0	0	0
Cycle	0	20	0	0	0
Total Vehicles	445	2062	12	81	59
Total PCUs	369	1696	8	57	42
% PCU	**4%**	**19%**	**0%**	**1%**	**0%**

From Cubbon Park	Minssk Square	Anil Kumble Circle	St. Mark's Rd	Kasturba Road	U-Turn
Two Wheelers	3	0	0	3	0
Auto Rickshaws	0	0	0	0	0
Cars/Jeep/Van	1	0	0	0	0
Mini Bus	0	0	0	0	0
Bus	0	0	0	0	0
LCV	0	0	0	0	0
HCV	0	0	0	0	0
Containers	0	0	0	0	0
Military Vehicles	0	0	0	0	0
Emergency Vehicles	0	0	0	0	0
Cycle	0	0	0	0	0
Total Vehicles	4	0	0	3	0
Total PCUs	3	0	0	2	0
#VALUE!	**0%**	**0%**	**0%**	**0%**	**0%**

Peak Hour	**6.00-7.00**
Peak Hour Volume	**11599**
Peak Volume (PCUs)	**9040**

Figure 7: Cauvery Arts & Crafts Junction Morning Peak Hour Volume (24/03/2016)



Peak Hour	10.00-11.00 AM
Peak Hour Volume (Nos.)	10798
Peak Volume (in PCUs)	7817

From AnilKumble Road	↑	→	↓	U-Turn
Two Wheelers	75	960	662	22
Auto Rickshaws	3	4	2	0
Cars / Jeep / Van	68	380	289	5
Mini Bus	1	0	0	0
Bus	11	2	0	0
LCV	2	7	0	0
HCV	0	0	0	0
Containers	0	0	0	0
Military Vehicles	0	0	0	0
Emergency Vehicles	0	1	0	0
Cycle	3	6	2	0
Total Vehicles	163	1360	955	27
Total PCUs	140	882	623	16
% PCU	**2%**	**11%**	**8%**	**0%**

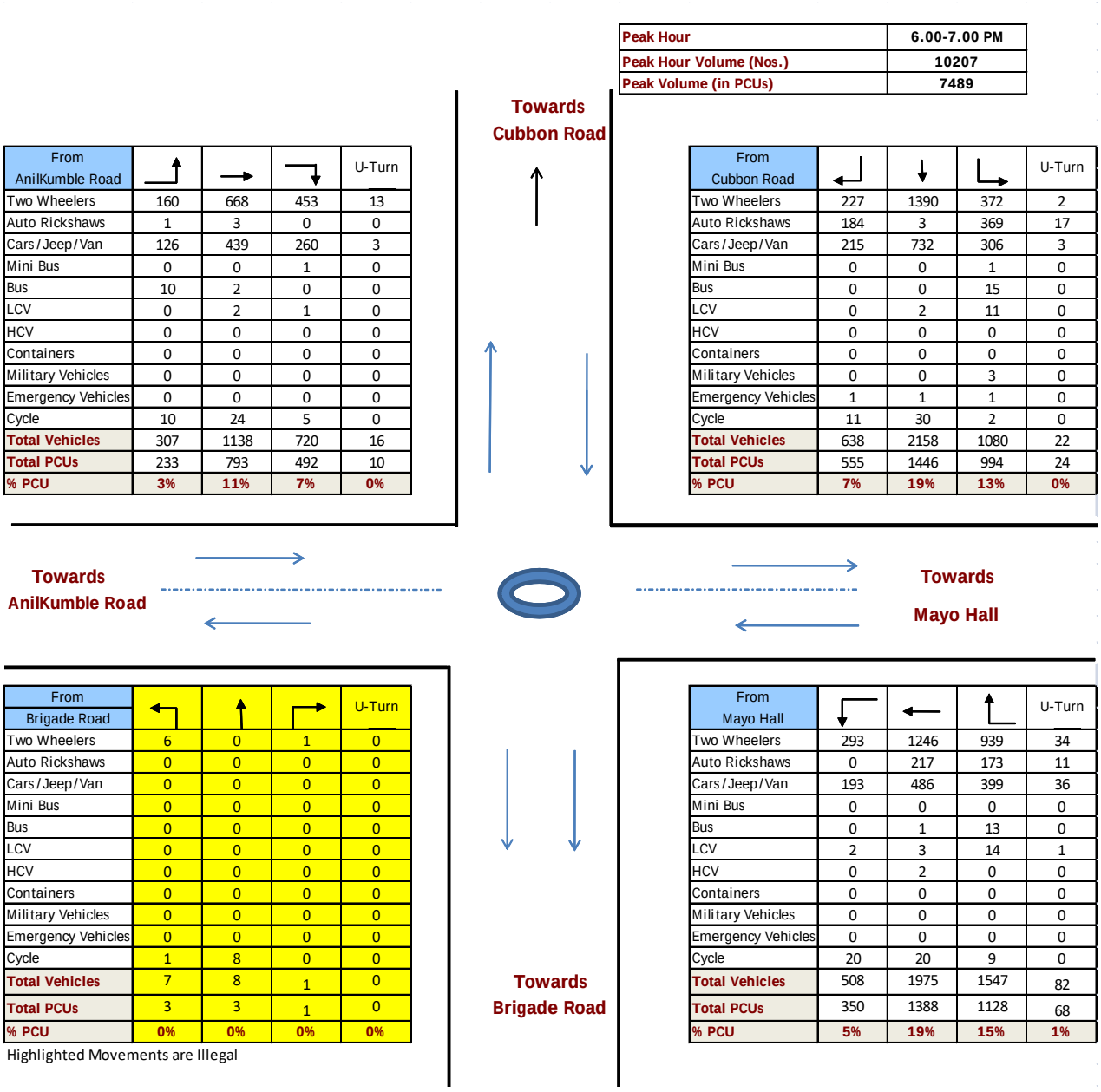
From Cubbon Road	←	↓	→	U-Turn
Two Wheelers	498	2059	596	1
Auto Rickshaws	201	2	335	17
Cars / Jeep / Van	238	739	275	4
Mini Bus	0	0	2	0
Bus	0	1	26	0
LCV	5	11	14	0
HCV	0	0	0	0
Containers	0	0	0	0
Military Vehicles	0	0	0	0
Emergency Vehicles	0	0	0	0
Cycle	10	44	3	0
Total Vehicles	952	2856	1251	22
Total PCUs	739	1806	1057	25
% PCU	**9%**	**23%**	**14%**	**0%**

From Brigade Road	←	↑	→	U-Turn
Two Wheelers	1	0	1	0
Auto Rickshaws	1	0	0	0
Cars / Jeep / Van	0	0	0	0
Mini Bus	0	0	0	0
Bus	0	0	0	0
LCV	0	0	0	0
HCV	0	0	0	0
Containers	0	0	0	0
Military Vehicles	0	0	0	0
Emergency Vehicles	0	0	0	0
Cycle	2	8	0	0
Total Vehicles	4	8	1	0
Total PCUs	3	3	1	0
% PCU	**0%**	**0%**	**0%**	**0%**

Highlighted Movements are Illegal

From Mayo Hall	↓	←	↑	U-Turn
Two Wheelers	251	795	534	14
Auto Rickshaws	0	400	194	33
Cars / Jeep / Van	139	470	223	32
Mini Bus	0	0	0	0
Bus	0	0	13	0
LCV	3	5	25	0
HCV	0	3	0	0
Containers	0	0	0	0
Military Vehicles	0	0	0	0
Emergency Vehicles	0	2	0	0
Cycle	34	18	11	0
Total Vehicles	427	1693	1000	79
Total PCUs	282	1370	791	79
% PCU	**4%**	**18%**	**10%**	**1%**

Figure 8: Cauvery Arts & Crafts Junction Evening Peak Hour Volume (24/03/2016)



Peak Hour	6.00-7.00 PM
Peak Hour Volume (Nos.)	10207
Peak Volume (in PCUs)	7489

From AnilKumble Road				U-Turn
Two Wheelers	160	668	453	13
Auto Rickshaws	1	3	0	0
Cars / Jeep / Van	126	439	260	3
Mini Bus	0	0	1	0
Bus	10	2	0	0
LCV	0	2	1	0
HCV	0	0	0	0
Containers	0	0	0	0
Military Vehicles	0	0	0	0
Emergency Vehicles	0	0	0	0
Cycle	10	24	5	0
Total Vehicles	307	1138	720	16
Total PCUs	233	793	492	10
% PCU	**3%**	**11%**	**7%**	**0%**

From Cubbon Road				U-Turn
Two Wheelers	227	1390	372	2
Auto Rickshaws	184	3	369	17
Cars / Jeep / Van	215	732	306	3
Mini Bus	0	0	1	0
Bus	0	0	15	0
LCV	0	2	11	0
HCV	0	0	0	0
Containers	0	0	0	0
Military Vehicles	0	0	3	0
Emergency Vehicles	1	1	1	0
Cycle	11	30	2	0
Total Vehicles	638	2158	1080	22
Total PCUs	555	1446	994	24
% PCU	**7%**	**19%**	**13%**	**0%**

From Brigade Road				U-Turn
Two Wheelers	6	0	1	0
Auto Rickshaws	0	0	0	0
Cars / Jeep / Van	0	0	0	0
Mini Bus	0	0	0	0
Bus	0	0	0	0
LCV	0	0	0	0
HCV	0	0	0	0
Containers	0	0	0	0
Military Vehicles	0	0	0	0
Emergency Vehicles	0	0	0	0
Cycle	1	8	0	0
Total Vehicles	7	8	1	0
Total PCUs	3	3	1	0
% PCU	**0%**	**0%**	**0%**	**0%**

Highlighted Movements are Illegal

From Mayo Hall				U-Turn
Two Wheelers	293	1246	939	34
Auto Rickshaws	0	217	173	11
Cars / Jeep / Van	193	486	399	36
Mini Bus	0	0	0	0
Bus	0	1	13	0
LCV	2	3	14	1
HCV	0	2	0	0
Containers	0	0	0	0
Military Vehicles	0	0	0	0
Emergency Vehicles	0	0	0	0
Cycle	20	20	9	0
Total Vehicles	508	1975	1547	82
Total PCUs	350	1388	1128	68
% PCU	**5%**	**19%**	**15%**	**1%**

Figure 9: Cauvery Arts & Crafts Junction Morning Peak Hour Volume (29/03/2016)

Peak Hour	10.00-11.00 AM
Peak Hour Volume (Nos.)	11842
Peak Volume (in PCUs)	8430

Towards Cubbon Road

From AnilKumble Road				U-Turn
Two Wheelers	84	1302	695	55
Auto Rickshaws	2	5	0	0
Cars/Jeep/Van	66	492	297	6
Mini Bus	1	0	0	0
Bus	12	1	0	0
LCV	1	7	0	0
HCV	0	0	0	0
Containers	0	0	0	0
Military Vehicles	0	0	0	0
Emergency Vehicles	0	0	0	0
Cycle	2	8	1	0
Total Vehicles	168	1815	993	61
Total PCUs	141	1164	645	34
% PCU	2%	14%	8%	0%

From Cubbon Road				U-Turn
Two Wheelers	578	2231	699	4
Auto Rickshaws	231	2	361	15
Cars/Jeep/Van	255	843	297	0
Mini Bus	0	0	0	0
Bus	0	0	29	0
LCV	3	4	16	0
HCV	0	1	2	0
Containers	0	0	0	0
Military Vehicles	0	0	0	0
Emergency Vehicles	0	0	0	0
Cycle	14	33	1	0
Total Vehicles	1081	3114	1405	19
Total PCUs	831	1982	1171	20
% PCU	10%	24%	14%	0%

Towards AnilKumble Road

Towards Mayo Hall

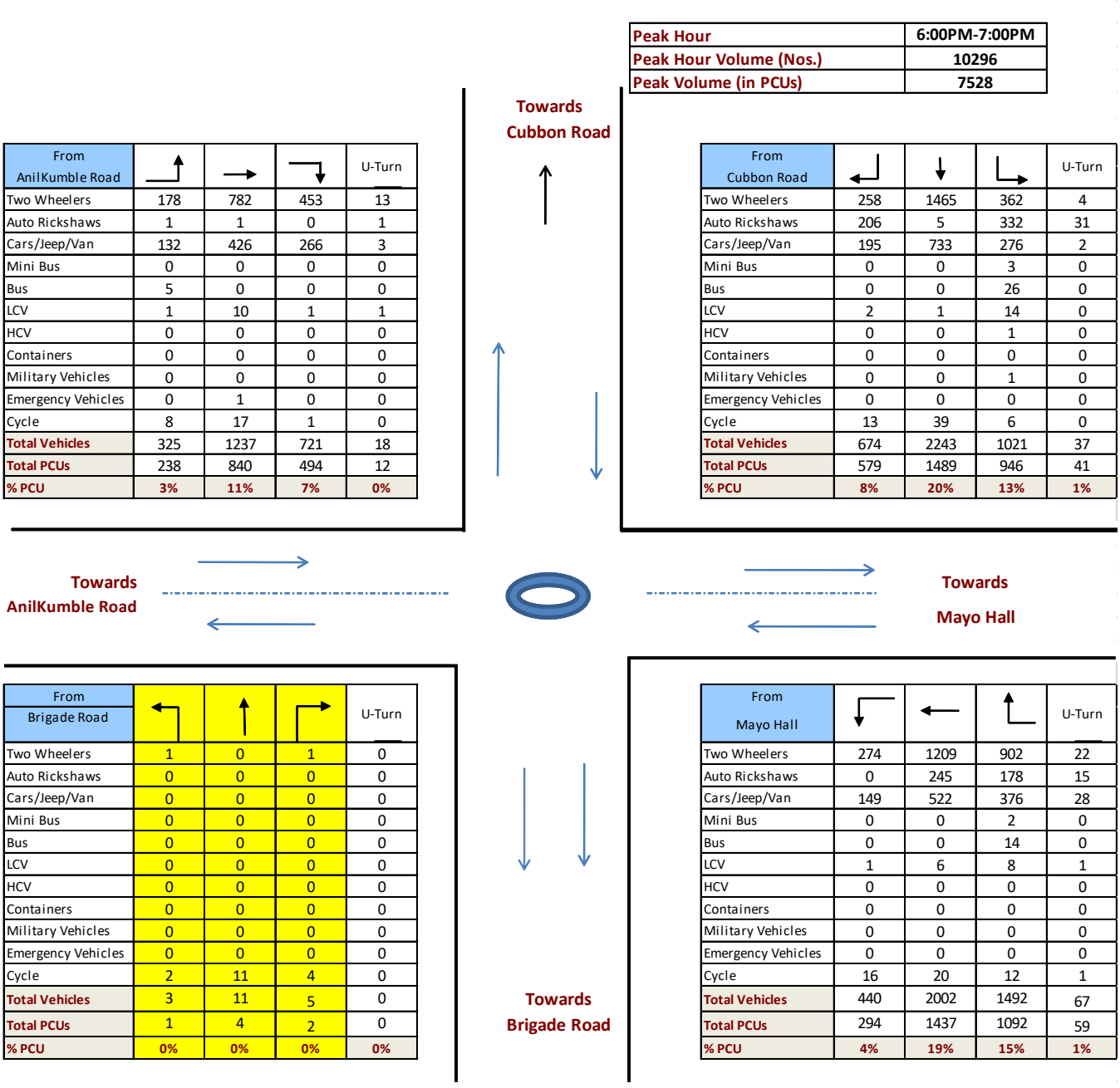
From Brigade Road				U-Turn
Two Wheelers	1	0	0	0
Auto Rickshaws	0	1	0	0
Cars/Jeep/Van	0	0	0	0
Mini Bus	0	0	0	0
Bus	0	0	0	0
LCV	0	0	0	0
HCV	0	0	0	0
Containers	0	0	0	0
Military Vehicles	0	0	0	0
Emergency Vehicles	0	0	0	0
Cycle	0	7	2	0
Total Vehicles	1	8	2	0
Total PCUs	1	4	1	0
% PCU	0%	0%	0%	0%

Towards Brigade Road

From Mayo Hall				U-Turn
Two Wheelers	259	954	522	5
Auto Rickshaws	2	400	188	19
Cars/Jeep/Van	111	375	226	24
Mini Bus	0	1	0	0
Bus	0	1	17	0
LCV	0	8	13	0
HCV	0	3	0	0
Containers	0	0	0	0
Military Vehicles	0	1	1	0
Emergency Vehicles	0	0	1	0
Cycle	21	15	7	1
Total Vehicles	393	1758	975	49
Total PCUs	251	1362	774	50
% PCU	3%	16%	9%	1%

Figure 10: Cauvery Arts & Crafts Junction Evening Peak Hour Volume (29/03/2016)

Peak Hour	6:00PM-7:00PM
Peak Hour Volume (Nos.)	10296
Peak Volume (in PCUs)	7528



From AnilKumble Road	↑	→	↓	U-Turn
Two Wheelers	178	782	453	13
Auto Rickshaws	1	1	0	1
Cars/Jeep/Van	132	426	266	3
Mini Bus	0	0	0	0
Bus	5	0	0	0
LCV	1	10	1	1
HCV	0	0	0	0
Containers	0	0	0	0
Military Vehicles	0	0	0	0
Emergency Vehicles	0	1	0	0
Cycle	8	17	1	0
Total Vehicles	325	1237	721	18
Total PCUs	238	840	494	12
% PCU	3%	11%	7%	0%

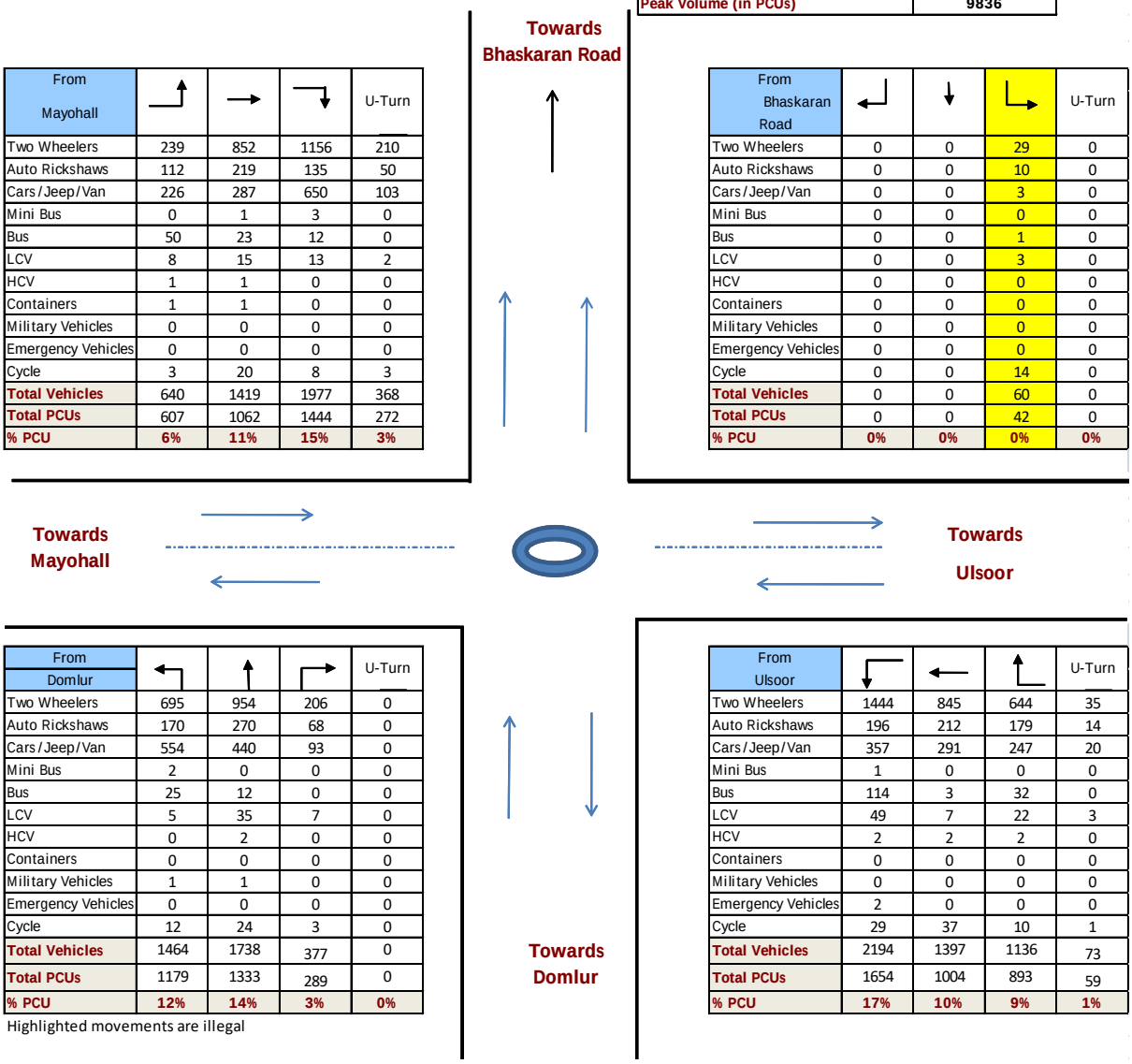
From Cubbon Road	←	↓	→	U-Turn
Two Wheelers	258	1465	362	4
Auto Rickshaws	206	5	332	31
Cars/Jeep/Van	195	733	276	2
Mini Bus	0	0	3	0
Bus	0	0	26	0
LCV	2	1	14	0
HCV	0	0	1	0
Containers	0	0	0	0
Military Vehicles	0	0	1	0
Emergency Vehicles	0	0	0	0
Cycle	13	39	6	0
Total Vehicles	674	2243	1021	37
Total PCUs	579	1489	946	41
% PCU	8%	20%	13%	1%

From Brigade Road	←	↑	→	U-Turn
Two Wheelers	1	0	1	0
Auto Rickshaws	0	0	0	0
Cars/Jeep/Van	0	0	0	0
Mini Bus	0	0	0	0
Bus	0	0	0	0
LCV	0	0	0	0
HCV	0	0	0	0
Containers	0	0	0	0
Military Vehicles	0	0	0	0
Emergency Vehicles	0	0	0	0
Cycle	2	11	4	0
Total Vehicles	3	11	5	0
Total PCUs	1	4	2	0
% PCU	0%	0%	0%	0%

From Mayo Hall	↓	←	↑	U-Turn
Two Wheelers	274	1209	902	22
Auto Rickshaws	0	245	178	15
Cars/Jeep/Van	149	522	376	28
Mini Bus	0	0	2	0
Bus	0	0	14	0
LCV	1	6	8	1
HCV	0	0	0	0
Containers	0	0	0	0
Military Vehicles	0	0	0	0
Emergency Vehicles	0	0	0	0
Cycle	16	20	12	1
Total Vehicles	440	2002	1492	67
Total PCUs	294	1437	1092	59
% PCU	4%	19%	15%	1%

Figure 11: Trinity Circle Morning Peak Hour Volume (24/03/2016)

Peak Hour	9.00-10.00 AM
Peak Hour Volume (Nos.)	12843
Peak Volume (in PCUs)	9836



From Mayohall				U-Turn
Two Wheelers	239	852	1156	210
Auto Rickshaws	112	219	135	50
Cars / Jeep / Van	226	287	650	103
Mini Bus	0	1	3	0
Bus	50	23	12	0
LCV	8	15	13	2
HCV	1	1	0	0
Containers	1	1	0	0
Military Vehicles	0	0	0	0
Emergency Vehicles	0	0	0	0
Cycle	3	20	8	3
Total Vehicles	640	1419	1977	368
Total PCUs	607	1062	1444	272
% PCU	**6%**	**11%**	**15%**	**3%**

From Bhaskaran Road				U-Turn
Two Wheelers	0	0	29	0
Auto Rickshaws	0	0	10	0
Cars / Jeep / Van	0	0	3	0
Mini Bus	0	0	0	0
Bus	0	0	1	0
LCV	0	0	3	0
HCV	0	0	0	0
Containers	0	0	0	0
Military Vehicles	0	0	0	0
Emergency Vehicles	0	0	0	0
Cycle	0	0	14	0
Total Vehicles	0	0	60	0
Total PCUs	0	0	42	0
% PCU	**0%**	**0%**	**0%**	**0%**

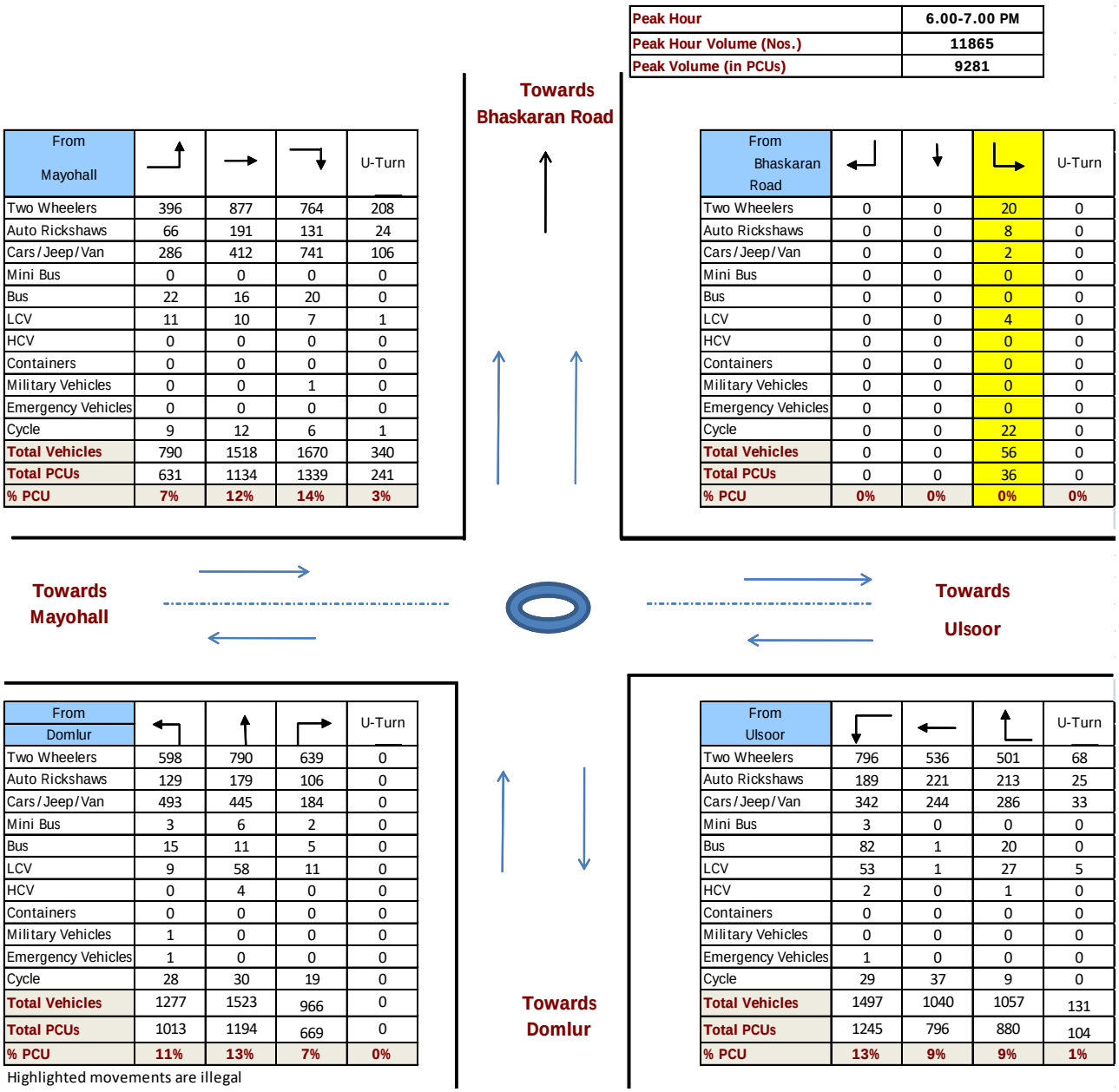
From Domlur				U-Turn
Two Wheelers	695	954	206	0
Auto Rickshaws	170	270	68	0
Cars / Jeep / Van	554	440	93	0
Mini Bus	2	0	0	0
Bus	25	12	0	0
LCV	5	35	7	0
HCV	0	2	0	0
Containers	0	0	0	0
Military Vehicles	1	1	0	0
Emergency Vehicles	0	0	0	0
Cycle	12	24	3	0
Total Vehicles	1464	1738	377	0
Total PCUs	1179	1333	289	0
% PCU	**12%**	**14%**	**3%**	**0%**

Highlighted movements are illegal

From Ulsoor				U-Turn
Two Wheelers	1444	845	644	35
Auto Rickshaws	196	212	179	14
Cars / Jeep / Van	357	291	247	20
Mini Bus	1	0	0	0
Bus	114	3	32	0
LCV	49	7	22	3
HCV	2	2	2	0
Containers	0	0	0	0
Military Vehicles	0	0	0	0
Emergency Vehicles	2	0	0	0
Cycle	29	37	10	1
Total Vehicles	2194	1397	1136	73
Total PCUs	1654	1004	893	59
% PCU	**17%**	**10%**	**9%**	**1%**

Figure 12: Trinity Circle Evening Peak Hour Volume (24/03/2016)

Peak Hour	6.00-7.00 PM
Peak Hour Volume (Nos.)	11865
Peak Volume (in PCUs)	9281



From Mayohall	↑	→	↓	U-Turn
Two Wheelers	396	877	764	208
Auto Rickshaws	66	191	131	24
Cars/Jeep/Van	286	412	741	106
Mini Bus	0	0	0	0
Bus	22	16	20	0
LCV	11	10	7	1
HCV	0	0	0	0
Containers	0	0	0	0
Military Vehicles	0	0	1	0
Emergency Vehicles	0	0	0	0
Cycle	9	12	6	1
Total Vehicles	790	1518	1670	340
Total PCUs	631	1134	1339	241
% PCU	**7%**	**12%**	**14%**	**3%**

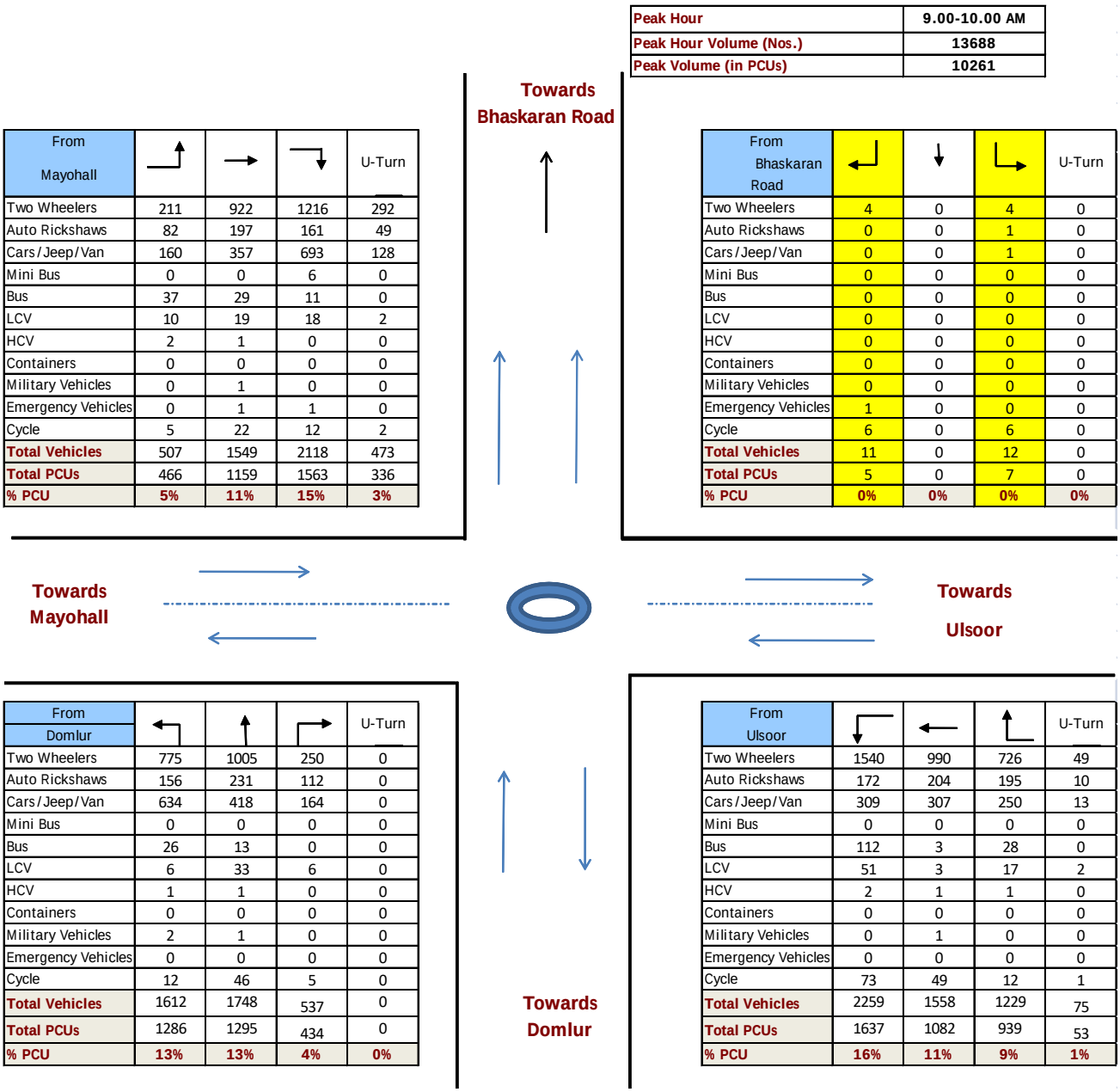
From Bhaskaran Road	←	↓	→	U-Turn
Two Wheelers	0	0	20	0
Auto Rickshaws	0	0	8	0
Cars/Jeep/Van	0	0	2	0
Mini Bus	0	0	0	0
Bus	0	0	0	0
LCV	0	0	4	0
HCV	0	0	0	0
Containers	0	0	0	0
Military Vehicles	0	0	0	0
Emergency Vehicles	0	0	0	0
Cycle	0	0	22	0
Total Vehicles	0	0	56	0
Total PCUs	0	0	36	0
% PCU	**0%**	**0%**	**0%**	**0%**

From Domlur	←	↑	→	U-Turn
Two Wheelers	598	790	639	0
Auto Rickshaws	129	179	106	0
Cars/Jeep/Van	493	445	184	0
Mini Bus	3	6	2	0
Bus	15	11	5	0
LCV	9	58	11	0
HCV	0	4	0	0
Containers	0	0	0	0
Military Vehicles	1	0	0	0
Emergency Vehicles	1	0	0	0
Cycle	28	30	19	0
Total Vehicles	1277	1523	966	0
Total PCUs	1013	1194	669	0
% PCU	**11%**	**13%**	**7%**	**0%**

Highlighted movements are illegal

From Ulsoor	↓	←	↑	U-Turn
Two Wheelers	796	536	501	68
Auto Rickshaws	189	221	213	25
Cars/Jeep/Van	342	244	286	33
Mini Bus	3	0	0	0
Bus	82	1	20	0
LCV	53	1	27	5
HCV	2	0	1	0
Containers	0	0	0	0
Military Vehicles	0	0	0	0
Emergency Vehicles	1	0	0	0
Cycle	29	37	9	0
Total Vehicles	1497	1040	1057	131
Total PCUs	1245	796	880	104
% PCU	**13%**	**9%**	**9%**	**1%**

Figure 13: Trinity Circle Morning Peak Hour Volume (31/03/2016)



Peak Hour	9.00-10.00 AM
Peak Hour Volume (Nos.)	13688
Peak Volume (in PCUs)	10261

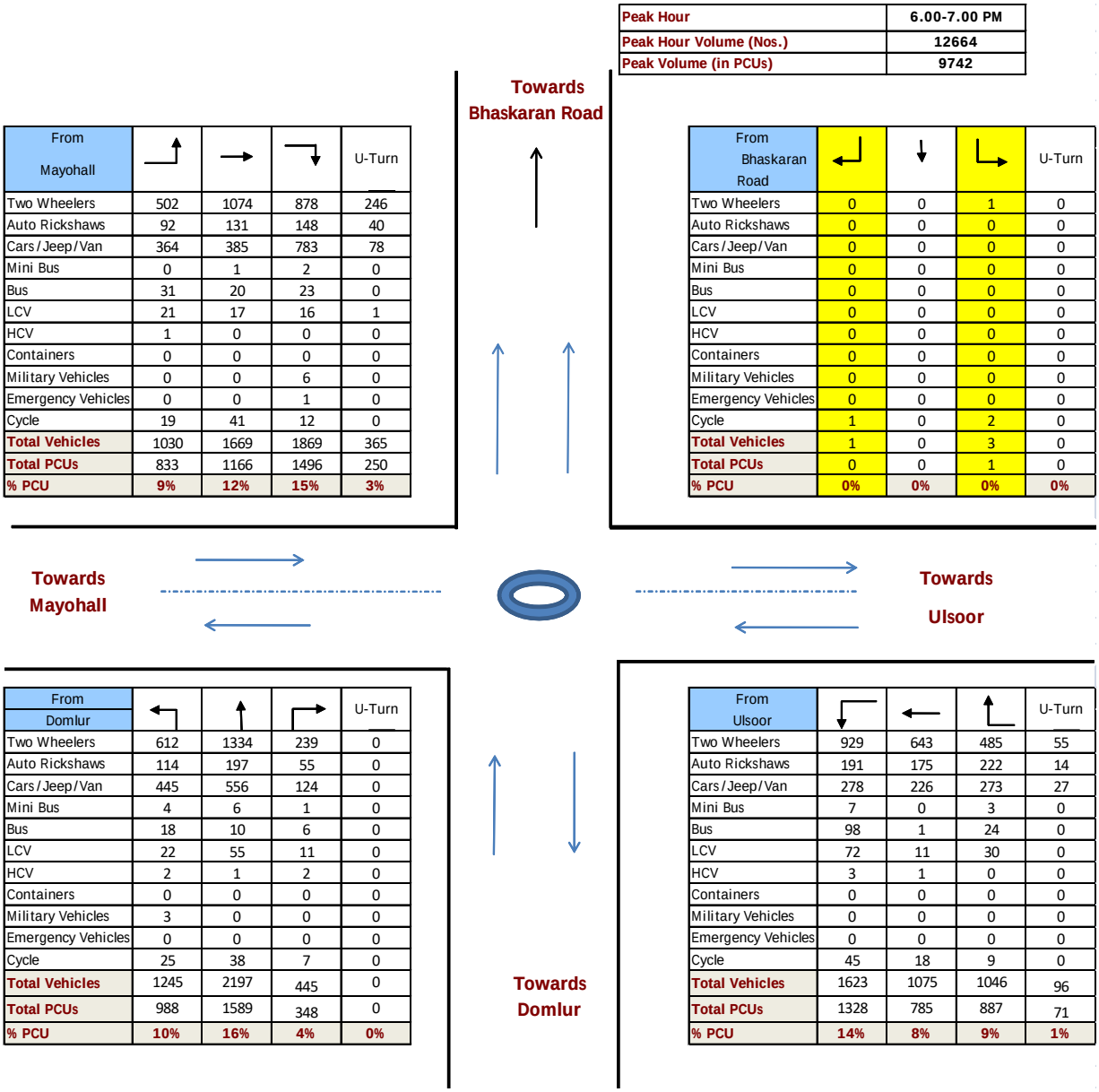
From Mayohall	↑	→	↓	U-Turn
Two Wheelers	211	922	1216	292
Auto Rickshaws	82	197	161	49
Cars/Jeep/Van	160	357	693	128
Mini Bus	0	0	6	0
Bus	37	29	11	0
LCV	10	19	18	2
HCV	2	1	0	0
Containers	0	0	0	0
Military Vehicles	0	1	0	0
Emergency Vehicles	0	1	1	0
Cycle	5	22	12	2
Total Vehicles	507	1549	2118	473
Total PCUs	466	1159	1563	336
% PCU	**5%**	**11%**	**15%**	**3%**

From Bhaskaran Road	↵	↓	↳	U-Turn
Two Wheelers	4	0	4	0
Auto Rickshaws	0	0	1	0
Cars/Jeep/Van	0	0	1	0
Mini Bus	0	0	0	0
Bus	0	0	0	0
LCV	0	0	0	0
HCV	0	0	0	0
Containers	0	0	0	0
Military Vehicles	0	0	0	0
Emergency Vehicles	1	0	0	0
Cycle	6	0	6	0
Total Vehicles	11	0	12	0
Total PCUs	5	0	7	0
% PCU	**0%**	**0%**	**0%**	**0%**

From Domlur	←	↑	→	U-Turn
Two Wheelers	775	1005	250	0
Auto Rickshaws	156	231	112	0
Cars/Jeep/Van	634	418	164	0
Mini Bus	0	0	0	0
Bus	26	13	0	0
LCV	6	33	6	0
HCV	1	1	0	0
Containers	0	0	0	0
Military Vehicles	2	1	0	0
Emergency Vehicles	0	0	0	0
Cycle	12	46	5	0
Total Vehicles	1612	1748	537	0
Total PCUs	1286	1295	434	0
% PCU	**13%**	**13%**	**4%**	**0%**

From Ulsoor	↓	←	↑	U-Turn
Two Wheelers	1540	990	726	49
Auto Rickshaws	172	204	195	10
Cars/Jeep/Van	309	307	250	13
Mini Bus	0	0	0	0
Bus	112	3	28	0
LCV	51	3	17	2
HCV	2	1	1	0
Containers	0	0	0	0
Military Vehicles	0	1	0	0
Emergency Vehicles	0	0	0	0
Cycle	73	49	12	1
Total Vehicles	2259	1558	1229	75
Total PCUs	1637	1082	939	53
% PCU	**16%**	**11%**	**9%**	**1%**

Figure 14: Trinity Circle Evening Peak Hour Volume (31/03/2016)



Peak Hour	6.00-7.00 PM
Peak Hour Volume (Nos.)	12664
Peak Volume (in PCUs)	9742

From Mayohall				U-Turn
Two Wheelers	502	1074	878	246
Auto Rickshaws	92	131	148	40
Cars / Jeep / Van	364	385	783	78
Mini Bus	0	1	2	0
Bus	31	20	23	0
LCV	21	17	16	1
HCV	1	0	0	0
Containers	0	0	0	0
Military Vehicles	0	0	6	0
Emergency Vehicles	0	0	1	0
Cycle	19	41	12	0
Total Vehicles	1030	1669	1869	365
Total PCUs	833	1166	1496	250
% PCU	**9%**	**12%**	**15%**	**3%**

From Bhaskaran Road				U-Turn
Two Wheelers	0	0	1	0
Auto Rickshaws	0	0	0	0
Cars / Jeep / Van	0	0	0	0
Mini Bus	0	0	0	0
Bus	0	0	0	0
LCV	0	0	0	0
HCV	0	0	0	0
Containers	0	0	0	0
Military Vehicles	0	0	0	0
Emergency Vehicles	0	0	0	0
Cycle	1	0	2	0
Total Vehicles	1	0	3	0
Total PCUs	0	0	1	0
% PCU	**0%**	**0%**	**0%**	**0%**

From Domlur				U-Turn
Two Wheelers	612	1334	239	0
Auto Rickshaws	114	197	55	0
Cars / Jeep / Van	445	556	124	0
Mini Bus	4	6	1	0
Bus	18	10	6	0
LCV	22	55	11	0
HCV	2	1	2	0
Containers	0	0	0	0
Military Vehicles	3	0	0	0
Emergency Vehicles	0	0	0	0
Cycle	25	38	7	0
Total Vehicles	1245	2197	445	0
Total PCUs	988	1589	348	0
% PCU	**10%**	**16%**	**4%**	**0%**

From Ulsoor				U-Turn
Two Wheelers	929	643	485	55
Auto Rickshaws	191	175	222	14
Cars / Jeep / Van	278	226	273	27
Mini Bus	7	0	3	0
Bus	98	1	24	0
LCV	72	11	30	0
HCV	3	1	0	0
Containers	0	0	0	0
Military Vehicles	0	0	0	0
Emergency Vehicles	0	0	0	0
Cycle	45	18	9	0
Total Vehicles	1623	1075	1046	96
Total PCUs	1328	785	887	71
% PCU	**14%**	**8%**	**9%**	**1%**

Figure 15: Kamraj & Cubbon Road Junction Morning Peak Hour Volume (17/03/2016)

Peak Hour	9.00-10.00 AM
Peak Hour Volume (Nos.)	13105
Peak Volume (in PCUs)	9591

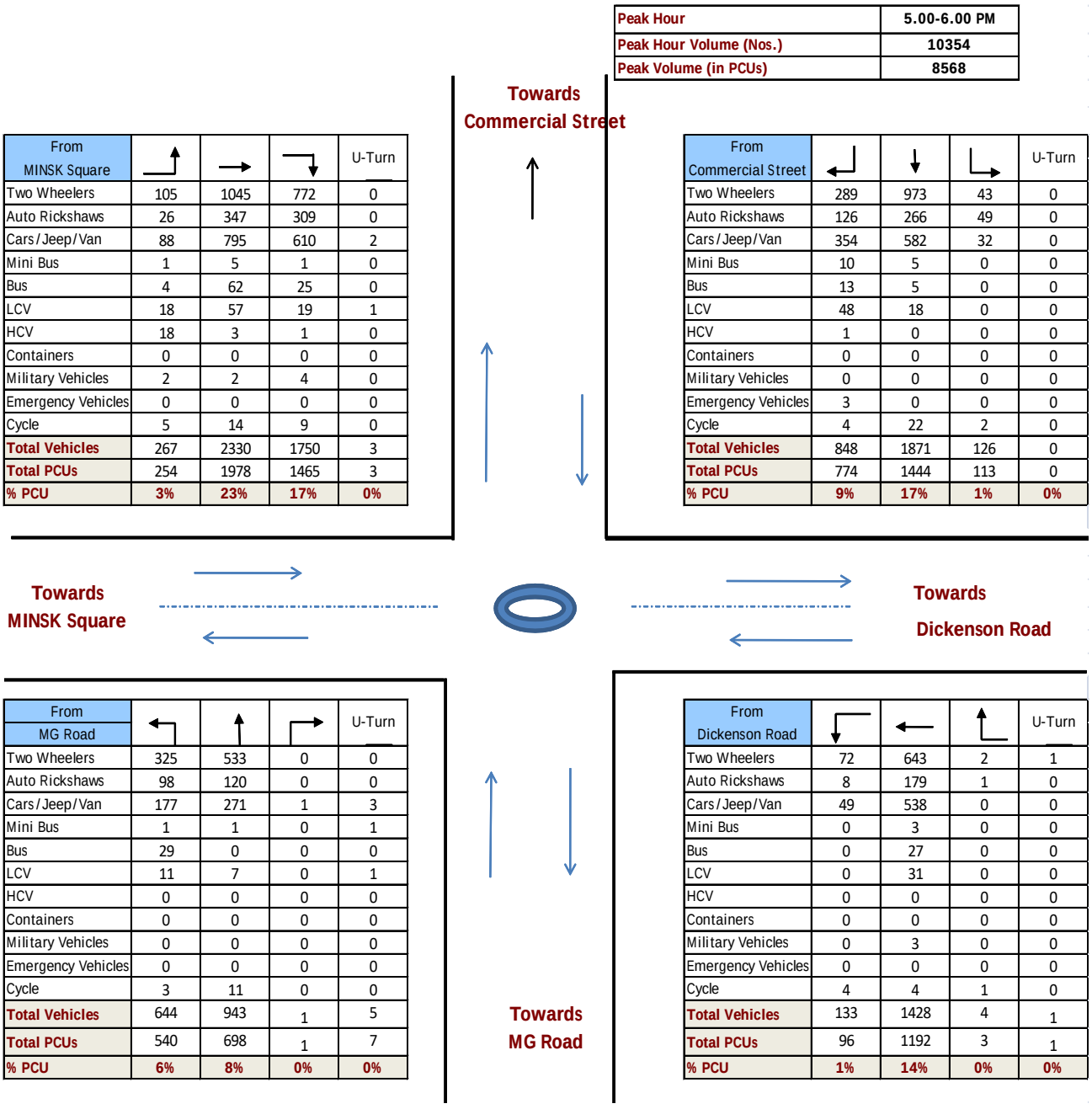
From MISN SK Square	↰	↑	↱	U-Turn
Two Wheelers	51	1913	1402	0
Auto Rickshaws	7	442	265	0
Cars/Jeep/Van	19	928	593	0
Mini Bus	0	2	2	0
Bus	0	43	33	0
LCV	9	34	10	0
HCV	7	1	0	0
Containers	0	0	0	0
Military Vehicles	1	1	1	0
Emergency Vehicles	0	0	0	0
Cycle	2	13	5	0
Total Vehicles	96	3377	2311	0
Total PCUs	84	2571	1707	0
% PCU	**1%**	**27%**	**18%**	**0%**

From Commercial Street	↰	↓	↱	U-Turn
Two Wheelers	479	2785	84	0
Auto Rickshaws	111	193	17	0
Cars/Jeep/Van	350	762	27	0
Mini Bus	2	0	0	0
Bus	7	0	0	0
LCV	32	22	0	0
HCV	4	0	0	0
Containers	0	0	0	0
Military Vehicles	6	1	0	0
Emergency Vehicles	0	0	0	0
Cycle	4	58	1	0
Total Vehicles	995	3821	129	0
Total PCUs	811	2442	90	0
% PCU	**8%**	**25%**	**1%**	**0%**

From M G Road	↰	↑	↱	U-Turn
Two Wheelers	253	339	0	0
Auto Rickshaws	76	73	0	0
Cars/Jeep/Van	95	125	0	0
Mini Bus	0	0	0	0
Bus	33	0	0	0
LCV	11	9	0	0
HCV	0	0	0	0
Containers	0	0	0	0
Military Vehicles	1	0	0	0
Emergency Vehicles	0	0	0	0
Cycle	9	40	0	0
Total Vehicles	478	586	0	0
Total PCUs	407	411	0	0
% PCU	**4%**	**4%**	**0%**	**0%**

From Dickenson Road	↓	←	↰	U-Turn
Two Wheelers	66	528	0	0
Auto Rickshaws	10	156	0	0
Cars/Jeep/Van	38	426	0	0
Mini Bus	0	0	0	0
Bus	0	30	0	0
LCV	0	12	0	0
HCV	0	0	0	0
Containers	0	0	0	0
Military Vehicles	0	4	0	0
Emergency Vehicles	0	0	0	0
Cycle	16	25	1	0
Total Vehicles	130	1181	1	0
Total PCUs	89	979	0	0
% PCU	**1%**	**10%**	**0%**	**0%**

Figure 16: Kamraj & Cubbon Road Junction Evening Peak Hour Volume (17/03/2016)



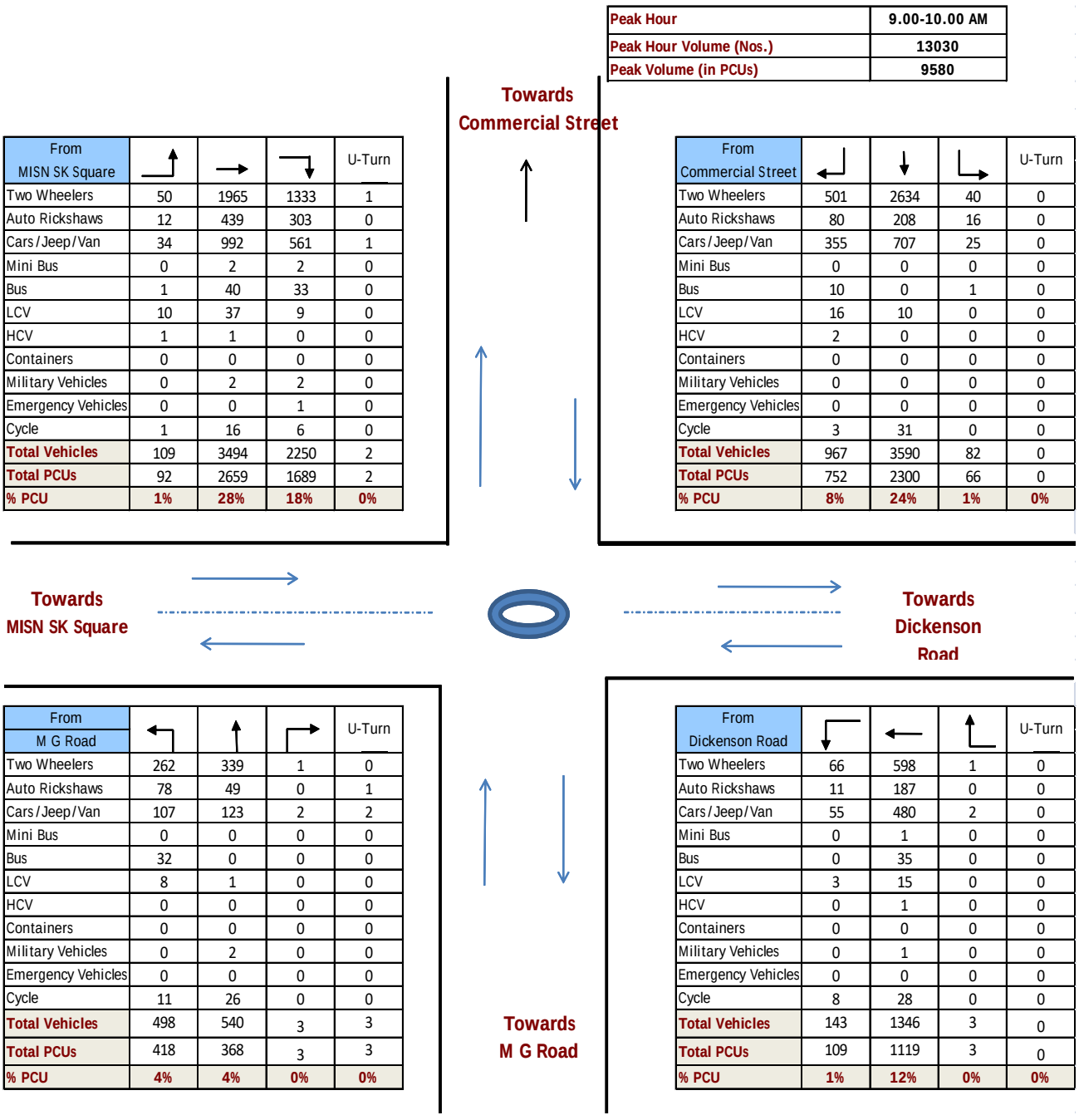
From MINSK Square	↑	→	↓	U-Turn
Two Wheelers	105	1045	772	0
Auto Rickshaws	26	347	309	0
Cars/Jeep/Van	88	795	610	2
Mini Bus	1	5	1	0
Bus	4	62	25	0
LCV	18	57	19	1
HCV	18	3	1	0
Containers	0	0	0	0
Military Vehicles	2	2	4	0
Emergency Vehicles	0	0	0	0
Cycle	5	14	9	0
Total Vehicles	267	2330	1750	3
Total PCUs	254	1978	1465	3
% PCU	**3%**	**23%**	**17%**	**0%**

From Commercial Street	←	↓	→	U-Turn
Two Wheelers	289	973	43	0
Auto Rickshaws	126	266	49	0
Cars/Jeep/Van	354	582	32	0
Mini Bus	10	5	0	0
Bus	13	5	0	0
LCV	48	18	0	0
HCV	1	0	0	0
Containers	0	0	0	0
Military Vehicles	0	0	0	0
Emergency Vehicles	3	0	0	0
Cycle	4	22	2	0
Total Vehicles	848	1871	126	0
Total PCUs	774	1444	113	0
% PCU	**9%**	**17%**	**1%**	**0%**

From MG Road	←	↑	→	U-Turn
Two Wheelers	325	533	0	0
Auto Rickshaws	98	120	0	0
Cars/Jeep/Van	177	271	1	3
Mini Bus	1	1	0	1
Bus	29	0	0	0
LCV	11	7	0	1
HCV	0	0	0	0
Containers	0	0	0	0
Military Vehicles	0	0	0	0
Emergency Vehicles	0	0	0	0
Cycle	3	11	0	0
Total Vehicles	644	943	1	5
Total PCUs	540	698	1	7
% PCU	**6%**	**8%**	**0%**	**0%**

From Dickenson Road	↓	←	↑	U-Turn
Two Wheelers	72	643	2	1
Auto Rickshaws	8	179	1	0
Cars/Jeep/Van	49	538	0	0
Mini Bus	0	3	0	0
Bus	0	27	0	0
LCV	0	31	0	0
HCV	0	0	0	0
Containers	0	0	0	0
Military Vehicles	0	3	0	0
Emergency Vehicles	0	0	0	0
Cycle	4	4	1	0
Total Vehicles	133	1428	4	1
Total PCUs	96	1192	3	1
% PCU	**1%**	**14%**	**0%**	**0%**

Figure 17: Kamraj & Cubbon Road Junction Morning Peak Hour Volume (22/03/2016)



Peak Hour	9.00-10.00 AM
Peak Hour Volume (Nos.)	13030
Peak Volume (in PCUs)	9580

From MISN SK Square	↑	→	↓	U-Turn
Two Wheelers	50	1965	1333	1
Auto Rickshaws	12	439	303	0
Cars/Jeep/Van	34	992	561	1
Mini Bus	0	2	2	0
Bus	1	40	33	0
LCV	10	37	9	0
HCV	1	1	0	0
Containers	0	0	0	0
Military Vehicles	0	2	2	0
Emergency Vehicles	0	0	1	0
Cycle	1	16	6	0
Total Vehicles	109	3494	2250	2
Total PCUs	92	2659	1689	2
% PCU	**1%**	**28%**	**18%**	**0%**

From Commercial Street	←	↓	→	U-Turn
Two Wheelers	501	2634	40	0
Auto Rickshaws	80	208	16	0
Cars/Jeep/Van	355	707	25	0
Mini Bus	0	0	0	0
Bus	10	0	1	0
LCV	16	10	0	0
HCV	2	0	0	0
Containers	0	0	0	0
Military Vehicles	0	0	0	0
Emergency Vehicles	0	0	0	0
Cycle	3	31	0	0
Total Vehicles	967	3590	82	0
Total PCUs	752	2300	66	0
% PCU	**8%**	**24%**	**1%**	**0%**

From M G Road	←	↑	→	U-Turn
Two Wheelers	262	339	1	0
Auto Rickshaws	78	49	0	1
Cars/Jeep/Van	107	123	2	2
Mini Bus	0	0	0	0
Bus	32	0	0	0
LCV	8	1	0	0
HCV	0	0	0	0
Containers	0	0	0	0
Military Vehicles	0	2	0	0
Emergency Vehicles	0	0	0	0
Cycle	11	26	0	0
Total Vehicles	498	540	3	3
Total PCUs	418	368	3	3
% PCU	**4%**	**4%**	**0%**	**0%**

From Dickenson Road	↓	←	↑	U-Turn
Two Wheelers	66	598	1	0
Auto Rickshaws	11	187	0	0
Cars/Jeep/Van	55	480	2	0
Mini Bus	0	1	0	0
Bus	0	35	0	0
LCV	3	15	0	0
HCV	0	1	0	0
Containers	0	0	0	0
Military Vehicles	0	1	0	0
Emergency Vehicles	0	0	0	0
Cycle	8	28	0	0
Total Vehicles	143	1346	3	0
Total PCUs	109	1119	3	0
% PCU	**1%**	**12%**	**0%**	**0%**

Figure 18: Kamraj & Cubbon Road Junction Evening Peak Hour Volume (22/03/2016)

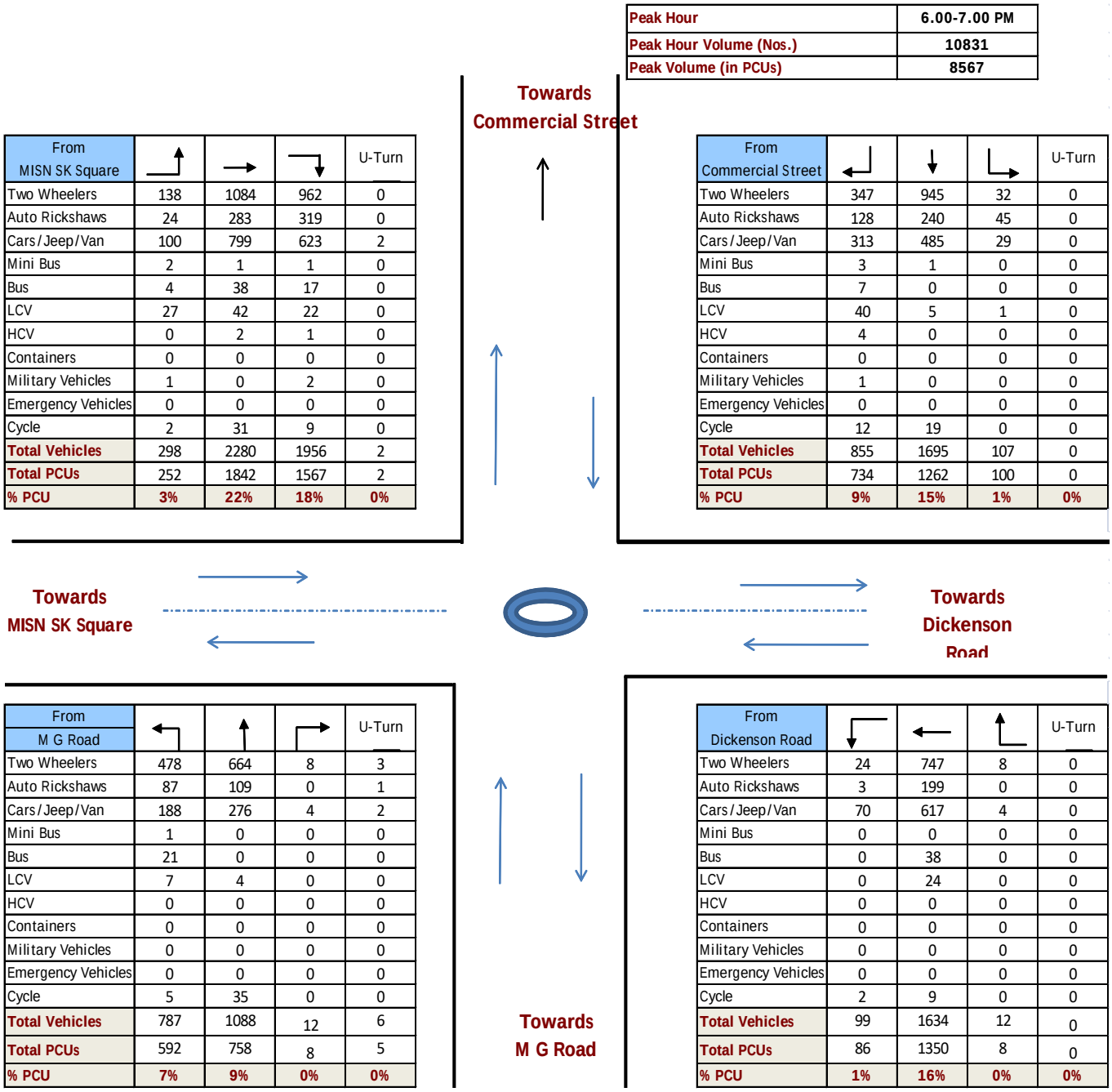
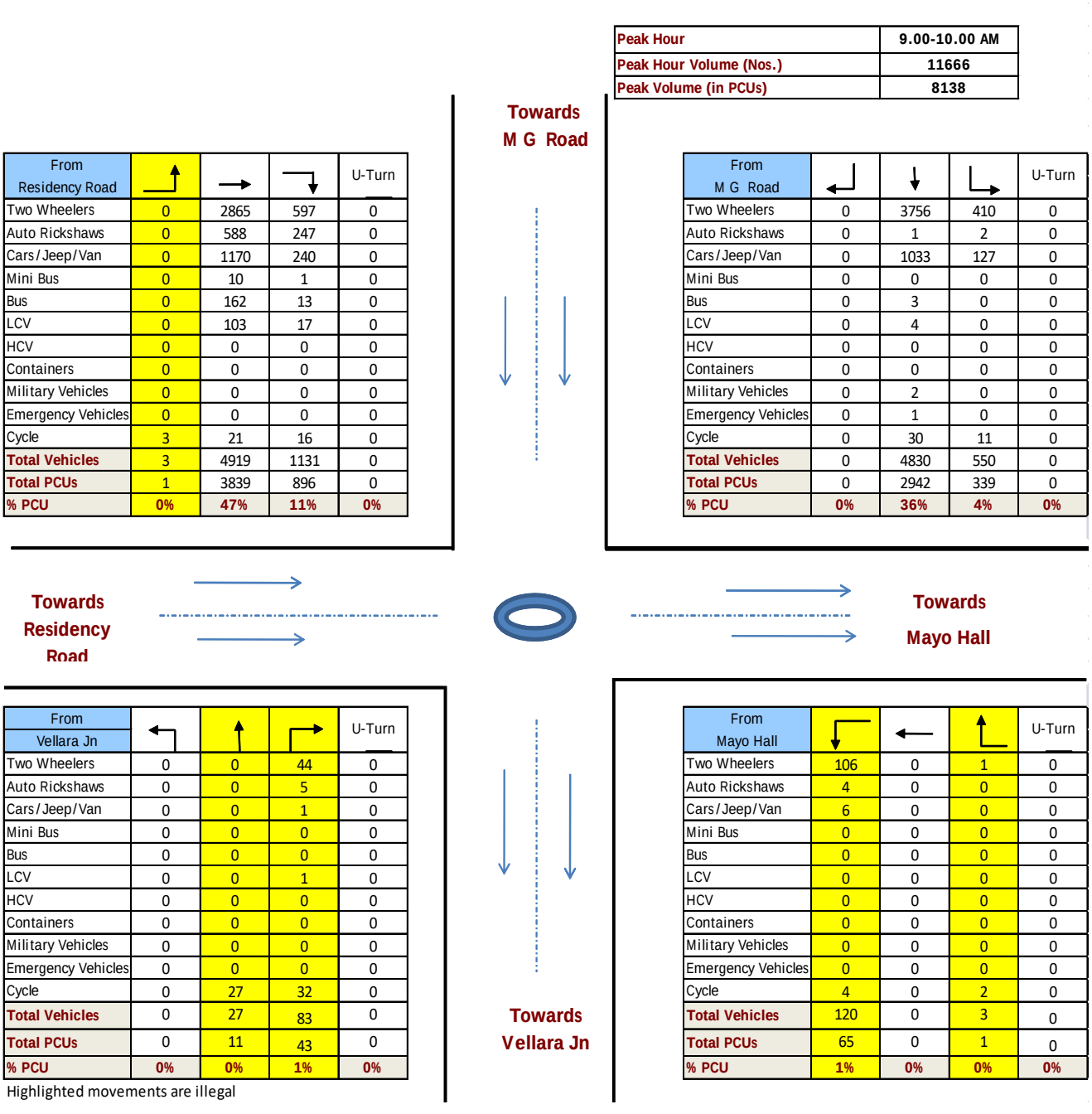


Figure 19: Opera Junction Morning Peak Hour Volume (17/03/2016)

Peak Hour	9.00-10.00 AM
Peak Hour Volume (Nos.)	11666
Peak Volume (in PCUs)	8138



From Residency Road	↑	→	↓	U-Turn
Two Wheelers	0	2865	597	0
Auto Rickshaws	0	588	247	0
Cars/Jeep/Van	0	1170	240	0
Mini Bus	0	10	1	0
Bus	0	162	13	0
LCV	0	103	17	0
HCV	0	0	0	0
Containers	0	0	0	0
Military Vehicles	0	0	0	0
Emergency Vehicles	0	0	0	0
Cycle	3	21	16	0
Total Vehicles	3	4919	1131	0
Total PCUs	1	3839	896	0
% PCU	0%	47%	11%	0%

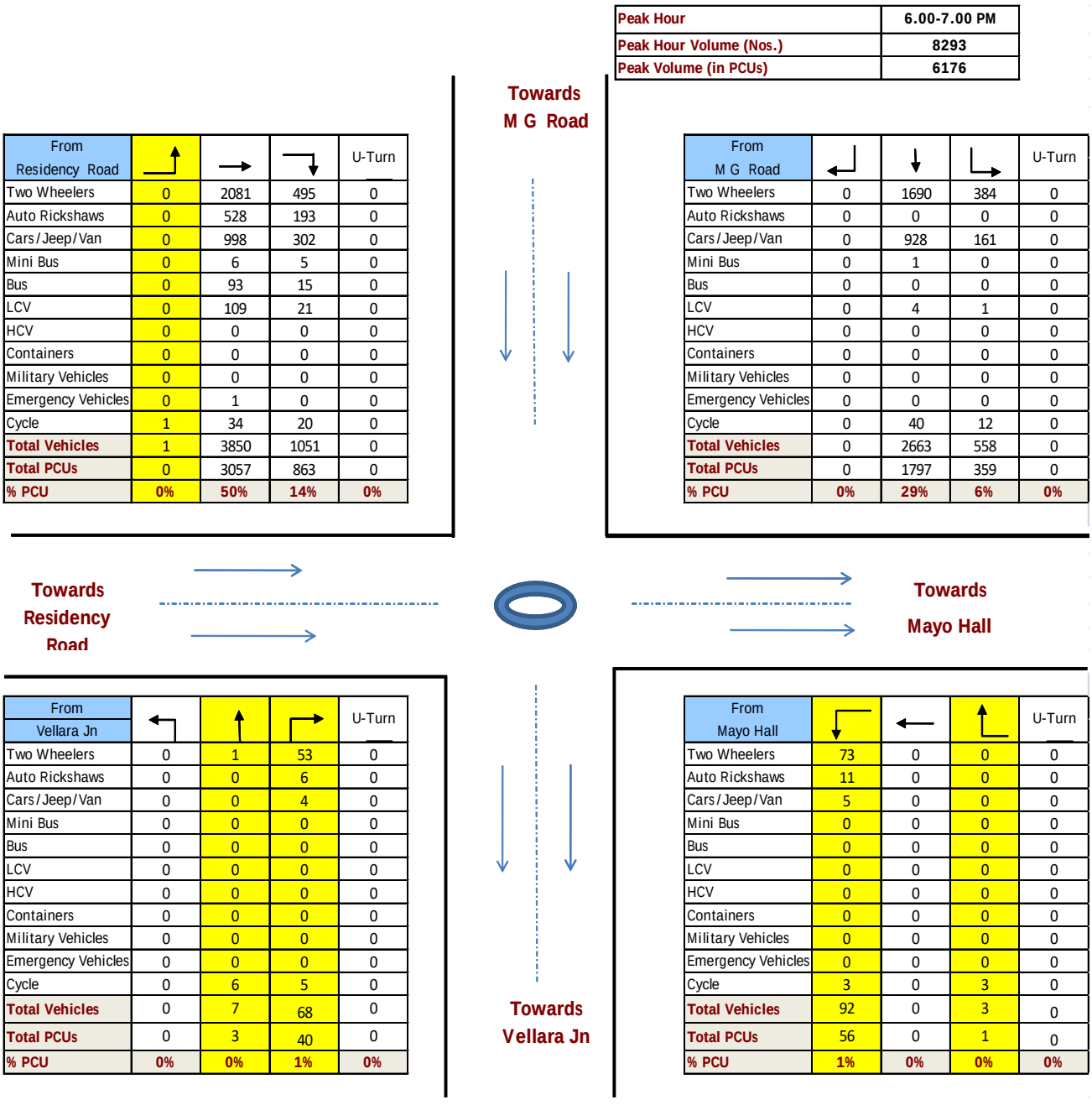
From M G Road	←	↓	→	U-Turn
Two Wheelers	0	3756	410	0
Auto Rickshaws	0	1	2	0
Cars/Jeep/Van	0	1033	127	0
Mini Bus	0	0	0	0
Bus	0	3	0	0
LCV	0	4	0	0
HCV	0	0	0	0
Containers	0	0	0	0
Military Vehicles	0	2	0	0
Emergency Vehicles	0	1	0	0
Cycle	0	30	11	0
Total Vehicles	0	4830	550	0
Total PCUs	0	2942	339	0
% PCU	0%	36%	4%	0%

From Vellara Jn	←	↑	→	U-Turn
Two Wheelers	0	0	44	0
Auto Rickshaws	0	0	5	0
Cars/Jeep/Van	0	0	1	0
Mini Bus	0	0	0	0
Bus	0	0	0	0
LCV	0	0	1	0
HCV	0	0	0	0
Containers	0	0	0	0
Military Vehicles	0	0	0	0
Emergency Vehicles	0	0	0	0
Cycle	0	27	32	0
Total Vehicles	0	27	83	0
Total PCUs	0	11	43	0
% PCU	0%	0%	1%	0%

Highlighted movements are illegal

From Mayo Hall	↓	←	↑	U-Turn
Two Wheelers	106	0	1	0
Auto Rickshaws	4	0	0	0
Cars/Jeep/Van	6	0	0	0
Mini Bus	0	0	0	0
Bus	0	0	0	0
LCV	0	0	0	0
HCV	0	0	0	0
Containers	0	0	0	0
Military Vehicles	0	0	0	0
Emergency Vehicles	0	0	0	0
Cycle	4	0	2	0
Total Vehicles	120	0	3	0
Total PCUs	65	0	1	0
% PCU	1%	0%	0%	0%

Figure 20: Opera Junction Evening Peak Hour Volume (17/03/2016)



From Residency Road	↑	→	↓	U-Turn
Two Wheelers	0	2081	495	0
Auto Rickshaws	0	528	193	0
Cars/Jeep/Van	0	998	302	0
Mini Bus	0	6	5	0
Bus	0	93	15	0
LCV	0	109	21	0
HCV	0	0	0	0
Containers	0	0	0	0
Military Vehicles	0	0	0	0
Emergency Vehicles	0	1	0	0
Cycle	1	34	20	0
Total Vehicles	1	3850	1051	0
Total PCUs	0	3057	863	0
% PCU	**0%**	**50%**	**14%**	**0%**

From M G Road	←	↓	→	U-Turn
Two Wheelers	0	1690	384	0
Auto Rickshaws	0	0	0	0
Cars/Jeep/Van	0	928	161	0
Mini Bus	0	1	0	0
Bus	0	0	0	0
LCV	0	4	1	0
HCV	0	0	0	0
Containers	0	0	0	0
Military Vehicles	0	0	0	0
Emergency Vehicles	0	0	0	0
Cycle	0	40	12	0
Total Vehicles	0	2663	558	0
Total PCUs	0	1797	359	0
% PCU	**0%**	**29%**	**6%**	**0%**

From Vellara Jn	←	↑	→	U-Turn
Two Wheelers	0	1	53	0
Auto Rickshaws	0	0	6	0
Cars/Jeep/Van	0	0	4	0
Mini Bus	0	0	0	0
Bus	0	0	0	0
LCV	0	0	0	0
HCV	0	0	0	0
Containers	0	0	0	0
Military Vehicles	0	0	0	0
Emergency Vehicles	0	0	0	0
Cycle	0	6	5	0
Total Vehicles	0	7	68	0
Total PCUs	0	3	40	0
% PCU	**0%**	**0%**	**1%**	**0%**

From Mayo Hall	↓	←	↑	U-Turn
Two Wheelers	73	0	0	0
Auto Rickshaws	11	0	0	0
Cars/Jeep/Van	5	0	0	0
Mini Bus	0	0	0	0
Bus	0	0	0	0
LCV	0	0	0	0
HCV	0	0	0	0
Containers	0	0	0	0
Military Vehicles	0	0	0	0
Emergency Vehicles	0	0	0	0
Cycle	3	0	3	0
Total Vehicles	92	0	3	0
Total PCUs	56	0	1	0
% PCU	**1%**	**0%**	**0%**	**0%**

Figure 21: Opera Junction Morning Peak Hour Volume (22/03/2016)

From Residency Road	↑	→	↓	U-Turn
Two Wheelers	0	2740	718	0
Auto Rickshaws	0	551	263	0
Cars/Jeep/Van	0	1126	275	0
Mini Bus	0	7	0	0
Bus	0	126	12	0
LCV	0	75	14	0
HCV	0	1	0	0
Containers	0	0	0	0
Military Vehicles	0	0	1	0
Emergency Vehicles	0	0	0	0
Cycle	1	19	15	0
Total Vehicles	1	4645	1298	0
Total PCUs	0	3565	1004	0
% PCU	0%	49%	14%	0%

From M G Road	←	↓	→	U-Turn
Two Wheelers	2	2659	320	0
Auto Rickshaws	0	2	1	0
Cars/Jeep/Van	0	984	132	0
Mini Bus	0	0	0	0
Bus	0	0	0	0
LCV	0	9	0	0
HCV	0	0	1	0
Containers	0	0	0	0
Military Vehicles	0	0	0	0
Emergency Vehicles	0	0	0	0
Cycle	1	31	4	0
Total Vehicles	3	3685	458	0
Total PCUs	1	2341	297	0
% PCU	0%	32%	4%	0%

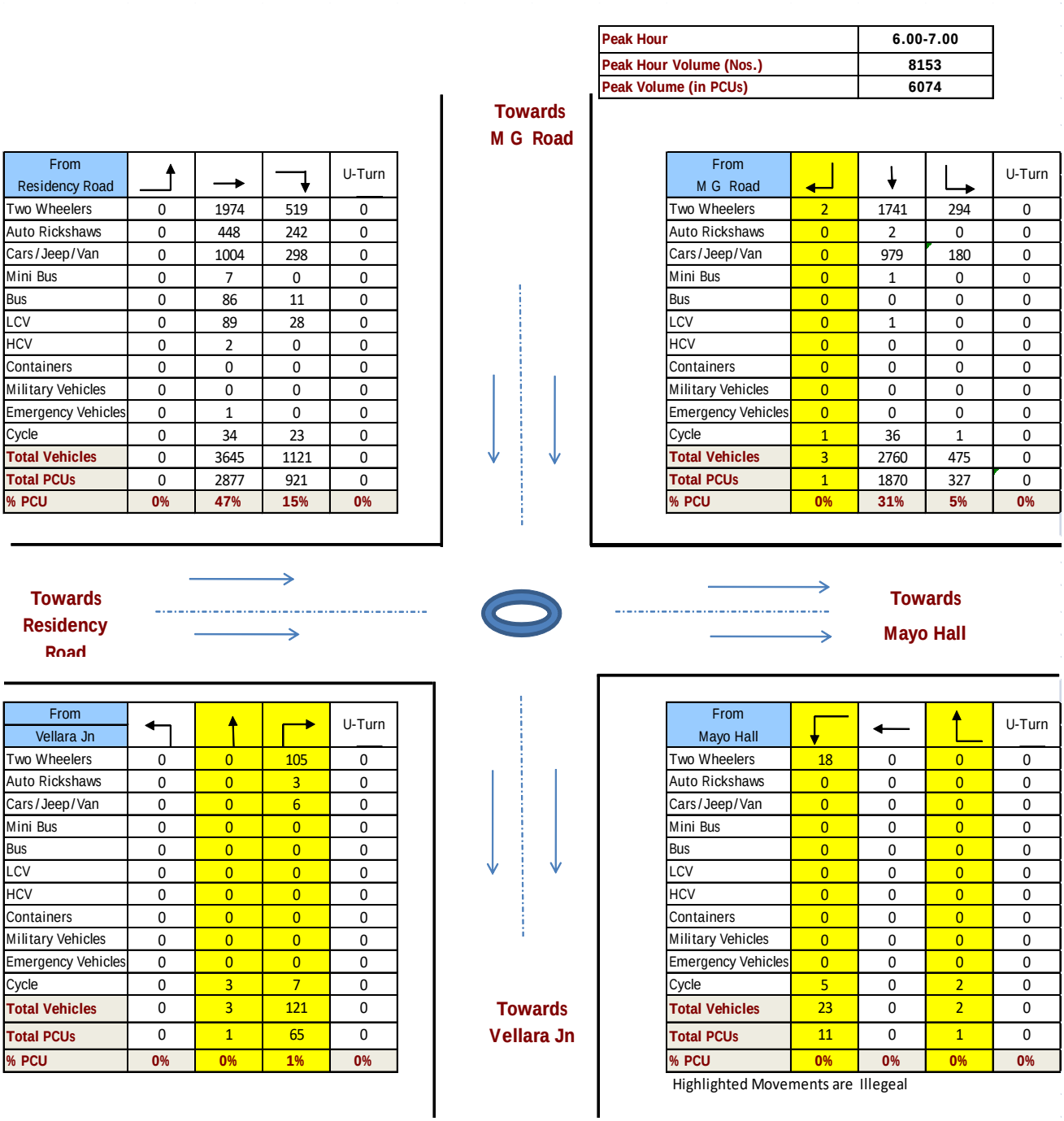
From Vellara Jn	←	↑	→	U-Turn
Two Wheelers	0	0	69	0
Auto Rickshaws	0	0	8	0
Cars/Jeep/Van	0	0	9	0
Mini Bus	0	0	0	0
Bus	0	0	0	0
LCV	0	0	0	0
HCV	0	0	0	0
Containers	0	0	0	0
Military Vehicles	0	0	0	0
Emergency Vehicles	0	0	0	0
Cycle	0	11	19	0
Total Vehicles	0	11	105	0
Total PCUs	0	4	61	0
% PCU	0%	0%	1%	0%

From Mayo Hall	↓	←	↑	U-Turn
Two Wheelers	2	0	0	0
Auto Rickshaws	1	0	0	0
Cars/Jeep/Van	0	0	0	0
Mini Bus	0	0	0	0
Bus	0	0	0	0
LCV	0	0	0	0
HCV	0	0	0	0
Containers	0	0	0	0
Military Vehicles	0	0	0	0
Emergency Vehicles	0	0	0	0
Cycle	3	0	0	0
Total Vehicles	6	0	0	0
Total PCUs	3	0	0	0
% PCU	0%	0%	0%	0%

Highlighted Movements are Illegeal

Figure 22: Opera Junction Evening Peak Hour Volume (22/03/2016)

Peak Hour	6.00-7.00
Peak Hour Volume (Nos.)	8153
Peak Volume (in PCUs)	6074



From Residency Road	↑	→	↓	U-Turn
Two Wheelers	0	1974	519	0
Auto Rickshaws	0	448	242	0
Cars/Jeep/Van	0	1004	298	0
Mini Bus	0	7	0	0
Bus	0	86	11	0
LCV	0	89	28	0
HCV	0	2	0	0
Containers	0	0	0	0
Military Vehicles	0	0	0	0
Emergency Vehicles	0	1	0	0
Cycle	0	34	23	0
Total Vehicles	0	3645	1121	0
Total PCUs	0	2877	921	0
% PCU	**0%**	**47%**	**15%**	**0%**

From M G Road	←	↓	→	U-Turn
Two Wheelers	2	1741	294	0
Auto Rickshaws	0	2	0	0
Cars/Jeep/Van	0	979	180	0
Mini Bus	0	1	0	0
Bus	0	0	0	0
LCV	0	1	0	0
HCV	0	0	0	0
Containers	0	0	0	0
Military Vehicles	0	0	0	0
Emergency Vehicles	0	0	0	0
Cycle	1	36	1	0
Total Vehicles	3	2760	475	0
Total PCUs	1	1870	327	0
% PCU	**0%**	**31%**	**5%**	**0%**

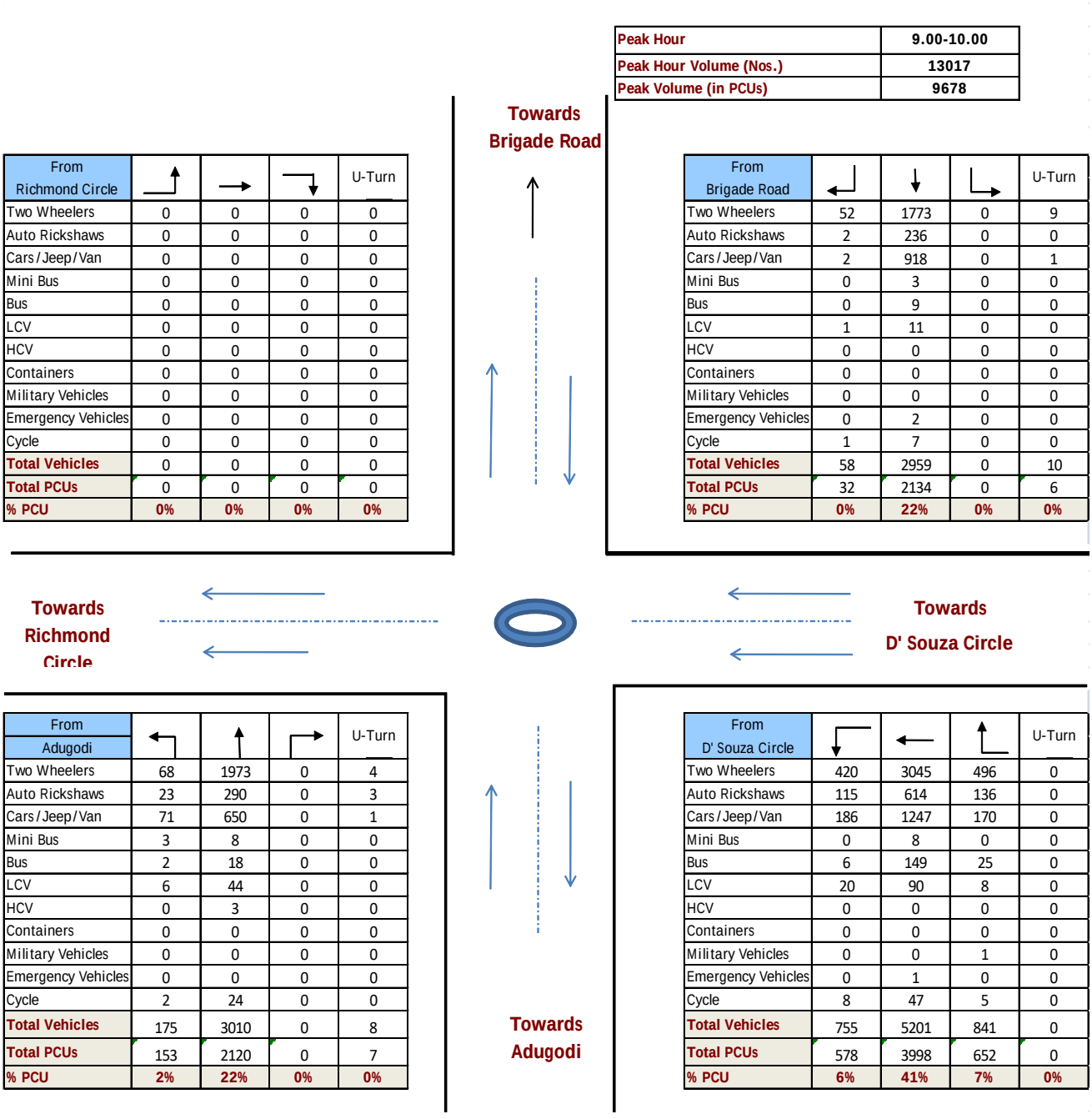
From Vellara Jn	←	↑	→	U-Turn
Two Wheelers	0	0	105	0
Auto Rickshaws	0	0	3	0
Cars/Jeep/Van	0	0	6	0
Mini Bus	0	0	0	0
Bus	0	0	0	0
LCV	0	0	0	0
HCV	0	0	0	0
Containers	0	0	0	0
Military Vehicles	0	0	0	0
Emergency Vehicles	0	0	0	0
Cycle	0	3	7	0
Total Vehicles	0	3	121	0
Total PCUs	0	1	65	0
% PCU	**0%**	**0%**	**1%**	**0%**

From Mayo Hall	↓	←	↑	U-Turn
Two Wheelers	18	0	0	0
Auto Rickshaws	0	0	0	0
Cars/Jeep/Van	0	0	0	0
Mini Bus	0	0	0	0
Bus	0	0	0	0
LCV	0	0	0	0
HCV	0	0	0	0
Containers	0	0	0	0
Military Vehicles	0	0	0	0
Emergency Vehicles	0	0	0	0
Cycle	5	0	2	0
Total Vehicles	23	0	2	0
Total PCUs	11	0	1	0
% PCU	**0%**	**0%**	**0%**	**0%**

Highlighted Movements are Illegeal

Figure 23: Vellara Junction Morning Peak Hour Volume (17/03/2016)

Peak Hour	9.00-10.00
Peak Hour Volume (Nos.)	13017
Peak Volume (in PCUs)	9678



From Richmond Circle	↑	→	↓	U-Turn
Two Wheelers	0	0	0	0
Auto Rickshaws	0	0	0	0
Cars / Jeep / Van	0	0	0	0
Mini Bus	0	0	0	0
Bus	0	0	0	0
LCV	0	0	0	0
HCV	0	0	0	0
Containers	0	0	0	0
Military Vehicles	0	0	0	0
Emergency Vehicles	0	0	0	0
Cycle	0	0	0	0
Total Vehicles	0	0	0	0
Total PCUs	0	0	0	0
% PCU	**0%**	**0%**	**0%**	**0%**

From Brigade Road	←	↓	→	U-Turn
Two Wheelers	52	1773	0	9
Auto Rickshaws	2	236	0	0
Cars / Jeep / Van	2	918	0	1
Mini Bus	0	3	0	0
Bus	0	9	0	0
LCV	1	11	0	0
HCV	0	0	0	0
Containers	0	0	0	0
Military Vehicles	0	0	0	0
Emergency Vehicles	0	2	0	0
Cycle	1	7	0	0
Total Vehicles	58	2959	0	10
Total PCUs	32	2134	0	6
% PCU	**0%**	**22%**	**0%**	**0%**

From Adugodi	←	↑	→	U-Turn
Two Wheelers	68	1973	0	4
Auto Rickshaws	23	290	0	3
Cars / Jeep / Van	71	650	0	1
Mini Bus	3	8	0	0
Bus	2	18	0	0
LCV	6	44	0	0
HCV	0	3	0	0
Containers	0	0	0	0
Military Vehicles	0	0	0	0
Emergency Vehicles	0	0	0	0
Cycle	2	24	0	0
Total Vehicles	175	3010	0	8
Total PCUs	153	2120	0	7
% PCU	**2%**	**22%**	**0%**	**0%**

From D' Souza Circle	↓	←	↑	U-Turn
Two Wheelers	420	3045	496	0
Auto Rickshaws	115	614	136	0
Cars / Jeep / Van	186	1247	170	0
Mini Bus	0	8	0	0
Bus	6	149	25	0
LCV	20	90	8	0
HCV	0	0	0	0
Containers	0	0	0	0
Military Vehicles	0	0	1	0
Emergency Vehicles	0	1	0	0
Cycle	8	47	5	0
Total Vehicles	755	5201	841	0
Total PCUs	578	3998	652	0
% PCU	**6%**	**41%**	**7%**	**0%**

Figure 24: Vellara Junction Evening Peak Hour Volume (17/03/2016)

Peak Hour	5.00-6.00
Peak Hour Volume (Nos.)	11420
Peak Volume (in PCUs)	9127

Towards Brigade Road

From Richmond Circle	↑	→	↓	U-Turn
Two Wheelers	0	0	0	0
Auto Rickshaws	0	0	0	0
Cars/Jeep/Van	0	0	0	0
Mini Bus	0	0	0	0
Bus	0	0	0	0
LCV	0	0	0	0
HCV	0	0	0	0
Containers	0	0	0	0
Military Vehicles	0	0	0	0
Emergency Vehicles	0	0	0	0
Cycle	0	0	0	0
Total Vehicles	0	0	0	0
Total PCUs	0	0	0	0
% PCU	**0%**	**0%**	**0%**	**0%**

From Brigade Road	←	↓	→	U-Turn
Two Wheelers	89	1249	0	20
Auto Rickshaws	5	270	0	1
Cars/Jeep/Van	12	927	0	1
Mini Bus	0	8	0	0
Bus	0	17	0	0
LCV	2	26	0	0
HCV	0	0	0	0
Containers	0	0	0	0
Military Vehicles	0	0	0	0
Emergency Vehicles	0	1	0	0
Cycle	1	13	0	0
Total Vehicles	109	2511	0	22
Total PCUs	66	1973	0	12
% PCU	**1%**	**22%**	**0%**	**0%**

Towards Richmond Circle

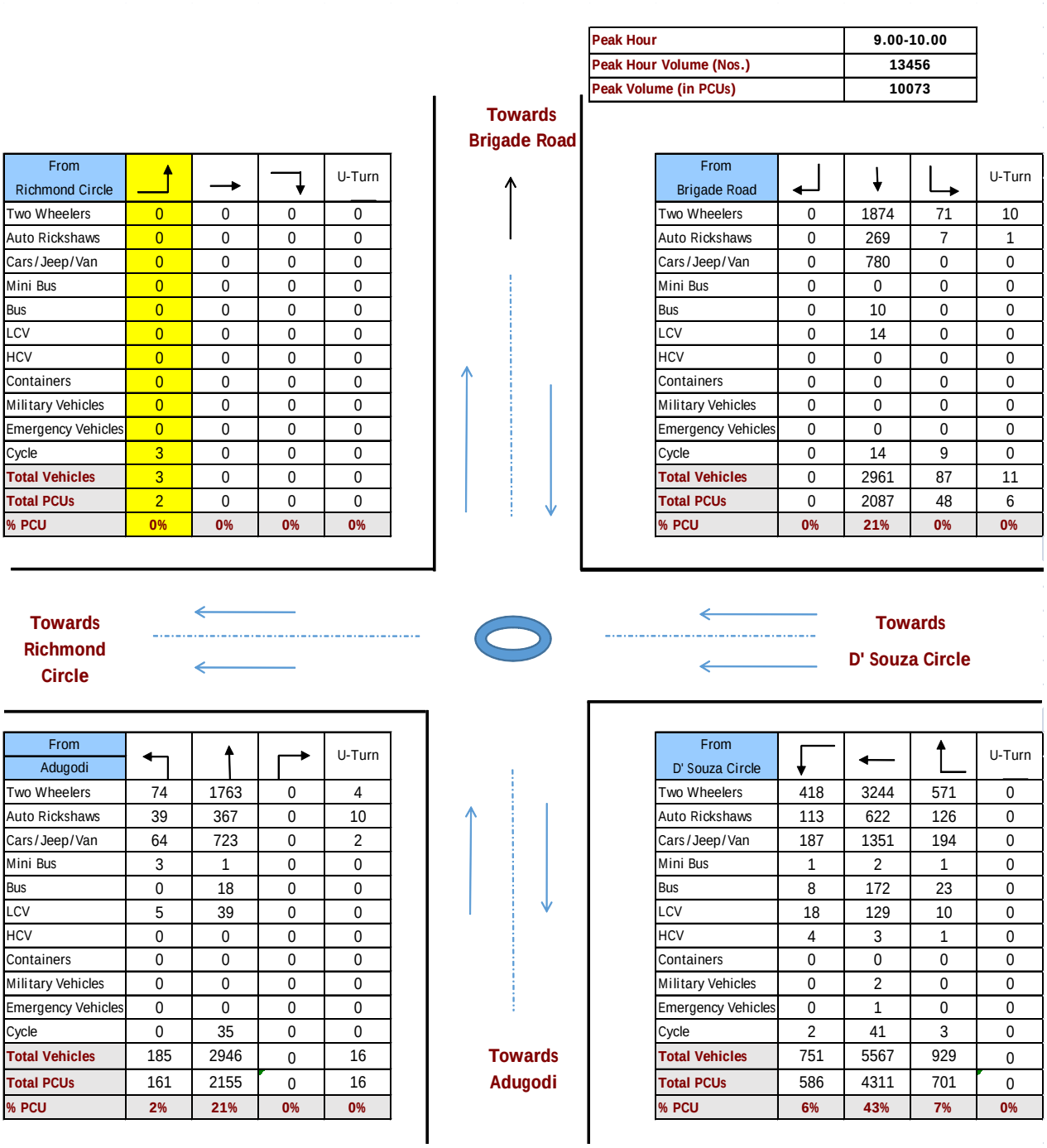
Towards D' Souza Circle

From Adugodi	←	↑	→	U-Turn
Two Wheelers	95	1131	0	8
Auto Rickshaws	26	287	0	5
Cars/Jeep/Van	80	848	0	5
Mini Bus	1	8	0	0
Bus	3	20	0	0
LCV	9	80	0	0
HCV	0	2	0	0
Containers	0	0	0	0
Military Vehicles	0	0	0	0
Emergency Vehicles	0	0	0	0
Cycle	1	8	0	0
Total Vehicles	215	2384	0	18
Total PCUs	181	1939	0	15
% PCU	**2%**	**21%**	**0%**	**0%**

Towards Adugodi

From D' Souza Circle	↓	←	↑	U-Turn
Two Wheelers	380	2608	310	0
Auto Rickshaws	118	584	129	0
Cars/Jeep/Van	188	1313	126	0
Mini Bus	0	17	0	0
Bus	8	110	12	0
LCV	30	203	6	0
HCV	1	0	0	0
Containers	0	0	0	0
Military Vehicles	0	0	0	0
Emergency Vehicles	0	0	1	0
Cycle	3	11	3	0
Total Vehicles	728	4846	587	0
Total PCUs	583	3886	473	0
% PCU	**6%**	**43%**	**5%**	**0%**

Figure 25: Vellara Junction Morning Peak Hour Volume (22/03/2016)



Peak Hour	9.00-10.00
Peak Hour Volume (Nos.)	13456
Peak Volume (in PCUs)	10073

From Richmond Circle	↑	→	↓	U-Turn
Two Wheelers	0	0	0	0
Auto Rickshaws	0	0	0	0
Cars/Jeep/Van	0	0	0	0
Mini Bus	0	0	0	0
Bus	0	0	0	0
LCV	0	0	0	0
HCV	0	0	0	0
Containers	0	0	0	0
Military Vehicles	0	0	0	0
Emergency Vehicles	0	0	0	0
Cycle	3	0	0	0
Total Vehicles	3	0	0	0
Total PCUs	2	0	0	0
% PCU	0%	0%	0%	0%

From Brigade Road	←	↓	→	U-Turn
Two Wheelers	0	1874	71	10
Auto Rickshaws	0	269	7	1
Cars/Jeep/Van	0	780	0	0
Mini Bus	0	0	0	0
Bus	0	10	0	0
LCV	0	14	0	0
HCV	0	0	0	0
Containers	0	0	0	0
Military Vehicles	0	0	0	0
Emergency Vehicles	0	0	0	0
Cycle	0	14	9	0
Total Vehicles	0	2961	87	11
Total PCUs	0	2087	48	6
% PCU	0%	21%	0%	0%

From Adugodi	←	↑	→	U-Turn
Two Wheelers	74	1763	0	4
Auto Rickshaws	39	367	0	10
Cars/Jeep/Van	64	723	0	2
Mini Bus	3	1	0	0
Bus	0	18	0	0
LCV	5	39	0	0
HCV	0	0	0	0
Containers	0	0	0	0
Military Vehicles	0	0	0	0
Emergency Vehicles	0	0	0	0
Cycle	0	35	0	0
Total Vehicles	185	2946	0	16
Total PCUs	161	2155	0	16
% PCU	2%	21%	0%	0%

From D' Souza Circle	↓	←	↑	U-Turn
Two Wheelers	418	3244	571	0
Auto Rickshaws	113	622	126	0
Cars/Jeep/Van	187	1351	194	0
Mini Bus	1	2	1	0
Bus	8	172	23	0
LCV	18	129	10	0
HCV	4	3	1	0
Containers	0	0	0	0
Military Vehicles	0	2	0	0
Emergency Vehicles	0	1	0	0
Cycle	2	41	3	0
Total Vehicles	751	5567	929	0
Total PCUs	586	4311	701	0
% PCU	6%	43%	7%	0%

Figure 26: Vellara Junction Evening Peak Hour Volume (22/03/2016)

Peak Hour	6.00-7.00
Peak Hour Volume (Nos.)	11252
Peak Volume (in PCUs)	8865

Towards Brigade Road

From Richmond Circle	↑	→	↓	U-Turn
Two Wheelers	1	0	0	0
Auto Rickshaws	0	0	0	0
Cars/Jeep/Van	0	0	0	0
Mini Bus	0	0	0	0
Bus	0	0	0	0
LCV	0	0	0	0
HCV	0	0	0	0
Containers	0	0	0	0
Military Vehicles	0	0	0	0
Emergency Vehicles	0	0	0	0
Cycle	1	0	0	0
Total Vehicles	2	0	0	0
Total PCUs	1	0	0	0
% PCU	**0%**	**0%**	**0%**	**0%**

From Brigade Road	←	↓	→	U-Turn
Two Wheelers	0	1313	120	7
Auto Rickshaws	0	252	7	1
Cars/Jeep/Van	0	831	10	4
Mini Bus	0	1	0	0
Bus	0	10	0	0
LCV	0	24	2	0
HCV	0	0	0	0
Containers	0	0	0	0
Military Vehicles	0	0	0	0
Emergency Vehicles	0	0	0	0
Cycle	0	12	6	0
Total Vehicles	0	2443	145	12
Total PCUs	0	1853	84	9
% PCU	**0%**	**21%**	**1%**	**0%**

Towards Richmond Circle

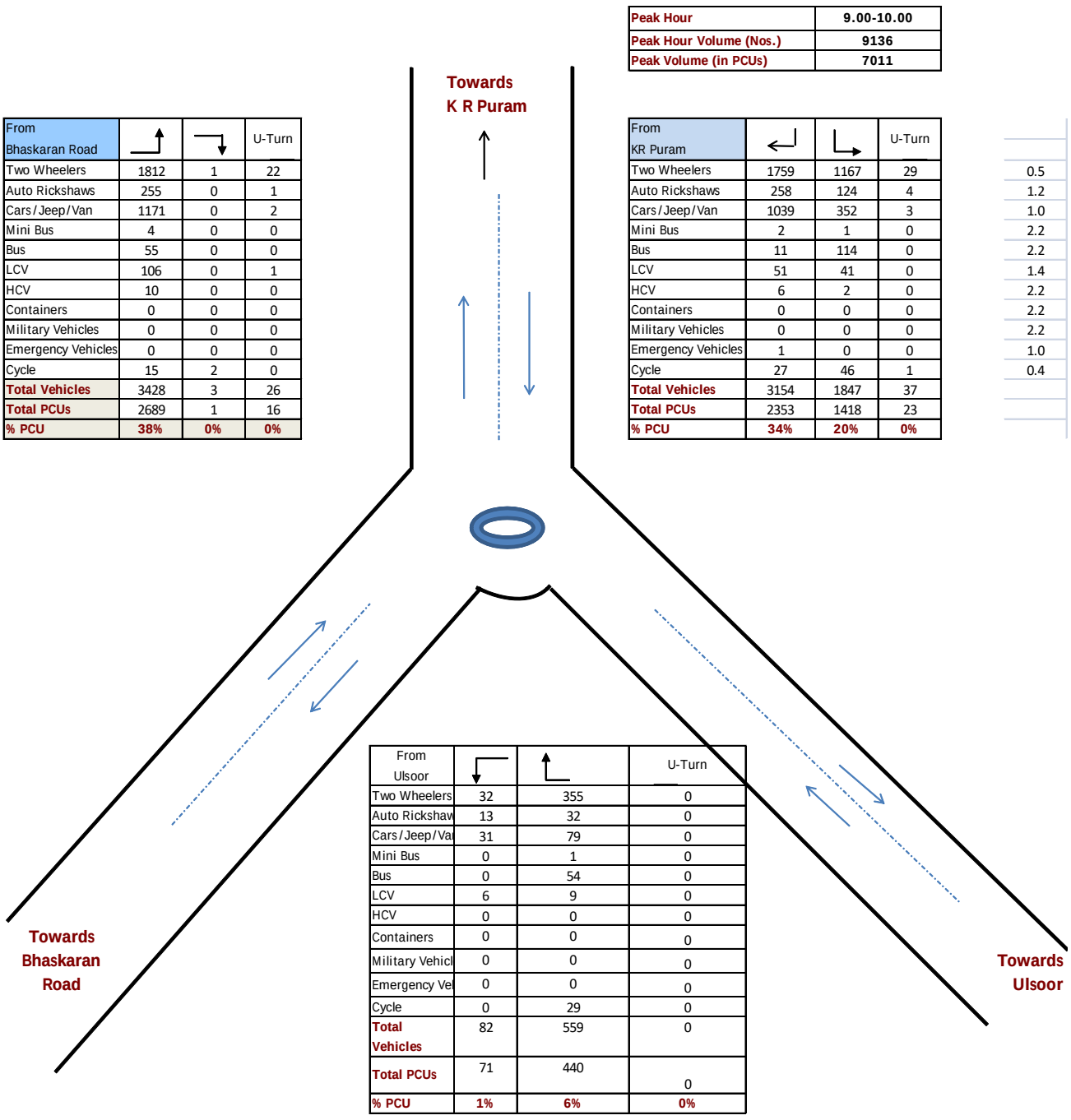
Towards D' Souza Circle

From Adugodi	←	↑	→	U-Turn
Two Wheelers	82	1302	0	15
Auto Rickshaws	20	268	0	4
Cars/Jeep/Van	83	799	0	7
Mini Bus	2	11	0	0
Bus	1	23	0	0
LCV	8	74	0	1
HCV	0	0	0	0
Containers	0	0	0	0
Military Vehicles	0	0	0	0
Emergency Vehicles	0	2	0	0
Cycle	2	28	0	0
Total Vehicles	198	2507	0	27
Total PCUs	167	1963	0	21
% PCU	**2%**	**22%**	**0%**	**0%**

Towards Adugodi

From D' Souza Circle	↓	←	↑	U-Turn
Two Wheelers	399	2416	338	0
Auto Rickshaws	99	499	107	0
Cars/Jeep/Van	176	1342	154	0
Mini Bus	2	37	1	0
Bus	11	118	11	0
LCV	15	156	14	0
HCV	0	4	0	0
Containers	0	1	0	0
Military Vehicles	0	0	0	0
Emergency Vehicles	1	1	0	0
Cycle	0	15	1	0
Total Vehicles	703	4589	626	0
Total PCUs	545	3726	498	0
% PCU	**6%**	**42%**	**6%**	**0%**

Figure 27: Dr. Bhaskaran Road & Swami Vivekanda Junction Morning Peak Hour Volume (24/03/2016)



Peak Hour	9.00-10.00
Peak Hour Volume (Nos.)	9136
Peak Volume (in PCUs)	7011

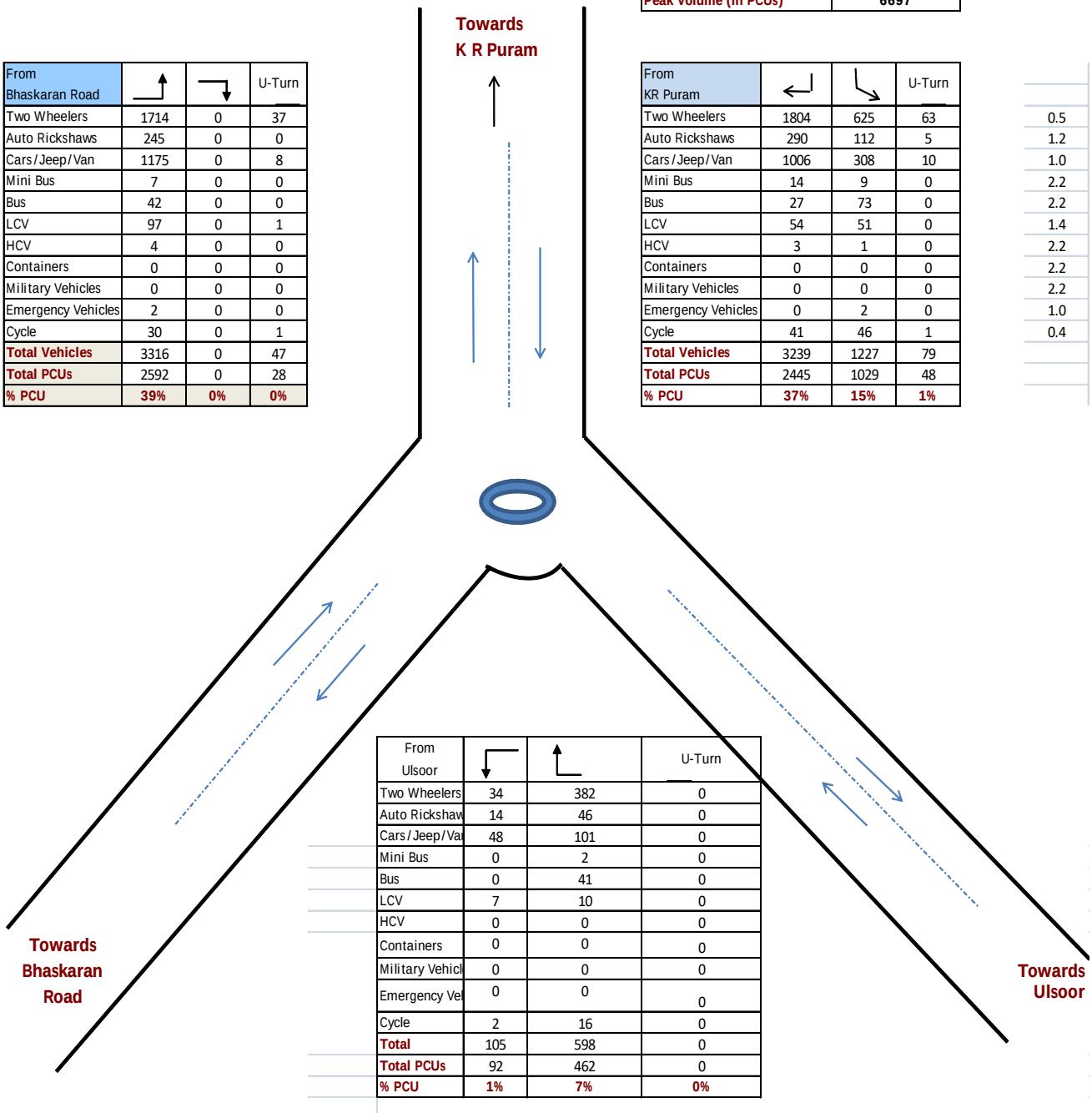
From Bhaskaran Road	↑	↓	U-Turn
Two Wheelers	1812	1	22
Auto Rickshaws	255	0	1
Cars / Jeep / Van	1171	0	2
Mini Bus	4	0	0
Bus	55	0	0
LCV	106	0	1
HCV	10	0	0
Containers	0	0	0
Military Vehicles	0	0	0
Emergency Vehicles	0	0	0
Cycle	15	2	0
Total Vehicles	3428	3	26
Total PCUs	2689	1	16
% PCU	**38%**	**0%**	**0%**

From KR Puram	←	→	U-Turn	
Two Wheelers	1759	1167	29	0.5
Auto Rickshaws	258	124	4	1.2
Cars / Jeep / Van	1039	352	3	1.0
Mini Bus	2	1	0	2.2
Bus	11	114	0	2.2
LCV	51	41	0	1.4
HCV	6	2	0	2.2
Containers	0	0	0	2.2
Military Vehicles	0	0	0	2.2
Emergency Vehicles	1	0	0	1.0
Cycle	27	46	1	0.4
Total Vehicles	3154	1847	37	
Total PCUs	2353	1418	23	
% PCU	**34%**	**20%**	**0%**	

From Ulsoor	↓	←	U-Turn
Two Wheelers	32	355	0
Auto Rickshaw	13	32	0
Cars / Jeep / Va	31	79	0
Mini Bus	0	1	0
Bus	0	54	0
LCV	6	9	0
HCV	0	0	0
Containers	0	0	0
Military Vehicl	0	0	0
Emergency Ve	0	0	0
Cycle	0	29	0
Total Vehicles	82	559	0
Total PCUs	71	440	0
% PCU	**1%**	**6%**	**0%**

Figure 28: Dr. Bhaskaran Road & Swami Vivekanda Junction Evening Peak Hour Volume (24/03/2016)

Peak Hour	6.00-7.00
Peak Hour Volume (Nos.)	8611
Peak Volume (in PCUs)	6697

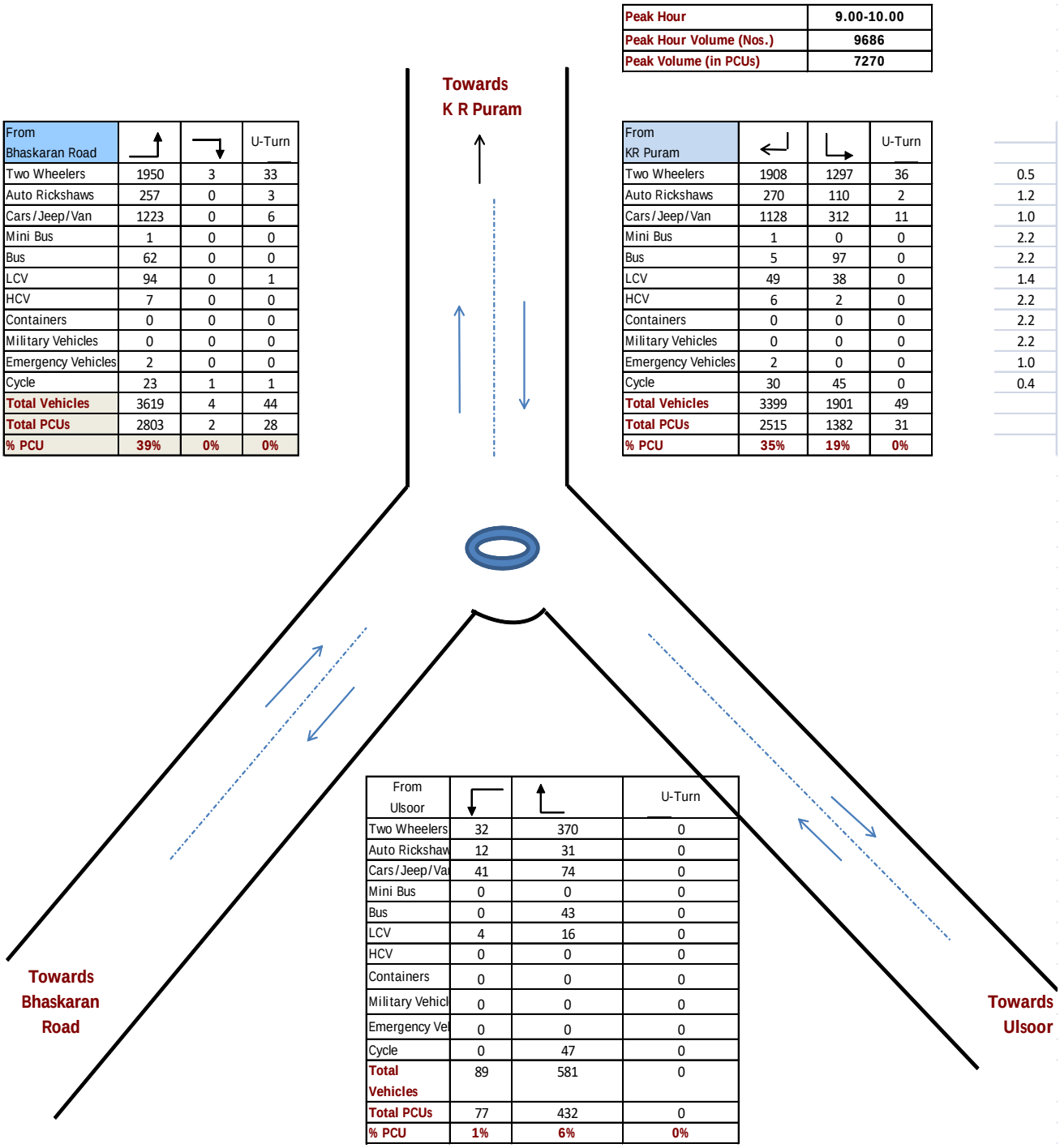


From Bhaskaran Road			U-Turn
Two Wheelers	1714	0	37
Auto Rickshaws	245	0	0
Cars / Jeep / Van	1175	0	8
Mini Bus	7	0	0
Bus	42	0	0
LCV	97	0	1
HCV	4	0	0
Containers	0	0	0
Military Vehicles	0	0	0
Emergency Vehicles	2	0	0
Cycle	30	0	1
Total Vehicles	3316	0	47
Total PCUs	2592	0	28
% PCU	**39%**	**0%**	**0%**

From KR Puram			U-Turn	
Two Wheelers	1804	625	63	0.5
Auto Rickshaws	290	112	5	1.2
Cars / Jeep / Van	1006	308	10	1.0
Mini Bus	14	9	0	2.2
Bus	27	73	0	2.2
LCV	54	51	0	1.4
HCV	3	1	0	2.2
Containers	0	0	0	2.2
Military Vehicles	0	0	0	2.2
Emergency Vehicles	0	2	0	1.0
Cycle	41	46	1	0.4
Total Vehicles	3239	1227	79	
Total PCUs	2445	1029	48	
% PCU	**37%**	**15%**	**1%**	

From Ulsoor			U-Turn
Two Wheelers	34	382	0
Auto Rickshaw	14	46	0
Cars / Jeep / Va	48	101	0
Mini Bus	0	2	0
Bus	0	41	0
LCV	7	10	0
HCV	0	0	0
Containers	0	0	0
Military Vehicl	0	0	0
Emergency Ve	0	0	0
Cycle	2	16	0
Total	105	598	0
Total PCUs	92	462	0
% PCU	**1%**	**7%**	**0%**

Figure 29: Dr. Bhaskaran Road & Swami Vivekanda Junction Morning Peak Hour Volume (29/03/2016)



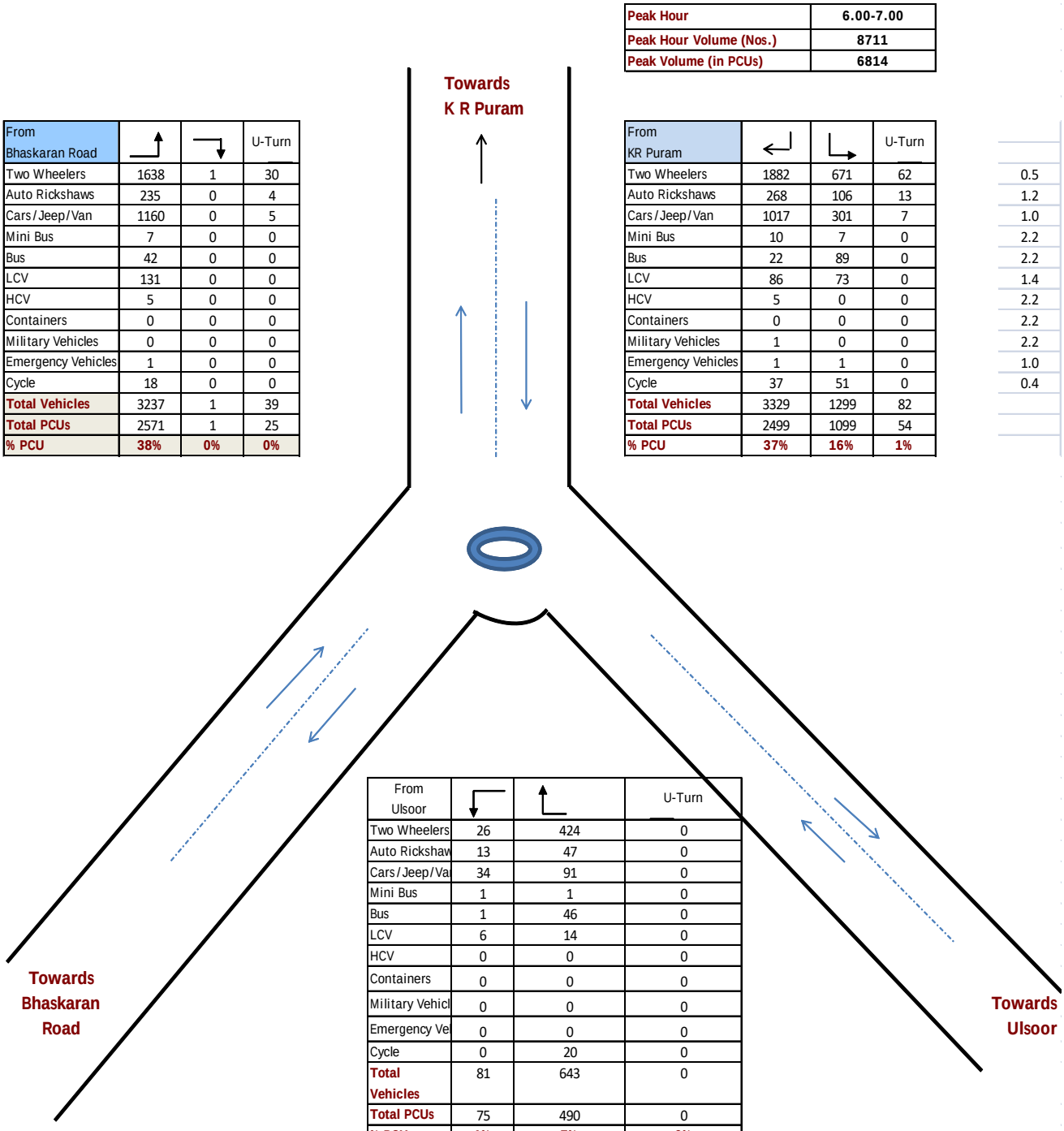
Peak Hour	9.00-10.00
Peak Hour Volume (Nos.)	9686
Peak Volume (in PCUs)	7270

From Bhaskaran Road	↑	↓	U-Turn
Two Wheelers	1950	3	33
Auto Rickshaws	257	0	3
Cars / Jeep / Van	1223	0	6
Mini Bus	1	0	0
Bus	62	0	0
LCV	94	0	1
HCV	7	0	0
Containers	0	0	0
Military Vehicles	0	0	0
Emergency Vehicles	2	0	0
Cycle	23	1	1
Total Vehicles	3619	4	44
Total PCUs	2803	2	28
% PCU	**39%**	**0%**	**0%**

From KR Puram	←	→	U-Turn	
Two Wheelers	1908	1297	36	0.5
Auto Rickshaws	270	110	2	1.2
Cars / Jeep / Van	1128	312	11	1.0
Mini Bus	1	0	0	2.2
Bus	5	97	0	2.2
LCV	49	38	0	1.4
HCV	6	2	0	2.2
Containers	0	0	0	2.2
Military Vehicles	0	0	0	2.2
Emergency Vehicles	2	0	0	1.0
Cycle	30	45	0	0.4
Total Vehicles	3399	1901	49	
Total PCUs	2515	1382	31	
% PCU	**35%**	**19%**	**0%**	

From Ulsoor	↓	←	U-Turn
Two Wheelers	32	370	0
Auto Rickshaw	12	31	0
Cars / Jeep / Va	41	74	0
Mini Bus	0	0	0
Bus	0	43	0
LCV	4	16	0
HCV	0	0	0
Containers	0	0	0
Military Vehicl	0	0	0
Emergency Ve	0	0	0
Cycle	0	47	0
Total Vehicles	89	581	0
Total PCUs	77	432	0
% PCU	**1%**	**6%**	**0%**

Figure 30: Dr. Bhaskaran Road & Swami Vivekanda Junction Evening Peak Hour Volume (29/03/2016)



Peak Hour	6.00-7.00
Peak Hour Volume (Nos.)	8711
Peak Volume (in PCUs)	6814

From Bhaskaran Road	↑	↓	U-Turn
Two Wheelers	1638	1	30
Auto Rickshaws	235	0	4
Cars/Jeep/Van	1160	0	5
Mini Bus	7	0	0
Bus	42	0	0
LCV	131	0	0
HCV	5	0	0
Containers	0	0	0
Military Vehicles	0	0	0
Emergency Vehicles	1	0	0
Cycle	18	0	0
Total Vehicles	3237	1	39
Total PCUs	2571	1	25
% PCU	**38%**	**0%**	**0%**

From KR Puram	←	→	U-Turn	
Two Wheelers	1882	671	62	0.5
Auto Rickshaws	268	106	13	1.2
Cars/Jeep/Van	1017	301	7	1.0
Mini Bus	10	7	0	2.2
Bus	22	89	0	2.2
LCV	86	73	0	1.4
HCV	5	0	0	2.2
Containers	0	0	0	2.2
Military Vehicles	1	0	0	2.2
Emergency Vehicles	1	1	0	1.0
Cycle	37	51	0	0.4
Total Vehicles	3329	1299	82	
Total PCUs	2499	1099	54	
% PCU	**37%**	**16%**	**1%**	

From Ulsoor	↓	↑	U-Turn
Two Wheelers	26	424	0
Auto Rickshaw	13	47	0
Cars/Jeep/Va	34	91	0
Mini Bus	1	1	0
Bus	1	46	0
LCV	6	14	0
HCV	0	0	0
Containers	0	0	0
Military Vehicl	0	0	0
Emergency Ve	0	0	0
Cycle	0	20	0
Total Vehicles	81	643	0
Total PCUs	75	490	0
% PCU	**1%**	**7%**	**0%**

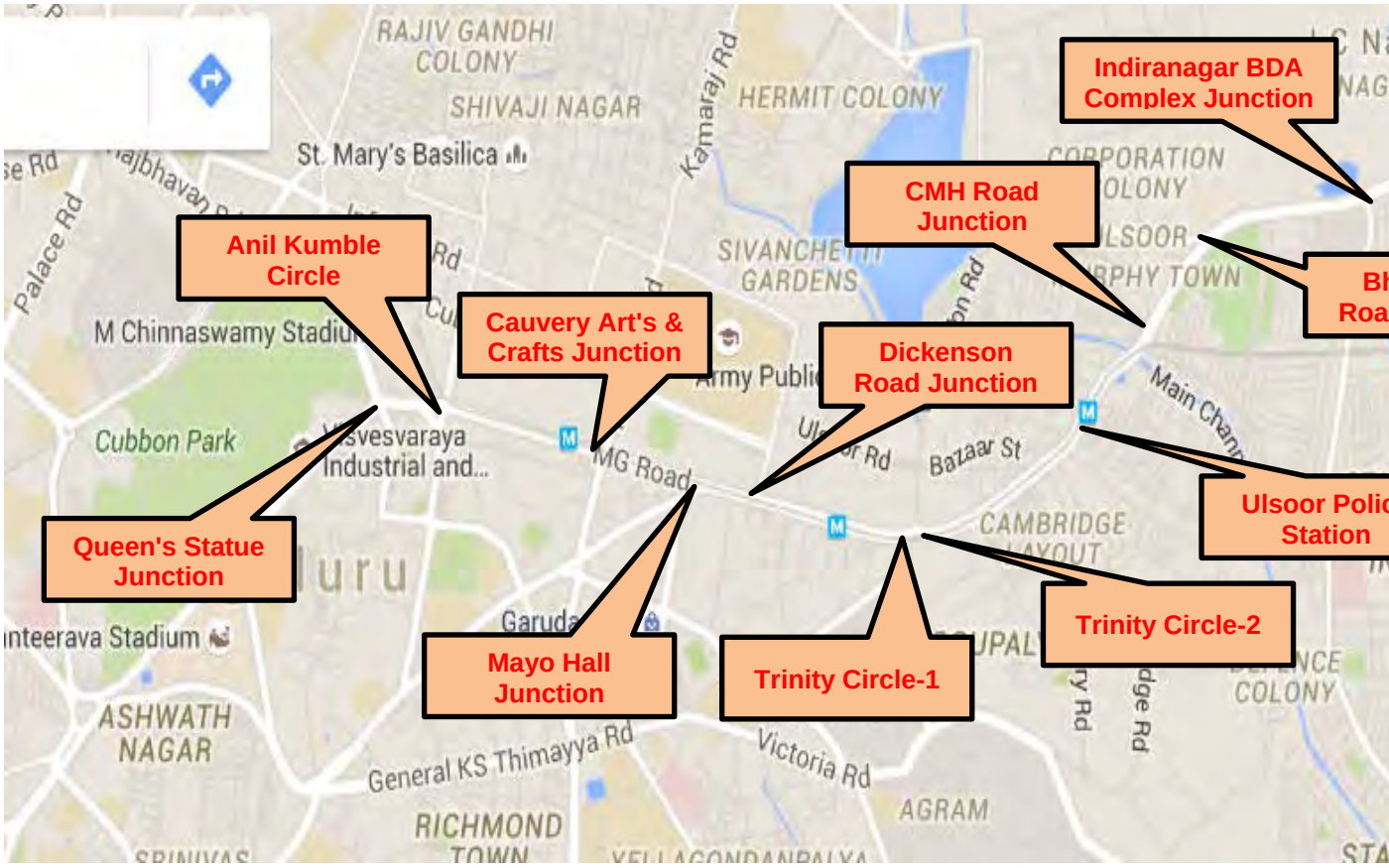
3. TRAVEL TIME SURVEY

The objective of the survey was to find out the journey speed, running speed and the type of delay (both fixed and variable). The survey was conducted at the following two corridors in two directions.

- Housr Road Stretch Corridor (Elgin Flour Mill Junction ↔ Mayohall Junction)
- M.G. Road Stretch Corridor (Indiranagar 100 feet Road Junction ↔ Queen's Statue Junction)

The study corridors are indicated in the following figures.

Figure 31: M.G. Road Stretch Corridor



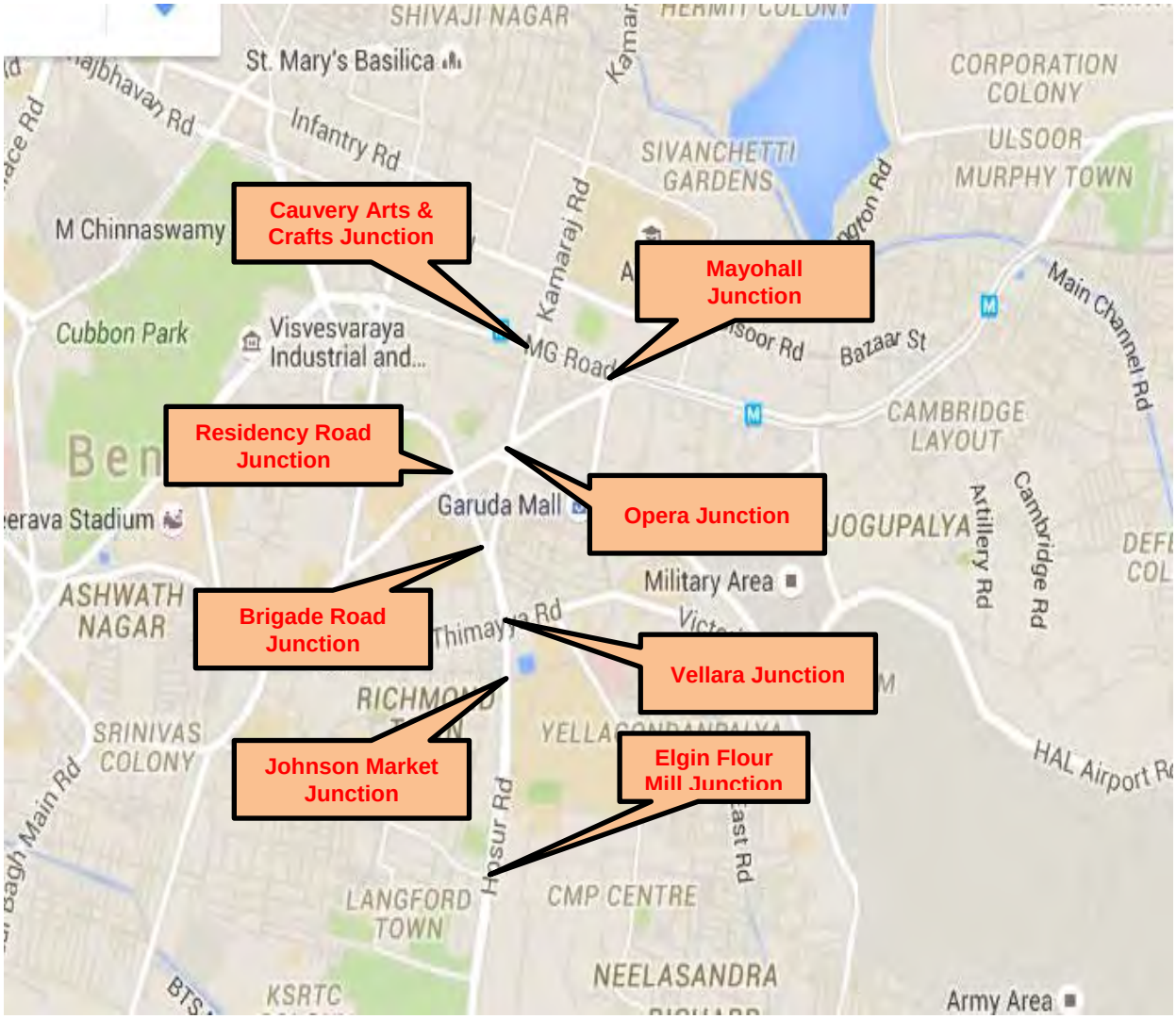


Figure 32: Hosur Road Stretch Corridor

The travel time is recorded by running along the traffic in a passenger car in both the study corridors. A stop watch is used to record the running time and various delays occurred during the travel. The data is tabulated in the excel sheet. The entries are recorded for node to node in each corridor. Several trial runs are made at different time intervals. For each node, the journey speed and running speed is then calculated from the recorded travel time and journey time. The variation in journey speed and running speed is plotted with the help of line charts. The delay occurred during the journey is also noted and reported.

The travel time survey data is analyzed for each corridors for both directions and are presented in the below charts.

Table 4: Analysis of Travel Time Survey at Hosur Road Stretch Corridor

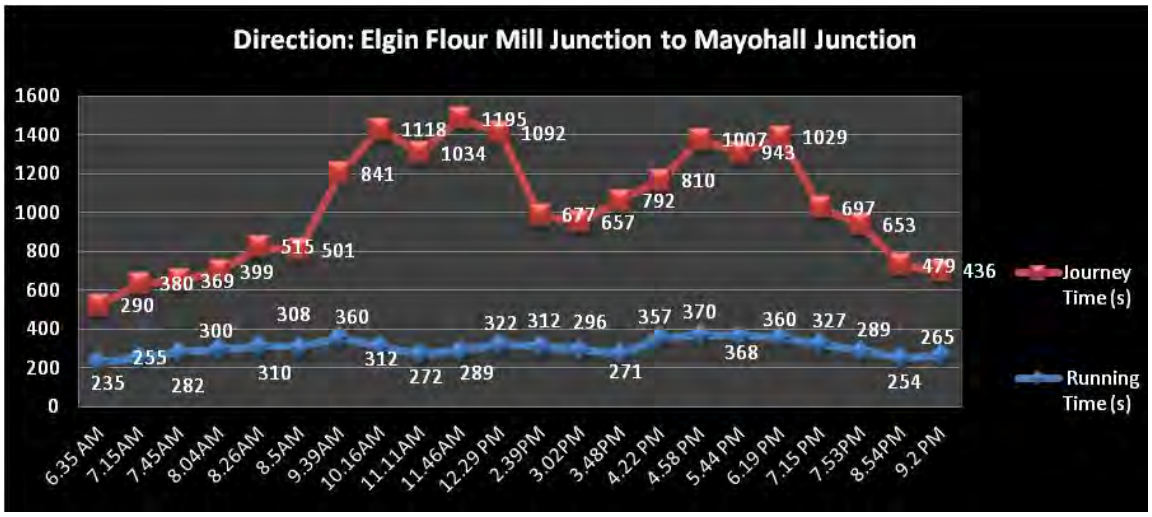


Figure 33: Running and Journey Time (sec)

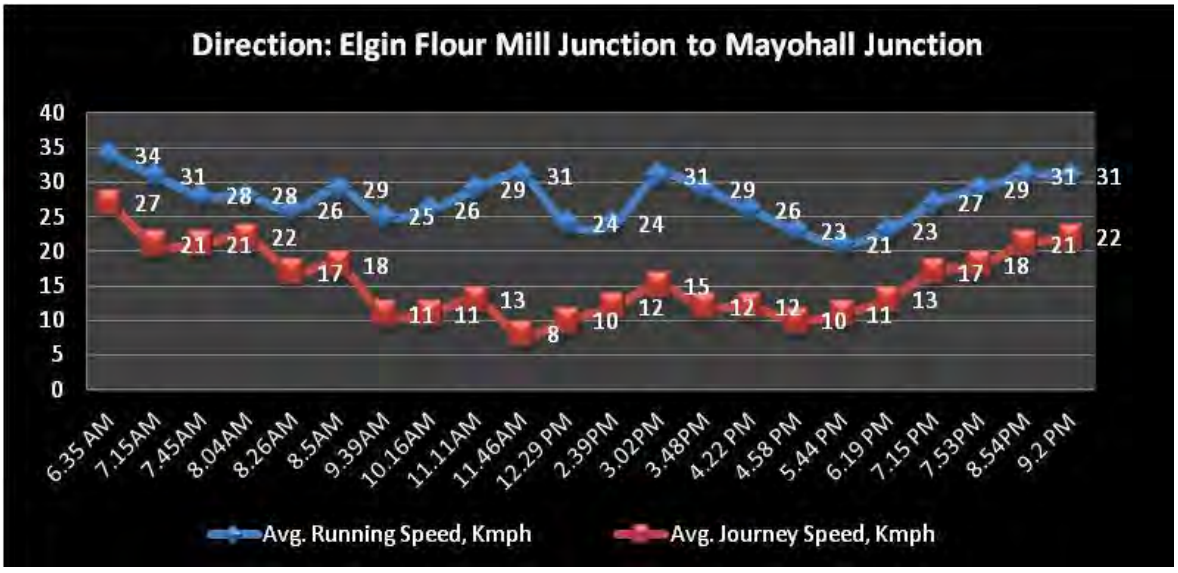


Figure 34: Running Speed Journey Speed (Kmph)

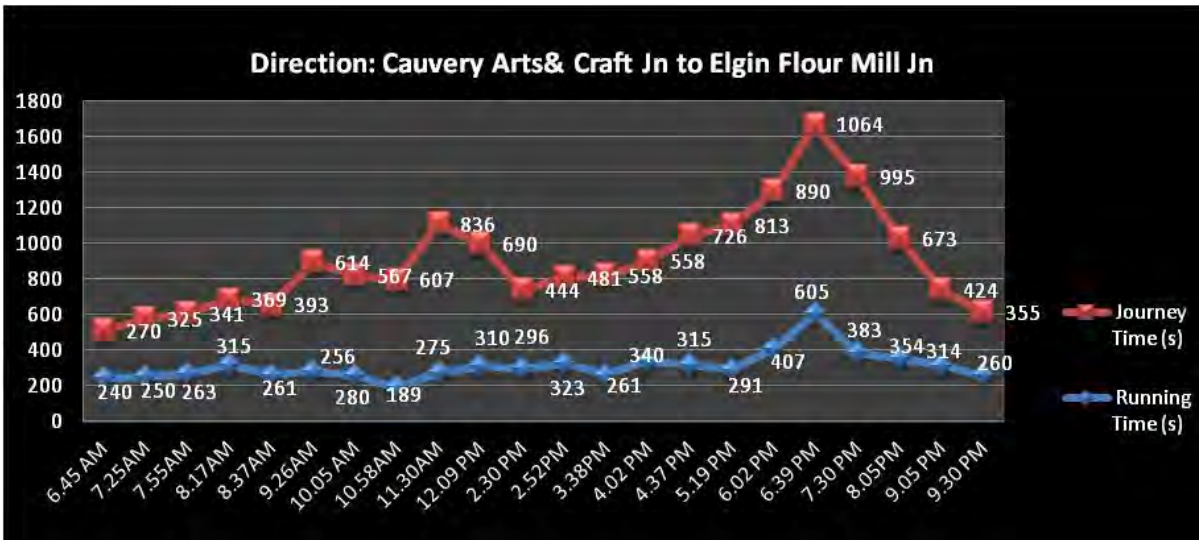


Figure 35: Running and Journey Time (sec)

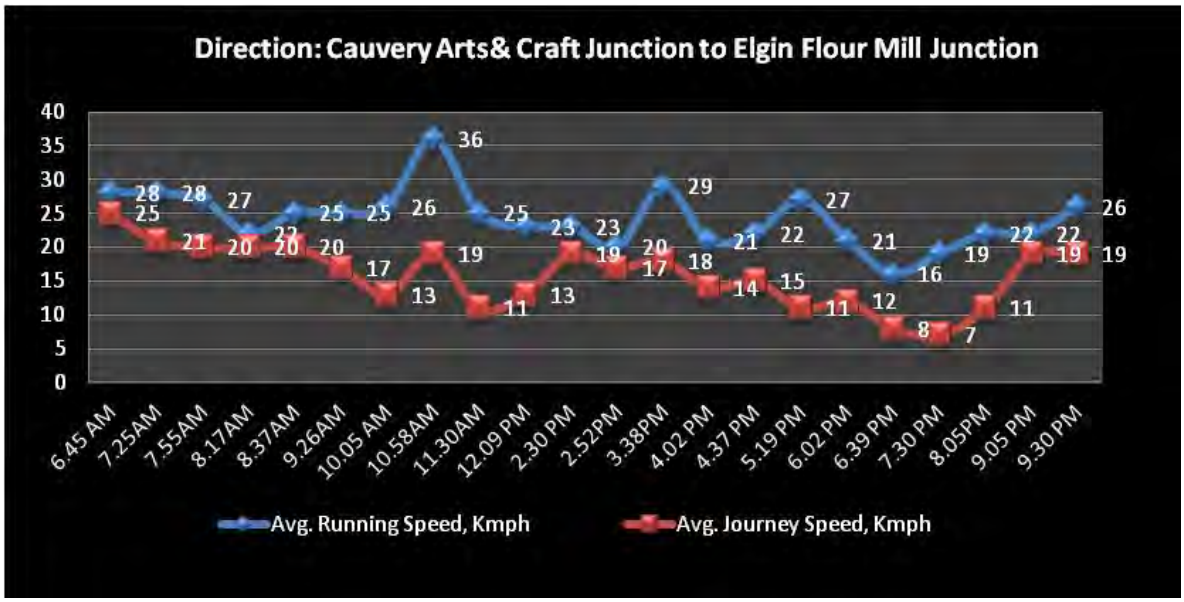


Figure 36: Running Speed Journey Speed (Kmph)

Table 5: Analysis of Travel Time Survey on M.G. Road Stretch Corridor

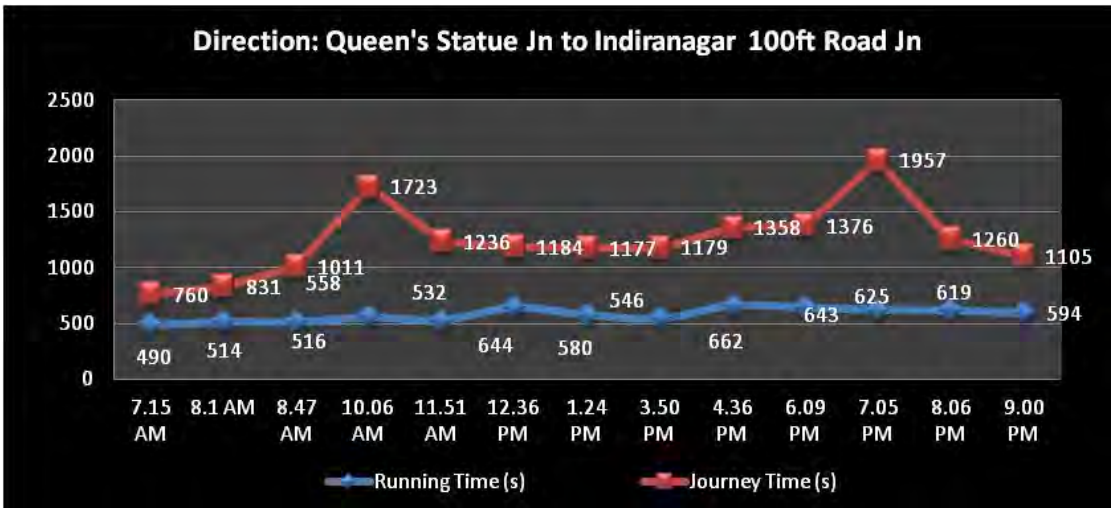


Figure 37: Running and Journey Time (Sec)

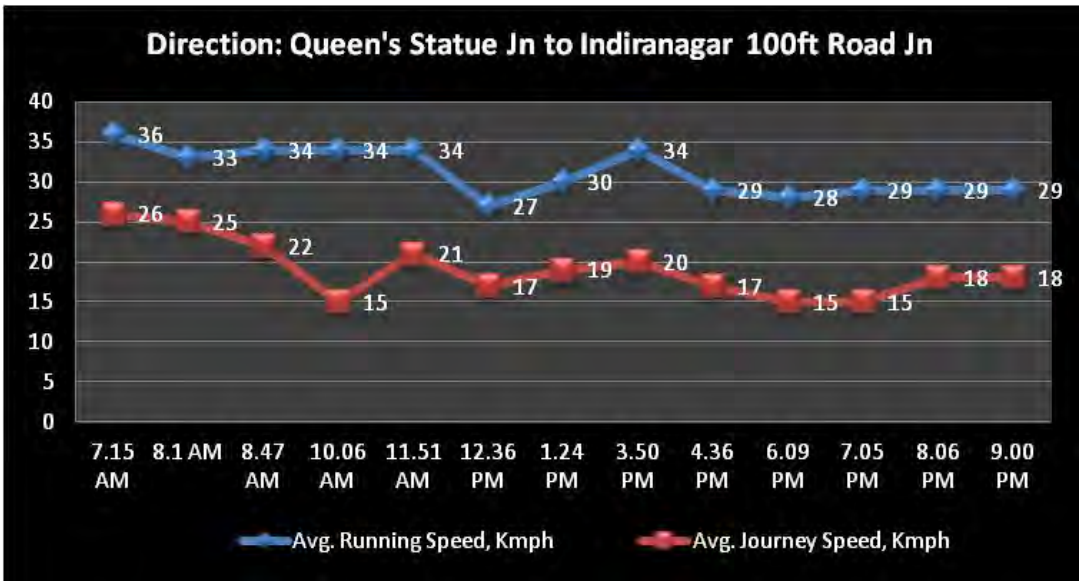


Figure 38: Running Speed Journey Speed (Kmph)

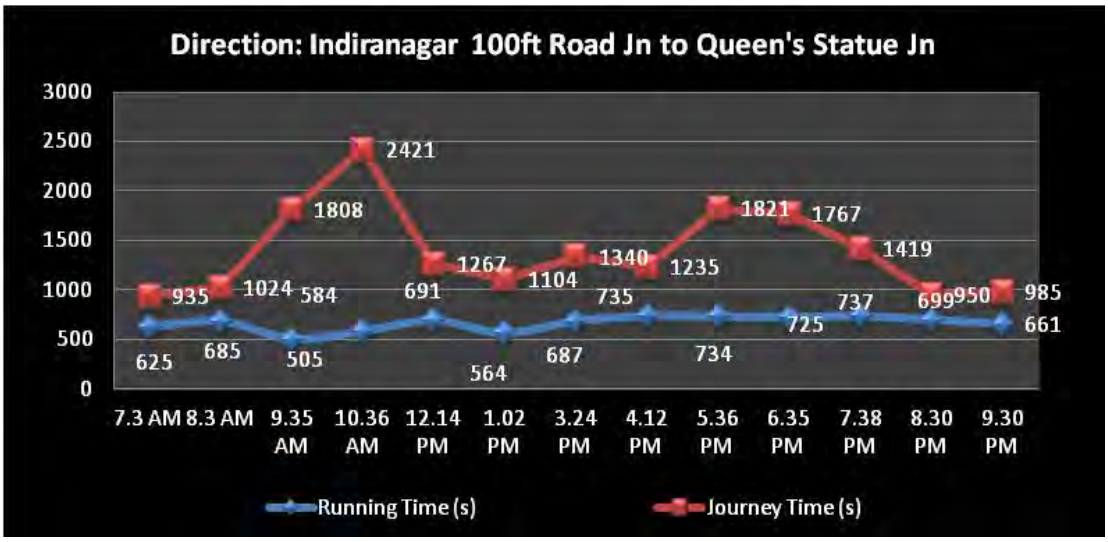


Figure 39: Running and Journey Time (Sec)

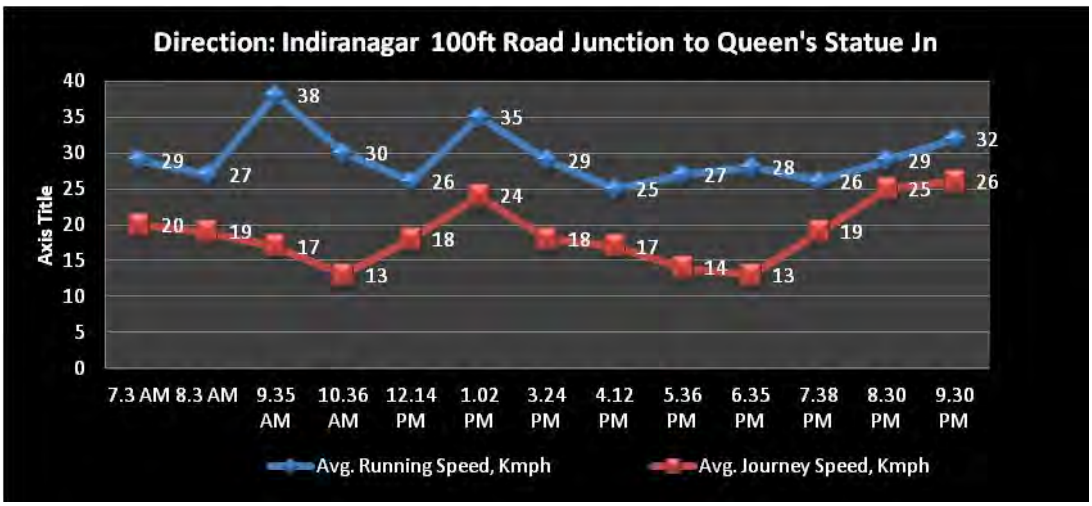


Figure 40: Running Speed Journey Speed (Kmph)

4. INTERSECTION DELAY SURVEY

Survey Location: At all approaches of the same intersections where the intersection traffic volume survey is conducted
Survey Day: Same day as the intersection traffic survey

Survey Time:

The survey will be performed three periods in a day. It must cover starting time of morning peak hour and ending time of evening peak hour respectively. The tentative survey period is set as follows. The survey will be conducted for a total of seven hours.

Survey Period

Period	Time	Remarks
1	08:00 – 10:30	AM peak
2	12:00 – 14:00	Mid-day off peak
3	19:00 –21:30	PM peak

5. APPENDIX


17/03/2016 09:39


17/03/2016 09:00

PREPARATORY SURVEY
ON THE PROJECT
FOR
BENGALURU METROPOLITAN REGION ITS
IN
THE REPUBLIC OF INDIA

ADDITIONAL TRAFFIC SURVEY REPORT

JULY 2017

JAPAN INTERNATIONAL COOPERATION AGENCY

NIPPON KOEI CO., LTD.

EAST NIPPON EXPRESSWAY COMPANY LIMITED

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1. INTRODUCTION

The scope of the work is to perform and analyze a preparatory traffic survey for the project for 'Bengaluru Metropolitan Region ITS in India'. A detailed framework of the intended study has been specified in TOR. The scope of work includes performing following traffic studies on approach roads at sever intersections in M.G. Road and Hosur Road.

- Signal Phase Time Survey
- Wasted /Dead Green Signal Survey
- Passing Vehicle Count Survey

The above three (3) surveys were carried out under the following conditions: The data was collected on three days, two weekdays and one weekend for each location. The time duration was 6:00 AM to 22:00 PM in all days.

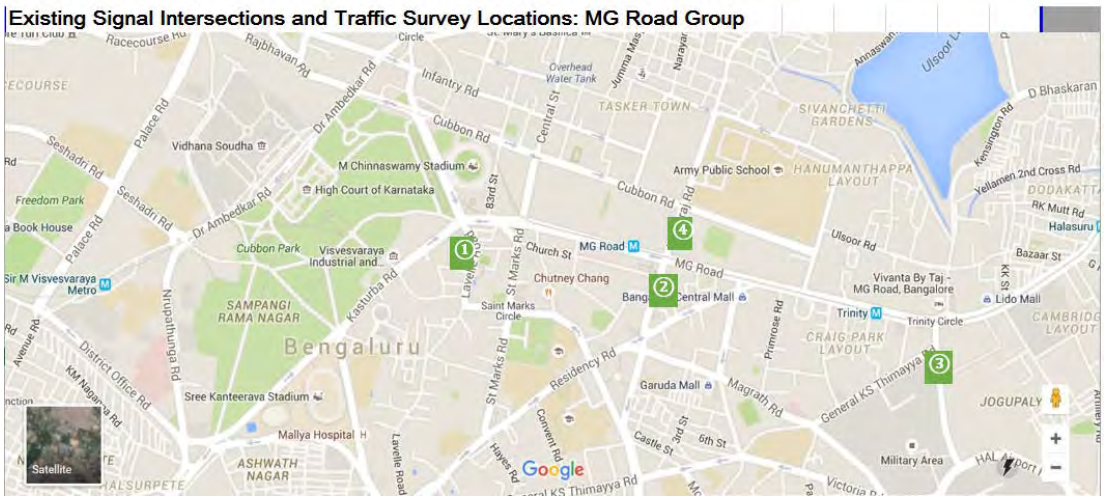
The report presents the details of traffic studies, data collection and analysis. The data was entered in excel sheet in the required format as suggested by the client. The photographs showing the video camera on site and the enumerators on field are presented in the appendix.

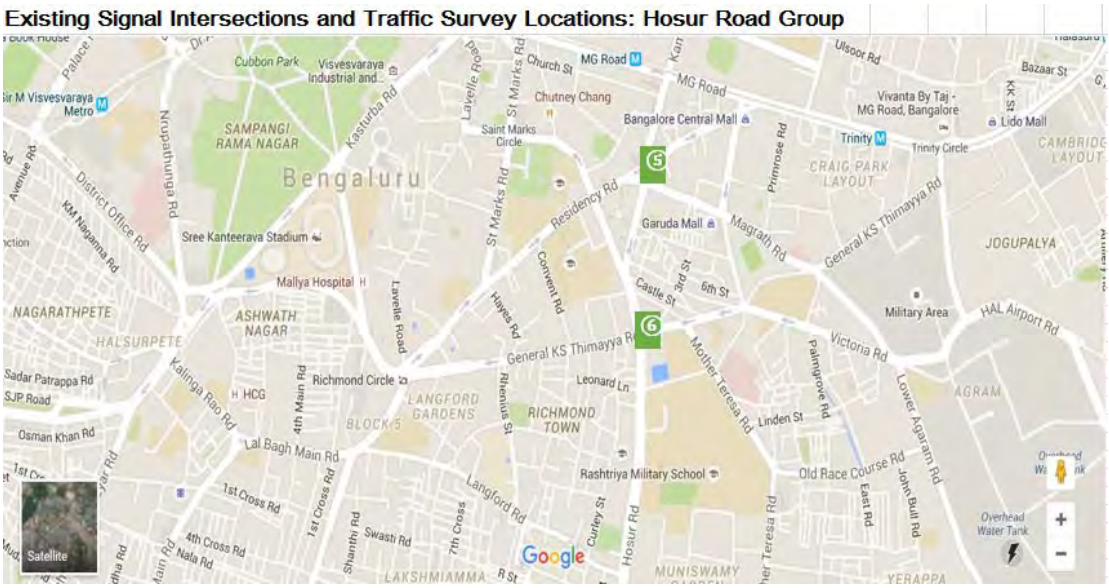
2. SURVEY LOCATION

The traffic studies were carried out on approach roads at sever intersections in M.G. Road and Hosur Road. The intersection details are listed in Table 1 and a snapshot of the location map is shown in Figure 1.

Table I: Details of Survey Locations

No.	Name of the Intersection
1	Cauvery Arts & Craft Intersection
2	Dr. Bhaskaran Road & Swami Vivekanadha Intersection
3	Kamraj & Cubbon Road Intersection
4	Opera Intersection
5	Queen's Statue Intersection
6	Trinity Circle
7	Vellara Intersection





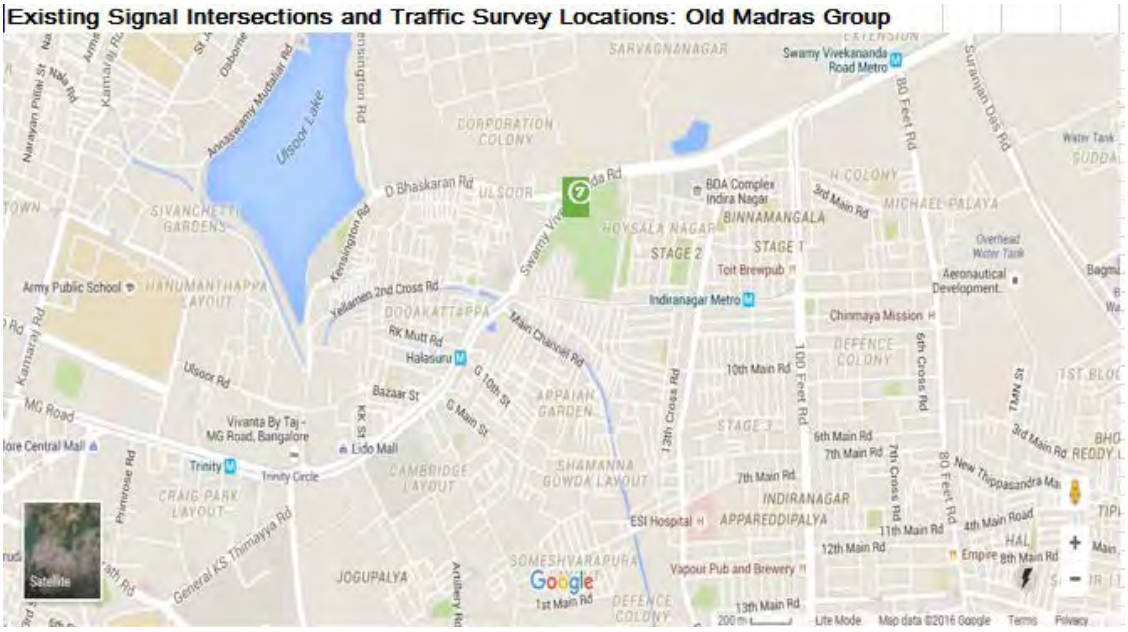


Figure 1: Map of Traffic Volume Survey Locations

3. SURVEY DATE AND TIME PERIOD

Each intersection data was collected on three days, two weekdays and one weekend. The survey study duration was 6:00 AM to 22:00 PM in all the days. The details are listed in the table below.

Table II: Details of Survey Locations

No.	Intersection	Day 1: Weekday	Day 2: Weekday	Day 3: Weekend
1	Cauvery Arts & Craft Intersection	11/05/2017	18/05/2017	14/05/2017
2	Dr. Bhaskaran Road & Swami Vivekanadha Intersection	10/05/2017	17/05/2017	21/05/2017
3	Kamraj & Cubbon Road Intersection	10/05/2017	17/05/2017	21/05/2017
4	Opera Intersection	11/05/2017	18/05/2017	14/05/2017
5	Queen's Statue Intersection	11/05/2017	18/05/2017	14/05/2017
6	Trinity Circle	10/05/2017	17/05/2017	21/05/2017
7	Vellara Intersection	11/05/2017	18/05/2017	14/05/2017

4. SURVEY METHODOLOGY

Three major traffic signal studies are performed as art of the study. The survey method is briefed below.

3.1 Signal Phase Time Survey

The objective is to measure the Cycle Length (C) at an intersection. Cycle length is the time in seconds that it takes a signal to complete one full cycle of indications. It indicates the time interval between the starting of green for one approach till the next time the green starts. It can

be calculated by measuring the length in seconds for each signal indication i.e. green, yellow and red. Most of the urban road intersections in Bengaluru has exclusive pedestrian signals to enable the pedestrians to cross the road safely. The total Cycle Length is inclusive of the pedestrian signal time.

The present study employed enumerators at each intersection to measure the signal indication duration (green, yellow, red) and pedestrian signal time for respective cycle. Each enumerator was equipped with stop watch to note the time duration. The length in second for above each signal indication for one cycle was observed and recorded for every half an hour interval. The survey duration was from 6:00 AM to 22:00 PM. All approach directions in an intersection was performed in similar manner. The phase wise observations was made at all the intersection. The study was performed on both weekday as well as weekend.

The data recorded was later entered into the excel sheet in the stated format. A snapshot of the data format is shown in the following figure.

SIGNAL PHASE TIME SURVEY							
JUNCTION NAME : CAUVERY ARTS AND CRAFT JUNCTION							
DIRECTION: MAYO HALL TO ANIL KUMBLE							
DATE: 11-5-2017							DAY: THURSDAY
Time		Observed	CYCLE TIME (s)				
From	To	Time	GREEN	RED	AMBER	PEDESTRIAN	Total
6.00	6.30	6.15	20	40	3	0	63
6.30	7.00	6.40	20	40	3	0	63
7.00	7.30	7.12	40	70	3	10	123
7.30	8.00	7.4	50	70	3	10	133
8.00	8.30	8.15	50	95	3	15	163
8.30	9.00	8.37	50	95	3	15	163
9.00	9.30	9.15	50	95	3	15	163
9.30	10.00	9.30	50	95	3	15	163
10.00	10.30	10.17	50	95	3	15	163

Figure 2: Snapshot of the Signal Phase Time Survey Data

3.2 Wasted/Dead Green Signal Survey

The objective is to identify the effective usage of the apportioned green time for respective cycle. The green time was classified into 'Wasted Green' and 'Dead Green' based on the following conditions:

- Wasted Green: No vehicles are passing through the intersection during green signal due to absence of traffic
- Dead Green: Vehicles cannot move forward at the intersection during green signal because the traffic got blocked ahead

If the wasted green/dead green phenomenon occurred at least one time during 30 minutes, it was observed and recorded as 'Occupied (Occurred)'. Such data were represented by (√) symbol.

The above procedure was repeated for all the seven intersection. The data was later entered in the stated format. A snapshot of the data format is shown in the following figure.

WASTE/DEAD GREEN SIGNAL SURVEY					
JUNCTION NAME : CAUVERY ARTS AND CRAFT JUNCTION					
DIRECTION: MAYO HALL TO ANIL KUMBLE					
DATE: 11-5-2017					DAY: THURSDAY
Time		DEAD GREEN		WASTAGE OF GREEN	
From	To	OCCUPIED	NOT OCCUPIED	OCCUPIED	NOT OCCUPIED
6.00	6.30			√	
6.30	7.00			√	
7.00	7.30			√	
7.30	8.00			√	
8.00	8.30			√	
8.30	9.00			√	
9.00	9.30				
9.30	10.00				
10.00	10.30				

Figure 3: Snapshot of the Waste/Dead Green Survey Data

3.3 Passing Vehicle Count Survey

The objective is to count the number of vehicles passing in the green signal indication. The vehicles are counted under the following conditions;

- The vehicles which passes the stop line at intersection during green signal
- Vehicles with straight movement. The vehicles which turn right or left and make U-turn are exempted from the count.

Only the number of the vehicle are measured regardless of the vehicle type. But all types of vehicle e.g. two-wheelers, auto-rickshaws, buses, trucks, passenger vehicles and etc. are included in the counted number as long as the above conditions mentioned are met. The vehicle count are made for the duration of green signal indication of one cycle at every half an hour interval.

The total number of passing vehicle were counted manually by the enumerators at every 10 second during the green signal indication. The passing vehicles were counted until termination of green signal indication.

The survey was repeated at all approach roads of each intersection. The data is later entered into stated excel sheet format indicated by approach road of each intersection, accordingly. A snapshot of the data format is shown in the following figure.

SIGNAL PHASE TIME SURVEY													
JUNCTION NAME : CAUVERY ARTS AND CRAFT JUNCTION													
DIRECTION: MAYO HALL TO ANIL KUMBLE													
DATE:11-5-2017												DAY:THURSADY	
Time		Observed	Total Vehicle Count (s)										
From	To	Time	10	10	10	10	10	10	10	10	10	10	Total
6.00	6.30	6.15	2	3									5
6.30	7.00	6.40	1	5									6
7.00	7.30	7.12	20	6	2	0	0						28
7.30	8.00	7.4	15	4	0	0	0						19
8.00	8.30	8.15	20	30	15	2	0						67
8.30	9.00	8.37	25	35	21	6	1						88
9.00	9.30	9.15	17	44	36	28	10						135
9.30	10.00	9.30											

Figure 4: Snapshot of the Passing Vehicle Count Survey Data

5. DATA ANALYSIS

The data corresponding to the three surveys – signal phase time survey, dead/waste green survey and the passing vehicle count survey was entered into the respective excel sheets. For each intersection, the data was analyzed and the signal split time was summarized for respective phase of signal. Details are listed below.

4.1 Cauvery Arts & Craft Intersection

A pictorial representation of Cauvery Arts & Craft Intersection, with details of approach movements and Signal Posts Locations is shown in the figure below.

Figure 5: Details of Cauvery Arts & Craft Intersection

From the Signal phase time survey, the cycle length was calculated. The phase wise apportioned signal timing or in other words the 'Signal Split' was calculated. The Cauvery Arts & Craft Intersection signal consists of three phases – Phase 1, Phase 2 and Phase 3. An exclusive pedestrian signal phase is also exist which is represented by Phase 5. In each phase, the respective approach movements are marked with reference to the directions (A, B, C) marked in the diagram (figure 5). The notations R, L and S denotes Right, Left and Straight movements. The observed green signal indication timings are entered corresponding to the time intervals in each phase phase and the total cycle length (cycle time) in seconds were calculated. Details are presented in the table below.

CAUVERY ARTS & CRAFT Junction Signal Timings													
Date: 11/05/2017													
ARTS & CRAFT Junction			PHASE										CYCLE TIME
	Road	From	1			2			3			5	
Data	A	MAYO HALL	R	L	S							EXCLUSIVE PEDESTRIAN	
	B	ANIL KUMBLE CIRCLE				R	L	S		L			
	C	KAMRAJ & CUBBON CIRCLE		L					R	L	S		
TIMINGS	06:00	07:00	20			20			15			-	55
	07:00	08:00	40			40			20			10	110
	08:00	12:00	50			40			50			15	155
	12:00	15:00	50			40			50			15	155
	15:00	19:00	50			40			60			10	160
	19:00	22:00	50			40			60			10	160

Figure 6: Cycle Length of Cauvery Arts & Craft Intersection on 11/05/2017

CAUVERY ARTS & CRAFT Junction Signal Timings														
Date: 14/05/2017 Sunday														
ARTS & CRAFT Junction			PHASE											CYCLE TIME
	Road	From	1			2			3			5		
Data	A	MAYO HALL	R	L	S							EXCLUSIVE PEDESTRIAN		
	B	ANIL KUMBLE CIRCLE				R	L	S		L				
	C	KAMRAJ & CUBBON CIRCLE		L					R	L	S			
TIMINGS	06:00	07:00	50			50			50			-	150	
	07:00	08:00	50			55			55			10	170	
	08:00	12:00	50			55			55			15	175	
	12:00	15:00	50			55			55			15	175	
	15:00	19:00	50			50			55			10	165	
	19:00	22:00	50			50			55			10	165	

Figure 7: Cycle Length of Cauvery Arts & Craft Intersection on 14/05/2017

CAUVERY ARTS & CRAFT Junction Signal Timings														
Date: 18/05/2017														
ARTS & CRAFT Junction			PHASE											CYCLE TIME
	Road	From	1			2			3			5		
Data	A	MAYO HALL	R	L	S							EXCLUSIVE PEDESTRIAN		
	B	ANIL KUMBLE CIRCLE				R	L	S		L				
	C	KAMRAJ & CUBBON CIRCLE		L					R	L	S			
TIMINGS	06:00	07:00	20			20			20			-	60	
	07:00	08:00	40			50			20			10	120	
	08:00	12:00	40			50			50			15	155	
	12:00	15:00	40			50			50			15	155	
	15:00	19:00	40			50			60			10	160	
	19:00	22:00	40			50			75			10	175	

Figure 8: Cycle Length of Cauvery Arts & Craft Intersection on 18/05/2017

The cycle length varied at different time intervals. Day wise variation was also observed. The cycle length varied from 55 – 175 seconds. At peak hour the apportioned signal indication (green time) timing were more compared to the off-peak hours. The pedestrian signal time duration was 10-15 in general with highest allocation at peak hours.

Table 01: Signal Phase Time Survey at Cauvery Arts and Crafts Intersection on 11/05/2017

SIGNAL PHASE TIME SURVEY							
JUNCTION NAME : CAUVERY ARTS AND CRAFT JUNCTION							
DIRECTION:MAYO HALL TO ANIL KUMBLE							
DATE:11-5-2017						DAY:THURSDAY	
Time		Observed Time	Cycle Time (s)				
From	To		Green	Red	Amber	Pedestrian	Total
6.00	6.30	6.15	20	40	3	0	63
6.30	7.00	6.40	20	40	3	0	63
7.00	7.30	7.12	40	70	3	10	123
7.30	8.00	7.40	40	70	3	10	123
8.00	8.30	8.15	50	95	3	15	163
8.30	9.00	8.37	50	95	3	15	163
9.00	9.30	9.15	50	95	3	15	163
9.30	10.00	9.30	50	95	3	15	163
10.00	10.30	10.17	50	95	3	15	163
10.30	11.00	10.41	50	95	3	30	178
11.00	11.30	11.20	50	95	3	15	163
11.30	12.00	11.50	50	95	3	15	163

12.00	12.30	12.8	50	95	3	15	163
12.30	13.00	12.51	50	95	3	15	163
13.00	13.30	13.15	50	100	3	15	168
13.30	14.00	13.36	50	100	3	15	168
14.00	14.30	14.14	50	100	3	15	168
14.30	15.00	14.33	50	100	3	15	168
15.00	15.30	15.10	50	110	3	15	178
15.30	16.00	15.35	50	110	3	15	178
16.00	16.30	16.10	50	110	3	15	178
16.30	17.00	16.35	50	100	3	15	168
17.00	17.30	17.10	50	110	3	15	178
17.30	18.00	17.35	50	110	3	10	173
18.00	18.30	18.10	50	110	3	10	173
18.30	19.00	18.35	50	110	3	10	173
19.00	19.30	19.10	50	110	3	10	173
19.30	20.00	19.35	50	110	3	10	173
20.00	20.30	20.05	50	110	3	10	173
20.30	21.00	20.35	50	110	3	10	173
21.00	21.30	21.05	50	110	3	10	173
21.30	22.00	21.35	50	110	3	10	173

SIGNAL PHASE TIME SURVEY

JUNCTION NAME : CAUVERY ARTS AND CRAFT JUNCTION

DIRECTION: ANIL KUMBLE TO MAYO HALL

DATE:11-5-2017 **DAY:THURSDAY**

Time		Observed Time	Cycle Time (s)				
From	To		Green	Red	Amber	Pedestrian	Total
6.00	6.30	6.15	20	40	3	0	63
6.30	7.00	6.35	20	40	3	0	63
7.00	7.30	7.10	40	115	3	10	168
7.30	8.00	7.35	40	115	3	10	168
8.00	8.30	8.03	40	120	3	15	178
8.30	9.00	8.05	40	120	3	15	178
9.00	9.30	9.10	40	120	3	15	178
9.30	10.00	9.35	40	120	3	15	178
10.00	10.30	1.10	40	120	3	15	178
10.30	11.00	10.40	40	120	3	15	178
11.00	11.30	11.05	40	120	3	15	178
11.30	12.00	11.35	40	120	3	15	178
12.00	12.30	12.05	40	120	3	15	178
12.30	13.00	12.40	40	120	3	15	178
13.00	13.30	13.05	40	120	3	15	178
13.30	14.00	13.35	40	120	3	15	178
14.00	14.30	14.05	40	120	3	15	178

14.30	15.00	14.40	40	120	3	15	178
15.00	15.30	15.10	40	120	3	15	178
15.30	16.00	15.35	40	120	3	15	178
16.00	16.30	16.15	40	120	3	15	178
16.30	17.00	16.35	40	120	3	15	178
17.00	17.30	17.10	40	120	3	15	178
17.30	18.00	17.36	40	120	3	15	178
18.00	18.30	18.15	40	120	3	15	178
18.30	19.00	18.33	40	120	3	15	178
19.00	19.30	19.10	40	120	3	15	178
19.30	20.00	19.35	40	120	3	15	178
20.00	20.30	20.05	40	120	3	15	178
20.30	21.00	20.34	40	120	3	15	178
21.00	21.30	21.10	40	120	3	15	178
21.30	22.00	21.35	40	120	3	15	178

SIGNAL PHASE TIME SURVEY

JUNCTION NAME : CAUVERY ARTS AND CRAFT JUNCTION

DIRECTION: CUBBON TO BRIGADE

DATE:11-5-2017 **DAY:THURSDAY**

Time		Observed Time	Cycle Time (s)				
From	To		Green	Red	Amber	Pedestrian	Total
6.00	6.30	6.15	15	45	3	0	63
6.30	7.00	6.35	15	45	3	0	63
7.00	7.30	7.10	20	100	3	10	133
7.30	8.00	7.35	20	100	3	10	133
8.00	8.30	8.03	50	110	3	15	178
8.30	9.00	8.05	50	110	3	15	178
9.00	9.30	9.10	50	110	3	15	178
9.30	10.00	9.35	50	110	3	15	178
10.00	10.30	1.10	50	110	3	15	178
10.30	11.00	10.40	50	110	3	15	178
11.00	11.30	11.05	50	110	3	15	178
11.30	12.00	11.35	50	115	3	15	183
12.00	12.30	12.05	50	115	3	15	183
12.30	13.00	12.40	50	115	3	15	183
13.00	13.30	13.05	50	115	3	15	183
13.30	14.00	13.35	50	115	3	15	183
14.00	14.30	14.05	50	115	3	15	183
14.30	15.00	14.40	50	115	3	15	183
15.00	15.30	15.10	60	60	3	10	133
15.30	16.00	15.35	60	60	3	10	133
16.00	16.30	16.15	60	80	3	10	153
16.30	17.00	16.35	60	80	3	10	153

17.00	17.30	17.10	60	80	3	10	153
17.30	18.00	17.36	60	80	3	10	153
18.00	18.30	18.15	60	80	3	10	153
18.30	19.00	18.40	60	95	3	10	168
19.00	19.30	19.10	60	95	3	10	168
19.30	20.00	19.35	60	95	3	10	168
20.00	20.30	20.05	60	95	3	10	168
20.30	21.00	20.50	60	95	3	15	173
21.00	21.30	21.25	60	90	3	15	168
21.30	22.00	21.4	60	90	3	15	168

Table 02: Signal Phase Time Survey at Cauvery Arts and Crafts Intersection on 14/05/2017

SIGNAL PHASE TIME SURVEY							
JUNCTION NAME : CAUVERY ARTS AND CRAFT JUNCTION							
DIRECTION:MAYO HALL TO ANIL KUMBLE							
DATE:14-5-2017						DAY:SUNDAY	
Time		Observed Time	Cycle Time (s)				
From	To		Green	Red	Amber	Pedestrian	Total
6.00	6.30	6.10	50	45	3	10	108
6.30	7.00	6.40	50	45	3	10	108
7.00	7.30	7.10	50	45	3	10	108
7.30	8.00	7.36	50	45	3	10	108
8.00	8.30	8.10	50	45	3	10	108
8.30	9.00	8.35	50	45	3	10	108
9.00	9.30	9.15	50	45	3	10	108
9.30	10.00	9.40	50	45	3	10	108
10.00	10.30	10.10	50	45	3	10	108
10.30	11.00	10.45	50	45	3	10	108
11.00	11.30	11.15	50	45	3	10	108
11.30	12.00	11.35	50	45	3	10	108
12.00	12.30	12.15	50	45	3	10	108
12.30	13.00	12.40	50	45	3	10	108
13.00	13.30	13.10	50	45	3	10	108
13.30	14.00	13.40	50	45	3	10	108
14.00	14.30	14.15	50	45	3	10	108
14.30	15.00	14.40	50	45	3	10	108
15.00	15.30	15.10	50	105	3	10	168
15.30	16.00	15.40	50	105	3	10	168
16.00	16.30	16.10	50	105	3	10	168
16.30	17.00	16.35	50	105	3	10	168
17.00	17.30	17.4	50	105	3	10	168
17.30	18.00	18.15	50	105	3	10	168

18.00	18.30	18.35	50	105	3	10	168
18.30	19.00	19.15	50	105	3	10	168
19.00	19.30	19.40	50	105	3	10	168
19.30	20.00	20.10	50	105	3	10	168
20.00	20.30	20.40	50	105	3	10	168
20.30	21.00	21.10	50	105	3	10	168
21.00	21.30	21.35	50	105	3	10	168
21.30	22.00	21.35	50	110	3	10	173

SIGNAL PHASE TIME SURVEY

JUNCTION NAME : CAUVERY ARTS AND CRAFT JUNCTION

DIRECTION: ANIL KUMBLE TO MAYO HALL

DATE:14-5-2017 **DAY:SUNDAY**

Time		Observed Time	Cycle Time (s)				
From	To		Green	Red	Amber	Pedestrian	Total
6.00	6.30	6.10	40	115	3	10	168
6.30	7.00	6.35	40	115	3	10	168
7.00	7.30	7.10	40	115	3	10	168
7.30	8.00	7.40	40	115	3	10	168
8.00	8.30	8.10	40	115	3	10	168
8.30	9.00	8.40	40	115	3	10	168
9.00	9.30	9.10	40	115	3	10	168
9.30	10.00	9.35	40	115	3	10	168
10.00	10.30	10.15	40	115	3	10	168
10.30	11.00	10.35	40	115	3	10	168
11.00	11.30	11.10	40	115	3	10	168
11.30	12.00	11.40	40	115	3	10	168
12.00	12.30	12.20	40	115	3	10	168
12.30	13.00	12.35	40	115	3	10	168
13.00	13.30	13.15	40	115	3	10	168
13.30	14.00	13.40	40	115	3	10	168
14.00	14.30	14.15	40	115	3	10	168
14.30	15.00	14.35	40	115	3	10	168
15.00	15.30	15.15	40	120	3	10	173
15.30	16.00	15.35	40	120	3	10	173
16.00	16.30	16.10	40	120	3	10	173
16.30	17.00	16.35	40	120	3	10	173
17.00	17.30	17.10	40	120	3	10	173
17.30	18.00	17.40	40	120	3	10	173
18.00	18.30	18.10	40	120	3	10	173
18.30	19.00	18.35	40	120	3	10	173
19.00	19.30	19.35	40	120	3	10	173
19.30	20.00	19.35	40	120	3	10	173
20.00	20.30	20.15	40	120	3	10	173

20.30	21.00	20.35	40	120	3	10	173
21.00	21.30	21.15	40	120	3	10	173
21.30	22.00	21.35	40	120	3	10	173

SIGNAL PHASE TIME SURVEY							
JUNCTION NAME : CAUVERY ARTS AND CRAFT JUNCTION							
DIRECTION: CUBBON TO BRIGADE							
DATE:14-5-2017						**DAY:SUNDAY**	
Time		**Observed Time**	**Cycle Time (s)**				
From	**To**		**Green**	**Red**	**Amber**	**Pedestrian**	**Total**
6.00	6.30	6.15	50	105	3	10	168
6.30	7.00	6.35	50	105	3	10	168
7.00	7.30	7.05	55	105	3	10	173
7.30	8.00	7.26	55	105	3	10	173
8.00	8.30	8.05	55	105	3	10	173
8.30	9.00	8.36	55	105	3	10	173
9.00	9.30	9.10	55	105	3	10	173
9.30	10.00	9.30	55	105	3	10	173
10.00	10.30	10.06	55	105	3	10	173
10.30	11.00	10.35	55	105	3	10	173
11.00	11.30	11.10	55	105	3	10	173
11.30	12.00	11.30	55	105	3	10	173
12.00	12.30	12.15	55	105	3	10	173
12.30	13.00	12.35	55	105	3	10	173
13.00	13.30	13.10	55	105	3	10	173
13.30	14.00	13.35	55	105	3	10	173
14.00	14.30	14.05	55	105	3	10	173
14.30	15.00	14.40	55	105	3	10	173
15.00	15.30	15.10	50	105	3	10	168
15.30	16.00	15.4	50	105	3	10	168
16.00	16.30	16.15	50	105	3	10	168
16.30	17.00	16.4	50	105	3	10	168
17.00	17.30	17.10	50	105	3	10	168
17.30	18.00	17.35	50	105	3	10	168
18.00	18.30	18.10	50	105	3	10	168
18.30	19.00	18.35	50	105	3	10	168
19.00	19.30	19.10	50	105	3	10	168
19.30	20.00	19.4	50	105	3	10	168
20.00	20.30	20.15	50	105	3	10	168
20.30	21.00	20.35	50	105	3	10	168
21.00	21.30	21.15	50	105	3	10	168
21.30	22.00	21.4	50	105	3	10	168

Table 03: Signal Phase Time Survey at Cauvery Arts and Crafts Intersection on 18/05/2017

SIGNAL PHASE TIME SURVEY							
JUNCTION NAME : CAUVERY ARTS AND CRAFT JUNCTION							
DIRECTION:MAYO HALL TO ANIL KUMBLE							
DATE:18-5-2017						DAY:THURSDAY	
Time		Observed Time	Cycle Time (s)				
From	To		Green	Red	Amber	Pedestrian	Total
6.00	6.30	6.10	20	40	3	0	63
6.30	7.00	6.40	20	40	3	0	63
7.00	7.30	7.10	40	45	3	10	98
7.30	8.00	7.45	40	45	3	10	98
8.00	8.30	8.10	40	45	3	10	98
8.30	9.00	8.35	40	45	3	15	103
9.00	9.30	9.15	40	45	3	15	103
9.30	10.00	9.40	40	45	3	15	103
10.00	10.30	10.10	40	45	3	15	103
10.30	11.00	10.45	40	45	3	15	103
11.00	11.30	11.15	40	45	3	15	103
11.30	12.00	11.35	50	45	3	15	113
12.00	12.30	12.15	50	45	3	15	113
12.30	13.00	12.40	50	45	3	15	113
13.00	13.30	13.10	50	45	3	15	113
13.30	14.00	13.40	50	45	3	15	113
14.00	14.30	14.15	50	45	3	15	113
14.30	15.00	14.40	50	45	3	15	113
15.00	15.30	15.10	50	110	3	10	173
15.30	16.00	15.40	50	110	3	10	173
16.00	16.30	16.10	50	110	3	10	173
16.30	17.00	16.35	50	110	3	10	173
17.00	17.30	17.4	50	110	3	10	173
17.30	18.00	18.15	50	110	3	10	173
18.00	18.30	18.35	50	110	3	10	173
18.30	19.00	19.15	50	110	3	10	173
19.00	19.30	19.40	50	110	3	10	173
19.30	20.00	20.10	50	110	3	10	173
20.00	20.30	20.40	50	110	3	10	173
20.30	21.00	21.10	50	110	3	10	173
21.00	21.30	21.35	50	110	3	10	173
21.30	22.00	21.35	50	110	3	10	173

SIGNAL PHASE TIME SURVEY
JUNCTION NAME : CAUVERY ARTS AND CRAFT JUNCTION
DIRECTION: ANIL KUMBLE TO MAYO HALL

DATE:18-5-2017						DAY:THURSDAY	
Time		Observed Time	Cycle Time (s)				
From	To		Green	Red	Amber	Pedestrian	Total
6.00	6.30	6.15	20	40	3	0	63
6.30	7.00	6.35	20	40	3	0	63
7.00	7.30	7.10	40	60	3	10	113
7.30	8.00	7.40	40	60	3	10	113
8.00	8.30	8.10	40	60	3	10	113
8.30	9.00	8.40	40	105	3	15	163
9.00	9.30	9.10	40	105	3	15	163
9.30	10.00	9.35	40	105	3	15	163
10.00	10.30	10.15	40	105	3	15	163
10.30	11.00	10.35	40	105	3	15	163
11.00	11.30	11.10	40	105	3	15	163
11.30	12.00	11.40	40	105	3	15	163
12.00	12.30	12.20	40	105	3	15	163
12.30	13.00	12.35	40	105	3	15	163
13.00	13.30	13.15	40	120	3	15	178
13.30	14.00	13.40	40	120	3	15	178
14.00	14.30	14.15	40	120	3	15	178
14.30	15.00	14.35	40	120	3	15	178
15.00	15.30	15.15	40	120	3	10	173
15.30	16.00	15.35	40	120	3	10	173
16.00	16.30	16.10	40	120	3	10	173
16.30	17.00	16.35	40	120	3	10	173
17.00	17.30	17.10	40	120	3	10	173
17.30	18.00	17.40	40	120	3	10	173
18.00	18.30	18.10	40	120	3	10	173
18.30	19.00	18.35	40	120	3	10	173
19.00	19.30	19.35	40	120	3	10	173
19.30	20.00	19.35	40	120	3	10	173
20.00	20.30	20.15	40	120	3	10	173
20.30	21.00	20.35	40	120	3	10	173
21.00	21.30	21.15	40	120	3	10	173
21.30	22.00	21.35	40	120	3	10	173

SIGNAL PHASE TIME SURVEY							
JUNCTION NAME : CAUVERY ARTS AND CRAFT JUNCTION							
DIRECTION: CUBBON TO BRIGADE							
DATE:18-5-2017						DAY:THURSDAY	
Time		Observed Time	Cycle Time (s)				
From	To		Green	Red	Amber	Pedestrian	Total
6.00	6.30	6.15	20	47	3	0	70
6.30	7.00	6.35	20	47	3	0	70

7.00	7.30	7.05	20	95	3	10	128
7.30	8.00	7.26	20	95	3	10	128
8.00	8.30	8.05	20	95	3	10	128
8.30	9.00	8.36	50	110	3	15	178
9.00	9.30	9.10	50	110	3	15	178
9.30	10.00	9.30	50	110	3	15	178
10.00	10.30	10.06	50	110	3	15	178
10.30	11.00	10.35	50	110	3	15	178
11.00	11.30	11.10	50	110	3	15	178
11.30	12.00	11.30	50	110	3	15	178
12.00	12.30	12.15	50	110	3	15	178
12.30	13.00	12.35	50	110	3	15	178
13.00	13.30	13.10	50	110	3	15	178
13.30	14.00	13.35	50	110	3	15	178
14.00	14.30	14.05	50	110	3	15	178
14.30	15.00	14.40	50	110	3	15	178
15.00	15.30	15.10	60	80	3	10	153
15.30	16.00	15.4	60	80	3	10	153
16.00	16.30	16.15	60	80	3	10	153
16.30	17.00	16.4	60	80	3	10	153
17.00	17.30	17.10	60	80	3	10	153
17.30	18.00	17.35	60	80	3	10	153
18.00	18.30	18.10	60	80	3	10	153
18.30	19.00	18.35	60	80	3	10	153
19.00	19.30	19.10	75	85	3	10	173
19.30	20.00	19.4	75	85	3	10	173
20.00	20.30	20.15	75	85	3	10	173
20.30	21.00	20.35	75	85	3	10	173
21.00	21.30	21.15	75	85	3	10	173
21.30	22.00	21.4	75	85	3	10	173

Table 04: Dead Green/Wastage of Green at Cauvery Arts and Crafts Intersection on 11/05/2017

WASTE/DEAD GREEN SIGNAL SURVEY			
JUNCTION NAME : CAUVERY ARTS AND CRAFT JUNCTION			
DIRECTION: MAYO HALL TO ANIL KUMBLE			
DATE:11-5-2017			DAY:THURSDAY
Time		Dead Green	Wastage of Green
From	To	Occurred	Occurred
6.00	6.30	-	√
6.30	7.00	-	√
7.00	7.30	-	√
7.30	8.00	-	√
8.00	8.30	-	√

8.30	9.00	-	√
9.00	9.30	-	-
9.30	10.00	-	-
10.00	10.30	-	-
10.30	11.00	-	-
11.00	11.30	-	-
11.30	12.00	-	-
12.00	12.30	-	-
12.30	13.00	-	-
13.00	13.30	-	-
13.30	14.00	-	-
14.00	14.30	-	-
14.30	15.00	-	-
15.00	15.30	-	-
15.30	16.00	-	-
16.00	16.30	-	-
16.30	17.00	-	-
17.00	17.30	-	-
17.30	18.00	-	-
18.00	18.30	-	-
18.30	19.00	-	-
19.00	19.30	-	-
19.30	20.00	-	-
20.00	20.30	-	-
20.30	21.00	-	-
21.00	21.30	-	√
21.30	22.00	-	√

WASTE/DEAD GREEN SIGNAL SURVEY			
JUNCTION NAME : CAUVERY ARTS AND CRAFT JUNCTION			
DIRECTION: ANIL KUMBLE TO MAYO HALL			
DATE:11-5-2017			**DAY:THURSDAY**
Time		**Dead Green**	**Wastage of Green**
From	**To**	**Occurred**	**Occurred**
6.00	6.30	-	√
6.30	7.00	-	-
7.00	7.30	-	√
7.30	8.00	-	√
8.00	8.30	-	-
8.30	9.00	-	-
9.00	9.30	-	-
9.30	10.00	-	-
10.00	10.30	-	√

10.30	11.00	-	-
11.00	11.30	-	-
11.30	12.00	-	-
12.00	12.30	-	-
12.30	13.00	-	-
13.00	13.30	-	-
13.30	14.00	-	-
14.00	14.30	-	-
14.30	15.00	-	-
15.00	15.30	-	-
15.30	16.00	-	-
16.00	16.30	-	-
16.30	17.00	-	-
17.00	17.30	-	-
17.30	18.00	-	-
18.00	18.30	-	-
18.30	19.00	-	-
19.00	19.30	-	-
19.30	20.00	-	-
20.00	20.30	-	-
20.30	21.00	-	√
21.00	21.30	-	-
21.30	22.00	-	√

WASTE/DEAD GREEN SIGNAL SURVEY			
JUNCTION NAME : CAUVERY ARTS AND CRAFT JUNCTION			
DIRECTION: CUBBON TO BRIGADE			
DATE:11-5-2017			**DAY:THURSDAY**
Time		**Dead Green**	**Wastage of Green**
From	**To**	**Occurred**	**Occurred**
6.00	6.30	-	√
6.30	7.00	-	√
7.00	7.30	-	-
7.30	8.00	-	-
8.00	8.30	-	√
8.30	9.00	-	-
9.00	9.30	-	-
9.30	10.00	-	-
10.00	10.30	-	-
10.30	11.00	-	-
11.00	11.30	-	-
11.30	12.00	-	-
12.00	12.30	-	-

12.30	13.00	-	-
13.00	13.30	-	-
13.30	14.00	-	-
14.00	14.30	-	-
14.30	15.00	-	-
15.00	15.30	-	√
15.30	16.00	-	√
16.00	16.30	-	-
16.30	17.00	-	-
17.00	17.30	-	-
17.30	18.00	-	-
18.00	18.30	-	-
18.30	19.00	-	-
19.00	19.30	-	-
19.30	20.00	-	-
20.00	20.30	-	-
20.30	21.00	-	-
21.00	21.30	-	-
21.30	22.00	-	-

Table 05: Dead Green/Wastage of Green at Cauvery Arts and Crafts Intersection on 14/05/2017

WASTE/DEAD GREEN SIGNAL SURVEY			
JUNCTION NAME : CAUVERY ARTS AND CRAFT JUNCTION			
DIRECTION: MAYO HALL TO ANIL KUMBLE			
DATE:14-5-2017			DAY:SUNDAY
Time		Dead Green	Wastage of Green
From	To	Occurred	Occurred
6.00	6.30	-	√
6.30	7.00	-	√
7.00	7.30	-	√
7.30	8.00	-	√
8.00	8.30	-	√
8.30	9.00	-	√
9.00	9.30	-	-
9.30	10.00	-	√
10.00	10.30	-	-
10.30	11.00	-	√
11.00	11.30	-	-
11.30	12.00	-	-
12.00	12.30	-	-
12.30	13.00	-	-
13.00	13.30	-	-
13.30	14.00	-	-

14.00	14.30	-	-
14.30	15.00	-	-
15.00	15.30	-	-
15.30	16.00	-	-
16.00	16.30	-	-
16.30	17.00	-	-
17.00	17.30	-	-
17.30	18.00	-	-
18.00	18.30	-	-
18.30	19.00	-	-
19.00	19.30	-	-
19.30	20.00	-	-
20.00	20.30	-	-
20.30	21.00	-	-
21.00	21.30	-	-
21.30	22.00	-	√

WASTE/DEAD GREEN SIGNAL SURVEY			
JUNCTION NAME : CAUVERY ARTS AND CRAFT JUNCTION			
DIRECTION: ANIL KUMBLE TO MAYO HALL			
DATE:14-5-2017			**DAY:SUNDAY**
Time		**Dead Green**	**Wastage of Green**
From	**To**	**Occurred**	**Occurred**
6.00	6.30	-	√
6.30	7.00	-	√
7.00	7.30	-	√
7.30	8.00	-	√
8.00	8.30	-	√
8.30	9.00	-	√
9.00	9.30	-	√
9.30	10.00	-	√
10.00	10.30	-	-
10.30	11.00	-	-
11.00	11.30	-	-
11.30	12.00	-	-
12.00	12.30	-	-
12.30	13.00	-	-
13.00	13.30	-	-
13.30	14.00	-	-
14.00	14.30	-	√
14.30	15.00	-	-
15.00	15.30	-	-
15.30	16.00	-	-
16.00	16.30	-	-

16.30	17.00	-	-
17.00	17.30	-	-
17.30	18.00	-	-
18.00	18.30	-	-
18.30	19.00	-	-
19.00	19.30	-	-
19.30	20.00	-	-
20.00	20.30	-	-
20.30	21.00	-	-
21.00	21.30	-	-
21.30	22.00	-	-

WASTE/DEAD GREEN SIGNAL SURVEY			
JUNCTION NAME : CAUVERY ARTS AND CRAFT JUNCTION			
DIRECTION: CUBBON TO BRIGADE			
DATE:14-5-2017			**DAY:SUNDAY**
Time		**Dead Green**	**Wastage of Green**
From	**To**	**Occurred**	**Occurred**
6.00	6.30	-	-
6.30	7.00	-	√
7.00	7.30	-	√
7.30	8.00	-	√
8.00	8.30	-	√
8.30	9.00	-	-
9.00	9.30	-	-
9.30	10.00	-	√
10.00	10.30	-	-
10.30	11.00	-	-
11.00	11.30	-	-
11.30	12.00	-	-
12.00	12.30	-	-
12.30	13.00	-	-
13.00	13.30	-	-
13.30	14.00	-	-
14.00	14.30	-	-
14.30	15.00	-	-
15.00	15.30	-	-
15.30	16.00	-	-
16.00	16.30	-	-
16.30	17.00	-	-
17.00	17.30	-	-
17.30	18.00	-	-
18.00	18.30	-	-
18.30	19.00	-	-

19.00	19.30	-	-
19.30	20.00	-	-
20.00	20.30	-	-
20.30	21.00	-	-
21.00	21.30	-	-
21.30	22.00	-	-

Table 06: Dead Green/Wastage of Green at Cauvery Arts and Crafts Intersection on 18/05/2017

WASTE/DEAD GREEN SIGNAL SURVEY			
JUNCTION NAME : CAUVERY ARTS AND CRAFT JUNCTION			
DIRECTION: MAYO HALL TO ANIL KUMBLE			
DATE:18-5-2017			DAY:THURSDAY
Time		Dead Green	Wastage of Green
From	To	Occurred	Occurred
6.00	6.30	-	√
6.30	7.00	-	√
7.00	7.30	-	√
7.30	8.00	-	√
8.00	8.30	-	-
8.30	9.00	-	-
9.00	9.30	-	-
9.30	10.00	-	-
10.00	10.30	-	-
10.30	11.00	-	-
11.00	11.30	-	-
11.30	12.00	-	-
12.00	12.30	-	-
12.30	13.00	-	-
13.00	13.30	-	-
13.30	14.00	-	-
14.00	14.30	-	-
14.30	15.00	-	-
15.00	15.30	-	-
15.30	16.00	-	-
16.00	16.30	-	-
16.30	17.00	-	-
17.00	17.30	-	-
17.30	18.00	-	-
18.00	18.30	-	-
18.30	19.00	-	-
19.00	19.30	-	-
19.30	20.00	-	-
20.00	20.30	-	-

20.30	21.00	-	-
21.00	21.30	-	-
21.30	22.00	-	√

WASTE/DEAD GREEN SIGNAL SURVEY			
JUNCTION NAME : CAUVERY ARTS AND CRAFT JUNCTION			
DIRECTION: ANIL KUMBLE TO MAYO HALL			
DATE:18-5-2017			**DAY:THURSDAY**
Time		**Dead Green**	**Wastage of Green**
From	**To**	**Occurred**	**Occurred**
6.00	6.30	-	√
6.30	7.00	-	√
7.00	7.30	-	√
7.30	8.00	-	-
8.00	8.30	-	√
8.30	9.00	-	-
9.00	9.30	-	-
9.30	10.00	-	-
10.00	10.30	-	-
10.30	11.00	-	-
11.00	11.30	-	-
11.30	12.00	-	-
12.00	12.30	-	-
12.30	13.00	-	√
13.00	13.30	-	√
13.30	14.00	-	-
14.00	14.30	-	-
14.30	15.00	-	-
15.00	15.30	-	-
15.30	16.00	-	-
16.00	16.30	-	-
16.30	17.00	-	-
17.00	17.30	-	-
17.30	18.00	-	-
18.00	18.30	-	-
18.30	19.00	-	-
19.00	19.30	-	-
19.30	20.00	-	-
20.00	20.30	-	-
20.30	21.00	-	-
21.00	21.30	-	-
21.30	22.00	-	-

WASTE/DEAD GREEN SIGNAL SURVEY

JUNCTION NAME : CAUVERY ARTS AND CRAFT JUNCTION			
DIRECTION: CUBBON TO BRIGADE			
DATE:18-5-2017			DAY:THURSDAY
Time		Dead Green	Wastage of Green
From	To	Occurred	Occurred
6.00	6.30	-	√
6.30	7.00	-	√
7.00	7.30	-	√
7.30	8.00	-	-
8.00	8.30	-	-
8.30	9.00	-	-
9.00	9.30	-	-
9.30	10.00	-	-
10.00	10.30	-	-
10.30	11.00	-	-
11.00	11.30	-	-
11.30	12.00	-	√
12.00	12.30	-	-
12.30	13.00	-	-
13.00	13.30	-	-
13.30	14.00	-	-
14.00	14.30	-	-
14.30	15.00	-	-
15.00	15.30	-	-
15.30	16.00	-	-
16.00	16.30	-	-
16.30	17.00	-	-
17.00	17.30	-	-
17.30	18.00	-	-
18.00	18.30	-	-
18.30	19.00	-	-
19.00	19.30	-	-
19.30	20.00	-	-
20.00	20.30	-	-
20.30	21.00	-	-
21.00	21.30	-	-
21.30	22.00	-	-

Table 07: Passing Vehicle Count Survey at Cauvery Arts and Crafts Intersection on 11/05/2017

PASSING VEHICLE COUNT SURVEY		
JUNCTION NAME : Cauvery Arts and Craft Junction		
DIRECTION: MAYO HALL TO ANIL KUMBLE		
DATE:11-5-2017		DAY:THURSDAY
Time	Observed	Total Vehicle Count (s)

From	To	Time	10	10	10	10	10	10	Total
6.00	6.30	6.15	2	3					5
6.30	7.00	6.40	1	5					6
7.00	7.30	7.12	20	6	2	0	0		28
7.30	8.00	7.40	15	4	0	0	0		19
8.00	8.30	8.15	20	30	15	2	0		67
8.30	9.00	8.37	25	35	21	6	1		88
9.00	9.30	9.15	17	44	36	28	10		135
9.30	10.00	9.30	27	54	39	28	15		163
10.00	10.30	10.17	44	40	35	29	9		157
10.30	11.00	10.41	24	34	22	19	5		104
11.00	11.30	11.20	17	24	40	41	40		162
11.30	12.00	11.50	20	31	45	17	28		141
12.00	12.30	12.8	25	35	31	35	21		147
12.30	13.00	12.51	29	33	42	37	20		161
13.00	13.30	13.15	20	25	35	34	44		158
13.30	14.00	13.36	29	33	42	37	20		161
14.00	14.30	14.14	26	20	57	22	18		143
14.30	15.00	14.33	33	40	23	24	9		129
15.00	15.30	15.10	21	19	18	18	6		82
15.30	16.00	15.35	12	11	15	22	16		76
16.00	16.30	16.10	10	21	18	16	11		76
16.30	17.00	16.35	15	18	19	12	7		71
17.00	17.30	17.10	10	18	21	10	5		64
17.30	18.00	17.35	18	21	19	12	2		72
18.00	18.30	18.10	10	19	21	15	18		83
18.30	19.00	18.35	15	12	9	11	10		57
19.00	19.30	19.10	10	15	19	12	10		66
19.30	20.00	19.35	12	18	20	15	10		75
20.00	20.30	20.05	6	14	17	20	8		65
20.30	21.00	20.35	9	11	16	10	11		57
21.00	21.30	21.05	11	10	15	5			41
21.30	22.00	21.35	11	14	18	3	2		48

PASSING VEHICLE COUNT SURVEY

JUNCTION NAME : Cauvery Arts and Craft Junction

DIRECTION: ANIL KUMBLE TO MAYOHALL

DATE:11-5-2017 | **DAY:THURSDAY**

Time		Observed Time	Total Vehicle Count (s)						
From	To		10	10	10	10	10	10	Total
6.00	6.30	6.15	4	2					6
6.30	7.00	6.35	6	11					17
7.00	7.30	7.10	3	9	1	0			13
7.30	8.00	7.35	4	6	0	0			10

8.00	8.30	8.03	11	10	11	4			36
8.30	9.00	8.05	8	22	14	11			55
9.00	9.30	9.10	11	15	20	17			63
9.30	10.00	9.35	20	12	17	7			56
10.00	10.30	1.10	15	14	8	1			38
10.30	11.00	10.40	20	9	14	19			62
11.00	11.30	11.05	11	13	11	20			55
11.30	12.00	11.35	10	7	11	9			37
12.00	12.30	12.05	8	15	9	9			41
12.30	13.00	12.40	5	14	7	8			34
13.00	13.30	13.05	7	9	7	13			36
13.30	14.00	13.35	10	16	13	5			44
14.00	14.30	14.05	14	17	16	6			53
14.30	15.00	14.40	5	12	11	9			37
15.00	15.30	15.10	16	12	6	10			44
15.30	16.00	15.35	13	15	10	9			47
16.00	16.30	16.15	18	15	8	5			46
16.30	17.00	16.35	17	13	7	8			45
17.00	17.30	17.10	19	13	11	5			48
17.30	18.00	17.36	17	11	15	5			48
18.00	18.30	18.15	14	15	18	9			56
18.30	19.00	18.33	19	14	11	5			49
19.00	19.30	19.10	18	15	13	7			53
19.30	20.00	19.35	10	15	12	8			45
20.00	20.30	20.05	17	13	11	5			46
20.30	21.00	20.34	10	8	11	3			32
21.00	21.30	21.10	11	9	8	5			33
21.30	22.00	21.35	10	8	7	3			28

PASSING VEHICLE COUNT SURVEY									
JUNCTION NAME : Cauvery Arts and Craft Junction									
DIRECTION: CUBBON TO BRIGADE									
DATE:11-5-2017								**DAY:THURSDAY**	
Time		**Observed Time**	**Total Vehicle Count (s)**						
From	**To**		**10**	**10**	**10**	**10**	**10**	**10**	Total
6.00	6.30	6.15	2	3					5
6.30	7.00	6.35	10	3					13
7.00	7.30	7.10	21	8					29
7.30	8.00	7.35	16	27	7				50
8.00	8.30	8.03	20	19	4	3	1		47
8.30	9.00	8.05	29	34	13	4	4		84
9.00	9.30	9.10	20	20	15	25	10		90
9.30	10.00	9.35	25	24	14	13	15		91
10.00	10.30	1.10	46	38	9	15	17		125

10.30	11.00	10.40	45	41	48	14	8		156
11.00	11.30	11.05	46	11	6	17	7		87
11.30	12.00	11.35	45	17	13	16	16		107
12.00	12.30	12.05	26	23	34	14	5		102
12.30	13.00	12.40	16	16	9	35	23		99
13.00	13.30	13.05	12	26	10	5	3		56
13.30	14.00	13.35	14	17	13	15	17		76
14.00	14.30	14.05	19	20	25	2	6		72
14.30	15.00	14.40	25	19	10	5	7		66
15.00	15.30	15.10	13	14	12	4	3		46
15.30	16.00	15.35	20	22	8	1	2		53
16.00	16.30	16.15	21	15	12	5	2		55
16.30	17.00	16.35	24	20	11	7	6		68
17.00	17.30	17.10	25	20	13	12	11		81
17.30	18.00	17.36	40	19	18	17	16		110
18.00	18.30	18.15	19	20	7	14	13		73
18.30	19.00	18.40	20	21	14	13	12		80
19.00	19.30	19.10	25	23	19	14	12		93
19.30	20.00	19.35	23	14	18	12	11		78
20.00	20.30	20.05	29	13	12	11	9		74
20.30	21.00	20.50	18	17	12	20	10		77
21.00	21.30	21.25	14	13	11	9	8		55
21.30	22.00	21.4	14	13	12	11	9		59

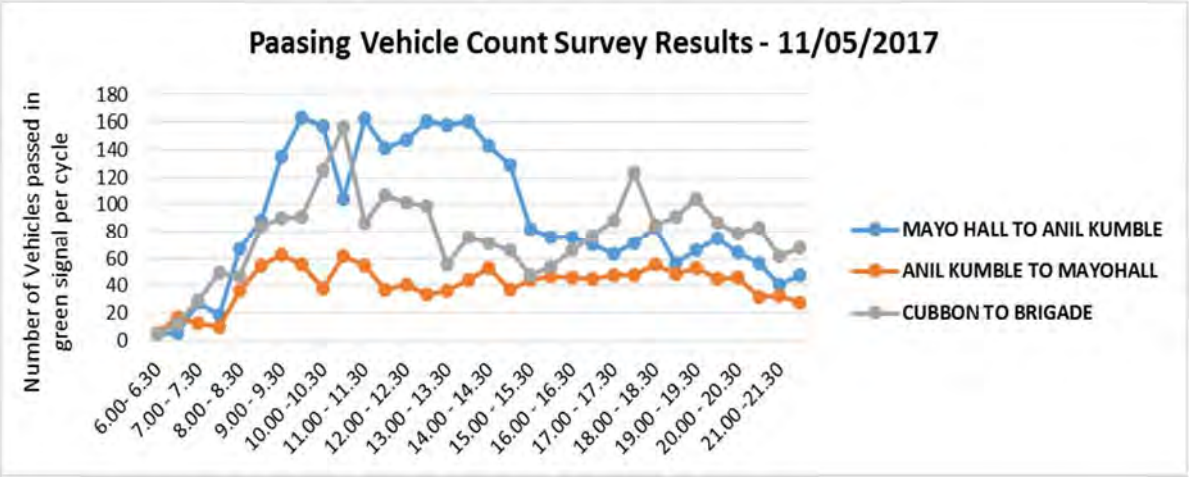


Figure 9: Passing Vehicles at Cauvery Arts & Craft Intersection on 11/05/2017

Table 08: Passing Vehicle Count Survey at Cauvery Arts and Crafts Intersection on 14/05/2017

PASSING VEHICLE COUNT SURVEY									
JUNCTION NAME : Cauvery Arts and Craft Junction									
DIRECTION: MAYO HALL TO ANIL KUMBLE									
DATE:14-5-2017								DAY:SUNDAY	
Time		Observed Time	Total Vehicle Count (s)						
From	To		10	10	10	10	10	10	Total
6.00	6.30	6.10	6	7	5	0	0		18
6.30	7.00	6.40	8	7	2	0	0		17
7.00	7.30	7.10	9	8	1	0	0		18
7.30	8.00	7.36	9	7	2	1	0		19
8.00	8.30	8.10	14	9	1	0	0		24
8.30	9.00	8.35	6	9	4	0	0		19
9.00	9.30	9.15	7	17	5	13	5		47
9.30	10.00	9.40	11	11	4	2	1		29
10.00	10.30	10.10	4	20	12	7	6		49
10.30	11.00	10.45	11	12	8	1	5		37
11.00	11.30	11.15	11	6	10	12	7		46
11.30	12.00	11.35	13	19	8	3	6		49
12.00	12.30	12.15	12	11	20	9	6		58
12.30	13.00	12.40	16	8	10	15	4		53
13.00	13.30	13.10	8	8	8	7	5		36
13.30	14.00	13.40	16	13	12	9	18		68
14.00	14.30	14.15	12	14	10	9	4		49
14.30	15.00	14.40	17	10	8	11	11		57
15.00	15.30	15.10	6	9	8	11	4		38
15.30	16.00	15.40	6	10	14	13	5		48
16.00	16.30	16.10	11	15	12	7	3		48
16.30	17.00	16.35	7	10	17	18	15		67
17.00	17.30	17.4	12	18	19	10	8		67
17.30	18.00	18.15	15	19	22	15	5		76
18.00	18.30	18.35	18	19	17	16	11		81
18.30	19.00	19.15	13	21	17	16	15		82
19.00	19.30	19.40	11	20	21	17	15		84
19.30	20.00	20.10	10	18	20	17	13		78
20.00	20.30	20.40	12	14	17	8	5		56
20.30	21.00	21.10	15	13	17	8	5		58
21.00	21.30	21.35	10	18	20	17	17		82
21.30	22.00	21.35	11	14	18	3	2		48

PASSING VEHICLE COUNT SURVEY
JUNCTION NAME : Cauvery Arts and Craft Junction
DIRECTION: ANIL KUMBLE TO MAYOHALL

DATE:14-5-2017									DAY:SUNDAY
Time		Observed Time	Total Vehicle Count (s)						
From	To		10	10	10	10	10	10	Total
6.00	6.30	6.10	9	3	4	0			16
6.30	7.00	6.35	8	4	9	0			21
7.00	7.30	7.10	9	5	5	2			21
7.30	8.00	7.40	9	3	1	0			13
8.00	8.30	8.10	10	6	3	2			21
8.30	9.00	8.40	6	7	6	4			23
9.00	9.30	9.10	1	8	3	1			13
9.30	10.00	9.35	18	7	2	7			34
10.00	10.30	10.15	7	6	6	6			25
10.30	11.00	10.35	7	12	12	8			39
11.00	11.30	11.10	7	5	12	2			26
11.30	12.00	11.40	8	4	10	10			32
12.00	12.30	12.20	15	10	3	5			33
12.30	13.00	12.35	6	11	8	5			30
13.00	13.30	13.15	10	13	11	6			40
13.30	14.00	13.40	11	11	5	8			35
14.00	14.30	14.15	18	4	6	2			30
14.30	15.00	14.35	2	14	10	9			35
15.00	15.30	15.15	8	11	8	10			37
15.30	16.00	15.35	10	7	5	4			26
16.00	16.30	16.10	15	11	10	8			44
16.30	17.00	16.35	17	13	10	4			44
17.00	17.30	17.10	19	13	15	10			57
17.30	18.00	17.40	15	11	8	7			41
18.00	18.30	18.10	21	18	13	8			60
18.30	19.00	18.35	20	18	12	8			58
19.00	19.30	19.35	25	17	13	10			65
19.30	20.00	19.35	23	18	13	18			72
20.00	20.30	20.15	20	15	10	7			52
20.30	21.00	20.35	15	11	8	7			41
21.00	21.30	21.15	19	15	11	5			50
21.30	22.00	21.35	20	16	11	4			51

PASSING VEHICLE COUNT SURVEY									
JUNCTION NAME : Cauvery Arts and Craft Junction									
DIRECTION: CUBBON TO BRIGADE									
DATE:14-5-2017									DAY:SUNDAY
Time		Observed Time	Total Vehicle Count (s)						
From	To		10	10	10	10	10	10	Total
6.00	6.30	6.15	12	7	4	5	6		34
6.30	7.00	6.35	17	4	3	5	0		29

7.00	7.30	7.05	20	13	4	0	1	0	38
7.30	8.00	7.26	11	12	13	9	6	2	53
8.00	8.30	8.05	19	6	3	8	4	3	43
8.30	9.00	8.36	10	27	11	12	7	5	72
9.00	9.30	9.10	11	17	8	3	6	4	49
9.30	10.00	9.30	20	20	13	6	1	3	63
10.00	10.30	10.06	22	11	12	11	4	8	68
10.30	11.00	10.35	21	16	15	7	11	9	79
11.00	11.30	11.10	19	16	9	9	5	7	65
11.30	12.00	11.30	10	32	7	5	3	4	61
12.00	12.30	12.15	16	18	12	5	5	2	58
12.30	13.00	12.35	12	21	13	12	9	4	71
13.00	13.30	13.10	19	17	8	5	6	5	60
13.30	14.00	13.35	24	14	11	6	3	8	66
14.00	14.30	14.05	25	15	13	6	5	7	71
14.30	15.00	14.40	26	22	8	8	4	5	73
15.00	15.30	15.10	10	13	15	17	9		64
15.30	16.00	15.4	11	14	16	18	5		64
16.00	16.30	16.15	17	13	14	10	5		59
16.30	17.00	16.4	18	12	15	8	7		60
17.00	17.30	17.10	14	10	13	11	8		56
17.30	18.00	17.35	18	15	17	10	5		65
18.00	18.30	18.10	20	17	10	9	6		62
18.30	19.00	18.35	25	18	14	11	5		73
19.00	19.30	19.10	20	18	15	13	9		75
19.30	20.00	19.4	23	17	13	11	5		69
20.00	20.30	20.15	20	18	14	13	8		73
20.30	21.00	20.35	15	11	13	10	8		57
21.00	21.30	21.15	18	13	11	8	5		55
21.30	22.00	21.4	20	18	15	11	8		72

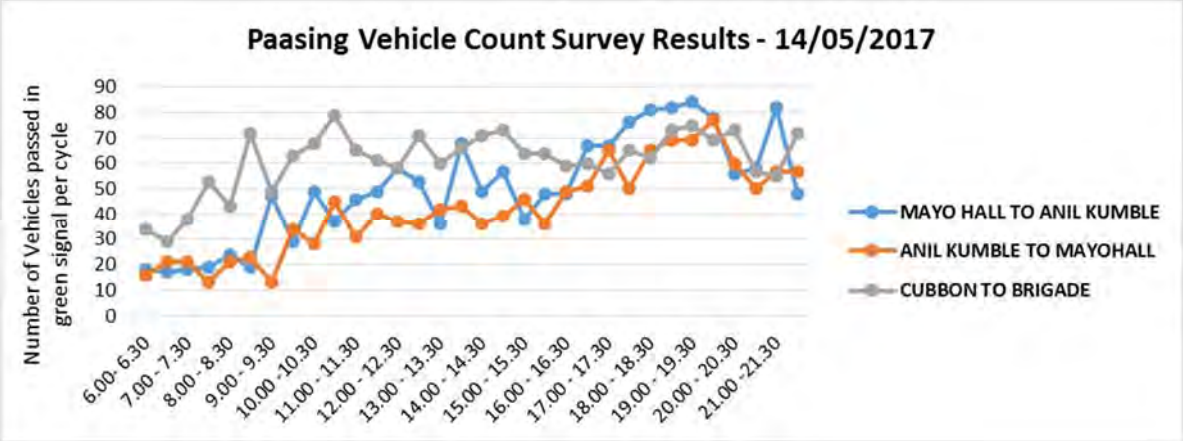


Figure 10: Passing Vehicles at Cauvery Arts & Craft Intersection on 14/05/2017

Table 09: Passing Vehicle Count Survey at Cauvery Arts and Crafts Intersection on 18/05/2017

PASSING VEHICLE COUNT SURVEY									
JUNCTION NAME : Cauvery Arts and Craft Junction									
DIRECTION: MAYO HALL TO ANIL KUMBLE									
DATE:18-5-2017								DAY:THURSDAY	
Time		Observed Time	Total Vehicle Count (s)						
From	To		10	10	10	10	10	10	Total
6.00	6.30	6.10	3	4					7
6.30	7.00	6.40	2	4					6
7.00	7.30	7.10	4	6	2	2			14
7.30	8.00	7.45	14	10	2	4			30
8.00	8.30	8.10	9	5	10	3			27
8.30	9.00	8.35	27	15	12	11			65
9.00	9.30	9.15	29	18	13	10			70
9.30	10.00	9.40	19	17	20	16			72
10.00	10.30	10.10	15	16	17	19			67
10.30	11.00	10.45	21	20	28	3			72
11.00	11.30	11.15	21	25	24	11			81
11.30	12.00	11.35	26	19	16	15	3		79
12.00	12.30	12.15	17	21	18	6	7		69
12.30	13.00	12.40	19	13	16	13	5		66
13.00	13.30	13.10	25	16	18	3	9		71
13.30	14.00	13.40	27	19	9	8	7		70
14.00	14.30	14.15	27	14	15	11	13		80
14.30	15.00	14.40	25	21	10	6	12		74
15.00	15.30	15.10	9	11	17	11	15		63
15.30	16.00	15.40	12	17	12	20	15		76
16.00	16.30	16.10	11	16	20	18	12		77
16.30	17.00	16.35	9	18	21	11	18		77
17.00	17.30	17.4	12	11	21	17	13		74
17.30	18.00	18.15	16	11	21	19	8		75
18.00	18.30	18.35	9	21	19	12	15		76
18.30	19.00	19.15	12	19	24	15	18		88
19.00	19.30	19.40	11	18	21	20	15		85
19.30	20.00	20.10	13	20	19	17	18		87
20.00	20.30	20.40	16	19	15	21	15		86
20.30	21.00	21.10	21	11	19	20	20		91
21.00	21.30	21.35	13	21	19	17	9		79
21.30	22.00	21.35	11	14	18	3	2		48

PASSING VEHICLE COUNT SURVEY

JUNCTION NAME : Cauvery Arts and Craft Junction									
DIRECTION: ANIL KUMBLE TO MAYOHALL									
DATE:18-5-2017								DAY:THURSDAY	
Time		Observed Time	Total Vehicle Count (s)						
From	To		10	10	10	10	10	10	Total
6.00	6.30	6.15	3	4					7
6.30	7.00	6.35	4	3					7
7.00	7.30	7.10	14	8	1	0			23
7.30	8.00	7.40	14	13	19	21			67
8.00	8.30	8.10	16	11	4	2			33
8.30	9.00	8.40	15	12	9	11			47
9.00	9.30	9.10	22	10	15	13			60
9.30	10.00	9.35	21	28	10	5			64
10.00	10.30	10.15	18	5	26	13			62
10.30	11.00	10.35	23	14	10	4			51
11.00	11.30	11.10	9	20	12	8			49
11.30	12.00	11.40	21	13	7	6			47
12.00	12.30	12.20	19	13	20	14			66
12.30	13.00	12.35	14	27	26	1			68
13.00	13.30	13.15	11	16	5	0			32
13.30	14.00	13.40	17	11	13	4			45
14.00	14.30	14.15	19	10	7	11			47
14.30	15.00	14.35	21	6	9	13			49
15.00	15.30	15.15	18	15	19	10			62
15.30	16.00	15.35	20	10	17	8			55
16.00	16.30	16.10	21	15	11	7			54
16.30	17.00	16.35	19	17	10	7			53
17.00	17.30	17.10	17	13	10	5			45
17.30	18.00	17.40	20	15	13	11			59
18.00	18.30	18.10	22	17	10	7			56
18.30	19.00	18.35	18	13	10	8			49
19.00	19.30	19.35	21	18	13	10			62
19.30	20.00	19.35	18	10	15	7			50
20.00	20.30	20.15	20	13	11	7			51
20.30	21.00	20.35	22	18	13	11			64
21.00	21.30	21.15	23	17	13	7			60
21.30	22.00	21.35	18	15	13	8			54

PASSING VEHICLE COUNT SURVEY									
JUNCTION NAME : Cauvery Arts and Craft Junction									
DIRECTION: CUBBON TO BRIGADE									
DATE:18-5-2017								DAY:THURSDAY	
Time		Observed Time	Total Vehicle Count (s)						
From	To		10	10	10	10	10	10	Total

6.00	6.30	6.15	9	3					12
6.30	7.00	6.35	10	4					14
7.00	7.30	7.05	12	3					15
7.30	8.00	7.26	28	18					46
8.00	8.30	8.05	5	30					35
8.30	9.00	8.36	40	39	19	5	9		112
9.00	9.30	9.10	42	24	10	13	17		106
9.30	10.00	9.30	12	16	44	3	2		77
10.00	10.30	10.06	22	17	18	19	7		83
10.30	11.00	10.35	36	4	48	11	36		135
11.00	11.30	11.10	42	18	12	14	11		97
11.30	12.00	11.30	105	17	19	7	2		150
12.00	12.30	12.15	43	21	12	10	2		88
12.30	13.00	12.35	42	20	17	3	9		91
13.00	13.30	13.10	43	22	14	7	8		94
13.30	14.00	13.35	47	5	14	5	9		80
14.00	14.30	14.05	41	15	17	11	4		88
14.30	15.00	14.40	37	4	30	15	2		88
15.00	15.30	15.10	19	13	10	11	9	3	65
15.30	16.00	15.4	21	18	13	10	11	4	77
16.00	16.30	16.15	22	15	11	12	9	7	76
16.30	17.00	16.4	23	18	17	12	9	6	85
17.00	17.30	17.10	24	20	13	10	9	5	81
17.30	18.00	17.35	18	13	12	11	2	3	59
18.00	18.30	18.10	18	12	10	8	7	6	61
18.30	19.00	18.35	22	18	17	13	10	5	85
19.00	19.30	19.10	23	18	17	13	10	5	86
19.30	20.00	19.4	20	14	12	17	7	5	75
20.00	20.30	20.15	25	18	17	18	14	5	97
20.30	21.00	20.35	18	14	13	12	11	10	78
21.00	21.30	21.15	20	18	13	10	14	12	87
21.30	22.00	21.4	14	13	11	9	7	5	59

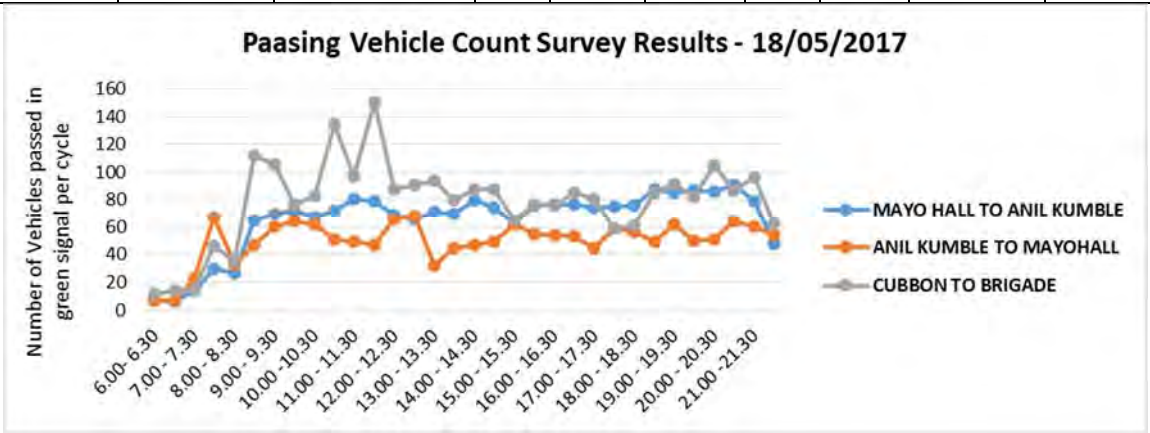


Figure 11: Passing Vehicles at Cauvery Arts & Craft Intersection on 18/05/2017

4.2 Dr. Bhaskaran Road & Swami Vivekanadha Intersection

pictorial representation of the intersection, with details of approach movements and Signal Posts Locations is shown in the figure below.

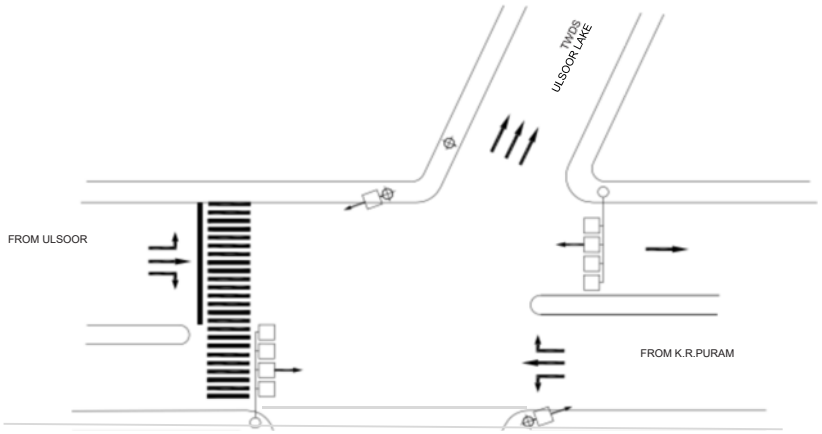


Figure 12: Details of Dr. Bhaskaran Road & Swami Vivekanadha Intersection

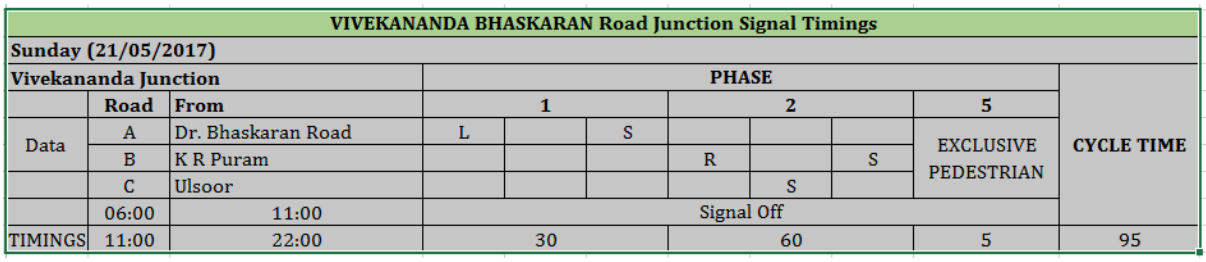
The observed green signal indication timings are entered corresponding to the time intervals in each phase phase and the total cycle length (cycle time) in seconds were calculated. Details are presented in the table below.

VIVEKANANDA BHASKARAN Road Junction Signal Timings											
Weekday (10/05/2017)											
Vivekananda Junction			PHASE								CYCLE TIME
	Road	From	1			2			5		
Data	A	Dr. Bhaskaran Road	L		S				EXCLUSIVE PEDESTRIAN		
	B	K R Puram				R		S			
	C	Ulsoor					S				
	06:00	07:00	Signal Off								
TIMINGS	07:00	15:00	30			90			10		130
	15:00	17:30	30			90			10		130
	17:30	21:00	30			110			10		150
	21:00	22:00	30			50			10		90

Figure 13: Cycle Length of Dr. Bhaskaran Road & Swami Vivekanadha Intersection on 10/05/2017

VIVEKANANDA BHASKARAN Road Junction Signal Timings											
Weekday (17/05/2017)											
Vivekananda Junction			PHASE								CYCLE TIME
	Road	From	1			2			5		
Data	A	Dr. Bhaskaran Road	L		S				EXCLUSIVE PEDESTRIAN		
	B	K R Puram				R		S			
	C	Ulsoor					S				
	06:00	10:00	Signal Off								
TIMINGS	10:00	15:00	30			90			10		130
	15:00	17:00	30			90			10		130
	17:30	21:00	Manual (30)			Manual (110-250)			10		
	21:00	22:00	30			50			10		90

Figure 14: Cycle Length of Dr. Bhaskaran Road & Swami Vivekanadha Intersection on 17/05/2017



VIVEKANANDA BHASKARAN Road Junction Signal Timings										
Sunday (21/05/2017)										
Vivekananda Junction			PHASE							
	Road	From	1			2			5	CYCLE TIME
Data	A	Dr. Bhaskaran Road	L		S				EXCLUSIVE PEDESTRIAN	
	B	K R Puram				R		S		
	C	Ulsoor					S			
	06:00	11:00	Signal Off							
TIMINGS	11:00	22:00	30			60			5	95

Figure 11: Cycle Length of Dr. Bhaskaran Road & Swami Vivekanadha Intersection on 21/05/2017

A two phase signal with exclusive pedestrian signal was operated at Bhaskaran Intersection. The signal operation was differed on weekdays and weekend. Signals were manually operated at times. The signal operation was started at different timings on different days. In general, the cycle length varied from 90-150 seconds.

Table 10: Signal Phase Time Survey at Dr.Bhaskaran Road & Swami Vivekananda Road Intersection on 10/05/2017

SIGNAL PHASE TIME SURVEY							
JUNCTION NAME : DR.BHASKARAN ROAD & SWAMI VIVEKANANDA ROAD JUNCTION							
DIRECTION: ULSOOR ROAD TO K R PURAM							
DATE:10-5-2017						DAY:WEDNESDAY	
Time		Observed Time	Cycle Time (s)				
From	To		Green	Red	Amber	Pedestrian	Total
6.00	6.30						
6.30	7.00						
7.00	7.30	7.15	90	45	3	10	148
7.30	8.00	7.35	90	45	3	10	148
8.00	8.30	8.05	90	45	3	10	148
8.30	9.00	8.35	90	45	3	10	148
9.00	9.30	9.07	90	45	3	10	148
9.30	10.00	9.35	90	45	3	10	148
10.00	10.30	10.10	90	45	3	10	148
10.30	11.00	10.45	90	45	3	10	148
11.00	11.30	11.15	90	45	3	10	148
11.30	12.00	11.45	90	45	3	10	148
12.00	12.30	12.15	90	45	3	10	148
12.30	13.00	12.35	90	45	3	10	148
13.00	13.30	13.15	90	45	3	10	148
13.30	14.00	13.40	90	45	3	10	148
14.00	14.30	14.15	90	45	3	10	148
14.30	15.00	14.45	90	45	3	10	148
15.00	15.30	15.15	90	45	3	10	148

15.30	16.00	15.35	90	45	3	10	148
16.00	16.30	16.25	90	45	3	10	148
16.30	17.00	16.40	90	45	3	10	148
17.00	17.30	17.15	90	45	3	10	148
17.30	18.00	17.40	110	45	3	10	168
18.00	18.30	18.15	110	45	3	10	168
18.30	19.00	18.40	110	45	3	10	168
19.00	19.30	19.10	110	45	3	10	168
19.30	20.00	19.40	110	45	3	10	168
20.00	20.30	20.10	110	45	3	10	168
20.30	21.00	20.33	110	45	3	10	168
21.00	21.30	21.17	50	45	3	10	108
21.30	22.00	21.47	50	45	3	10	108

SIGNAL PHASE TIME SURVEY

JUNCTION NAME : DR.BHASKARAN ROAD & SWAMI VIVEKANANDA ROAD JUNCTION

DIRECTION: K.R.PURAM TO DR.BHASKARAN ROAD

DATE:10-5-2017 **DAY:WEDNESDAY**

Time		Observed Time	Cycle Time (s)				
From	To		Green	Red	Amber	Pedestrian	Total
6.00	6.30						
6.30	7.00						
7.00	7.30	7.19	90	45	3	10	148
7.30	8.00	7.51	90	45	3	10	148
8.00	8.30	8.10	90	45	3	10	148
8.30	9.00	8.46	90	45	3	10	148
9.00	9.30	9.13	90	45	3	10	148
9.30	10.00	9.45	90	45	3	10	148
10.00	10.30	10.13	90	45	3	10	148
10.30	11.00	10.35	90	45	3	10	148
11.00	11.30	11.04	90	45	3	10	148
11.30	12.00	11.46	90	45	3	10	148
12.00	12.30	12.05	90	45	3	10	148
12.30	13.00	12.37	90	45	3	10	148
13.00	13.30	13.08	90	45	3	10	148
13.30	14.00	13.33	90	45	3	10	148
14.00	14.30	14.05	90	45	3	10	148
14.30	15.00	14.35	90	45	3	10	148
15.00	15.30	15.10	90	45	3	10	148
15.30	16.00	15.34	90	45	3	10	148
16.00	16.30	16.16	90	45	3	10	148
16.30	17.00	16.48	90	45	3	10	148
17.00	17.30	17.18	90	45	3	10	148
17.30	18.00	17.45	110	45	3	10	168

18.00	18.30	18.20	110	45	3	10	168
18.30	19.00	18.48	110	45	3	10	168
19.00	19.30	19.14	110	45	3	10	168
19.30	20.00	19.45	110	45	3	10	168
20.00	20.30	20.20	110	45	3	10	168
20.30	21.00	20.40	110	45	3	10	168
21.00	21.30	21.19	50	45	3	10	108
21.30	22.00	21.48	50	45	3	10	108

SIGNAL PHASE TIME SURVEY

JUNCTION NAME : DR.BHASKARAN ROAD & SWAMI VIVEKANANDA ROAD JUNCTION

DIRECTION: DR.BHASKARAN ROAD TO K.R.PURAM

DATE:10-5-2017 **DAY:WEDNESDAY**

Time		Observed Time	Cycle Time (s)				
From	To		Green	Red	Amber	Pedestrian	Total
6.00	6.30						
6.30	7.00						
7.00	7.30	7.20	30	110	3	10	153
7.30	8.00	7.43	30	110	3	10	153
8.00	8.30	8.07	30	110	3	10	153
8.30	9.00	8.34	30	110	3	10	153
9.00	9.30	9.10	30	110	3	10	153
9.30	10.00	9.44	30	110	3	10	153
10.00	10.30	10.04	30	110	3	10	153
10.30	11.00	10.34	30	110	3	10	153
11.00	11.30	11.10	30	110	3	10	153
11.30	12.00	11.36	30	110	3	10	153
12.00	12.30	12.08	30	110	3	10	153
12.30	13.00	12.37	30	110	3	10	153
13.00	13.30	13.11	30	110	3	10	153
13.30	14.00	13.33	30	110	3	10	153
14.00	14.30	14.12	30	110	3	10	153
14.30	15.00	14.38	30	110	3	10	153
15.00	15.30	15.14	30	110	3	10	153
15.30	16.00	15.40	30	110	3	10	153
16.00	16.30	16.19	30	110	3	10	153
16.30	17.00	16.48	30	110	3	10	153
17.00	17.30	17.16	30	110	3	10	153
17.30	18.00	17.39	30	110	3	10	153
18.00	18.30	18.15	30	110	3	10	153
18.30	19.00	18.40	30	110	3	10	153
19.00	19.30	19.11	30	110	3	10	153
19.30	20.00	19.49	30	110	3	10	153
20.00	20.30	20.15	30	110	3	10	153

20.30	21.00	20.49	30	110	3	10	153
21.00	21.30	21.04	30	60	3	10	103
21.30	22.00	21.54	30	60	3	10	103

Table 11: Signal Phase Time Survey at Dr.Bhaskaran Road & Swami Vivekananda Road Intersection on 17/05/2017

SIGNAL PHASE TIME SURVEY							
JUNCTION NAME : DR.BHASKARAN ROAD & SWAMI VIVEKANANDA ROAD JUNCTION							
DIRECTION: ULSOOR ROAD TO K R PURAM							
DATE:17-5-2017						DAY:WEDNESDAY	
Time		Observed Time	Cycle Time (s)				
From	To		Green	Red	Amber	Pedestrian	Total
6.00	6.30						
6.30	7.00						
7.00	7.30						
7.30	8.00						
8.00	8.30						
8.30	9.00						
9.00	9.30						
9.30	10.00						
10.00	10.30	10.20	90	45	3	10	148
10.30	11.00	10.54	90	45	3	10	148
11.00	11.30	11.05	90	45	3	10	148
11.30	12.00	11.41	90	45	3	10	148
12.00	12.30	12.26	90	45	3	10	148
12.30	13.00	12.55	90	45	3	10	148
13.00	13.30	13.05	90	45	3	10	148
13.30	14.00	13.46	90	45	3	10	148
14.00	14.30	14.20	90	45	3	10	148
14.30	15.00	14.45	90	45	3	10	148
15.00	15.30	15.15	90	45	3	10	148
15.30	16.00	15.48	90	45	3	10	148
16.00	16.30	16.12	90	45	3	10	148
16.30	17.00	16.55	90	45	3	10	148
17.00	17.30	17.17	90	45	3	10	148
17.30	18.00	17.36	90	45	3	10	148
18.00	18.30	18.17	90	45	3	10	148
18.30	19.00	18.37	90	45	3	10	148
19.00	19.30	BLINKING AMBER					
19.30	20.00	19.37	110	45	3	10	168
20.00	20.30	20.17	110	45	3	10	168
20.30	21.00	20.35	110	45	3	10	168
21.00	21.30	21.10	110	45	3	10	168
21.30	22.00	21.41	50	45	3	10	108

SIGNAL PHASE TIME SURVEY							
JUNCTION NAME : DR.BHASKARAN ROAD & SWAMI VIVEKANANDA ROAD JUNCTION							
DIRECTION: K.R.PURAM TO DR.BHASKARAN ROAD							
DATE:17-5-2017						DAY:WEDNESDAY	
Time		Observed Time	Cycle Time (s)				
From	To		Green	Red	Amber	Pedestrian	Total
6.00	6.30						
6.30	7.00						
7.00	7.30						
7.30	8.00						
8.00	8.30						
8.30	9.00						
9.00	9.30						
9.30	10.00						
10.00	10.30	10.08	90	45	3	10	148
10.30	11.00	10.41	90	45	3	10	148
11.00	11.30	11.07	90	45	3	10	148
11.30	12.00	11.47	90	45	3	10	148
12.00	12.30	12.10	90	45	3	10	148
12.30	13.00	12.54	90	45	3	10	148
13.00	13.30	13.10	90	45	3	10	148
13.30	14.00	13.54	90	45	3	10	148
14.00	14.30	14.15	90	45	3	10	148
14.30	15.00	14.50	90	45	3	10	148
15.00	15.30	15.05	90	45	3	10	148
15.30	16.00	15.30	90	45	3	10	148
16.00	16.30	16.05	90	45	3	10	148
16.30	17.00	16.35	90	45	3	10	148
17.00	17.30	17.11	110	45	3	10	168
17.30	18.00	17.00	110	45	3	10	168
18.00	18.30	18.10	110	45	3	10	168
18.30	19.00	18.35	170	45	3	10	228
19.00	19.30	19.21	236	45	3	10	294
19.30	20.00	BLINKING AMBER					
20.00	20.30	20.09	110	45	3	10	168
20.30	21.00	20.40	110	45	3	10	168
21.00	21.30	21.03	50	45	3	10	108
21.30	22.00	21.33	50	45	3	10	108

SIGNAL PHASE TIME SURVEY
JUNCTION NAME : DR.BHASKARAN ROAD & SWAMI VIVEKANANDA ROAD JUNCTION
DIRECTION: DR.BHASKARAN ROAD TO K.R.PURAM

DATE:17-5-2017						DAY:WEDNESDAY	
Time		Observed Time	Cycle Time (s)				
From	To		Green	Red	Amber	Pedestrian	Total
6.00	6.30						
6.30	7.00						
7.00	7.30						
7.30	8.00						
8.00	8.30						
8.30	9.00						
9.00	9.30						
9.30	10.00						
10.00	10.30	10.18	30	110	3	10	153
10.30	11.00	10.50	30	110	3	10	153
11.00	11.30	11.20	30	110	3	10	153
11.30	12.00	11.50	30	110	3	10	153
12.00	12.30	12.20	30	110	3	10	153
12.30	13.00	12.50	30	110	3	10	153
13.00	13.30	13.20	30	110	3	10	153
13.30	14.00	13.50	30	110	3	10	153
14.00	14.30	14.20	30	110	3	10	153
14.30	15.00	14.50	30	110	3	10	153
15.00	15.30	15.20	30	110	3	10	153
15.30	16.00	15.50	30	110	3	10	153
16.00	16.30	16.15	30	110	3	10	153
16.30	17.00	16.45	30	110	3	10	153
17.00	17.30	17.10	30	110	3	10	153
17.30	18.00	17.35	30	110	3	10	153
18.00	18.30	18.06	30	110	3	10	153
18.30	19.00	18.36	30	110	3	10	153
19.00	19.30	19.10	30	110	3	10	153
19.30	20.00	BLINKING AMBER					
20.00	20.30	20.08	30	110	3	10	153
20.30	21.00	20.38	30	110	3	10	153
21.00	21.30	21.17	30	60	3	10	103
21.30	22.00	21.45	30	60	3	10	103

Table 12: Signal Phase Time Survey at Dr.Bhaskaran Road & Swami Vivekananda Road Intersection on 21/05/2017

SIGNAL PHASE TIME SURVEY							
JUNCTION NAME : DR.BHASKARAN ROAD & SWAMI VIVEKANANDA ROAD JUNCTION							
DIRECTION: ULSOOR ROAD TO K R PURAM							
DATE:21-5-2017						DAY:SUNDAY	
Time		Observed Time	Cycle Time (s)				
From	To		Green	Red	Amber	Pedestrian	Total

6.00	6.30						
6.30	7.00						
7.00	7.30						
7.30	8.00						
8.00	8.30						
8.30	9.00						
9.00	9.30						
9.30	10.00						
10.00	10.30						
10.30	11.00						
11.00	11.30	11.20	60	40	3	5	108
11.30	12.00	11.34	60	40	3	5	108
12.00	12.30	12.18	60	40	3	5	108
12.30	13.00	12.38	60	40	3	5	108
13.00	13.30	13.06	60	40	3	5	108
13.30	14.00	13.50	60	40	3	5	108
14.00	14.30	14.28	60	40	3	5	108
14.30	15.00	14.33	60	40	3	5	108
15.00	15.30	15.15	60	40	3	5	108
15.30	16.00	15.40	60	40	3	5	108
16.00	16.30	16.00	60	40	3	5	108
16.30	17.00	16.38	60	40	3	5	108
17.00	17.30	17.10	60	40	3	5	108
17.30	18.00	17.30	60	40	3	5	108
18.00	18.30	18.09	60	40	3	5	108
18.30	19.00	18.37	60	40	3	5	108
19.00	19.30	19.07	60	40	3	5	108
19.30	20.00	19.30	60	40	3	5	108
20.00	20.30	20.15	60	40	3	5	108
20.30	21.00	20.47	60	40	3	5	108
21.00	21.30	21.10	60	40	3	5	108
21.30	22.00	21.38	60	40	3	5	108

JUNCTION NAME : DR.BHASKARAN ROAD & SWAMI VIVEKANANDA ROAD JUNCTION							
DIRECTION: K.R.PURAM TO DR.BHASKARAN ROAD							
DATE:21-5-2017						**DAY:SUNDAY**	
Time		**Observed Time**	**Cycle Time (s)**				
From	**To**		**Green**	**Red**	**Amber**	**Pedestrian**	**Total**
6.00	6.30						
6.30	7.00						
7.00	7.30						
7.30	8.00						
8.00	8.30						
8.30	9.00						
9.00	9.30						

9.30	10.00						
10.00	10.30						
10.30	11.00						
11.00	11.30	11.15	60	40	3	5	108
11.30	12.00	11.45	60	40	3	5	108
12.00	12.30	12.15	60	40	3	5	108
12.30	13.00	12.35	60	40	3	5	108
13.00	13.30	13.15	60	40	3	5	108
13.30	14.00	13.35	60	40	3	5	108
14.00	14.30	14.15	60	40	3	5	108
14.30	15.00	14.45	60	40	3	5	108
15.00	15.30	15.07	60	40	3	5	108
15.30	16.00	15.30	60	40	3	5	108
16.00	16.30	16.07	60	40	3	5	108
16.30	17.00	16.30	60	40	3	5	108
17.00	17.30	17.05	60	40	3	5	108
17.30	18.00	17.38	60	40	3	5	108
18.00	18.30	18.00	60	40	3	5	108
18.30	19.00	18.30	60	40	3	5	108
19.00	19.30	19.07	60	40	3	5	108
19.30	20.00	19.38	60	40	3	5	108
20.00	20.30	20.10	60	40	3	5	108
20.30	21.00	20.50	60	40	3	5	108
21.00	21.30	21.12	60	40	3	5	108
21.30	22.00	21.30	60	40	3	5	108

SIGNAL PHASE TIME SURVEY

JUNCTION NAME : DR.BHASKARAN ROAD & SWAMI VIVEKANANDA ROAD JUNCTION

DIRECTION: DR.BHASKARAN ROAD TO K.R.PURAM

DATE:21-5-2017 **DAY:SUNDAY**

Time		Observed Time	Cycle Time (s)				
From	To		Green	Red	Amber	Pedestrian	Total
6.00	6.30						
6.30	7.00						
7.00	7.30						
7.30	8.00						
8.00	8.30						
8.30	9.00						
9.00	9.30						
9.30	10.00						
10.00	10.30						
10.30	11.00						
11.00	11.30	11.25	30	70	3	5	108
11.30	12.00	11.40	30	70	3	5	108

12.00	12.30	12.20	30	70	3	5	108
12.30	13.00	12.40	30	70	3	5	108
13.00	13.30	13.10	30	70	3	5	108
13.30	14.00	13.50	30	70	3	5	108
14.00	14.30	14.20	30	70	3	5	108
14.30	15.00	14.40	30	70	3	5	108
15.00	15.30	15.15	30	70	3	5	108
15.30	16.00	15.40	30	70	3	5	108
16.00	16.30	16.10	30	70	3	5	108
16.30	17.00	16.40	30	70	3	5	108
17.00	17.30	17.15	30	70	3	5	108
17.30	18.00	17.40	30	70	3	5	108
18.00	18.30	18.20	30	70	3	5	108
18.30	19.00	18.40	30	70	3	5	108
19.00	19.30	19.11	30	70	3	5	108
19.30	20.00	19.45	30	70	3	5	108
20.00	20.30	20.17	30	70	3	5	108
20.30	21.00	20.45	30	70	3	5	108
21.00	21.30	21.10	30	70	3	5	108
21.30	22.00	21.30	30	70	3	5	108

Table 13: Dead Green/Wastage of Green at Dr.Bhaskaran Road & Swami Vivekananda Road Intersection on 10/05/2017

WASTE/DEAD GREEN SIGNAL SURVEY			
JUNCTION NAME : DR.BHASKARAN ROAD & SWAMI VIVEKANANDA ROAD JUNCTION			
DIRECTION: ULSOOR ROAD TO K R PURAM			
DATE:10-5-2017			DAY:WEDNESDAY
Time		Dead Green	Wastage of Green
From	To	Occurred	Occurred
6.00	6.30	-	-
6.30	7.00	-	-
7.00	7.30	-	√
7.30	8.00	-	√
8.00	8.30	-	√
8.30	9.00	-	-
9.00	9.30	-	-
9.30	10.00	-	-
10.00	10.30	-	-
10.30	11.00	-	-
11.00	11.30	-	-
11.30	12.00	-	-
12.00	12.30	-	-
12.30	13.00	-	-
13.00	13.30	-	-

13.30	14.00	-	-
14.00	14.30	-	-
14.30	15.00	-	-
15.00	15.30	-	-
15.30	16.00	-	-
16.00	16.30	-	-
16.30	17.00	-	-
17.00	17.30	-	-
17.30	18.00	-	-
18.00	18.30	-	-
18.30	19.00	-	√
19.00	19.30	-	√
19.30	20.00	-	√
20.00	20.30	-	-
20.30	21.00	-	-
21.00	21.30	-	-
21.30	22.00	-	-

WASTE/DEAD GREEN SIGNAL SURVEY			
JUNCTION NAME : DR.BHASKARAN ROAD & SWAMI VIVEKANANDA ROAD JUNCTION			
DIRECTION: K.R.PURAM TO DR.BHASKARAN ROAD			
DATE:10-5-2017			**DAY:WEDNESDAY**
Time		**Dead Green**	**Wastage of Green**
From	**To**	**Occurred**	**Occurred**
6.00	6.30	-	-
6.30	7.00	-	-
7.00	7.30	-	√
7.30	8.00	-	√
8.00	8.30	-	-
8.30	9.00	-	-
9.00	9.30	-	-
9.30	10.00	-	-
10.00	10.30	-	-
10.30	11.00	-	-
11.00	11.30	-	-
11.30	12.00	-	√
12.00	12.30	-	-
12.30	13.00	-	-
13.00	13.30	-	-
13.30	14.00	-	-
14.00	14.30	-	√
14.30	15.00	-	-
15.00	15.30	-	-
15.30	16.00	-	-

16.00	16.30	-	-
16.30	17.00	-	-
17.00	17.30	-	-
17.30	18.00	-	-
18.00	18.30	-	-
18.30	19.00	-	-
19.00	19.30	-	-
19.30	20.00	-	-
20.00	20.30	-	-
20.30	21.00	-	-
21.00	21.30	-	-
21.30	22.00	-	-

WASTE/DEAD GREEN SIGNAL SURVEY			
JUNCTION NAME : DR.BHASKARAN ROAD & SWAMI VIVEKANANDA ROAD JUNCTION			
DIRECTION: D.R.BHASKARAN ROAD TO K R PURAM			
DATE:10-5-2017			**DAY:WEDNESDAY**
Time		**Dead Green**	**Wastage of Green**
From	**To**	**Occurred**	**Occurred**
6.00	6.30	-	-
6.30	7.00	-	-
7.00	7.30	-	-
7.30	8.00	-	-
8.00	8.30	-	-
8.30	9.00	-	-
9.00	9.30	-	-
9.30	10.00	-	-
10.00	10.30	-	-
10.30	11.00	-	-
11.00	11.30	-	-
11.30	12.00	-	-
12.00	12.30	-	-
12.30	13.00	-	-
13.00	13.30	-	-
13.30	14.00	-	-
14.00	14.30	-	-
14.30	15.00	-	-
15.00	15.30	-	-
15.30	16.00	-	-
16.00	16.30	-	-
16.30	17.00	-	-
17.00	17.30	-	-
17.30	18.00	-	-
18.00	18.30	-	-

18.30	19.00	-	-
19.00	19.30	-	-
19.30	20.00	-	-
20.00	20.30	-	-
20.30	21.00	-	-
21.00	21.30	-	-
21.30	22.00	-	√

Table 14: Dead Green/Wastage of Green at Dr.Bhaskaran Road & Swami Vivekananda Road Intersection on 17/05/2017

WASTE/DEAD GREEN SIGNAL SURVEY			
JUNCTION NAME : DR.BHASKARAN ROAD & SWAMI VIVEKANANDA ROAD JUNCTION			
DIRECTION: ULSOOR ROAD TO K R PURAM			
DATE:17-5-2017			DAY:WEDNESDAY
Time		Dead Green	Wastage of Green
From	To	Occurred	Occurred
6.00	6.30	-	-
6.30	7.00	-	-
7.00	7.30	-	-
7.30	8.00	-	-
8.00	8.30	-	-
8.30	9.00	-	-
9.00	9.30	-	-
9.30	10.00	-	-
10.00	10.30	-	-
10.30	11.00	-	√
11.00	11.30	-	√
11.30	12.00	-	√
12.00	12.30	-	√
12.30	13.00	-	√
13.00	13.30	-	√
13.30	14.00	-	-
14.00	14.30	-	√
14.30	15.00	-	√
15.00	15.30	-	-
15.30	16.00	-	-
16.00	16.30	-	-
16.30	17.00	-	-
17.00	17.30	-	-
17.30	18.00	-	-
18.00	18.30	-	-
18.30	19.00	-	-
19.00	19.30	-	-

19.30	20.00	-	-
20.00	20.30	-	-
20.30	21.00	-	-
21.00	21.30	-	-
21.30	22.00	-	-

WASTE/DEAD GREEN SIGNAL SURVEY			
JUNCTION NAME : DR.BHASKARAN ROAD & SWAMI VIVEKANANDA ROAD JUNCTION			
DIRECTION: K.R.PURAM TO DR.BHASKARAN ROAD			
DATE:17-5-2017			**DAY:WEDNESDAY**
Time		**Dead Green**	**Wastage of Green**
From	**To**	**Occurred**	**Occurred**
6.00	6.30	-	-
6.30	7.00	-	-
7.00	7.30	-	-
7.30	8.00	-	-
8.00	8.30	-	-
8.30	9.00	-	-
9.00	9.30	-	-
9.30	10.00	-	-
10.00	10.30	-	-
10.30	11.00	-	-
11.00	11.30	-	-
11.30	12.00	-	-
12.00	12.30	-	-
12.30	13.00	-	-
13.00	13.30	-	-
13.30	14.00	-	-
14.00	14.30	-	-
14.30	15.00	-	-
15.00	15.30	-	-
15.30	16.00	-	-
16.00	16.30	-	-
16.30	17.00	-	-
17.00	17.30	-	-
17.30	18.00	-	-
18.00	18.30	-	-
18.30	19.00	-	-
19.00	19.30	-	√
19.30	20.00	-	-
20.00	20.30	-	-
20.30	21.00	-	-
21.00	21.30	-	-
21.30	22.00	-	√

WASTE/DEAD GREEN SIGNAL SURVEY			
JUNCTION NAME : DR.BHASKARAN ROAD & SWAMI VIVEKANANDA ROAD JUNCTION			
DIRECTION: D.R.BHASKARAN ROAD TO K R PURAM			
DATE:17-5-2017			DAY:WEDNESDAY
Time		Dead Green	Wastage of Green
From	To	Occurred	Occurred
6.00	6.30	-	-
6.30	7.00	-	-
7.00	7.30	-	-
7.30	8.00	-	-
8.00	8.30	-	-
8.30	9.00	-	-
9.00	9.30	-	-
9.30	10.00	-	-
10.00	10.30	-	√
10.30	11.00	-	-
11.00	11.30	-	-
11.30	12.00	-	√
12.00	12.30	-	-
12.30	13.00	-	-
13.00	13.30	-	-
13.30	14.00	-	√
14.00	14.30	-	√
14.30	15.00	-	√
15.00	15.30	-	-
15.30	16.00	-	√
16.00	16.30	-	-
16.30	17.00	-	-
17.00	17.30	-	√
17.30	18.00	-	-
18.00	18.30	-	-
18.30	19.00	-	-
19.00	19.30	-	-
19.30	20.00	-	-
20.00	20.30	-	-
20.30	21.00	-	-
21.00	21.30	-	-
21.30	22.00	-	√

Table 15: Dead Green/Wastage of Green at Dr.Bhaskaran Road & Swami Vivekananda Road Intersection on 21/05/2017

WASTE/DEAD GREEN SIGNAL SURVEY
JUNCTION NAME : DR.BHASKARAN ROAD & SWAMI VIVEKANANDA ROAD JUNCTION

DIRECTION: ULSOOR ROAD TO K R PURAM			
DATE:21-5-2017			DAY:SUNDAY
Time		Dead Green	Wastage of Green
From	To	Occurred	Occurred
6.00	6.30	-	-
6.30	7.00	-	-
7.00	7.30	-	-
7.30	8.00	-	-
8.00	8.30	-	-
8.30	9.00	-	-
9.00	9.30	-	-
9.30	10.00	-	-
10.00	10.30	-	-
10.30	11.00	-	-
11.00	11.30	-	-
11.30	12.00	-	-
12.00	12.30	-	√
12.30	13.00	-	-
13.00	13.30	-	-
13.30	14.00	-	-
14.00	14.30	-	-
14.30	15.00	-	√
15.00	15.30	-	-
15.30	16.00	-	-
16.00	16.30	-	-
16.30	17.00	-	-
17.00	17.30	-	-
17.30	18.00	-	-
18.00	18.30	-	-
18.30	19.00	-	-
19.00	19.30	-	-
19.30	20.00	-	-
20.00	20.30	-	-
20.30	21.00	-	-
21.00	21.30	-	-
21.30	22.00	-	-

WASTE/DEAD GREEN SIGNAL SURVEY			
JUNCTION NAME : DR.BHASKARAN ROAD & SWAMI VIVEKANANDA ROAD JUNCTION			
DIRECTION: K.R.PURAM TO DR.BHASKARAN ROAD			
DATE:21-5-2017			DAY:SUNDAY
Time		Dead Green	Wastage of Green
From	To	Occurred	Occurred
6.30	7.00	-	-

7.00	7.30	-	-
7.30	8.00	-	-
8.00	8.30	-	-
8.30	9.00	-	-
9.00	9.30	-	-
9.30	10.00	-	-
10.00	10.30	-	-
10.30	11.00	-	-
11.00	11.30	-	-
11.30	12.00	-	-
12.00	12.30	-	-
12.30	13.00	-	√
13.00	13.30	-	-
13.30	14.00	-	-
14.00	14.30	-	-
14.30	15.00	-	-
15.00	15.30	-	-
15.30	16.00	-	-
16.00	16.30	-	-
16.30	17.00	-	-
17.00	17.30	-	-
17.30	18.00	-	-
18.00	18.30	-	-
18.30	19.00	-	-
19.00	19.30	-	-
19.30	20.00	-	-
20.00	20.30	-	-
20.30	21.00	-	-
21.00	21.30	-	-
21.30	22.00	-	√

WASTE/DEAD GREEN SIGNAL SURVEY			
JUNCTION NAME : DR.BHASKARAN ROAD & SWAMI VIVEKANANDA ROAD JUNCTION			
DIRECTION: D.R.BHASKARAN ROAD TO K R PURAM			
DATE:21-5-2017			**DAY:SUNDAY**
Time		**Dead Green**	**Wastage of Green**
From	**To**	**Occurred**	**Occurred**
6.00	6.30	-	-
6.30	7.00	-	-
7.00	7.30	-	-
7.30	8.00	-	-
8.00	8.30	-	-
8.30	9.00	-	-
9.00	9.30	-	-

9.30	10.00	-	-
10.00	10.30	-	-
10.30	11.00	-	-
11.00	11.30	-	√
11.30	12.00	-	-
12.00	12.30	-	√
12.30	13.00	-	-
13.00	13.30	-	-
13.30	14.00	-	-
14.00	14.30	-	-
14.30	15.00	-	-
15.00	15.30	-	-
15.30	16.00	-	-
16.00	16.30	-	-
16.30	17.00	-	-
17.00	17.30	-	-
17.30	18.00	-	-
18.00	18.30	-	-
18.30	19.00	-	-
19.00	19.30	-	-
19.30	20.00	-	-
20.00	20.30	-	-
20.30	21.00	-	-
21.00	21.30	-	-
21.30	22.00	-	-

Table 16: Passing Vehicle Count Survey at Dr.Bhaskaran Road & Swami Vivekananda Road Intersection on 10/05/2017

PASSING VEHICLE COUNT SURVEY

JUNCTION NAME : DR.BHASKARAN ROAD & SWAMI VIVEKANANDA ROAD JUNCTION														
DIRECTION: DR.BHASKARAN ROAD TO K R PURAM														
DATE:10-5-2017													DAY:WEDNESDAY	
Time		Observed Time	Total Vehicle Count (s)											
From	To		10	10	10	10	10	10	10	10	10	10	10	Total
6.00	6.30													
6.30	7.00													
7.00	7.30	7.15	20	6	1	5	12	15	8					67
7.30	8.00	7.35	18	13	11	9	4	5	5	4	11			80
8.00	8.30	8.05	15	17	5	3	8	8	9	11	6			82
8.30	9.00	8.35	15	18	20	22	18	20	9	8	8			138
9.00	9.30	9.07	15	16	10	13	16	15	13	16	10			124
9.30	10.00	9.35	16	20	18	15	10	11	15	3	2			110
10.00	10.30	10.10	18	15	13	10	15	6	8	8	3			96
10.30	11.00	10.45	22	13	18	18	15	12	7	4	11			120

11.00	11.30	11.15	26	20	20	17	10	6	9	7	3			118
11.30	12.00	11.45	19	14	9	17	14	8	9	5	4			99
12.00	12.30	12.15	13	7	17	15	15	12	10	10	7			106
12.30	13.00	12.35	15	18	12	9	9	11	9	13	6			102
13.00	13.30	13.15	22	15	18	12	10	9	7	6	4			103
13.30	14.00	13.40	18	21	7	10	11	9	11	4	4			95
14.00	14.30	14.15	15	16	14	13	12	4	5	5	2			86
14.30	15.00	14.45	15	16	12	16	11	9	6	6	3			94
15.00	15.30	15.15	37	18	23	7	11	6	5	3	2			112
15.30	16.00	15.35	17	12	21	9	5	2	8	5	6			85
16.00	16.30	16.25	27	21	12	2	9	11	5	8	3			98
16.30	17.00	16.40	32	12	17	5	11	15	5	8	2			107
17.00	17.30	17.15	28	17	20	11	18	0	12	14	3			123
17.30	18.00	17.40	32	27	21	8	4	11	13	6	13	4	11	150
18.00	18.30	18.15	39	28	22	17	12	13	10	12	7	13	13	186
18.30	19.00	18.40	45	21	17	13	6	0	3	9	13	12	9	148
19.00	19.30	19.10	22	23	17	18	21	5	11	13	3	2	0	135
19.30	20.00	19.40	36	32	21	5	18	13	7	0	2	11	10	155
20.00	20.30	20.10	31	21	26	22	19	13	11	10	9	11	10	183
20.30	21.00	20.33	23	21	18	12	3	4	2	4	1	2	3	93
21.00	21.30	21.17	20	14	17	20	15							86
21.30	22.00	21.47	17	12	19	14	13							75

PASSING VEHICLE COUNT SURVEY

JUNCTION NAME : DR.BHASKARAN ROAD & SWAMI VIVEKANANDA ROAD JUNCTION

DIRECTION: K R PURAM TO DR.BHASKARAN ROAD

DATE:10-5-2017 **DAY:WEDNESDAY**

Time		Observed Time	Total Vehicle Count (s)											
From	To		10	10	10	10	10	10	10	10	10	10	10	Total
6.00	6.30													
6.30	7.00													
7.00	7.30	7.19	9	7	10	2	1	5	0	1	3			38
7.30	8.00	7.51	2	7	5	6	3	2	4	3	1			33
8.00	8.30	8.10	3	4	8	8	2	3	3	7	10			48
8.30	9.00	8.46	2	8	9	4	7	2	12	10	8			62
9.00	9.30	9.13	5	3	2	4	6	3	5	4	20			52
9.30	10.00	9.45	10	7	5	8	8	2	8	8	2			58
10.00	10.30	10.13	5	5	7	6	6	7	4	5	4			49
10.30	11.00	10.35	5	10	10	5	8	3	6	5	8			60
11.00	11.30	11.04	5	7	10	6	8	14	10	2	2			64
11.30	12.00	11.46	10	9	6	5	5	1	6	5	5			52
12.00	12.30	12.05	5	2	2	4	4	3	6	6	7			39
12.30	13.00	12.37	6	2	1	5	5	5	5	5	6			40

13.00	13.30	13.08	4	1	7	8	10	8	7	8	7			60
13.30	14.00	13.33	5	2	6	10	8	7	7	9	0			54
14.00	14.30	14.05	8	6	8	15	9	8	15	6	0			75
14.30	15.00	14.35	3	5	4	6	7	5	6	8	5			49
15.00	15.30	15.10	4	6	4	7	8	10	6	4	5			54
15.30	16.00	15.34	5	6	10	8	9	6	9	6	9			68
16.00	16.30	16.16	4	6	10	9	7	7	8	5	7			63
16.30	17.00	16.48	7	5	4	5	6	7	8	7	6			55
17.00	17.30	17.18	5	2	4	5	3	6	8	4	5			42
17.30	18.00	17.45	2	2	5	2	4	3	10	9	3	3	2	45
18.00	18.30	18.20	7	8	6	4	3	4	3	5	3	4	5	52
18.30	19.00	18.48	4	3	5	4	3	2	4	3	2	3	4	37
19.00	19.30	19.14	6	4	3	7	6	3	4	2	5	4	3	47
19.30	20.00	19.45	4	3	2	4	2	3	2	1	3	2	2	28
20.00	20.30	20.20	4	3	3	5	4	2	4	1	2	3	4	35
20.30	21.00	20.40	3	4	8	5	4	2	4	1	2	3	4	40
21.00	21.30	21.19	3	2	1	4	3							13
21.30	22.00	21.48	4	2	1	3	2							12

PASSING VEHICLE COUNT SURVEY

JUNCTION NAME : DR.BHASKARAN ROAD & SWAMI VIVEKANANDA ROAD JUNCTION

DIRECTION: ULSOOR TO K R PURAM

DATE:21-5-2017 **DAY:SUNDAY**

Time		Observed Time	Total Vehicle Count (s)								
From	To		10	10	10	10	10	10	10	10	Total
6.00	6.30										
6.30	7.00										
7.00	7.30	7.20	10	1	3						14
7.30	8.00	7.43	8	4	1						13
8.00	8.30	8.07	12	7	2						21
8.30	9.00	8.34	11	2	6						19
9.00	9.30	9.10	12	10	0						22
9.30	10.00	9.44	7	7	2						16
10.00	10.30	10.04	8	4	8						20
10.30	11.00	10.34	13	2	3						18
11.00	11.30	11.10	10	8	2						20
11.30	12.00	11.36	10	1	1						12
12.00	12.30	12.08	15	1	0						16
12.30	13.00	12.37	10	3	11						24
13.00	13.30	13.11	12	2	0						14
13.30	14.00	13.33	8	4	4						16
14.00	14.30	14.12	12	7	4						23
14.30	15.00	14.38	17	7	0						24

15.00	15.30	15.14	7	6	6						19
15.30	16.00	15.40	15	8	12						35
16.00	16.30	16.19	8	0	0						8
16.30	17.00	16.48	13	9	5						27
17.00	17.30	17.16	2	5	7						14
17.30	18.00	17.39	5	9	10						24
18.00	18.30	18.15	9	8	14						31
18.30	19.00	18.40	8	12	15						35
19.00	19.30	19.11	15	13	19						47
19.30	20.00	19.49	6	8	12						26
20.00	20.30	20.15	19	10	9						38
20.30	21.00	20.49	12	8	10						30
21.00	21.30	21.04	10	7	8						25
21.30	22.00	21.54	5	6	3						14

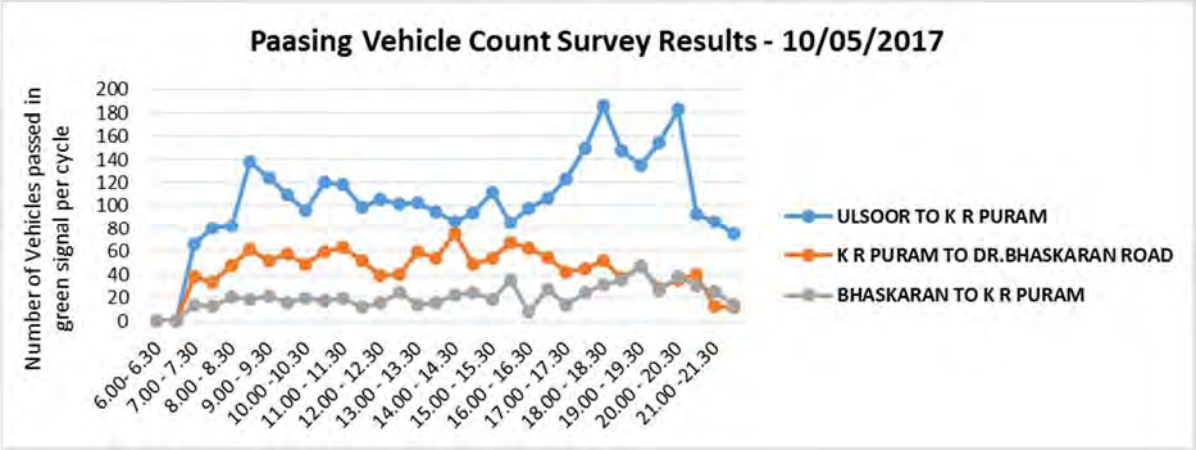


Figure 16: Passing Vehicles at Dr. Bhaskaran Road & Swami Vivekanda Intersection on 10/05/2017

Table 17: Passing Vehicle Count Survey at Dr.Bhaskaran Road & Swami Vivekananda Road Intersection on 17/05/2017

PASSING VEHICLE COUNT SURVEY

JUNCTION NAME : DR.BHASKARAN ROAD & SWAMI VIVEKANANDA ROAD JUNCTION														
DIRECTION: DR.BHASKARAN ROAD TO K R PURAM														
DATE:17-5-2017													DAY:WEDNESDAY	
Time		Observed Time	Total Vehicle Count (s)											
From	To		10	10	10	10	10	10	10	10	10	10	10	Total
6.00	6.30													
6.30	7.00													
7.00	7.30													
7.30	8.00													
8.00	8.30													

8.30	9.00													
9.00	9.30													
9.30	10.00													
10.00	10.30	10.20	15	10	21	26	21	14	8	22	17			154
10.30	11.00	10.54	17	14	11	16	15	13	16	6	8			116
11.00	11.30	11.05	14	17	5	13	7	10	6	12	0			84
11.30	12.00	11.41	10	12	22	14	7	8	10	14	0			97
12.00	12.30	12.26	13	11	12	3	5	10	8	10	6			78
12.30	13.00	12.55	8	11	12	3	4	6	11	11	7			73
13.00	13.30	13.05	6	12	8	9	12	6	12	9	13			87
13.30	14.00	13.46	13	14	16	17	7	6	8	8	6			95
14.00	14.30	14.20	15	10	15	13	14	12	4	4	0			87
14.30	15.00	14.45	12	14	13	17	10	6	8	9	5			94
15.00	15.30	15.15	15	11	8	15	12	14	13	11	10			109
15.30	16.00	15.48	14	10	9	16	13	15	12	10	8			107
16.00	16.30	16.12	16	8	10	11	9	13	10	9	10			96
16.30	17.00	16.55	11	15	9	5	3	7	6	8	4			68
17.00	17.30	17.17	13	18	10	7	12	8	9	7	9			93
17.30	18.00	17.36	16	5	9	10	20	13	9	8	7			97
18.00	18.30	18.17	20	19	8	9	15	13	12	6	10			112
18.30	19.00	18.37	18	16	11	13	8	9	10	13	17			115
19.00	19.30	**SIGNAL OFF**												
19.30	20.00	19.37	22	18	13	10	12	17	11	9	15			127
20.00	20.30	20.17	18	16	15	13	17	15	11	13	9			127
20.30	21.00	20.35	18	16	15	13	11	9	11	15	8			116
21.00	21.30	21.10	20	19	14	17	19	8	11	12	8			128
21.30	22.00	21.41	20	14	13	12	17							76

PASSING VEHICLE COUNT SURVEY

JUNCTION NAME : DR.BHASKARAN ROAD & SWAMI VIVEKANANDA ROAD JUNCTION														
DIRECTION: K R PURAM TO DR.BHASKARAN ROAD														
DATE:17-5-2017										**DAY:WEDNESDAY**				
Time		**Observed Time**	**Total Vehicle Count (s)**											
From	**To**		**10**	**10**	**10**	**10**	**10**	**10**	**10**	**10**	**10**	**10**	**10**	**Total**
6.00	6.30													
6.30	7.00													
7.00	7.30													
7.30	8.00													
8.00	8.30													
8.30	9.00													
9.00	9.30													
9.30	10.00													
10.00	10.30	10.08	10	12	8	6	8	4	3	4	5			60
10.30	11.00	10.41	2	5	5	6	3	1	4	7	8			41

11.00	11.30	11.07	5	3	4	6	6	4	8	10	9			55
11.30	12.00	11.47	4	13	7	5	16	8	6	6	3			68
12.00	12.30	12.10	4	8	2	5	3	7	3	2	3			37
12.30	13.00	12.54	6	2	7	5	7	4	2	3	2			38
13.00	13.30	13.10	6	1	2	7	5	3	5	1	2			32
13.30	14.00	13.54	0	2	5	10	7	2	4	1	3			34
14.00	14.30	14.15	3	4	9	5	6	5	1	0	1			34
14.30	15.00	14.50	5	4	7	5	6	2	1	0	1			31
15.00	15.30	15.05	7	2	0	0	2	3	2	2	1			19
15.30	16.00	15.30	4	3	7	6	8	6	4	3	3			44
16.00	16.30	16.05	3	2	4	3	2	0	1	2	6			23
16.30	17.00	16.35	5	3	4	2	1	3	2	1	3			24
17.00	17.30	17.11	6	4	7	10	9	8	7	5	6	8	5	75
17.30	18.00	17.00	9	7	11	8	4	7	9	6	3	5	4	73
18.00	18.30	18.10	7	11	10	9	6	7	4	7	3	5	8	77
18.30	19.00	18.35	6	12	14	10	3	7	4	2	0	3	1	62
19.00	19.30	19.21	7	10	11	4	10	12	10	9	7	4	5	89
19.30	20.00	**SIGNAL OFF**												
20.00	20.30	20.09	4	3	2	4	7	9	6	3	2	0	0	40
20.30	21.00	20.40	3	4	2	1	5	4	2	2	0	0	2	25
21.00	21.30	21.03	1	3	0	0	3							7
21.30	22.00	21.33	3	2	1	1	2							9

PASSING VEHICLE COUNT SURVEY

JUNCTION NAME : DR.BHASKARAN ROAD & SWAMI VIVEKANANDA ROAD JUNCTION

DIRECTION: ULSOOR TO K R PURAM

DATE:17-5-2017 **DAY:WEDNESDAY**

Time		Observed Time	Total Vehicle Count (s)											
From	To		10	10	10	10	10	10	10	10	10	10	10	Total
6.00	6.30													
6.30	7.00													
7.00	7.30													
7.30	8.00													
8.00	8.30													
8.30	9.00													
9.00	9.30													
9.30	10.00													
10.00	10.30	8	9	0										17
10.30	11.00	9	7	2										18
11.00	11.30	17	7	9										33
11.30	12.00	12	7	1										20
12.00	12.30	11	15	4										30
12.30	13.00	17	5	3										25
13.00	13.30	14	8	5										27

13.30	14.00	18	9	0										27
14.00	14.30	10	2	0										12
14.30	15.00	10	12	4										26
15.00	15.30	12	14	9										35
15.30	16.00	9	6	5										20
16.00	16.30	12	14	17										43
16.30	17.00	17	18	9										44
17.00	17.30	14	9	5										28
17.30	18.00	6	9	7										22
18.00	18.30	11	14	17										42
18.30	19.00	18	19	22										59
19.00	19.30	22	14	19										55
19.30	20.00													0
20.00	20.30	7	14	13										34
20.30	21.00	14	10	7										31
21.00	21.30	5	9	8										22
21.30	22.00	7	4	2										13

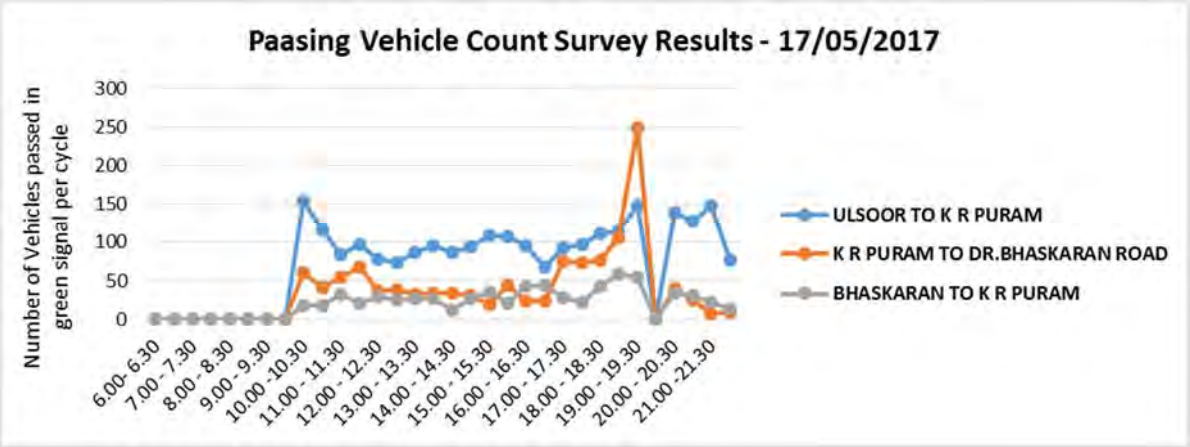


Figure 17: Passing Vehicles at Dr. Bhaskaran Road & Swami Vivekanda Intersection on 17/05/2017

Table 18: Passing Vehicle Count Survey at Dr.Bhaskaran Road & Swami Vivekananda Road Intersection on 21/05/2017

PASSING VEHICLE COUNT SURVEY									
JUNCTION NAME : DR.BHASKARAN ROAD & SWAMI VIVEKANANDA ROAD JUNCTION									
DIRECTION: DR.BHASKARAN ROAD TO K R PURAM									
DATE:21-5-2017								DAY:WEDNESDAY	
Time		Observed Time	Total Vehicle Count (s)						
From	To		10	10	10	10	10	10	Total
6.00	6.30								
6.30	7.00								
7.00	7.30								

7.30	8.00								
8.00	8.30								
8.30	9.00								
9.00	9.30								
9.30	10.00								
10.00	10.30								
10.30	11.00								
11.00	11.30	11.20	10	8	13	7	4	5	47
11.30	12.00	11.34	10	13	15	18	15	5	76
12.00	12.30	12.18	16	18	6	8	5	0	53
12.30	13.00	12.38	10	12	16	10	6	6	60
13.00	13.30	13.06	8	8	8	12	6	3	45
13.30	14.00	13.50	7	17	4	11	10	7	56
14.00	14.30	14.28	7	10	4	1	6	0	28
14.30	15.00	14.33	8	8	13	5	8	0	42
15.00	15.30	15.15	17	15	18	14	19	12	95
15.30	16.00	15.40	20	17	19	22	20	18	116
16.00	16.30	16.00	23	14	18	13	15	19	102
16.30	17.00	16.38	27	20	22	14	18	14	115
17.00	17.30	17.10	24	19	17	20	18	16	114
17.30	18.00	17.30	25	23	19	18	21	17	123
18.00	18.30	18.09	22	19	14	9	7	10	81
18.30	19.00	18.37	17	15	18	11	14	16	91
19.00	19.30	19.07	21	14	19	17	11	13	95
19.30	20.00	19.30	14	13	12	15	9	13	76
20.00	20.30	20.15	17	21	16	7	4	11	76
20.30	21.00	20.47	24	19	17	17	17	15	109
21.00	21.30	21.10	19	14	20	13	15	11	92
21.30	22.00	21.38	22	17	14	11	9	7	80

PASSING VEHICLE COUNT SURVEY

JUNCTION NAME : DR.BHASKARAN ROAD & SWAMI VIVEKANANDA ROAD JUNCTION									
DIRECTION: K R PURAM TO DR.BHASKARAN ROAD									
DATE:21-5-2017						**DAY:WEDNESDAY**			
Time		**Observed Time**	**Total Vehicle Count (s)**						
From	**To**		**10**	**10**	**10**	**10**	**10**	**10**	**Total**
6.30	7.00								
7.00	7.30								
7.30	8.00								
8.00	8.30								
8.30	9.00								
9.00	9.30								
9.30	10.00								
10.00	10.30								

10.30	11.00								
11.00	11.30	11.15	2	5	3	4	5	5	24
11.30	12.00	11.45	4	1	7	4	4	2	22
12.00	12.30	12.15	2	4	4	6	4	5	25
12.30	13.00	12.35	3	6	5	11	7	4	36
13.00	13.30	13.15	3	5	4	2	5	4	23
13.30	14.00	13.35	4	1	3	4	5	1	18
14.00	14.30	14.15	3	3	9	1	5	6	27
14.30	15.00	14.45	4	3	4	1	3	2	17
15.00	15.30	15.07	7	4	3	2	5	3	24
15.30	16.00	15.30	5	3	2	1	3	2	16
16.00	16.30	16.07	5	3	5	4	2	0	19
16.30	17.00	16.30	11	12	9	8	3	2	45
17.00	17.30	17.05	7	9	4	8	3	1	32
17.30	18.00	17.38	4	6	9	11	4	5	39
18.00	18.30	18.00	2	0	0	1	0	2	5
18.30	19.00	18.30	5	7	6	3	2	4	27
19.00	19.30	19.07	4	6	0	0	3	1	14
19.30	20.00	19.38	3	5	4	3	0	1	16
20.00	20.30	20.10	2	7	4	2	1	3	19
20.30	21.00	20.50	8	3	4	2	3	1	21
21.00	21.30	21.12	11	4	7	3	2	2	29
21.30	22.00	21.30	4	7	2	0	0	1	14

PASSING VEHICLE COUNT SURVEY

JUNCTION NAME : DR.BHASKARAN ROAD & SWAMI VIVEKANANDA ROAD JUNCTION									
DIRECTION: ULSOOR TO K R PURAM									
DATE:21-5-2017			**DAY:WEDNESDAY**						
Time		**Observed Time**	**Total Vehicle Count (s)**						
From	**To**		**10**	**10**	**10**	**10**	**10**	**10**	**Total**
6.00	6.30								
6.30	7.00								
7.00	7.30								
7.30	8.00								
8.00	8.30								
8.30	9.00								
9.00	9.30								
9.30	10.00								
10.00	10.30								
10.30	11.00								
11.00	11.30	11.25	9	3	1				13
11.30	12.00	11.40	9	8	4				21
12.00	12.30	12.20	10	3	5				18
12.30	13.00	12.40	7	3	3				13

13.00	13.30	13.10	13	6	2				21
13.30	14.00	13.50	10	7	9				26
14.00	14.30	14.20	9	11	5				25
14.30	15.00	14.40	11	1	0				12
15.00	15.30	15.15	9	2	0				11
15.30	16.00	15.40	9	4	0				13
16.00	16.30	16.10	10	9	2				21
16.30	17.00	16.40	10	8	3				21
17.00	17.30	17.15	9	6	0				15
17.30	18.00	17.40	4	2	0				6
18.00	18.30	18.20	9	2	0				11
18.30	19.00	18.40	8	6	0				14
19.00	19.30	19.11	9	2	2				13
19.30	20.00	19.45	4	2	7				13
20.00	20.30	20.17	9	3	7				19
20.30	21.00	20.45	11	7	4				22
21.00	21.30	21.10	9	2	2				13
21.30	22.00	21.30	7	3	1				11

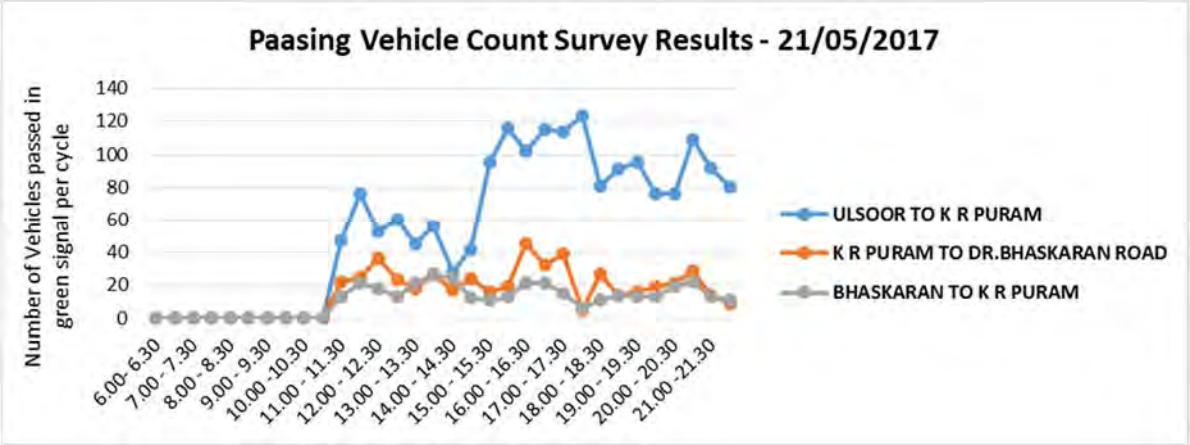


Figure 18: Passing Vehicles at Dr. Bhaskaran Road & Swami Vivekanda Intersection on 21/05/2017

4.3 Kamraj & Cubbon Road Intersection

A pictorial representation of the intersection, with details of approach movements and Signal Posts Locations is shown in the figure below.

The observed green signal indication timings are entered corresponding to the time intervals in each phase phase and the total cycle length (cycle time) in seconds were calculated. Details are presented in the table below.

Figure 12: Details of Kamraj and Cubbon Road Intersection

Kamraj Cubbon Road Junction Signal Timings																
Date: 10/05/2017, 17/05/2017 and 21/05/2017																
Kamraj Cubbon Road Junction			PHASE													CYCLE TIME
	Road	From	1			2			3			4			5	
Data	A	BRV (MISN SK SQUARE)	R	L	S		L	S							EXCLUSIVE PEDESTRIAN	
	B	MANIPAL CENTRE (DICKENSON ROAD)					L	S								
	C	COMMERCIAL STREET							R	L	S		L	S		
	D	M.G. ROAD		L									L	S		
TIMINGS	06:30	07:00	35			35			45			25			9	114
	07:00	08:00	35			35			45			25			9	114
	08:00	12:00	35			35			45			25			9	114
	12:00	15:00	35			35			45			25			9	114
	15:00	19:00	35			35			45			25			9	114
	19:00	22:00	35			35			45			25			9	114

Figure 20: Cycle Length of Kamraj and Cubbon Road Intersection on 10th, 17th and 21st June 2017

A four phase signal with exclusive pedestrian signal was operated at Kamraj and Cubbon Road Intersection. A consistent signal split up was followed throughout the day. Due to the commercial activities of the location, the weekend signal operation was similar to weekdays. The cycle length was 114 seconds.

Table 19: Signal Phase Time Survey at Kamraj Road and Cubbon Road Intersection on 10/05/2017

SIGNAL PHASE TIME SURVEY							
JUNCTION NAME : KAMRAJ AND CUBBON ROAD JUNCTION							
DIRECTION: COMMERCIAL STREET TO MG ROAD							
DATE:10-5-2017						DAY:WEDNESDAY	
Time		Observed Time	Cycle Time (s)				
From	To		Green	Red	Amber	Pedestrian	Total
6.00	6.30	Signal Off					

6.30	7.00						
7.00	7.30						
7.30	8.00	7.35	70	90	3	9	172
8.00	8.30	8.10	70	90	3	9	172
8.30	9.00	8.30	70	90	3	9	172
9.00	9.30	9.00	70	90	3	9	172
9.30	10.00	9.30	70	90	3	9	172
10.00	10.30	10.00	70	90	3	9	172
10.30	11.00	10.30	70	90	3	9	172
11.00	11.30	11.15	70	90	3	9	172
11.30	12.00	11.38	70	90	3	9	172
12.00	12.30	12.00	70	90	3	9	172
12.30	13.00	12.35	70	90	3	9	172
13.00	13.30	13.06	70	90	3	9	172
13.30	14.00	13.38	70	90	3	9	172
14.00	14.30	14.12	70	90	3	9	172
14.30	15.00	14.42	70	90	3	9	172
15.00	15.30	15.02	70	90	3	9	172
15.30	16.00	15.38	70	90	3	9	172
16.00	16.30	16.21	70	90	3	9	172
16.30	17.00	16.32	70	90	3	9	172
17.00	17.30	17.09	70	90	3	9	172
17.30	18.00	17.49	70	90	3	9	172
18.00	18.30	18.05	70	90	3	9	172
18.30	19.00	18.47	70	90	3	9	172
19.00	19.30	19.14	70	90	3	9	172
19.30	20.00	19.51	70	90	3	9	172
20.00	20.30	20.12	70	90	3	9	172
20.30	21.00	20.31	70	90	3	9	172
21.00	21.30	21.14	70	90	3	9	172
21.30	22.00	21.38	70	90	3	9	172

SIGNAL PHASE TIME SURVEY

JUNCTION NAME : KAMRAJ AND CUBBON ROAD JUNCTION

DIRECTION: MG ROAD TO COMMERCIAL STREET

DATE:10-5-2017 **DAY:WEDNESDAY**

Time		Observed Time	Cycle Time (s)				
From	To		Green	Red	Amber	Pedestrian	Total
6.00	6.30	Signal Off					
6.30	7.00						
7.00	7.30						
7.30	8.00	7.38	25	85	3	9	122
8.00	8.30	8.17	25	85	3	9	122
8.30	9.00	8.50	25	85	3	9	122

9.00	9.30	9.24	25	85	3	9	122
9.30	10.00	9.38	25	85	3	9	122
10.00	10.30	10.12	25	85	3	9	122
10.30	11.00	10.48	25	85	3	9	122
11.00	11.30	11.16	25	85	3	9	122
11.30	12.00	11.42	25	85	3	9	122
12.00	12.30	12.06	25	85	3	9	122
12.30	13.00	12.38	25	85	3	9	122
13.00	13.30	13.08	25	85	3	9	122
13.30	14.00	13.54	25	85	3	9	122
14.00	14.30	14.08	25	85	3	9	122
14.30	15.00	14.32	25	85	3	9	122
15.00	15.30	15.15	25	85	3	9	122
15.30	16.00	15.38	25	85	3	9	122
16.00	16.30	16.02	25	85	3	9	122
16.30	17.00	16.31	25	85	3	9	122
17.00	17.30	17.17	25	85	3	9	122
17.30	18.00	17.38	25	85	3	9	122
18.00	18.30	18.05	25	85	3	9	122
18.30	19.00	18.45	25	85	3	9	122
19.00	19.30	19.03	25	85	3	9	122
19.30	20.00	19.32	25	85	3	9	122
20.00	20.30	20.15	25	85	3	9	122
20.30	21.00	20.42	25	85	3	9	122
21.00	21.30	21.11	25	85	3	9	122
21.30	22.00	21.32	25	85	3	9	122

SIGNAL PHASE TIME SURVEY

JUNCTION NAME : KAMRAJ AND CUBBON ROAD JUNCTION

DIRECTION: DICKENSON TO MISN SK SQUARE ROAD

DATE:10-5-2017 **DAY:WEDNESDAY**

Time		Observed Time	Cycle Time (s)				
From	To		Green	Red	Amber	Pedestrian	Total
6.00	6.30	Signal Off					
6.30	7.00	6.45					
7.00	7.30	7.15					
7.30	8.00	7.48	35	130	3	9	177
8.00	8.30	8.10	35	130	3	9	177
8.30	9.00	8.47	35	130	3	9	177
9.00	9.30	9.05	35	130	3	9	177
9.30	10.00	9.32	35	130	3	9	177
10.00	10.30	10.02	35	130	3	9	177
10.30	11.00	10.32	35	130	3	9	177
11.00	11.30	11.02	35	130	3	9	177

11.30	12.00	11.32	35	130	3	9	177
12.00	12.30	12.05	35	130	3	9	177
12.30	13.00	12.35	35	130	3	9	177
13.00	13.30	13.05	35	130	3	9	177
13.30	14.00	13.35	35	130	3	9	177
14.00	14.30	14.05	35	130	3	9	177
14.30	15.00	14.35	35	130	3	9	177
15.00	15.30	15.15	35	130	3	9	177
15.30	16.00	15.36	35	130	3	9	177
16.00	16.30	16.17	35	130	3	9	177
16.30	17.00	16.44	35	130	3	9	177
17.00	17.30	17.08	35	130	3	9	177
17.30	18.00	17.33	35	130	3	9	177
18.00	18.30	18.1	35	130	3	9	177
18.30	19.00	18.32	35	130	3	9	177
19.00	19.30	19.14	35	130	3	9	177
19.30	20.00	19.45	35	130	3	9	177
20.00	20.30	20.1	35	130	3	9	177
20.30	21.00	20.3	35	130	3	9	177
21.00	21.30	21.06	35	130	3	9	177
21.30	22.00	21.41	35	130	3	9	177

SIGNAL PHASE TIME SURVEY

JUNCTION NAME : KAMRAJ AND CUBBON ROAD JUNCTION

DIRECTION: MISN SK SQUARE ROAD TO DICKENSON

DATE:10-5-2017 **DAY:WEDNESDAY**

Time		Observed Time	Cycle Time (s)				
From	To		Green	Red	Amber	Pedestrian	Total
6.00	6.30	Signal Off					
6.30	7.00						
7.00	7.30						
7.30	8.00	7.45	85	80	3	9	177
8.00	8.30	8.05	85	80	3	9	177
8.30	9.00	8.38	85	80	3	9	177
9.00	9.30	9.20	85	80	3	9	177
9.30	10.00	9.30	85	80	3	9	177
10.00	10.30	10.20	85	80	3	9	177
10.30	11.00	10.50	85	80	3	9	177
11.00	11.30	11.09	85	80	3	9	177
11.30	12.00	11.46	85	80	3	9	177
12.00	12.30	12.08	85	80	3	9	177
12.30	13.00	12.36	85	80	3	9	177
13.00	13.30	13.03	85	80	3	9	177
13.30	14.00	13.40	85	80	3	9	177

14.00	14.30	14.11	85	80	3	9	177
14.30	15.00	14.32	85	80	3	9	177
15.00	15.30	15.15	85	90	3	9	187
15.30	16.00	15.36	85	90	3	9	187
16.00	16.30	16.17	85	90	3	9	187
16.30	17.00	16.44	85	90	3	9	187
17.00	17.30	17.08	85	90	3	9	187
17.30	18.00	17.33	85	90	3	9	187
18.00	18.30	18.1	85	90	3	9	187
18.30	19.00	18.32	85	90	3	9	187
19.00	19.30	19.14	85	90	3	9	187
19.30	20.00	19.45	85	90	3	9	187
20.00	20.30	20.1	85	90	3	9	187
20.30	21.00	20.3	85	90	3	9	187
21.00	21.30	21.06	85	90	3	9	187
21.30	22.00	21.41	85	90	3	9	187

Table 20: Signal Phase Time Survey at Kamraj Road and Cubbon Road Intersection on 17/05/2017

SIGNAL PHASE TIME SURVEY							
JUNCTION NAME : KAMRAJ AND CUBBON ROAD JUNCTION							
DIRECTION: COMMERCIAL STREET TO MG ROAD							
DATE:17-5-2017						DAY:WEDNESDAY	
Time		Observed Time	Cycle Time (s)				
From	To		Green	Red	Amber	Pedestrian	Total
6.00	6.30	Signal Off					
6.30	7.00	6.49	70	90	3	9	172
7.00	7.30	7.09	70	90	3	9	172
7.30	8.00	7.38	70	90	3	9	172
8.00	8.30	8.16	70	90	3	9	172
8.30	9.00	8.38	70	90	3	9	172
9.00	9.30	9.15	70	90	3	9	172
9.30	10.00	9.27	70	90	3	9	172
10.00	10.30	10.16	70	90	3	9	172
10.30	11.00	10.34	70	90	3	9	172
11.00	11.30	11.05	70	90	3	9	172
11.30	12.00	11.33	70	90	3	9	172
12.00	12.30	12.13	70	90	3	9	172
12.30	13.00	12.40	70	90	3	9	172
13.00	13.30	13.16	70	90	3	9	172
13.30	14.00	13.42	70	90	3	9	172
14.00	14.30	14.24	70	90	3	9	172
14.30	15.00	14.35	70	90	3	9	172
15.00	15.30	15.15	70	90	3	9	172

15.30	16.00	15.31	70	90	3	9	172
16.00	16.30	16.11	70	90	3	9	172
16.30	17.00	16.42	70	90	3	9	172
17.00	17.30	17.09	70	90	3	9	172
17.30	18.00	17.42	70	90	3	9	172
18.00	18.30	18.12	70	90	3	9	172
18.30	19.00	18.38	70	90	3	9	172
19.00	19.30	19.05	70	90	3	9	172
19.30	20.00	19.49	70	90	3	9	172
20.00	20.30	20.16	70	90	3	9	172
20.30	21.00	20.36	70	90	3	9	172
21.00	21.30	21.08	70	90	3	9	172
21.30	22.00	21.51	70	90	3	9	172

SIGNAL PHASE TIME SURVEY							
JUNCTION NAME : KAMRAJ AND CUBBON ROAD JUNCTION							
DIRECTION: MG ROAD TO COMMERCIAL STREET							
DATE:17-5-2017						**DAY:WEDNESDAY**	
Time		**Observed Time**	**Cycle Time (s)**				
From	**To**		**Green**	**Red**	**Amber**	**Pedestrian**	**Total**
6.00	6.30	Signal Off					
6.30	7.00	6.49	25	85	3	9	122
7.00	7.30	7.09	25	85	3	9	122
7.30	8.00	7.38	25	85	3	9	122
8.00	8.30	8.17	25	85	3	9	122
8.30	9.00	8.50	25	85	3	9	122
9.00	9.30	9.24	25	85	3	9	122
9.30	10.00	9.38	25	85	3	9	122
10.00	10.30	10.12	25	85	3	9	122
10.30	11.00	10.48	25	85	3	9	122
11.00	11.30	11.16	25	85	3	9	122
11.30	12.00	11.42	25	85	3	9	122
12.00	12.30	12.06	25	85	3	9	122
12.30	13.00	12.38	25	85	3	9	122
13.00	13.30	13.08	25	85	3	9	122
13.30	14.00	13.54	25	85	3	9	122
14.00	14.30	14.08	25	85	3	9	122
14.30	15.00	14.32	25	85	3	9	122
15.00	15.30	15.15	25	85	3	9	122
15.30	16.00	15.38	25	85	3	9	122
16.00	16.30	16.02	25	85	3	9	122
16.30	17.00	16.31	25	85	3	9	122
17.00	17.30	17.17	25	85	3	9	122
17.30	18.00	17.38	25	85	3	9	122

18.00	18.30	18.05	25	85	3	9	122
18.30	19.00	18.45	25	85	3	9	122
19.00	19.30	19.03	25	85	3	9	122
19.30	20.00	19.32	25	85	3	9	122
20.00	20.30	20.15	25	85	3	9	122
20.30	21.00	20.42	25	85	3	9	122
21.00	21.30	21.11	25	85	3	9	122
21.30	22.00	21.32	25	85	3	9	122

SIGNAL PHASE TIME SURVEY

JUNCTION NAME : KAMRAJ AND CUBBON ROAD JUNCTION

DIRECTION: DICKENSON TO MISN SK SQUARE ROAD

DATE:17-5-2017 **DAY:WEDNESDAY**

Time		Observed Time	Cycle Time (s)				
From	To		Green	Red	Amber	Pedestrian	Total
6.00	6.30	Signal Off					
6.30	7.00	6.45	35	130	3	9	177
7.00	7.30	7.15	35	130	3	9	177
7.30	8.00	7.48	35	130	3	9	177
8.00	8.30	8.10	35	130	3	9	177
8.30	9.00	8.47	35	130	3	9	177
9.00	9.30	9.05	35	130	3	9	177
9.30	10.00	9.32	35	130	3	9	177
10.00	10.30	10.02	35	130	3	9	177
10.30	11.00	10.32	35	130	3	9	177
11.00	11.30	11.02	35	130	3	9	177
11.30	12.00	11.32	35	130	3	9	177
12.00	12.30	12.05	35	130	3	9	177
12.30	13.00	12.35	35	130	3	9	177
13.00	13.30	13.05	35	130	3	9	177
13.30	14.00	13.35	35	130	3	9	177
14.00	14.30	14.05	35	130	3	9	177
14.30	15.00	14.35	35	130	3	9	177
15.00	15.30	15.15	35	130	3	9	177
15.30	16.00	15.36	35	130	3	9	177
16.00	16.30	16.17	35	130	3	9	177
16.30	17.00	16.44	35	130	3	9	177
17.00	17.30	17.08	35	130	3	9	177
17.30	18.00	17.33	35	130	3	9	177
18.00	18.30	18.1	35	130	3	9	177
18.30	19.00	18.32	35	130	3	9	177
19.00	19.30	19.14	35	130	3	9	177
19.30	20.00	19.45	35	130	3	9	177
20.00	20.30	20.1	35	130	3	9	177

20.30	21.00	20.3	35	130	3	9	177
21.00	21.30	21.06	35	130	3	9	177
21.30	22.00	21.41	35	130	3	9	177

SIGNAL PHASE TIME SURVEY

JUNCTION NAME : KAMRAJ AND CUBBON ROAD JUNCTION

DIRECTION: MISN SK SQUARE ROAD TO DICKENSON

DATE:17-5-2017 **DAY:WEDNESDAY**

Time		Observed Time	Cycle Time (s)				
From	To		Green	Red	Amber	Pedestrian	Total
6.00	6.30	Signal Off					
6.30	7.00	6.49	85	80	3	9	177
7.00	7.30	7.09	85	80	3	9	177
7.30	8.00	7.38	85	80	3	9	177
8.00	8.30	8.05	85	80	3	9	177
8.30	9.00	8.38	85	80	3	9	177
9.00	9.30	9.20	85	80	3	9	177
9.30	10.00	9.30	85	80	3	9	177
10.00	10.30	10.20	85	80	3	9	177
10.30	11.00	10.50	85	80	3	9	177
11.00	11.30	11.09	85	80	3	9	177
11.30	12.00	11.46	85	80	3	9	177
12.00	12.30	12.08	85	80	3	9	177
12.30	13.00	12.36	85	80	3	9	177
13.00	13.30	13.03	85	80	3	9	177
13.30	14.00	13.40	85	80	3	9	177
14.00	14.30	14.11	85	80	3	9	177
14.30	15.00	14.32	85	80	3	9	177
15.00	15.30	15.15	85	90	3	9	187
15.30	16.00	15.36	85	90	3	9	187
16.00	16.30	16.17	85	90	3	9	187
16.30	17.00	16.44	85	90	3	9	187
17.00	17.30	17.08	85	90	3	9	187
17.30	18.00	17.33	85	90	3	9	187
18.00	18.30	18.1	85	90	3	9	187
18.30	19.00	18.32	85	90	3	9	187
19.00	19.30	19.14	85	90	3	9	187
19.30	20.00	19.45	85	90	3	9	187
20.00	20.30	20.1	85	90	3	9	187
20.30	21.00	20.3	85	90	3	9	187
21.00	21.30	21.06	85	90	3	9	187
21.30	22.00	21.41	85	90	3	9	187

Table 21: Signal Phase Time Survey at Kamraj Road and Cubbon Road Intersection on 21/05/2017

SIGNAL PHASE TIME SURVEY							
JUNCTION NAME : KAMRAJ AND CUBBON ROAD JUNCTION							
DIRECTION: COMMERCIAL STREET TO MG ROAD							
DATE:21-5-2017						DAY:SUNDAY	
Time		Observed Time	Cycle Time (s)				
From	To		Green	Red	Amber	Pedestrian	Total
6.00	6.30	Signal Off					
6.30	7.00	6.49	70	90	3	9	172
7.00	7.30	7.09	70	90	3	9	172
7.30	8.00	7.38	70	90	3	9	172
8.00	8.30	8.16	70	90	3	9	172
8.30	9.00	8.38	70	90	3	9	172
9.00	9.30	9.15	70	90	3	9	172
9.30	10.00	9.27	70	90	3	9	172
10.00	10.30	10.16	70	90	3	9	172
10.30	11.00	10.34	70	90	3	9	172
11.00	11.30	11.05	70	90	3	9	172
11.30	12.00	11.33	70	90	3	9	172
12.00	12.30	12.13	70	90	3	9	172
12.30	13.00	12.40	70	90	3	9	172
13.00	13.30	13.16	70	90	3	9	172
13.30	14.00	13.42	70	90	3	9	172
14.00	14.30	14.24	70	90	3	9	172
14.30	15.00	14.35	70	90	3	9	172
15.00	15.30	15.15	70	90	3	9	172
15.30	16.00	15.31	70	90	3	9	172
16.00	16.30	16.11	70	90	3	9	172
16.30	17.00	16.42	70	90	3	9	172
17.00	17.30	17.09	70	90	3	9	172
17.30	18.00	17.42	70	90	3	9	172
18.00	18.30	18.12	70	90	3	9	172
18.30	19.00	18.38	70	90	3	9	172
19.00	19.30	19.05	70	90	3	9	172
19.30	20.00	19.49	70	90	3	9	172
20.00	20.30	20.16	70	90	3	9	172
20.30	21.00	20.36	70	90	3	9	172
21.00	21.30	21.08	70	90	3	9	172
21.30	22.00	21.51	70	90	3	9	172

SIGNAL PHASE TIME SURVEY
JUNCTION NAME : KAMRAJ AND CUBBON ROAD JUNCTION

DIRECTION: MG ROAD TO COMMERCIAL STREET							
DATE:21-5-2017						DAY:SUNDAY	
Time		Observed Time	Cycle Time (s)				
From	To		Green	Red	Amber	Pedestrian	Total
6.00	6.30	Signal Off					
6.30	7.00	6.49	25	85	3	9	122
7.00	7.30	7.09	25	85	3	9	122
7.30	8.00	7.38	25	85	3	9	122
8.00	8.30	8.17	25	85	3	9	122
8.30	9.00	8.50	25	85	3	9	122
9.00	9.30	9.24	25	85	3	9	122
9.30	10.00	9.38	25	85	3	9	122
10.00	10.30	10.12	25	85	3	9	122
10.30	11.00	10.48	25	85	3	9	122
11.00	11.30	11.16	25	85	3	9	122
11.30	12.00	11.42	25	85	3	9	122
12.00	12.30	12.06	25	85	3	9	122
12.30	13.00	12.38	25	85	3	9	122
13.00	13.30	13.08	25	85	3	9	122
13.30	14.00	13.54	25	85	3	9	122
14.00	14.30	14.08	25	85	3	9	122
14.30	15.00	14.32	25	85	3	9	122
15.00	15.30	15.15	25	85	3	9	122
15.30	16.00	15.38	25	85	3	9	122
16.00	16.30	16.02	25	85	3	9	122
16.30	17.00	16.31	25	85	3	9	122
17.00	17.30	17.17	25	85	3	9	122
17.30	18.00	17.38	25	85	3	9	122
18.00	18.30	18.05	25	85	3	9	122
18.30	19.00	18.45	25	85	3	9	122
19.00	19.30	19.03	25	85	3	9	122
19.30	20.00	19.32	25	85	3	9	122
20.00	20.30	20.15	25	85	3	9	122
20.30	21.00	20.42	25	85	3	9	122
21.00	21.30	21.11	25	85	3	9	122
21.30	22.00	21.32	25	85	3	9	122

JUNCTION NAME : KAMRAJ AND CUBBON ROAD JUNCTION							
DIRECTION: DICKENSON TO MISN SK SQUARE ROAD							
DATE:21-5-2017						DAY:SUNDAY	
Time		Observed Time	Cycle Time (s)				
From	To		Green	Red	Amber	Pedestrian	Total
6.00	6.30	Signal Off					
6.30	7.00	6.45	35	130	3	9	177

7.00	7.30	7.15	35	130	3	9	177
7.30	8.00	7.48	35	130	3	9	177
8.00	8.30	8.10	35	130	3	9	177
8.30	9.00	8.47	35	130	3	9	177
9.00	9.30	9.05	35	130	3	9	177
9.30	10.00	9.32	35	130	3	9	177
10.00	10.30	10.02	35	130	3	9	177
10.30	11.00	10.32	35	130	3	9	177
11.00	11.30	11.02	35	130	3	9	177
11.30	12.00	11.32	35	130	3	9	177
12.00	12.30	12.05	35	130	3	9	177
12.30	13.00	12.35	35	130	3	9	177
13.00	13.30	13.05	35	130	3	9	177
13.30	14.00	13.35	35	130	3	9	177
14.00	14.30	14.05	35	130	3	9	177
14.30	15.00	14.35	35	130	3	9	177
15.00	15.30	15.15	35	130	3	9	177
15.30	16.00	15.36	35	130	3	9	177
16.00	16.30	16.17	35	130	3	9	177
16.30	17.00	16.44	35	130	3	9	177
17.00	17.30	17.08	35	130	3	9	177
17.30	18.00	17.33	35	130	3	9	177
18.00	18.30	18.1	35	130	3	9	177
18.30	19.00	18.32	35	130	3	9	177
19.00	19.30	19.14	35	130	3	9	177
19.30	20.00	19.45	35	130	3	9	177
20.00	20.30	20.1	35	130	3	9	177
20.30	21.00	20.3	35	130	3	9	177
21.00	21.30	21.06	35	130	3	9	177
21.30	22.00	21.41	35	130	3	9	177

SIGNAL PHASE TIME SURVEY

JUNCTION NAME : KAMRAJ AND CUBBON ROAD JUNCTION

DIRECTION: MISN SK SQUARE ROAD TO DICKENSON

DATE:21-5-2017 **DAY:SUNDAY**

Time		Observed Time	Cycle Time (s)				
From	To		Green	Red	Amber	Pedestrian	Total
6.00	6.30	Signal Off					
6.30	7.00	6.49	85	80	3	9	177
7.00	7.30	7.09	85	80	3	9	177
7.30	8.00	7.38	85	80	3	9	177
8.00	8.30	8.05	85	80	3	9	177
8.30	9.00	8.38	85	80	3	9	177

9.00	9.30	9.20	85	80	3	9	177
9.30	10.00	9.30	85	80	3	9	177
10.00	10.30	10.20	85	80	3	9	177
10.30	11.00	10.50	85	80	3	9	177
11.00	11.30	11.09	85	80	3	9	177
11.30	12.00	11.46	85	80	3	9	177
12.00	12.30	12.08	85	80	3	9	177
12.30	13.00	12.36	85	80	3	9	177
13.00	13.30	13.03	85	80	3	9	177
13.30	14.00	13.40	85	80	3	9	177
14.00	14.30	14.11	85	80	3	9	177
14.30	15.00	14.32	85	80	3	9	177
15.00	15.30	15.15	85	90	3	9	187
15.30	16.00	15.36	85	90	3	9	187
16.00	16.30	16.17	85	90	3	9	187
16.30	17.00	16.44	85	90	3	9	187
17.00	17.30	17.08	85	90	3	9	187
17.30	18.00	17.33	85	90	3	9	187
18.00	18.30	18.1	85	90	3	9	187
18.30	19.00	18.32	85	90	3	9	187
19.00	19.30	19.14	85	90	3	9	187
19.30	20.00	19.45	85	90	3	9	187
20.00	20.30	20.1	85	90	3	9	187
20.30	21.00	20.3	85	90	3	9	187
21.00	21.30	21.06	85	90	3	9	187
21.30	22.00	21.41	85	90	3	9	187

Table 22: Dead Green/Wastage Green Survey at Kamraj Road and Cubbon Road Intersection on 10/05/2017

WASTE/DEAD GREEN SIGNAL SURVEY			
JUNCTION NAME : KAMRAJ AND CUBBON ROAD JUNCTIONVIVEKANANDA ROAD JUNCTION			
DIRECTION: MG ROAD TO COMMERCIAL STREET			
DATE:10-5-2017			DAY:WEDNESDAY
Time		Dead Green	Wastage of Green
From	To	Occurred	Occurred
6.00	6.30	-	-
6.30	7.00	-	-
7.00	7.30	-	-
7.30	8.00	-	-
8.00	8.30	-	-
8.30	9.00	-	-
9.00	9.30	-	-
9.30	10.00	-	-

10.00	10.30	-	-
10.30	11.00	-	-
11.00	11.30	-	-
11.30	12.00	-	-
12.00	12.30	-	-
12.30	13.00	-	-
13.00	13.30	-	-
13.30	14.00	-	-
14.00	14.30	-	-
14.30	15.00	-	-
15.00	15.30	-	-
15.30	16.00	-	-
16.00	16.30	-	-
16.30	17.00	-	-
17.00	17.30	-	-
17.30	18.00	-	-
18.00	18.30	-	-
18.30	19.00	-	-
19.00	19.30	-	-
19.30	20.00	-	-
20.00	20.30	-	-
20.30	21.00	-	-
21.00	21.30	-	-
21.30	22.00	-	-

WASTE/DEAD GREEN SIGNAL SURVEY			
JUNCTION NAME : KAMRAJ AND CUBBON ROAD JUNCTIONVIVEKANANDA ROAD JUNCTION			
DIRECTION: COMMERCIAL STREET TO MG ROAD			
DATE:10-5-2017			**DAY:WEDNESDAY**
Time		**Dead Green**	**Wastage of Green**
From	**To**	**Occurred**	**Occurred**
6.00	6.30	-	-
6.30	7.00	-	-
7.00	7.30	-	-
7.30	8.00	-	-
8.00	8.30	-	-
8.30	9.00	-	-
9.00	9.30	-	-
9.30	10.00	-	-
10.00	10.30	-	-
10.30	11.00	-	-
11.00	11.30	-	-
11.30	12.00	-	-

12.00	12.30	-	-
12.30	13.00	-	-
13.00	13.30	-	-
13.30	14.00	-	-
14.00	14.30	-	-
14.30	15.00	-	-
15.00	15.30	-	-
15.30	16.00	-	-
16.00	16.30	-	-
16.30	17.00	-	-
17.00	17.30	-	-
17.30	18.00	-	-
18.00	18.30	-	-
18.30	19.00	-	-
19.00	19.30	-	-
19.30	20.00	-	-
20.00	20.30	-	-
20.30	21.00	-	-
21.00	21.30	-	-
21.30	22.00	-	-

WASTE/DEAD GREEN SIGNAL SURVEY			
JUNCTION NAME : KAMRAJ AND CUBBON ROAD JUNCTIONVIVEKANANDA ROAD JUNCTION			
DIRECTION: DICKENSON TO MISN SK SQUARE			
DATE:10-5-2017			**DAY:WEDNESDAY**
Time		**Dead Green**	**Wastage of Green**
From	**To**	**Occurred**	**Occurred**
6.00	6.30	-	-
6.30	7.00	-	-
7.00	7.30	-	-
7.30	8.00	-	✓
8.00	8.30	-	✓
8.30	9.00	-	✓
9.00	9.30	-	-
9.30	10.00	-	✓
10.00	10.30	-	-
10.30	11.00	-	-
11.00	11.30	-	-
11.30	12.00	-	-
12.00	12.30	-	-
12.30	13.00	-	-
13.00	13.30	-	-
13.30	14.00	-	-

14.00	14.30	-	-
14.30	15.00	-	-
15.00	15.30	-	-
15.30	16.00	-	-
16.00	16.30	-	-
16.30	17.00	-	-
17.00	17.30	-	-
17.30	18.00	-	-
18.00	18.30	-	-
18.30	19.00	-	-
19.00	19.30	-	-
19.30	20.00	-	-
20.00	20.30	-	-
20.30	21.00	-	-
21.00	21.30	-	-
21.30	22.00	-	-

WASTE/DEAD GREEN SIGNAL SURVEY			
JUNCTION NAME : KAMRAJ AND CUBBON ROAD JUNCTIONVIVEKANANDA ROAD JUNCTION			
DIRECTION: MINSK Square to Dickenson Road			
DATE:10-5-2017			**DAY:WEDNESDAY**
Time		**Dead Green**	**Wastage of Green**
From	**To**	**Occurred**	**Occurred**
6.00	6.30	-	-
6.30	7.00	-	-
7.00	7.30	-	-
7.30	8.00	-	✓
8.00	8.30	-	✓
8.30	9.00	-	-
9.00	9.30	-	-
9.30	10.00	-	✓
10.00	10.30	-	-
10.30	11.00	-	-
11.00	11.30	-	-
11.30	12.00	-	-
12.00	12.30	-	-
12.30	13.00	-	-
13.00	13.30	✓	-
13.30	14.00	-	-
14.00	14.30	-	-
14.30	15.00	-	-
15.00	15.30	-	-
15.30	16.00	-	-

16.00	16.30	-	-
16.30	17.00	-	-
17.00	17.30	-	-
17.30	18.00	-	-
18.00	18.30	-	-
18.30	19.00	-	-
19.00	19.30	-	-
19.30	20.00	-	-
20.00	20.30	-	-
20.30	21.00	-	-
21.00	21.30	-	-
21.30	22.00	-	-

Table 23: Dead Green/Wastage Green Survey at Kamraj Road and Cubbon Road Intersection on 17/05/2017

WASTE/DEAD GREEN SIGNAL SURVEY			
JUNCTION NAME : KAMRAJ AND CUBBON ROAD JUNCTIONVIVEKANANDA ROAD JUNCTION			
DIRECTION: MG ROAD TO COMMERCIAL STREET			
DATE:17-5-2017			DAY:WEDNESDAY
Time		Dead Green	Wastage of Green
From	To	Occurred	Occurred
6.00	6.30	-	-
6.30	7.00	-	✓
7.00	7.30	-	✓
7.30	8.00	-	-
8.00	8.30	-	✓
8.30	9.00	-	-
9.00	9.30	-	-
9.30	10.00	-	-
10.00	10.30	-	-
10.30	11.00	-	-
11.00	11.30	-	-
11.30	12.00	-	-
12.00	12.30	-	-
12.30	13.00	-	-
13.00	13.30	-	-
13.30	14.00	-	-
14.00	14.30	-	-
14.30	15.00	-	-
15.00	15.30	-	-
15.30	16.00	-	-
16.00	16.30	-	-
16.30	17.00	-	-
17.00	17.30	-	-

17.30	18.00	-	-
18.00	18.30	-	-
18.30	19.00	-	-
19.00	19.30	-	-
19.30	20.00	-	-
20.00	20.30	-	-
20.30	21.00	-	-
21.00	21.30	-	-
21.30	22.00	-	-

WASTE/DEAD GREEN SIGNAL SURVEY			
JUNCTION NAME : KAMRAJ AND CUBBON ROAD JUNCTIONVIVEKANANDA ROAD JUNCTION			
DIRECTION: COMMERCIAL STREET TO MG ROAD			
DATE:17-5-2017			**DAY:WEDNESDAY**
Time		**Dead Green**	**Wastage of Green**
From	**To**	**Occurred**	**Occurred**
6.00	6.30	-	-
6.30	7.00	-	✓
7.00	7.30	-	✓
7.30	8.00	-	✓
8.00	8.30	-	-
8.30	9.00	-	-
9.00	9.30	-	-
9.30	10.00	-	-
10.00	10.30	-	-
10.30	11.00	-	-
11.00	11.30	-	-
11.30	12.00	-	-
12.00	12.30	-	-
12.30	13.00	-	-
13.00	13.30	-	-
13.30	14.00	-	-
14.00	14.30	-	-
14.30	15.00	-	-
15.00	15.30	-	-
15.30	16.00	-	-
16.00	16.30	-	-
16.30	17.00	-	-
17.00	17.30	-	-
17.30	18.00	-	-
18.00	18.30	-	-
18.30	19.00	-	-
19.00	19.30	-	-
19.30	20.00	-	-

20.00	20.30	-	-
20.30	21.00	-	-
21.00	21.30	-	-
21.30	22.00	-	-

WASTE/DEAD GREEN SIGNAL SURVEY			
JUNCTION NAME : KAMRAJ AND CUBBON ROAD JUNCTIONVIVEKANANDA ROAD JUNCTION			
DIRECTION: DICKENSON TO MISN SK SQUARE			
DATE:17-5-2017			**DAY:WEDNESDAY**
Time		**Dead Green**	**Wastage of Green**
From	**To**	**Occurred**	**Occurred**
6.00	6.30	-	-
6.30	7.00	-	✓
7.00	7.30	-	-
7.30	8.00	-	-
8.00	8.30	-	-
8.30	9.00	-	-
9.00	9.30	-	-
9.30	10.00	-	-
10.00	10.30	-	-
10.30	11.00	-	-
11.00	11.30	-	-
11.30	12.00	-	-
12.00	12.30	-	-
12.30	13.00	-	-
13.00	13.30	-	-
13.30	14.00	-	✓
14.00	14.30	-	-
14.30	15.00	-	-
15.00	15.30	-	-
15.30	16.00	-	-
16.00	16.30	-	-
16.30	17.00	-	-
17.00	17.30	-	-
17.30	18.00	-	-
18.00	18.30	-	-
18.30	19.00	-	-
19.00	19.30	-	-
19.30	20.00	-	-
20.00	20.30	-	-
20.30	21.00	-	-
21.00	21.30	-	✓
21.30	22.00	-	-

WASTE/DEAD GREEN SIGNAL SURVEY			
JUNCTION NAME : KAMRAJ AND CUBBON ROAD JUNCTIONVIVEKANANDA ROAD JUNCTION			
DIRECTION: MINSK Square to Dickenson Road			
DATE:17-5-2017			DAY:WEDNESDAY
Time		Dead Green	Wastage of Green
From	To	Occurred	Occurred
6.00	6.30	-	-
6.30	7.00	-	✓
7.00	7.30	-	✓
7.30	8.00	-	✓
8.00	8.30	-	✓
8.30	9.00	-	-
9.00	9.30	-	-
9.30	10.00	-	-
10.00	10.30	-	-
10.30	11.00	-	-
11.00	11.30	-	-
11.30	12.00	-	-
12.00	12.30	-	-
12.30	13.00	-	-
13.00	13.30	-	-
13.30	14.00	-	-
14.00	14.30	-	-
14.30	15.00	-	-
15.00	15.30	-	-
15.30	16.00	-	-
16.00	16.30	-	-
16.30	17.00	-	-
17.00	17.30	-	-
17.30	18.00	-	-
18.00	18.30	-	-
18.30	19.00	-	-
19.00	19.30	-	-
19.30	20.00	-	-
20.00	20.30	-	-
20.30	21.00	-	-
21.00	21.30	-	-
21.30	22.00	-	-

Table 24: Dead Green/Wastage Green Survey at Kamraj Road and Cubbon Road Intersection on 21/05/2017

WASTE/DEAD GREEN SIGNAL SURVEY
JUNCTION NAME : KAMRAJ AND CUBBON ROAD JUNCTIONVIVEKANANDA ROAD JUNCTION

DIRECTION: MG ROAD TO COMMERCIAL STREET			
DATE:21-5-2017			DAY:SUNDAY
Time		Dead Green	Wastage of Green
From	To	Occurred	Occurred
6.00	6.30	-	-
6.30	7.00	-	-
7.00	7.30	-	-
7.30	8.00	-	-
8.00	8.30	-	-
8.30	9.00	-	-
9.00	9.30	-	✓
9.30	10.00	-	✓
10.00	10.30	-	✓
10.30	11.00	-	✓
11.00	11.30	-	✓
11.30	12.00	-	-
12.00	12.30	-	-
12.30	13.00	-	-
13.00	13.30	-	-
13.30	14.00	-	-
14.00	14.30	-	-
14.30	15.00	-	-
15.00	15.30	-	-
15.30	16.00	-	-
16.00	16.30	-	-
16.30	17.00	-	-
17.00	17.30	-	-
17.30	18.00	-	-
18.00	18.30	-	-
18.30	19.00	-	-
19.00	19.30	-	-
19.30	20.00	-	-
20.00	20.30	-	-
20.30	21.00	-	-
21.00	21.30	-	-
21.30	22.00	-	-

WASTE/DEAD GREEN SIGNAL SURVEY			
JUNCTION NAME : KAMRAJ AND CUBBON ROAD JUNCTIONVIVEKANANDA ROAD JUNCTION			
DIRECTION: COMMERCIAL STREET TO MG ROAD			
DATE:21-5-2017			DAY:SUNDAY
Time		Dead Green	Wastage of Green
From	To	Occurred	Occurred

6.00	6.30	-	-
6.30	7.00	-	-
7.00	7.30	-	-
7.30	8.00	-	-
8.00	8.30	-	-
8.30	9.00	-	-
9.00	9.30	-	-
9.30	10.00	-	-
10.00	10.30	-	-
10.30	11.00	-	-
11.00	11.30	-	-
11.30	12.00	-	-
12.00	12.30	-	-
12.30	13.00	-	-
13.00	13.30	-	-
13.30	14.00	-	-
14.00	14.30	-	-
14.30	15.00	-	-
15.00	15.30	-	-
15.30	16.00	-	-
16.00	16.30	-	-
16.30	17.00	-	-
17.00	17.30	-	-
17.30	18.00	-	-
18.00	18.30	-	-
18.30	19.00	-	-
19.00	19.30	-	-
19.30	20.00	-	-
20.00	20.30	-	-
20.30	21.00	-	-
21.00	21.30	-	-
21.30	22.00	-	-

WASTE/DEAD GREEN SIGNAL SURVEY			
JUNCTION NAME : KAMRAJ AND CUBBON ROAD JUNCTIONVIVEKANANDA ROAD JUNCTION			
DIRECTION: DICKENSON TO MISN SK SQUARE			
DATE:21-5-2017			**DAY:SUNDAY**
Time		**Dead Green**	**Wastage of Green**
From	**To**	**Occurred**	**Occurred**
6.00	6.30	-	-
6.30	7.00	-	-
7.00	7.30	-	-
7.30	8.00	-	-

8.00	8.30	-	-
8.30	9.00	-	-
9.00	9.30	-	-
9.30	10.00	-	-
10.00	10.30	-	-
10.30	11.00	-	-
11.00	11.30	-	-
11.30	12.00	-	-
12.00	12.30	-	-
12.30	13.00	-	-
13.00	13.30	-	-
13.30	14.00	-	-
14.00	14.30	-	-
14.30	15.00	-	-
15.00	15.30	-	-
15.30	16.00	-	-
16.00	16.30	-	-
16.30	17.00	-	-
17.00	17.30	-	-
17.30	18.00	-	-
18.00	18.30	-	-
18.30	19.00	-	-
19.00	19.30	-	-
19.30	20.00	-	-
20.00	20.30	-	-
20.30	21.00	-	-
21.00	21.30	-	-
21.30	22.00	-	✓

WASTE/DEAD GREEN SIGNAL SURVEY			
JUNCTION NAME : KAMRAJ AND CUBBON ROAD JUNCTIONVIVEKANANDA ROAD JUNCTION			
DIRECTION: MINSK Square to Dickenson Road			
DATE:21-5-2017			**DAY:SUNDAY**
Time		**Dead Green**	**Wastage of Green**
From	**To**	**Occurred**	**Occurred**
6.00	6.30	-	-
6.30	7.00	-	-
7.00	7.30	-	-
7.30	8.00	-	-
8.00	8.30	-	-
8.30	9.00	-	-
9.00	9.30	-	-
9.30	10.00	-	✓

10.00	10.30	-	✓
10.30	11.00	-	✓
11.00	11.30	-	✓
11.30	12.00	-	✓
12.00	12.30	-	✓
12.30	13.00	-	✓
13.00	13.30	-	-
13.30	14.00	-	-
14.00	14.30	-	-
14.30	15.00	-	-
15.00	15.30	-	-
15.30	16.00	-	-
16.00	16.30	-	-
16.30	17.00	-	-
17.00	17.30	-	-
17.30	18.00	-	-
18.00	18.30	-	-
18.30	19.00	-	-
19.00	19.30	-	-
19.30	20.00	-	-
20.00	20.30	-	-
20.30	21.00	-	-
21.00	21.30	-	-
21.30	22.00	-	-

Table 25: Passing Vehicle Count Surve at Kamraj Road and Cubbon Road Intersection on 10/05/2017

PASSING VEHICLE COUNT SURVEY

JUNCTION NAME : KAMRAJ AND CUBBON ROAD JUNCTION										
DIRECTION: COMMERCIAL STREET TO MG ROAD										
DATE:10-5-2017							DAY:WEDNESDAY			
Time		Observed Time	Total Vehicle Count (s)							
From	To		10	10	10	10	10	10	10	Total
6.00	6.30									
6.30	7.00									
7.00	7.30									
7.30	8.00	7.35	9	21	15	28	2	1	3	79
8.00	8.30	8.10	3	16	15	15	14	5	19	87
8.30	9.00	8.30	9	27	24	25	19	18	10	132
9.00	9.30	9.00	9	10	24	36	30	21	21	151
9.30	10.00	9.30	2	16	18	20	18	15	15	104
10.00	10.30	10.00	2	14	12	29	13	12	13	95
10.30	11.00	10.30	9	8	13	16	19	13	5	83
11.00	11.30	11.15	7	16	14	13	17	16	9	92
11.30	12.00	11.38	3	16	18	16	19	8	8	88
12.00	12.30	12.00	7	17	16	7	9	13	13	82

12.30	13.00	12.35	6	20	1	10	14	10	6	67
13.00	13.30	13.06	9	8	16	14	16	6	3	72
13.30	14.00	13.38	8	11	7	17	11	14	17	85
14.00	14.30	14.12	18	30	15	8	8	14	15	108
14.30	15.00	14.42	20	18	25	11	10	7	8	99
15.00	15.30	15.02	25	18	10	20	5	9	3	90
15.30	16.00	15.38	24	17	9	14	9	8	4	85
16.00	16.30	16.21	25	19	8	15	10	4	4	85
16.30	17.00	16.32	29	20	11	14	18	9	7	108
17.00	17.30	17.09	30	20	19	13	18	3	5	108
17.30	18.00	17.49	18	19	16	16	17	16	11	113
18.00	18.30	18.05	16	21	18	11	8	6	9	89
18.30	19.00	18.47	18	20	14	5	8	6	8	79
19.00	19.30	19.14	19	17	18	10	8	6	7	85
19.30	20.00	19.51	23	14	12	16	11	12	9	97
20.00	20.30	20.12	25	16	14	12	8	11	12	98
20.30	21.00	20.31	23	14	12	12	4	10	9	84
21.00	21.30	21.14	21	13	11	11	9	11	12	88
21.30	22.00	21.38	5	6	3					14

PASSING VEHICLE COUNT SURVEY

JUNCTION NAME : KAMRAJ AND CUBBON ROAD JUNCTION

DIRECTION: MG ROAD TO COMMERCIAL STREET

DATE:10-5-2017 **DAY:WEDNESDAY**

Time		Observed	Total Vehicle Count (s)							
From	To	Time	10	10	10	10	10	10	10	Total
6.00	6.30									
6.30	7.00									
7.00	7.30									
7.30	8.00	7.35	20	4	0					24
8.00	8.30	8.10	15	17	0					32
8.30	9.00	8.30	21	17	7					45
9.00	9.30	9.00	15	7	0					22
9.30	10.00	9.30	20	21	1					42
10.00	10.30	10.00	16	14	11					41
10.30	11.00	10.30	23	17	9					49
11.00	11.30	11.15	15	12	10					37
11.30	12.00	11.38	24	19	8					51
12.00	12.30	12.00	20	16	16					52
12.30	13.00	12.35	17	25	15					57
13.00	13.30	13.06	16	13	8					37
13.30	14.00	13.38	30	13	8					51
14.00	14.30	14.12	25	12	0					37
14.30	15.00	14.42	26	14	11					51
15.00	15.30	15.02	22	16	13					51
15.30	16.00	15.38	27	15	10					52
16.00	16.30	16.21	21	16	11					48
16.30	17.00	16.32	24	11	9					44
17.00	17.30	17.09	24	22	12					58
17.30	18.00	17.49	26	17	14					57

18.00	18.30	18.05	30	18	10					58
18.30	19.00	18.47	22	10	8					40
19.00	19.30	19.14	41	14	9					64
19.30	20.00	19.51	32	12	10					54
20.00	20.30	20.12	32	12	6					50
20.30	21.00	20.31	29	10	6					45
21.00	21.30	21.14	23	14	2					39
21.30	22.00	21.38	5	6	3					14

PASSING VEHICLE COUNT SURVEY

JUNCTION NAME : KAMRAJ AND CUBBON ROAD JUNCTION										
DIRECTION: DICKENSON TO MISN SK SQUARE										
DATE:10-5-2017							DAY:WEDNESDAY			
Time		Observed	Total Vehicle Count (s)							
From	To	Time	10	10	10	10	10	10	10	Total
6.00	6.30									
6.30	7.00									
7.00	7.30									
7.30	8.00	7.48	15	12	5	2				34
8.00	8.30	8.10	15	3	1	0				19
8.30	9.00	8.47	15	16	1	0				32
9.00	9.30	9.05	21	16	17	9				63
9.30	10.00	9.32	25	11	17	0				53
10.00	10.30	10.02	20	24	12	8				64
10.30	11.00	10.32	17	17	17	14				65
11.00	11.30	11.02	21	23	19	9				72
11.30	12.00	11.32	6	20	19	21				66
12.00	12.30	12.05	10	25	21	11				67
12.30	13.00	12.35	8	17	19	8				52
13.00	13.30	13.05	5	19	21	4				49
13.30	14.00	13.35	10	24	9	7				50
14.00	14.30	14.05	23	9	3	7				42
14.30	15.00	14.35	11	16	22	5				54
15.00	15.30	15.15	10	18	29	11				68
15.30	16.00	15.36	12	17	20	9				58
16.00	16.30	16.17	10	17	12	8				47
16.30	17.00	16.44	22	18	20	10				70
17.00	17.30	17.08	20	21	13	11				65
17.30	18.00	17.33	19	24	25	15				83
18.00	18.30	18.1	19	20	23	10				72
18.30	19.00	18.32	27	21	32	15				95
19.00	19.30	19.14	22	18	15	8				63
19.30	20.00	19.45	16	18	19	11				64
20.00	20.30	20.1	19	23	16	11				69
20.30	21.00	20.3	14	9	21	12				56
21.00	21.30	21.06	21	13	20	13				67
21.30	22.00	21.41	18	12	10	9				49

PASSING VEHICLE COUNT SURVEY

JUNCTION NAME : KAMRAJ AND CUBBON ROAD JUNCTION

DIRECTION: MINSK square to Dickenson road												
DATE:10-5-2017											DAY:WEDNESDAY	
Time		Observed	Total Vehicle Count (s)									
From	To	Time	10	10	10	10	10	10	10	10	10	Total
6.00	6.30											
6.30	7.00											
7.00	7.30											
7.30	8.00	7.35	20	4	5	6	7	8	8			58
8.00	8.30	8.05	15	8	12	8	18	10	0	0	0	71
8.30	9.00	8.38	14	7	13	17	21	15	14	9	6	116
9.00	9.30	9.20	10	18	22	21	16	11	14	3	4	119
9.30	10.00	9.30	10	17	13	20	13	12	10	3	2	100
10.00	10.30	10.20	12	11	12	14	2	5	17	23	11	107
10.30	11.00	10.50	14	7	17	22	18	17	8	12	10	125
11.00	11.30	11.09	12	17	5	8	20	12	12	12	8	106
11.30	12.00	11.46	10	5	7	7	10	31	12	6	9	97
12.00	12.30	12.08	13	11	15	16	13	6	10	7	11	102
12.30	13.00	12.36	24	15	13	11	11	7	15	4	7	107
13.00	13.30	13.03	0	8	15	12	15	8	8	6	8	80
13.30	14.00	13.40	12	21	13	11	30	13	14	11	4	129
14.00	14.30	14.11	12	13	11	6	12	2	27	10	5	98
14.30	15.00	14.32	10	4	29	8	16	6	16	5	7	101
15.00	15.30	15.15	23	30	18	20	16	19	20	10	3	159
15.30	16.00	15.36	35	25	29	20	19	15	14	10	5	172
16.00	16.30	16.17	34	29	20	25	18	14	18	10	7	175
16.30	17.00	16.44	35	20	15	13	10	12	14	9	11	139
17.00	17.30	17.08	22	21	18	13	16	14	10	4	9	127
17.30	18.00	17.33	10	13	7	17	12	18	10	15	10	112
18.00	18.30	18.1	10	14	11	9	6	12	8	15	9	94
18.30	19.00	18.32	15	13	11	12	13	15	15	16	7	117
19.00	19.30	19.14	7	10	15	11	14	15	21	13	3	109
19.30	20.00	19.45	10	9	15	11	15	19	22	10	9	120
20.00	20.30	20.1	11	9	14	17	19	23	18	13	4	128
20.30	21.00	20.3	9	12	13	7	10	9	13	14	6	93
21.00	21.30	21.06	11	14	10	8	15	18	13	10	8	107
21.30	22.00	21.41	10	13	10	9	19	22	14	10	7	114

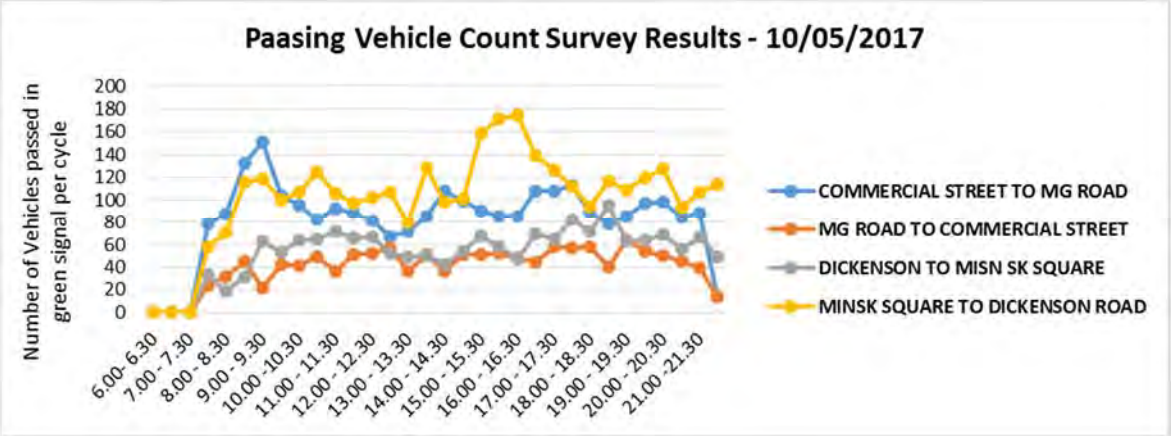


Figure 21: Passing Vehicles at Kamraj & Cubbon Road Intersection on 10/05/2017

Table 26: Passing Vehicle Count Survey at Kamraj Road and Cubbon Road Intersection on 17/05/2017

PASSING VEHICLE COUNT SURVEY

JUNCTION NAME : KAMRAJ AND CUBBON ROAD JUNCTION											
DIRECTION: COMMERCIAL STREET TO MG ROAD											
DATE:17-5-2017								DAY:WEDNESDAY			
Time		Observed Time	Total Vehicle Count (s)								
From	To		10	10	10	10	10	10	10	10	Total
6.00	6.30										
6.30	7.00	6.38	11	5	2	3	3				24
7.00	7.30	7.05	10	20	2	3	5				40
7.30	8.00	7.30	15	10	4	5	3				37
8.00	8.30	8.10	15	15	18	15	5				68
8.30	9.00	8.40	11	17	21	20	14				83
9.00	9.30	9.15	14	10	15	25	20				84
9.30	10.00	9.45	15	25	12	25	25				102
10.00	10.30	10.10	15	15	20	10	15				75
10.30	11.00	10.38	30	25	20	25	15				115
11.00	11.30	11.15	11	7	20	13	12				63
11.30	12.00	11.45	14	15	20	31	10				90
12.00	12.30	12.05	12	11	16	19	10				68
12.30	13.00	12.45	12	11	10	12	18				63
13.00	13.30	13.15	12	10	13	15	12				62
13.30	14.00	13.40	15	12	15	18	20				80
14.00	14.30	14.10	16	12	15	18	22				83
14.30	15.00	14.45	18	14	13	9	11				65
15.00	15.30	15.02	18	15	17	13	10				73
15.30	16.00	15.38	20	17	15	10	15				77
16.00	16.30	16.16	19	16	21	17	10				83
16.30	17.00	16.35	20	22	17	10	8				77
17.00	17.30	17.12	22	18	14	16	11				81

17.30	18.00	17.41	22	21	18	16	18				95
18.00	18.30	18.02	21	19	18	16	13				87
18.30	19.00	18.46	22	21	19	16	17				95
19.00	19.30	19.06	34	29	21	21	20				125
19.30	20.00	19.51	31	28	27	22	24				132
20.00	20.30	20.04	30	25	26	22	19				122
20.30	21.00	20.39	28	25	22	24	15				114
21.00	21.30	21.05	22	20	16	14	12				84
21.30	22.00	21.32	20	21	19	17	14				91

PASSING VEHICLE COUNT SURVEY

JUNCTION NAME : KAMRAJ AND CUBBON ROAD JUNCTION											
DIRECTION: MG ROAD TO COMMERCIAL STREET											
DATE:17-5-2017								DAY:WEDNESDAY			
Time		Observed Time	Total Vehicle Count (s)								
From	To		10	10	10	10	10	10	10	10	Total
6.00	6.30										
6.30	7.00	6.49	3	1	1						5
7.00	7.30	7.09	12	0	0						12
7.30	8.00	7.38	14	2	0						16
8.00	8.30	8.16	12	4	0						16
8.30	9.00	8.38	19	9	0						28
9.00	9.30	9.15	22	7	0						29
9.30	10.00	9.27	13	15	6						34
10.00	10.30	10.16	9	14	3						26
10.30	11.00	10.34	22	11	2						35
11.00	11.30	11.05	35	2	3						40
11.30	12.00	11.33	24	21	6						51
12.00	12.30	12.13	32	14	11						57
12.30	13.00	12.40	27	14	8						49
13.00	13.30	13.16	30	13	8						51
13.30	14.00	13.42	28	11	12						51
14.00	14.30	14.24	26	14	13						53
14.30	15.00	14.35	22	21	6						49
15.00	15.30	15.15	16	14	2						32
15.30	16.00	15.31	15	14	4						33
16.00	16.30	16.11	16	8	2						26
16.30	17.00	16.42	12	6	3						21
17.00	17.30	17.09	26	14	6						46
17.30	18.00	17.42	26	14	11						51
18.00	18.30	18.12	26	17	4						47
18.30	19.00	18.38	34	15	8						57
19.00	19.30	19.05	32	16	8						56
19.30	20.00	19.49	34	14	13						61

20.00	20.30	20.16	28	12	6						46
20.30	21.00	20.36	32	16	9						57
21.00	21.30	21.08	28	16	8						52
21.30	22.00	21.51	29	12	9						50

PASSING VEHICLE COUNT SURVEY

JUNCTION NAME : KAMRAJ AND CUBBON ROAD JUNCTION											
DIRECTION: DICKENSON TO MISN SK SQUARE											
DATE:17-5-2017								DAY:WEDNESDAY			
Time		Observed Time	Total Vehicle Count (s)								
From	To		10	10	10	10	10	10	10	10	Total
6.00	6.30										
6.30	7.00	6.47	13	5	0	0					18
7.00	7.30	7.15	10	7	3	0					20
7.30	8.00	7.48	11	14	4	0					29
8.00	8.30	8.10	24	6	2	0					32
8.30	9.00	8.47	26	3	0	0					29
9.00	9.30	9.05	21	11	8	0					40
9.30	10.00	9.32	20	15	8	0					43
10.00	10.30	10.02	24	18	7	0					49
10.30	11.00	10.32	25	11	9	0					45
11.00	11.30	11.02	26	24	8	0					58
11.30	12.00	11.32	27	12	15	19					73
12.00	12.30	12.05	29	14	7	8					58
12.30	13.00	12.35	30	14	13	12					69
13.00	13.30	13.05	33	11	5	16					65
13.30	14.00	13.35	29	14	7	0					50
14.00	14.30	14.05	22	9	8	7					46
14.30	15.00	14.35	20	14	6	9					49
15.00	15.30	15.15	13	36	10	8					67
15.30	16.00	15.36	9	21	19	11					60
16.00	16.30	16.17	16	29	17	9					71
16.30	17.00	16.44	17	11	14	8					50
17.00	17.30	17.08	15	17	28	6					66
17.30	18.00	17.33	20	25	18	7					70
18.00	18.30	18.1	12	29	20	14					75
18.30	19.00	18.32	16	21	11	20					68
19.00	19.30	19.14	15	21	18	15					69
19.30	20.00	19.45	16	27	30	19					92
20.00	20.30	20.1	13	30	25	15					83
20.30	21.00	20.3	13	21	17	9					60
21.00	21.30	21.06	29	30	10	8					77
21.30	22.00	21.41	19	13	29	9					70

PASSING VEHICLE COUNT SURVEY											
JUNCTION NAME : KAMRAJ AND CUBBON ROAD JUNCTION											
DIRECTION: MINSK square to dickenson road											
DATE:17-5-2017								DAY:WEDNESDAY			
Time		Observed Time	Total Vehicle Count (s)								
From	To		10	10	10	10	10	10	10	10	Total
6.00	6.30										
6.30	7.00	6.37	19	21	10	2	4	6	2	6	70
7.00	7.30	7.05	8	12	10	10	7	1	2	3	53
7.30	8.00	7.5	7	10	10	5	2	2	1	0	37
8.00	8.30	8.1	10	11	8	9	12	6	10	2	68
8.30	9.00	8.48	11	12	11	14	10	12	10	9	89
9.00	9.30	9.2	12	20	21	19	12	16	17	19	136
9.30	10.00	9.3	14	7	12	10	9	4	11	5	72
10.00	10.30	10.06	6	11	14	15	14	6	12	9	87
10.30	11.00	10.36	10	9	5	10	13	9	13	2	71
11.00	11.30	11.16	10	9	6	9	14	11	16	13	88
11.30	12.00	11.34	10	13	13	13	17	9	13	7	95
12.00	12.30	12.15	25	14	10	11	12	17	19	21	129
12.30	13.00	12.33	20	15	11	20	10	15	4	18	113
13.00	13.30	13.05	31	16	12	6	15	14	21	12	127
13.30	14.00	13.33	15	11	11	19	11	9	12	7	95
14.00	14.30	14.05	25	14	6	12	7	9	15	22	110
14.30	15.00	14.35	30	9	6	12	7	9	15	28	116
15.00	15.30	15.15	14	6	10	15	13	11	11	9	89
15.30	16.00	15.36	17	10	13	16	12	10	8	12	98
16.00	16.30	16.17	19	17	18	15	13	10	12	14	118
16.30	17.00	16.44	22	8	17	15	13	17	15	11	118
17.00	17.30	17.08	18	15	13	11	15	13	11	14	110
17.30	18.00	17.33	23	19	15	14	11	17	10	13	122
18.00	18.30	18.1	19	21	18	17	16	15	14	13	133
18.30	19.00	18.32	20	15	10	18	16	11	10	8	108
19.00	19.30	19.14	25	23	15	18	20	17	14	11	143
19.30	20.00	19.45	30	28	25	21	18	17	14	11	164
20.00	20.30	20.1	28	26	22	19	17	13	15	10	150
20.30	21.00	20.3	18	14	17	14	10	8	11	7	99
21.00	21.30	21.06	17	18	10	18	11	15	13	10	112
21.30	22.00	21.41	20	17	16	15	13	10	14	10	115

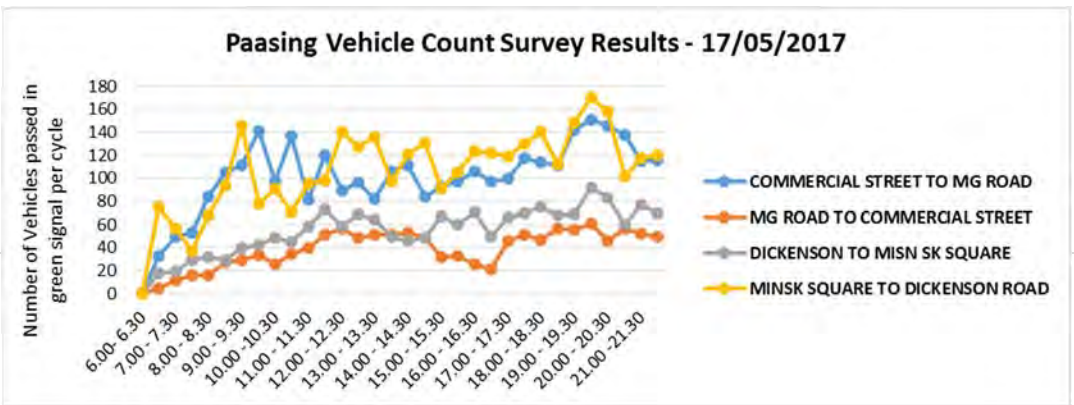


Figure 22: Passing Vehicles at Kamraj & Cubbon Road Intersection on 17/05/2017

Table 27: Dead Green/Wastage Green Survey at Kamraj Road and Cubbon Road Intersection on 21/05/2017

PASSING VEHICLE COUNT SURVEY

JUNCTION NAME : KAMRAJ AND CUBBON ROAD JUNCTION											
DIRECTION: COMMERCIAL STREET TO MG ROAD											
DATE:21-5-2017										DAY:SUNDAY	
Time		Observed Time	Total Vehicle Count (s)								
From	To		10	10	10	10	10	10	10	10	Total
6.00	6.30										
6.30	7.00										0
7.00	7.30										0
7.30	8.00										0
8.00	8.30										0
8.30	9.00										0
9.00	9.30										0
9.30	10.00	9.45	15	20	2	5	7				49
10.00	10.30	10.02	12	15	6	8	2				43
10.30	11.00	10.45	11	16	11	6	7				51
11.00	11.30	11.10	12	10	13	8	4				47
11.30	12.00	11.40	13	11	12	5	7				48
12.00	12.30	12.00	5	8	6	9	2				30
12.30	13.00	12.30	14	15	10	3	5				47
13.00	13.30	13.00	15	10	12	6	4				47
13.30	14.00	13.30	10	9	12	5	4				40
14.00	14.30	14.10	9	5	15	10	22				61
14.30	15.00	14.40	10	14	11	10	8				53
15.00	15.30	15.12	5	7	12	10	12				46
15.30	16.00	15.32	7	10	15	13	11				56
16.00	16.30	16.08	10	13	18	15	11				67
16.30	17.00	16.38	15	10	13	7	12				57
17.00	17.30	17.02	20	18	15	10	14				77
17.30	18.00	17.38	21	19	18	16	12				86
18.00	18.30	18.09	23	21	17	18	12				91
18.30	19.00	18.32	9	18	10	13	12				62

19.00	19.30	19.12	20	23	18	18	12				91
19.30	20.00	19.32	19	19	16	17	14				85
20.00	20.30	20.02	17	19	12	15	12				75
20.30	21.00	20.35	15	18	14	17	13				77
21.00	21.30	21.01	19	16	15	14	11				75
21.30	22.00	21.35	18	15	12	16	10				71

PASSING VEHICLE COUNT SURVEY

JUNCTION NAME : KAMRAJ AND CUBBON ROAD JUNCTION

DIRECTION: MG ROAD TO COMMERCIAL STREET

DATE:21-5-2017 | **DAY:SUNDAY**

Time		Observed Time	Total Vehicle Count (s)								
From	To		10	10	10	10	10	10	10	10	Total
6.00	6.30										
6.30	7.00										0
7.00	7.30										0
7.30	8.00										0
8.00	8.30										0
8.30	9.00										0
9.00	9.30	9.32	10	9	0						19
9.30	10.00	10.17	18	8	6						32
10.00	10.30	10.42	18	18	3						39
10.30	11.00	11.03	20	9	2						31
11.00	11.30	11.41	21	11	3						35
11.30	12.00	12.06	21	4	6						31
12.00	12.30	12.32	15	10	11						36
12.30	13.00	13.02	21	22	8						51
13.00	13.30	13.31	22	14	8						44
13.30	14.00	14.08	22	21	12						55
14.00	14.30	14.33	22	17	13						52
14.30	15.00	15.09	9	15	6						30
15.00	15.30	15.48	13	19	2						34
15.30	16.00	16.21	13	15	4						32
16.00	16.30	16.36	10	14	2						26
16.30	17.00	17.12	13	15	3						31
17.00	17.30	17.32	9	17	6						32
17.30	18.00	18.08	0	2	11						13
18.00	18.30	18.38	18	9	4						31
18.30	19.00	19.12	8	17	8						33
19.00	19.30	19.46	13	10	8						31
19.30	20.00	20.12	7	21	13						41
20.00	20.30	20.32	10	17	6						33
20.30	21.00	21.02	12	4	9						25
21.00	21.30	21.28	7	8	8						23

21.30	22.00	21.51	29	12	9						50

PASSING VEHICLE COUNT SURVEY

JUNCTION NAME : KAMRAJ AND CUBBON ROAD JUNCTION											
DIRECTION: DICKENSON TO MISN SK SQUARE											
DATE:21-5-2017										DAY:SUNDAY	
Time		Observed Time	Total Vehicle Count (s)								
From	To		10	10	10	10	10	10	10	10	Total
6.00	6.30										
6.30	7.00	6.47	11	20	25						56
7.00	7.30	7.15	23	35	5						63
7.30	8.00	7.48	22	32	10						64
8.00	8.30	8.10	19	11	5						35
8.30	9.00	8.47	16	16	8						40
9.00	9.30	9.05	18	18	7						43
9.30	10.00	9.32	22	9	6						37
10.00	10.30	10.02	26	18	7						51
10.30	11.00	10.32	21	11	9						41
11.00	11.30	11.02	23	20	10						53
11.30	12.00	11.32	17	18	17						52
12.00	12.30	12.05	11	10	15						36
12.30	13.00	12.35	10	13	17						40
13.00	13.30	13.05	10	12	8						30
13.30	14.00	13.35	11	10	17						38
14.00	14.30	14.05	7	13	12						32
14.30	15.00	14.35	11	16	13						40
15.00	15.30	15.15	14	17	16						47
15.30	16.00	15.36	14	20	19						53
16.00	16.30	16.17	10	18	13						41
16.30	17.00	16.44	9	21	18						48
17.00	17.30	17.08	17	11	20						48
17.30	18.00	17.33	18	17	10						45
18.00	18.30	18.1	8	12	8						28
18.30	19.00	18.32	8	5	2						15
19.00	19.30	19.14	15	21	18						54
19.30	20.00	19.45	16	27	30						73
20.00	20.30	20.1	13	30	25						68
20.30	21.00	20.3	13	21	17						51
21.00	21.30	21.06	29	30	10						69
21.30	22.00	21.41	19	13	29						61

PASSING VEHICLE COUNT SURVEY

JUNCTION NAME : KAMRAJ AND CUBBON ROAD JUNCTION
DIRECTION: MINSK square to dickenson road

DATE:21-5-2017											DAY:SUNDAY
Time		Observed Time	Total Vehicle Count (s)								
From	To		10	10	10	10	10	10	10	10	Total
6.00	6.30										
6.30	7.00										
7.00	7.30										
7.30	8.00										
8.00	8.30										
8.30	9.00										
9.00	9.30										
9.30	10.00	9.50	10	10	8	9	2	2	2	8	51
10.00	10.30	10.10	7	12	10	6	4	5	1	2	47
10.30	11.00	10.32	7	3	12	5	7	3	2	0	39
11.00	11.30	11.10	9	5	8	8	11	3	1	0	45
11.30	12.00	11.32	2	3	11	11	11	2	2	0	42
12.00	12.30	12.17	10	11	8	12	4	7	2	0	54
12.30	13.00	12.37	6	14	5	17	11	3	4	0	60
13.00	13.30	13.10	6	7	14	20	11	11	5	14	88
13.30	14.00	13.40	4	6	6	10	13	7	10	6	62
14.00	14.30	14.09	2	9	11	4	8	9	4	2	49
14.30	15.00	14.34	3	7	11	11	12	5	10	6	65
15.00	15.30	15.15	5	7	12	10	12	7	10	5	68
15.30	16.00	15.36	7	10	13	8	14	10	5	7	74
16.00	16.30	16.17	6	9	13	10	12	7	10	7	74
16.30	17.00	16.44	10	7	5	10	9	11	7	9	68
17.00	17.30	17.08	15	8	13	10	12	7	10	9	84
17.30	18.00	17.33	19	15	10	11	13	8	7	10	93
18.00	18.30	18.1	21	15	13	10	15	17	8	6	105
18.30	19.00	18.32	6	8	13	8	9	10	4	10	68
19.00	19.30	19.14	10	11	13	7	14	10	8	6	79
19.30	20.00	19.45	7	13	10	8	15	15	8	9	85
20.00	20.30	20.1	9	7	10	16	19	11	13	7	92
20.30	21.00	20.3	6	8	9	13	10	14	11	8	79
21.00	21.30	21.06	10	9	14	17	13	8	7	10	88
21.30	22.00	21.41	11	8	13	10	14	11	8	7	82

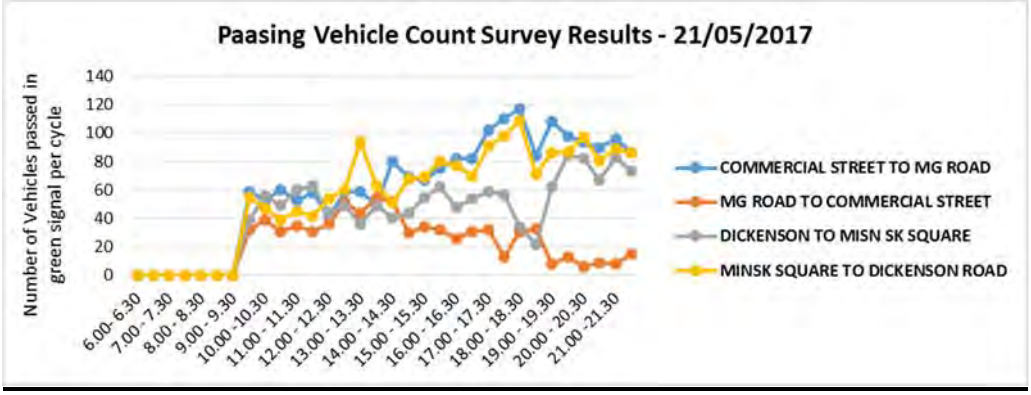


Figure 23: Passing Vehicles at Kamraj & Cubbon Road Intersection on 21/05/2017

4.4 Opera Intersection-

A pictorial representation of the intersection, with details of approach movements and Signal Posts Locations is shown in the figure.

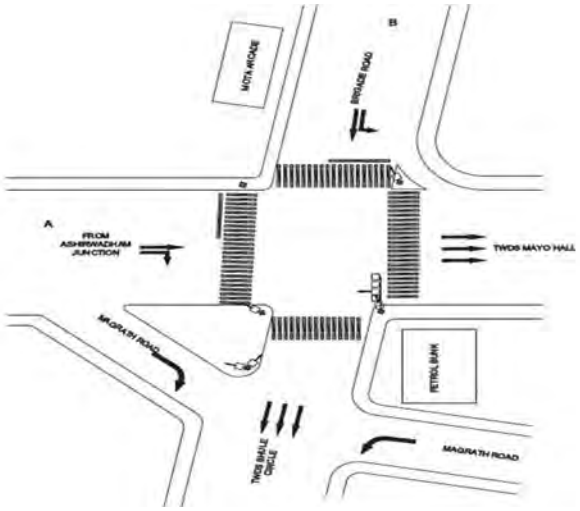


Figure 13: Details of Opera Intersection

The observed green signal indication timings are entered corresponding to the time intervals in each phase phase and the total cycle length (cycle time) in seconds were calculated. Details are presented in the table below.

Opera Road Junction Signal Timings											
Weekday (11/05/2017 and 18/05/2017)											
Opera Road Junction			PHASE								CYCLE TIME
	Road	From	1			2			5		
Data	A	ASHIRWADHAM (Residency Road)	R		S		P		EXCLUSIVE PEDESTRIAN		
	B	BRIGADE ROAD (MG Road)		P			L	S			
	06:00	06:30	Signal Off								
TIMINGS	06:30	07:00	25			15			10		50
	07:00	08:00	45			25			10		80
	08:00	12:00	70			30			10		110
	12:00	15:00	70			30			10		110
	15:00	20:00	70			30			10		110
	20:00	22:00	50			30			10		90

Figure 25: Cycle Length of Opera Road Intersection on 11th and 18th June 2017

Opera Road Junction Signal Timings											
Date: Sunday (14/05/2017)											
Opera Road Junction			PHASE								CYCLE TIME
	Road	From	1			2			5		
Data	A	ASHIRWADHAM (Residency Road)	R		S		P		EXCLUSIVE PEDESTRIAN		
	B	BRIGADE ROAD (MG Road)		P			L	S			
	06:00	06:30	Signal Off								
TIMINGS	06:30	07:00	15			25			10		50
	07:00	08:00	25			45			10		80
	08:00	12:00	45			70			10		125
	12:00	15:00	70			70			10		150
	15:00	20:00	70			30			10		110
	20:00	22:00	50			30			10		90

Figure 26: Cycle Length of Opera Road Intersection on 14/05/2017

A two phase with exclusive pedestrian signal was operated at opera Intersection. The cycle length varied from 50-110 seconds. The apportioned green time was more at peak hours. The weekday signal operation was similar while slight changes observed at weekend.

Table 28: Signal Phase Time Survey at Opera Intersection on 11/05/2017

SIGNAL PHASE TIME SURVEY							
JUNCTION NAME : OPERA JUNCTION							
DIRECTION: RICHMOND CIRCLE TO MAYOHALL							
DATE:11-5-2017						DAY:THURSDAY	
Time		Observed Time	Cycle Time (s)				
From	To		Green	Red	Amber	Pedestrian	Total
6.00	6.30						
6.30	7.00	6.45	25	18	3	10	56
7.00	7.30	7.15	45	35	3	10	93
7.30	8.00	7.48	45	35	3	10	93
8.00	8.30	8.10	70	45	3	10	128
8.30	9.00	8.47	70	45	3	10	128
9.00	9.30	9.05	70	45	3	10	128
9.30	10.00	9.32	70	45	3	10	128
10.00	10.30	10.02	70	45	3	10	128
10.30	11.00	10.32	70	45	3	10	128
11.00	11.30	11.02	70	45	3	10	128

11.30	12.00	11.32	70	45	3	10	128
12.00	12.30	12.05	70	45	3	10	128
12.30	13.00	12.35	70	45	3	10	128
13.00	13.30	13.05	70	45	3	10	128
13.30	14.00	13.35	70	45	3	10	128
14.00	14.30	14.05	70	45	3	10	128
14.30	15.00	14.35	70	45	3	10	128
15.00	15.30	15.15	70	45	3	10	128
15.30	16.00	15.36	70	45	3	10	128
16.00	16.30	16.17	70	45	3	10	128
16.30	17.00	16.44	70	45	3	10	128
17.00	17.30	17.08	70	45	3	10	128
17.30	18.00	17.33	70	45	3	10	128
18.00	18.30	18.1	70	45	3	10	128
18.30	19.00	18.32	70	45	3	10	128
19.00	19.30	19.14	70	45	3	10	128
19.30	20.00	19.45	70	45	3	10	128
20.00	20.30	20.1	70	45	3	10	128
20.30	21.00	20.3	50	35	3	10	98
21.00	21.30	21.06	50	35	3	10	98
21.30	22.00	21.41	50	35	3	10	98

SIGNAL PHASE TIME SURVEY							
JUNCTION NAME : OPERA JUNCTION							
DIRECTION: M.G.ROAD TO VELLARA JUNCTION							
DATE:11-5-2017						**DAY:THURSDAY**	
Time		**Observed Time**	**Cycle Time (s)**				
From	**To**		**Green**	**Red**	**Amber**	**Pedestrian**	**Total**
6.00	6.30						
6.30	7.00	6:40am	15	30	2	10	57
7.00	7.30	7:05am	15	30	2	10	57
7.30	8.00	7:40am	25	55	2	10	92
8.00	8.30	8:05am	30	85	2	10	127
8.30	9.00	8:50am	30	85	2	10	127
9.00	9.30	9:05am	30	85	2	10	127
9.30	10.00	9:40am	30	85	2	10	127
10.00	10.30	10:00am	30	85	2	10	127
10.30	11.00	10:35am	30	85	2	10	127
11.00	11.30	11:10am	30	85	2	10	127
11.30	12.00	11:35am	30	85	2	10	127
12.00	12.30	12:00pm	30	85	2	10	127
12.30	13.00	12:35pm	30	85	2	10	127
13.00	13.30	1:00pm	30	85	2	10	127
13.30	14.00	1:30pm	30	85	2	10	127

14.00	14.30	2:00pm	30	85	2	10	127
14.30	15.00	2:30pm	30	85	2	10	127
15.00	15.30	3:20pm	30	85	2	10	127
15.30	16.00	3:35pm	30	85	2	10	127
16.00	16.30	4:15pm	30	85	2	10	127
16.30	17.00	4:40pm	30	85	2	10	127
17.00	17.30	5:10pm	30	85	2	10	127
17.30	18.00	5:40pm	30	85	2	10	127
18.00	18.30	6:10pm	30	85	2	10	127
18.30	19.00	6:40pm	30	85	2	10	127
19.00	19.30	7:15pm	30	85	2	10	127
19.30	20.00	7:40pm	30	85	2	10	127
20.00	20.30	8:10pm	30	85	2	10	127
20.30	21.00	8:45pm	30	85	2	10	127
21.00	21.30	9:05pm	30	85	2	10	127
21.30	22.00	9:30pm	30	85	2	10	127

Table 29: Signal Phase Time Survey at Opera Intersection on 14/05/2017

SIGNAL PHASE TIME SURVEY							
JUNCTION NAME : OPERA JUNCTION							
DIRECTION: RICHMOND CIRCLE TO MAYOHALL							
DATE:14-5-2017						DAY:SUNDAY	
Time		Observed Time	Cycle Time (s)				
From	To		Green	Red	Amber	Pedestrian	Total
6.00	6.30						
6.30	7.00	6.45	15	30	3	9	57
7.00	7.30	7.20	15	30	3	9	57
7.30	8.00	7.38	45	70	3	9	127
8.00	8.30	8.10	45	70	3	9	127
8.30	9.00	8.40	45	70	3	9	127
9.00	9.30	9.20	45	70	3	9	127
9.30	9.45	9.34	45	70	3	9	127
10.00	10.30	10.16	45	70	3	9	127
10.30	11.00	10.34	45	70	3	9	127
11.00	11.30	11.25	45	70	3	9	127
11.30	12.00	11.53	45	70	3	9	127
12.00	12.30	12.13	45	70	3	9	127
12.30	13.00	12.34	45	70	3	9	127
13.00	13.30	13.09	45	70	3	9	127
13.30	14.00	13.45	45	70	3	9	127
14.00	14.30	14.15	45	70	3	9	127
14.30	15.00	14.35	45	70	3	9	127
15.00	15.30	15.15	70	45	3	9	127
15.30	16.00	15.36	70	45	3	9	127

16.00	16.30	16.17	70	45	3	9	127
16.30	17.00	16.44	70	45	3	9	127
17.00	17.30	17.08	70	45	3	9	127
17.30	18.00	17.33	70	45	3	9	127
18.00	18.30	18.1	70	45	3	9	127
18.30	19.00	18.32	70	45	3	9	127
19.00	19.30	19.14	70	45	3	9	127
19.30	20.00	19.45	70	45	3	9	127
20.00	20.30	20.1	50	35	3	9	97
20.30	21.00	20.3	50	35	3	9	97
21.00	21.30	21.06	50	35	3	9	97
21.30	22.00	21.41	50	35	3	9	97

SIGNAL PHASE TIME SURVEY							
JUNCTION NAME : OPERA JUNCTION							
DIRECTION: M.G.ROAD TO VELLARA JUNCTION							
DATE:14-5-2017						**DAY:SUNDAY**	
Time		**Observed Time**	**Cycle Time (s)**				
From	**To**		**Green**	**Red**	**Amber**	**Pedestrian**	**Total**
6.00	6.30						
6.30	7.00	6.45	25	20	3	10	58
7.00	7.30	7.35	45	40	3	10	98
7.30	8.00	8.15	45	40	3	10	98
8.00	8.30	8.40	70	50	3	10	133
8.30	9.00	9.10	70	50	3	10	133
9.00	9.30	9.35	70	50	3	10	133
9.30	10.00	10.10	70	50	3	10	133
10.00	10.30	10.35	70	50	3	10	133
10.30	11.00	11.05	70	50	3	10	133
11.00	11.30	11.35	70	50	3	10	133
11.30	12.00	12.00	70	50	3	10	133
12.00	12.30	12.30	70	50	3	10	133
12.30	13.00	13.00	70	50	3	10	133
13.00	13.30	13.15	70	50	3	10	133
13.30	14.00	13.30	70	50	3	10	133
14.00	14.30	14.00	70	50	3	10	133
14.30	15.00	14.30	70	50	3	10	133
15.00	15.30	15.10	30	80	3	10	123
15.30	16.00	15.40	30	80	3	10	123
16.00	16.30	16.15	30	80	3	10	123
16.30	17.00	16.40	30	80	3	10	123
17.00	17.30	17.10	30	80	3	10	123
17.30	18.00	17.35	30	80	3	10	123
18.00	18.30	18.10	30	80	3	10	123

18.30	19.00	18.35	30	80	3	10	123
19.00	19.30	19.12	30	80	3	10	123
19.30	20.00	19.43	30	80	3	10	123
20.00	20.30	20.07	30	60	3	10	103
20.30	21.00	20.34	30	60	3	10	103
21.00	21.30	21.01	30	60	3	10	103
21.30	22.00	21.32	30	60	3	10	103

Table 30: Signal Phase Time Survey at Opera Intersection on 18/05/2017

SIGNAL PHASE TIME SURVEY							
JUNCTION NAME : OPERA JUNCTION							
DIRECTION: RICHMOND CIRCLE TO MAYOHALL							
DATE:18-5-2017						DAY:THURSDAY	
Time		Observed Time	Cycle Time (s)				
From	To		Green	Red	Amber	Pedestrian	Total
6.00	6.30						
6.30	7.00	6.37	25	18	3	10	56
7.00	7.30	7.15	45	35	3	10	93
7.30	8.00	7.34	45	35	3	10	93
8.00	8.30	8.04	70	45	3	10	128
8.30	9.00	8.40	70	45	3	10	128
9.00	9.30	9.10	70	45	3	10	128
9.30	10.00	9.40	70	45	3	10	128
10.00	10.30	10.15	70	45	3	10	128
10.30	11.00	10.37	70	45	3	10	128
11.00	11.30	11.16	70	45	3	10	128
11.30	12.00	11.35	70	45	3	10	128
12.00	12.30	12.13	70	45	3	10	128
12.30	13.00	12.40	70	45	3	10	128
13.00	13.30	13.09	70	45	3	10	128
13.30	14.00	13.39	70	45	3	10	128
14.00	14.30	14.02	70	45	3	10	128
14.30	15.00	14.38	70	45	3	10	128
15.00	15.30	15.15	70	45	3	10	128
15.30	16.00	15.36	70	45	3	10	128
16.00	16.30	16.17	70	45	3	10	128
16.30	17.00	16.44	70	45	3	10	128
17.00	17.30	17.08	70	45	3	10	128
17.30	18.00	17.33	70	45	3	10	128
18.00	18.30	18.1	70	45	3	10	128
18.30	19.00	18.32	70	45	3	10	128
19.00	19.30	19.14	50	35	3	10	98
19.30	20.00	19.45	50	35	3	10	98
20.00	20.30	20.1	50	35	3	10	98

20.30	21.00	20.3	50	35	3	10	98
21.00	21.30	21.06	50	35	3	10	98
21.30	22.00	21.41	50	35	3	10	98

SIGNAL PHASE TIME SURVEY

JUNCTION NAME : OPERA JUNCTION

DIRECTION: M.G.ROAD TO VELLARA JUNCTION

DATE:18-5-2017 **DAY:THURSDAY**

Time		Observed Time	Cycle Time (s)				
From	To		Green	Red	Amber	Pedestrian	Total
6.00	6.30						
6.30	7.00	6:40am					
7.00	7.30	7:05am	15	30	2	10	57
7.30	8.00	7:40am	25	55	2	10	92
8.00	8.30	8:05am	30	85	2	10	127
8.30	9.00	8:50am	30	85	2	10	127
9.00	9.30	9:05am	30	85	2	10	127
9.30	10.00	9:40am	30	85	2	10	127
10.00	10.30	10:00am	30	85	2	10	127
10.30	11.00	10:35am	30	85	2	10	127
11.00	11.30	11:10am	30	85	2	10	127
11.30	12.00	11:35am	30	85	2	10	127
12.00	12.30	12:00pm	30	85	2	10	127
12.30	13.00	12:35pm	30	85	2	10	127
13.00	13.30	1:00pm	30	85	2	10	127
13.30	14.00	1:30pm	30	85	2	10	127
14.00	14.30	2:00pm	30	85	2	10	127
14.30	15.00	2:30pm	30	85	2	10	127
15.00	15.30	3:20pm	30	85	2	10	127
15.30	16.00	3:35pm	30	85	2	10	127
16.00	16.30	4:15pm	30	85	2	10	127
16.30	17.00	4:40pm	30	85	2	10	127
17.00	17.30	5:10pm	30	85	2	10	127
17.30	18.00	5:40pm	30	85	2	10	127
18.00	18.30	6:10pm	30	85	2	10	127
18.30	19.00	6:40pm	30	85	2	10	127
19.00	19.30	7:15pm	30	85	2	10	127
19.30	20.00	7:40pm	30	85	2	10	127
20.00	20.30	8:10pm	30	85	2	10	127
20.30	21.00	8:45pm	30	85	2	10	127
21.00	21.30	9:05pm	30	85	2	10	127
21.30	22.00	9:30pm	30	85	2	10	127

Table 31: Dead Green/Wastage of Green Survey at Opera Intersection on 11/05/2017

WASTE/DEAD GREEN SIGNAL SURVEY			
JUNCTION NAME : OPERA JUNCTION			
DIRECTION: RICHMOND CIRCLE TO MAYOHALL			
DATE:11-5-2017			DAY:THURSDAY
Time		Dead Green	Wastage of Green
From	To	Occurred	Occurred
6.00	6.30	-	-
6.30	7.00	-	✓
7.00	7.30	-	-
7.30	8.00	-	✓
8.00	8.30	-	-
8.30	9.00	-	-
9.00	9.30	-	-
9.30	10.00	-	-
10.00	10.30	-	-
10.30	11.00	-	-
11.00	11.30	-	-
11.30	12.00	-	-
12.00	12.30	-	-
12.30	13.00	-	-
13.00	13.30	-	-
13.30	14.00	-	-
14.00	14.30	-	-
14.30	15.00	-	-
15.00	15.30	-	-
15.30	16.00	-	-
16.00	16.30	-	-
16.30	17.00	-	-
17.00	17.30	-	-
17.30	18.00	-	-
18.00	18.30	-	-
18.30	19.00	-	-
19.00	19.30	-	-
19.30	20.00	-	-
20.00	20.30	-	-
20.30	21.00	-	-
21.00	21.30	-	-
21.30	22.00	-	✓

WASTE/DEAD GREEN SIGNAL SURVEY
JUNCTION NAME : OPERA JUNCTION
DIRECTION: M.G.ROAD TO VELLARA JUNCTION

DATE:11-5-2017			DAY:THURSDAY
Time		Dead Green	Wastage of Green
From	To	Occurred	Occurred
6.00	6.30	-	-
6.30	7.00	-	√
7.00	7.30	-	√
7.30	8.00	-	-
8.00	8.30	-	-
8.30	9.00	-	-
9.00	9.30	-	-
9.30	10.00	-	-
10.00	10.30	-	-
10.30	11.00	-	-
11.00	11.30	-	-
11.30	12.00	-	-
12.00	12.30	-	-
12.30	13.00	-	-
13.00	13.30	-	-
13.30	14.00	-	-
14.00	14.30	-	-
14.30	15.00	-	-
15.00	15.30	-	-
15.30	16.00	-	-
16.00	16.30	-	-
16.30	17.00	-	-
17.00	17.30	-	-
17.30	18.00	-	-
18.00	18.30	-	-
18.30	19.00	-	-
19.00	19.30	-	-
19.30	20.00	-	-
20.00	20.30	-	-
20.30	21.00	-	-
21.00	21.30	-	-
21.30	22.00	-	-

Table 32: Dead Green/Wastage of Green Survey at Opera Intersection on 14/05/2017

WASTE/DEAD GREEN SIGNAL SURVEY			
JUNCTION NAME : OPERA JUNCTION			
DIRECTION: RICHMOND CIRCLE TO MAYOHALL			
DATE:14-5-2017			DAY:SUNDAY
Time		Dead Green	Wastage of Green
From	To	Occurred	Occurred
6.00	6.30	-	-

6.30	7.00	-	✓
7.00	7.30	-	✓
7.30	8.00	-	✓
8.00	8.30	-	✓
8.30	9.00	-	✓
9.00	9.30	-	✓
9.30	9.45	-	-
10.00	10.30	-	-
10.30	11.00	-	✓
11.00	11.30	-	-
11.30	12.00	-	-
12.00	12.30	-	-
12.30	13.00	-	-
13.00	13.30	-	✓
13.30	14.00	-	-
14.00	14.30	-	-
14.30	15.00	-	-
15.00	15.30	-	-
15.30	16.00	-	-
16.00	16.30	-	-
16.30	17.00	-	-
17.00	17.30	-	-
17.30	18.00	-	-
18.00	18.30	-	-
18.30	19.00	-	-
19.00	19.30	-	-
19.30	20.00	-	-
20.00	20.30	-	✓
20.30	21.00	-	-
21.00	21.30	-	-
21.30	22.00	-	-

WASTE/DEAD GREEN SIGNAL SURVEY			
JUNCTION NAME : OPERA JUNCTION			
DIRECTION: M.G.ROAD TO VELLARA JUNCTION			
DATE:14-5-2017			**DAY:SUNDAY**
Time		**Dead Green**	**Wastage of Green**
From	**To**	**Occurred**	**Occurred**
6.00	6.30	-	-
6.30	7.00	-	√
7.00	7.30	-	√
7.30	8.00	-	√
8.00	8.30	-	-
8.30	9.00	-	-

9.00	9.30	-	√
9.30	10.00	-	√
10.00	10.30	-	-
10.30	11.00	-	√
11.00	11.30	-	-
11.30	12.00	-	-
12.00	12.30	-	-
12.30	13.00	-	-
13.00	13.30	-	√
13.30	14.00	-	-
14.00	14.30	-	-
14.30	15.00	-	-
15.00	15.30	-	-
15.30	16.00	-	-
16.00	16.30	-	-
16.30	17.00	-	-
17.00	17.30	-	-
17.30	18.00	-	-
18.00	18.30	-	-
18.30	19.00	-	-
19.00	19.30	-	-
19.30	20.00	-	-
20.00	20.30	-	-
20.30	21.00	-	-
21.00	21.30	-	-
21.30	22.00	-	-

Table 33: Dead Green/Wastage of Green Survey at Opera Intersection on 18/05/2017

WASTE/DEAD GREEN SIGNAL SURVEY			
JUNCTION NAME : OPERA JUNCTION			
DIRECTION: RICHMOND CIRCLE TO MAYOHALL			
DATE:18-5-2017			**DAY:THURSDAY**
Time		**Dead Green**	**Wastage of Green**
From	**To**	**Occurred**	**Occurred**
6.00	6.30	-	-
6.30	7.00	-	-
7.00	7.30	-	-
7.30	8.00	-	✓
8.00	8.30	-	✓
8.30	9.00	-	-
9.00	9.30	-	-
9.30	10.00	-	✓
10.00	10.30	-	□
10.30	11.00	-	✓

11.00	11.30	-	-
11.30	12.00	-	✓
12.00	12.30	-	✓
12.30	13.00	-	-
13.00	13.30	-	-
13.30	14.00	-	-
14.00	14.30	-	-
14.30	15.00	-	-
15.00	15.30	-	-
15.30	16.00	-	-
16.00	16.30	-	-
16.30	17.00	-	-
17.00	17.30	-	-
17.30	18.00	-	-
18.00	18.30	-	-
18.30	19.00	-	-
19.00	19.30	-	-
19.30	20.00	-	-
20.00	20.30	-	-
20.30	21.00	-	-
21.00	21.30	-	-
21.30	22.00	-	-

WASTE/DEAD GREEN SIGNAL SURVEY			
JUNCTION NAME : OPERA JUNCTION			
DIRECTION: M.G.ROAD TO VELLARA JUNCTION			
DATE:18-5-2017			**DAY:THURSDAY**
Time		**Dead Green**	**Wastage of Green**
From	**To**	**Occupied**	**Occupied**
6.00	6.30	-	-
6.30	7.00	-	-
7.00	7.30	-	-
7.30	8.00	-	-
8.00	8.30	-	-
8.30	9.00	-	-
9.00	9.30	-	-
9.30	10.00	-	-
10.00	10.30	-	-
10.30	11.00	-	-
11.00	11.30	-	-
11.30	12.00	-	-
12.00	12.30	-	-
12.30	13.00	-	-
13.00	13.30	-	-

13.30	14.00	-	-
14.00	14.30	-	-
14.30	15.00	-	-
15.00	15.30	-	-
15.30	16.00	-	-
16.00	16.30	-	-
16.30	17.00	-	-
17.00	17.30	-	-
17.30	18.00	-	-
18.00	18.30	-	-
18.30	19.00	-	-
19.00	19.30	-	-
19.30	20.00	-	-
20.00	20.30	-	-
20.30	21.00	-	-
21.00	21.30	-	-
21.30	22.00	-	-

Table 34: Passing Vehicle Count Survey at Opera Intersection on 11/05/2017

JUNCTION NAME : OPERA JUNCTION										
DIRECTION: RICHMOND CIRCLE TO MAYOHALL										
DATE:11-5-2017										DAY:THURS DAY
Time		Observed Time	Total Vehicle Count (s)							
From	To		10	10	10	10	10	10	10	Total
6.00	6.30									
6.30	7.00	6.45	13	3						16
7.00	7.30	7.15	9	13	13	12	7			54
7.30	8.00	7.48	8	17	7	0				32
8.00	8.30	8.10	6	20	20	21	5	2	3	77
8.30	9.00	8.47	16	27	25	17	7	6	8	106
9.00	9.30	9.05	16	25	20	22	13	15	5	116
9.30	10.00	9.32	20	18	25	17	23	15	8	126
10.00	10.30	10.02	25	17	20	20	20	120	10	232
10.30	11.00	10.32	26	18	22	15	14	10	12	117
11.00	11.30	11.02	18	19	20	11	11	6	5	90
11.30	12.00	11.32	20	15	15	11	12	20	14	107
12.00	12.30	12.05	25	16	18	16	12	18	15	120
12.30	13.00	12.35	24	17	19	16	13	17	16	122
13.00	13.30	13.05	25	18	20	16	14	19	17	129
13.30	14.00	13.35	25	19	12	17	15	20	18	126
14.00	14.30	14.05	21	18	20	18	13	18	18	126
14.30	15.00	14.35	22	18	20	18	14	18	17	127

15.00	15.30	15.15	12	15	10	18	13	14	15	97
15.30	16.00	15.36	18	17	21	25	15	7	12	115
16.00	16.30	16.17	19	23	18	22	16	19	12	129
16.30	17.00	16.44	17	22	19	17	16	22	19	132
17.00	17.30	17.08	18	24	19	17	13	18	22	131
17.30	18.00	17.33	19	22	21	18	17	16	13	126
18.00	18.30	18.1	15	19	20	19	12	11	17	113
18.30	19.00	18.32	16	20	22	23	16	11	13	121
19.00	19.30	19.14	15	18	17	16	12	14	12	104
19.30	20.00	19.45	30	28	22	16	18	17	25	156
20.00	20.30	20.1	30	24	22	16	19	22	19	152
20.30	21.00	20.3	15	16	12	10	2			55
21.00	21.30	21.06	12	13	16	12	5			58
21.30	22.00	21.41	18	12	6	5				41

PASSING VEHICLE COUNT SURVEY

JUNCTION NAME : OPERA JUNCTION										
DIRECTION: M.G.ROAD TO VELLARA JUNCTION										
DATE:11-5-2017								**DAY:THURSDAY**		
Time		**Observed Time**	**Total Vehicle Count (s)**							
From	**To**		**10**	**10**	**10**	**10**	**10**	**10**	**10**	**Total**
6.00	6.30									0
6.30	7.00	6:40am	22	1						23
7.00	7.30	7:05am	6	1						7
7.30	8.00	7:40am	15	13	4					32
8.00	8.30	8:05am	23	5						28
8.30	9.00	8:50am	15	13	4					32
9.00	9.30	9:05am	20	10	15					45
9.30	10.00	9:40am	24	5	3					32
10.00	10.30	10:00am	27	10	5					42
10.30	11.00	10:35am	30	24	20					74
11.00	11.30	11:10am	30	7	5					42
11.30	12.00	11:35am	15	6	3					24
12.00	12.30	12:00pm	30	14	8					52
12.30	13.00	12:35pm	27	13	4					44
13.00	13.30	1:00pm	14	18	10					42
13.30	14.00	1:30pm	10	7	6					23
14.00	14.30	2:00pm	15	5	8					28
14.30	15.00	2:30pm	30	25	9					64
15.00	15.30	3:20pm	25	15	5					45
15.30	16.00	3:35pm	20	22	9					51
16.00	16.30	4:15pm	15	16	12					43
16.30	17.00	4:40pm	20	25	13					58
17.00	17.30	5:10pm	23	20	13					56

17.30	18.00	5:40pm	17	22	24					63
18.00	18.30	6:10pm	30	22	9					61
18.30	19.00	6:40pm	19	22	33					74
19.00	19.30	7:15pm	23	20	17					60
19.30	20.00	7:40pm	20	24	3					47
20.00	20.30	8:10pm	20	16	8					44
20.30	21.00	8:45pm	20	15	4					39
21.00	21.30	9:05pm	20	12	3					35
21.30	22.00	9:30pm	25	15	4					44

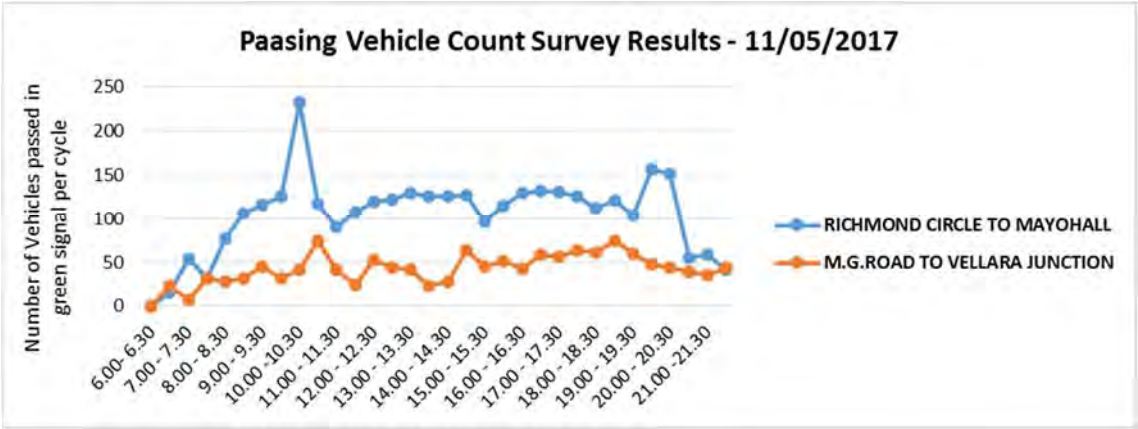


Figure 14: Passing Vehicles at Opera Intersection on 11/05/2017

Table 35: Passing Vehicle Count Survey at Opera Intersection on 14/05/2017

PASSING VEHICLE COUNT SURVEY

JUNCTION NAME : OPERA JUNCTION										
DIRECTION: RICHMOND CIRCLE TO MAYOHALL										
DATE:14-5-2017							DAY:SUNDAY			
Time		Observed Time	Total Vehicle Count (s)							
From	To		10	10	10	10	10	10	10	Total
6.00	6.30									
6.30	7.00	6.45	11	12						23
7.00	7.30	7.20	10	7	3					20
7.30	8.00	7.38	11	14	4					29
8.00	8.30	8.10	15	6	2					23
8.30	9.00	8.40	26	20	5					51
9.00	9.30	9.20	1	0	0					1
9.30	9.45	9.34	15	20	5	3	7	1		51
10.00	10.30	10.16	15	18	10	2	8	8		61
10.30	11.00	10.34	9	8	2	1	1	2		23
11.00	11.30	11.25	20	24	10	5	3	1		63
11.30	12.00	11.53	10	9	2	1	7	9		38

12.00	12.30	12.13	20	13	9	7	2	1		52
12.30	13.00	12.34	20	10	10	2	7	3		52
13.00	13.30	13.09	20	20	10	1	4	1		56
13.30	14.00	13.45	10	20	15	1	8	2		56
14.00	14.30	14.15	20	20	10	2	2	7		61
14.30	15.00	14.35	20	14	6	9	3	5		57
15.00	15.30	15.15	11	18	16	17	13	11	7	93
15.30	16.00	15.36	20	120	13	15	17	8	7	200
16.00	16.30	16.17	17	20	25	17	15	17	7	118
16.30	17.00	16.44	21	12	15	17	10	14	7	96
17.00	17.30	17.08	2	17	9	6	8	14	4	60
17.30	18.00	17.33	24	14	18	33	4	9	2	104
18.00	18.30	18.1	12	29	20	24	19	18	15	137
18.30	19.00	18.32	16	21	11	32	30	30	24	164
19.00	19.30	19.14	15	21	18	30	29	25	23	161
19.30	20.00	19.45	16	27	30	29	21	30	31	184
20.00	20.30	20.1	13	30	25	30				98
20.30	21.00	20.3	13	21	17	6				57
21.00	21.30	21.06	29	30	10	7				76
21.30	22.00	21.41	19	30	29	8				86

PASSING VEHICLE COUNT SURVEY

JUNCTION NAME : OPERA JUNCTION										
DIRECTION: M.G.ROAD TO VELLARA JUNCTION										
DATE:14-5-2017							DAY:SUNDAY			
Time		Observed Time	Total Vehicle Count (s)							
From	To		10	10	10	10	10	10	10	Total
6.00	6.30									
6.30	7.00	6.45	5	7	1					13
7.00	7.30	7.35	15	10	5	2				32
7.30	8.00	8.15	30	8	6	0				44
8.00	8.30	8.40	30	6	5	3	2	3	5	54
8.30	9.00	9.10	25	5	6	13	4	12	2	67
9.00	9.30	9.35	28	6	10	14	3	2		63
9.30	10.00	10.10	25	6	11	2	13	1		58
10.00	10.30	10.35	20	11	16	18	13	13	9	100
10.30	11.00	11.05	23	10	9	7	14	6		69
11.00	11.30	11.35	20	10	13	9	4	13		69
11.30	12.00	12.00	20	10	13	9	4	13	1	70
12.00	12.30	12.30	22	3	12	8	16	9	11	81
12.30	13.00	13.00	20	22	28	16	9	12	5	112
13.00	13.30	13.15	21	16	10	19	12	10		88
13.30	14.00	13.30	15	28	9	14	26	18	8	118
14.00	14.30	14.00	20	20	5	20	10	9	3	87

14.30	15.00	14.30	10	15	20	16	13	7	20	101
15.00	15.30	15.10	18	15	13					46
15.30	16.00	15.40	24	12	6					42
16.00	16.30	16.15	20	20	6					46
16.30	17.00	16.40	28	11	9					48
17.00	17.30	17.10	20	16	8					44
17.30	18.00	17.35	23	14	15					52
18.00	18.30	18.10	21	16	10					47
18.30	19.00	18.35	16	8	12					36
19.00	19.30	19.12	18	16	5					39
19.30	20.00	19.43	19	21	8					48
20.00	20.30	20.07	22	27	17					66
20.30	21.00	20.34	15	10	3					28
21.00	21.30	21.01	14	7	2					23
21.30	22.00	21.32	17	10	2					29

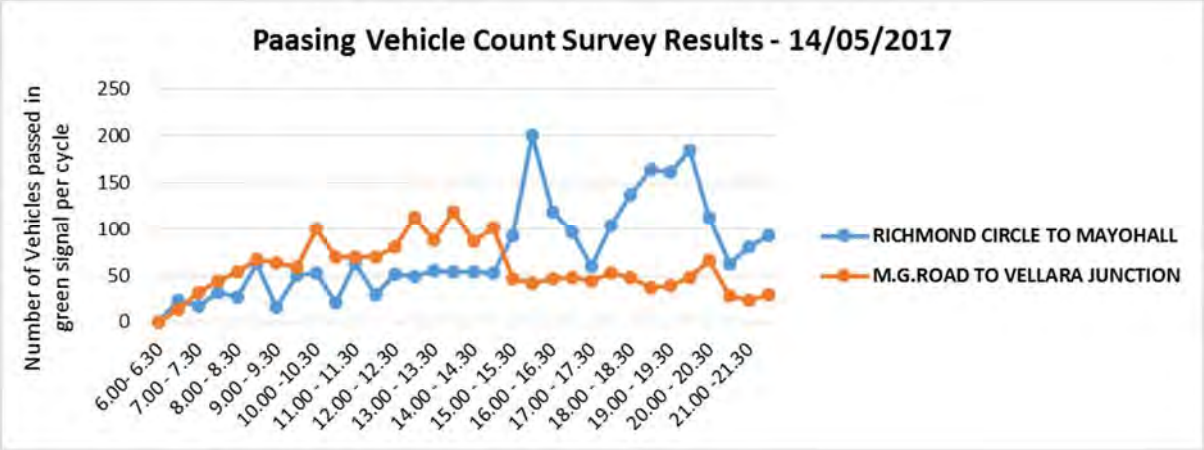


Figure 15: Passing Vehicles at Opera Intersection on 14/05/2017

Table 36: Passing Vehicle Count Survey at Opera Intersection on 18/05/2017

PASSING VEHICLE COUNT SURVEY

JUNCTION NAME : OPERA JUNCTION										
DIRECTION: RICHMOND CIRCLE TO MAYOHALL										
DATE:18-5-2017								DAY:THURSDAY		
Time		Observed Time	Total Vehicle Count (s)							
From	To		10	10	10	10	10	10	10	Total
6.00	6.30									
6.30	7.00	6.37								
7.00	7.30	7.15	15	10	12	2				39
7.30	8.00	7.34	5	10	8	5	2			30
8.00	8.30	8.04	20	10	15	15	6	12	13	91
8.30	9.00	8.40	20	23	5	11	11	12	14	96
9.00	9.30	9.10	20	22	18	23	25	24	8	140

9.30	10.00	9.40	20	21	25	25	21	25	12	149
10.00	10.30	10.15	27	35	15	20	25	10	0	132
10.30	11.00	10.37	30	25	20	15	16	20	17	143
11.00	11.30	11.16	20	30	20	10	9	12	4	105
11.30	12.00	11.35	19	13	15	20	19	20	15	121
12.00	12.30	12.13	25	15	10	16	20	20	8	114
12.30	13.00	12.40	24	20	11	15	10	20	10	110
13.00	13.30	13.09	24	20	19	16	15	8		102
13.30	14.00	13.39	20	20	10	14	6	8		78
14.00	14.30	14.02	25	20	15	10	9	16	5	100
14.30	15.00	14.38	14	15	20	10	10	15	8	92
15.00	15.30	15.15	21	19	18	17	23	16	12	126
15.30	16.00	15.36	23	16	20	13	25	28	21	146
16.00	16.30	16.17	21	18	14	24	14	15	17	123
16.30	17.00	16.44	22	24	30	20	17	11	16	140
17.00	17.30	17.08	21	19	14	18	11	17	15	115
17.30	18.00	17.33	26	30	19	29	24	12	18	158
18.00	18.30	18.1	25	27	19	16	20	23	16	146
18.30	19.00	18.32	20	24	21	27	16	21	8	137
19.00	19.30	19.14	23	27	29	24	18	12		133
19.30	20.00	19.45	28	31	29	27	20	19		154
20.00	20.30	20.1	28	32	30	24	12	16		142
20.30	21.00	20.3	26	21	17	20	10	7		101
21.00	21.30	21.06	29	23	20	17	11	9		109
21.30	22.00	21.41	18	11	16	10	8	9		72

PASSING VEHICLE COUNT SURVEY

JUNCTION NAME : OPERA JUNCTION										
DIRECTION: M.G.ROAD TO VELLARA JUNCTION										
DATE:18-5-2017								**DAY:THURSDAY**		
Time		**Observed Time**	**Total Vehicle Count (s)**							
From	**To**		**10**	**10**	**10**	**10**	**10**	**10**	**10**	**Total**
6.00	6.30									0
6.30	7.00	6:40am								0
7.00	7.30	7:05am	23	5						28
7.30	8.00	7:40am	17	19	0					36
8.00	8.30	8:05am	20	17	5					42
8.30	9.00	8:50am	18	15	5					38
9.00	9.30	9:05am	29	20	8					57
9.30	10.00	9:40am	35	15	5					55
10.00	10.30	10:00am	26	20	8					54
10.30	11.00	10:35am	20	20	10					50
11.00	11.30	11:10am	18	20	5					43
11.30	12.00	11:35am	28	10	5					43

12.00	12.30	12:00pm	28	25	8					61
12.30	13.00	12:35pm	30	18	3					51
13.00	13.30	1:00pm	32	20	6					58
13.30	14.00	1:30pm	28	18	2					48
14.00	14.30	2:00pm	22	23	5					50
14.30	15.00	2:30pm	28	15	9					52
15.00	15.30	3:20pm	27	22	18					67
15.30	16.00	3:35pm	18	20	17					55
16.00	16.30	4:15pm	18	15	12					45
16.30	17.00	4:40pm	27	23	34					84
17.00	17.30	5:10pm	22	30	22					74
17.30	18.00	5:40pm	22	25	18					65
18.00	18.30	6:10pm	20	23	20					63
18.30	19.00	6:40pm	25	30	15					70
19.00	19.30	7:15pm	31	23	12					66
19.30	20.00	7:40pm	28	24	8					60
20.00	20.30	8:10pm	26	29	18					73
20.30	21.00	8:45pm	28	21	17					66
21.00	21.30	9:05pm	26	23	14					63
21.30	22.00	9:30pm	18	13	17					48

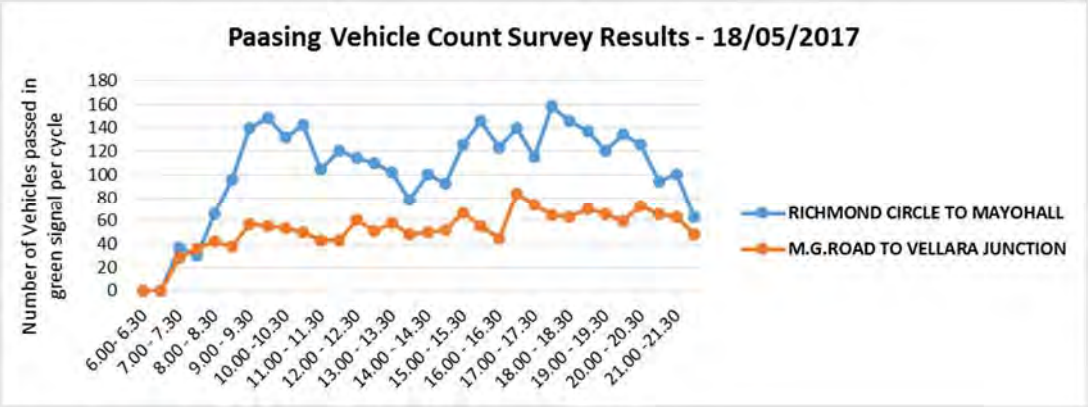


Figure 16: Passing Vehicles at Opera Intersection on 18/05/2017

4.5 Queen's Statue Intersection

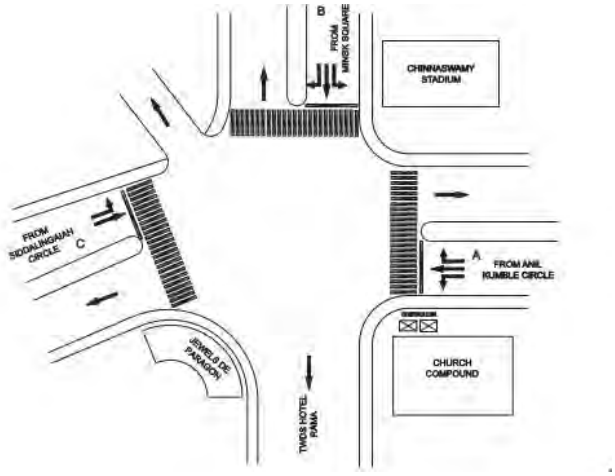


Figure 17: Details of Queen's Statue Intersection

A pictorial representation of the intersection, with details of approach movements and Signal Posts Locations is shown in the above figure.

The observed green signal indication timings are entered corresponding to the time intervals in each phase phase and the total cycle length (cycle time) in seconds were calculated. Details are presented in the table below.

QUEENS STATUE Junction Signal Timings													
Date: 11/05/17													
QUEENS STATUE Junction			PHASE										CYCLE TIME
	Road	From	1			2			3			5	
Data	A	ANIL KUMBLE CIRCLE				R	L	S		L	S	EXCLUSIVE PEDESTRI	
	B	MISN SK SQAURE	R	L	S		L						
	C	SIDDALINGAIAH CIRCLE (KASTURBA ROAD)		L						L	S		
TIMINGS	06:30	08:00	44			60			24			15	143
	08:00	15:00	54			90			40			10	194
	15:00	18:00	54			80			40			10	184
	18:00	20:00	54			70			40			10	174
	20:00	22:00	54			40			40			10	144

Figure 31: Cycle Length of Queen's Statue Intersection on 11/05/2017

QUEENS STATUE Junction Signal Timings													
Date: 18/05/17													
QUEENS STATUE Junction			PHASE										CYCLE TIME
	Road	From	1			2			3			5	
Data	A	ANIL KUMBLE CIRCLE				R	L	S		L	S	EXCLUSIVE PEDESTRI	
	B	MISN SK SQAURE	R	L	S		L						
	C	SIDDALINGAIAH CIRCLE (KASTURBA ROAD)		L						L	S		
TIMINGS	06:30	08:30	44			60			24			15	143
	14:00	15:00	54			90			40			10	194
	15:00	18:00	54			80			40			10	184
	18:00	20:00	54			90			40			10	194
	20:00	22:00	54			70			40			10	174

Figure 32: Cycle Length of Queen's Statue Intersection on 18/05/2017

QUEENS STATUE Junction Signal Timings													
Date: 14/05/17 (SUNDAY)													
QUEENS STATUE Junction			PHASE										CYCLE TIME
	Road	From	1			2			3			5	
Data	A	ANIL KUMBLE CIRCLE				R	L	S		L	S	EXCLUSIVE PEDESTRI	
	B	MISN SK SQAURE	R	L	S		L						
	C	SIDDALINGAIAH CIRCLE (KASTURBA ROAD)		L						L	S		
TIMINGS	06:30	08:30	35			60			30			15	140
	08:30	15:00	54			90			40			10	194
	15:00	18:00	54			82			40			10	186
	18:00	20:00	54			70			40			10	174
	20:00	22:00	54			40			40			10	144

Figure 33: Cycle Length of Queen's Statue Intersection on 14/05/2017

A three phase signal with exclusive pedestrian signal was operated at Queens Statue Junction. The cycle length varied from 140-194 seconds. The signal split up was almost similar on both weekdays and weekends.

Table 37: Signal Phase Time Survey at Queen's Statue Intersection on 11/05/2017

SIGNAL PHASE TIME SURVEY							
JUNCTION NAME : QUEEN'S STATUE JUNCTION							
DIRECTION: MINSK SQUARE TO ST.MARKS ROAD							
DATE:11-5-2017						DAY:THURSDAY	
Time		Observed Time	Cycle Time (s)				
From	To		Green	Red	Amber	Pedestrian	Total
6.00	6.30	off					
6.30	7.00	6.40	44	81	3	15	143
7.00	7.30	7.05	44	81	3	15	143

7.30	8.00	7.35	44	81	3	15	143
8.00	8.30	8.00	54	105	3	10	172
8.30	9.00	8.34	54	105	3	10	172
9.00	9.30	9.18	54	105	3	10	172
9.30	10.00	9.33	54	105	3	10	172
10.00	10.30	10.05	54	105	3	10	172
10.30	11.00	11.00	54	105	3	10	172
11.00	11.30	11.18	54	105	3	10	172
11.30	12.00	11.38	54	105	3	10	172
12.00	12.30	12.05	54	105	3	10	172
12.30	13.00	12.50	54	105	3	10	172
13.00	13.30	13.05	54	105	3	10	172
13.30	14.00	13.34	54	105	3	10	172
14.00	14.30	14.15	54	105	3	10	172
14.30	15.00	14.37	54	105	3	10	172
15.00	15.30	15.00	54	105	3	10	172
15.30	16.00	15.35	54	105	3	10	172
16.00	16.30	16.10	54	105	3	10	172
16.30	17.00	16.40	54	105	3	10	172
17.00	17.30	17.05	54	105	3	10	172
17.30	18.00	17.35	54	105	3	10	172
18.00	18.30	18.05	54	105	3	10	172
18.30	19.00	18.35	54	105	3	10	172
19.00	19.30	19.00	54	105	3	10	172
19.30	20.00	19.35	54	105	3	10	172
20.00	20.30	20.05	54	105	3	10	172
20.30	21.00	20.35	54	105	3	10	172
21.00	21.30	21.05	54	105	3	10	172
21.30	22.00	21.35	54	105	3	10	172

SIGNAL PHASE TIME SURVEY							
JUNCTION NAME : QUEEN'S STATUE JUNCTION							
DIRECTION: ANIL KUMBLE CIRCLE TO KASTURBA ROAD							
DATE:11-5-2017						**DAY:THURSDAY**	
Time		**Observed Time**	**Cycle Time (s)**				
From	**To**		**Green**	**Red**	**Amber**	**Pedestrian**	**Total**
6.00	6.30	off					
6.30	7.00	6.45	60	60	3	15	138
7.00	7.30	7.05	60	60	3	15	138
7.30	8.00	7.35	60	60	3	15	138
8.00	8.30	8.05	90	72	3	10	175
8.30	9.00	8.40	90	72	3	10	175
9.00	9.30	9.20	90	72	3	10	175
9.30	10.00	9.40	90	72	3	10	175

10.00	10.30	10.10	90	72	3	10	175
10.30	11.00	10.45	90	72	3	10	175
11.00	11.30	11.20	90	72	3	10	175
11.30	12.00	11.40	90	72	3	10	175
12.00	12.30	12.20	90	72	3	10	175
12.30	13.00	12.45	90	72	3	10	175
13.00	13.30	13.15	90	72	3	10	175
13.30	14.00	13.35	90	72	3	10	175
14.00	14.30	14.15	90	72	3	10	175
14.30	15.00	14.45	90	72	3	10	175
15.00	15.30	15.00	80	60	3	10	153
15.30	16.00	15.30	80	60	3	10	153
16.00	16.30	16.00	80	60	3	10	153
16.30	17.00	16.30	80	60	3	10	153
17.00	17.30	17.00	80	60	3	10	153
17.30	18.00	17.30	80	60	3	10	153
18.00	18.30	18.00	70	80	3	10	163
18.30	19.00	18.30	70	80	3	10	163
19.00	19.30	19.00	70	80	3	10	163
19.30	20.00	19.30	70	80	3	10	163
20.00	20.30	20.00	40	120	3	10	173
20.30	21.00	20.30	40	120	3	10	173
21.00	21.30	21.00	40	120	3	10	173
21.30	22.00	21.30	40	120	3	10	173

SIGNAL PHASE TIME SURVEY

JUNCTION NAME : QUEEN'S STATUE JUNCTION

DIRECTION: KASTURBA ROAD TO ANIL KUMBLE CIRCLE

DATE:11-5-2017 **DAY:THURSDAY**

Time		Observed Time	Cycle Time (s)				
From	To		Green	Red	Amber	Pedestrian	Total
6.00	6.30	off					
6.30	7.00	6.42	24	100	3	15	142
7.00	7.30	7.04	24	100	3	15	142
7.30	8.00	7.32	24	100	3	15	142
8.00	8.30	8.03	40	120	3	10	173
8.30	9.00	8.40	40	120	3	10	173
9.00	9.30	9.20	40	120	3	10	173
9.30	10.00	9.40	40	120	3	10	173
10.00	10.30	10.10	40	120	3	10	173
10.30	11.00	10.45	40	120	3	10	173
11.00	11.30	11.10	40	120	3	10	173
11.30	12.00	11.40	40	120	3	10	173
12.00	12.30	12.15	40	120	3	10	173

12.30	13.00	12.50	40	120	3	10	173
13.00	13.30	13.10	40	120	3	10	173
13.30	14.00	13.45	40	120	3	10	173
14.00	14.30	14.10	40	120	3	10	173
14.30	15.00	14.45	40	120	3	10	173
15.00	15.30	15.05	40	120	3	10	173
15.30	16.00	15.35	40	120	3	10	173
16.00	16.30	16.05	40	120	3	10	173
16.30	17.00	16.35	40	120	3	10	173
17.00	17.30	17.05	40	120	3	10	173
17.30	18.00	17.35	40	120	3	10	173
18.00	18.30	18.05	40	120	3	10	173
18.30	19.00	18.35	40	120	3	10	173
19.00	19.30	19.05	40	120	3	10	173
19.30	20.00	19.35	40	120	3	10	173
20.00	20.30	20.05	40	120	3	10	173
20.30	21.00	20.35	40	120	3	10	173
21.00	21.30	21.05	40	120	3	10	173
21.30	22.00	21.35	40	120	3	10	173

Table 38: Signal Phase Time Survey at Queen's Statue Intersection on 14/05/2017

SIGNAL PHASE TIME SURVEY							
JUNCTION NAME : QUEEN'S STATUE JUNCTION							
DIRECTION: MINSK SQUARE TO ST.MARKS ROAD							
DATE:14-5-2017						DAY:SUNDAY	
Time		Observed Time	Cycle Time (s)				
From	To		Green	Red	Amber	Pedestrian	Total
6.00	6.30	off					
6.30	7.00	6.37	35	85	3	15	138
7.00	7.30	7.00	35	85	3	15	138
7.30	8.00	7.33	35	85	3	15	138
8.00	8.30	8.02	35	85	3	15	138
8.30	9.00	8.45	54	105	3	10	172
9.00	9.30	9.10	54	105	3	10	172
9.30	10.00	9.45	54	105	3	10	172
10.00	10.30	10.06	54	105	3	10	172
10.30	11.00	10.48	54	105	3	10	172
11.00	11.30	11.02	54	105	3	10	172
11.30	12.00	11.34	54	105	3	10	172
12.00	12.30	12.06	54	105	3	10	172
12.30	13.00	12.47	54	105	3	10	172
13.00	13.30	13.00	54	105	3	10	172
13.30	14.00	13.35	54	105	3	10	172
14.00	14.30	14.00	54	105	3	10	172

14.30	15.00	14.30	54	105	3	10	172
15.00	15.30	15.05	54	105	3	10	172
15.30	16.00	15.35	54	105	3	10	172
16.00	16.30	16.10	54	105	3	10	172
16.30	17.00	16.40	54	105	3	10	172
17.00	17.30	17.05	54	105	3	10	172
17.30	18.00	17.35	54	105	3	10	172
18.00	18.30	18.05	54	105	3	10	172
18.30	19.00	18.35	54	105	3	10	172
19.00	19.30	19.00	54	105	3	10	172
19.30	20.00	19.35	54	105	3	10	172
20.00	20.30	20.05	54	105	3	10	172
20.30	21.00	20.35	54	105	3	10	172
21.00	21.30	21.05	54	105	3	10	172
21.30	22.00	21.35	54	105	3	10	172

SIGNAL PHASE TIME SURVEY

JUNCTION NAME : QUEEN'S STATUE JUNCTION

DIRECTION: ANIL KUMBLE CIRCLE TO KASTURBA ROAD

DATE:14-5-2017 **DAY:SUNDAY**

Time		Observed Time	Cycle Time (s)				
From	To		Green	Red	Amber	Pedestrian	Total
6.00	6.30	off					
6.30	7.00	6.46	60	60	3	15	138
7.00	7.30	7.15	60	60	3	15	138
7.30	8.00	7.40	60	60	3	15	138
8.00	8.30	8.15	60	60	3	15	138
8.30	9.00	8.42	90	72	3	15	180
9.00	9.30	9.00	90	72	3	15	180
9.30	10.00	9.30	90	72	3	15	180
10.00	10.30	10.00	90	72	3	15	180
10.30	11.00	10.50	90	72	3	15	180
11.00	11.30	11.15	90	72	3	15	180
11.30	12.00	11.45	90	72	3	15	180
12.00	12.30	12.10	90	72	3	15	180
12.30	13.00	12.40	90	72	3	15	180
13.00	13.30	13.10	90	72	3	15	180
13.30	14.00	13.45	90	72	3	15	180
14.00	14.30	14.10	90	72	3	15	180
14.30	15.00	14.30	90	72	3	15	180
15.00	15.30	15.00	82	60	3	10	155
15.30	16.00	15.30	82	60	3	10	155
16.00	16.30	16.00	82	60	3	10	155
16.30	17.00	16.30	82	60	3	10	155

17.00	17.30	17.00	82	60	3	10	155
17.30	18.00	17.30	82	60	3	10	155
18.00	18.30	18.00	70	80	3	10	163
18.30	19.00	18.30	70	80	3	10	163
19.00	19.30	19.00	70	80	3	10	163
19.30	20.00	19.30	70	80	3	10	163
20.00	20.30	20.00	40	120	3	10	173
20.30	21.00	20.30	40	120	3	10	173
21.00	21.30	21.00	40	120	3	10	173
21.30	22.00	21.30	40	120	3	10	173

SIGNAL PHASE TIME SURVEY

JUNCTION NAME : QUEEN'S STATUE JUNCTION

DIRECTION: KASTURBA ROAD TO ANIL KUMBLE CIRCLE

DATE:14-5-2017 | **DAY:SUNDAY**

Time		Observed Time	Cycle Time (s)				
From	To		Green	Red	Amber	Pedestrian	Total
6.00	6.30	off					
6.30	7.00	6.40	30	95	3	15	143
7.00	7.30	7.05	30	95	3	15	143
7.30	8.00	7.35	30	95	3	15	143
8.00	8.30	8.05	30	95	3	15	143
8.30	9.00	8.45	40	120	3	10	173
9.00	9.30	9.10	40	120	3	10	173
9.30	10.00	9.45	40	120	3	10	173
10.00	10.30	10.05	40	120	3	10	173
10.30	11.00	10.45	40	120	3	10	173
11.00	11.30	11.05	40	120	3	10	173
11.30	12.00	11.35	40	120	3	10	173
12.00	12.30	12.05	40	120	3	10	173
12.30	13.00	12.45	40	120	3	10	173
13.00	13.30	13.05	40	120	3	10	173
13.30	14.00	13.35	40	120	3	10	173
14.00	14.30	14.05	40	120	3	10	173
14.30	15.00	14.40	40	120	3	10	173
15.00	15.30	15.05	40	120	3	10	173
15.30	16.00	15.35	40	120	3	10	173
16.00	16.30	16.05	40	120	3	10	173
16.30	17.00	16.35	40	120	3	10	173
17.00	17.30	17.05	40	120	3	10	173
17.30	18.00	17.35	40	120	3	10	173
18.00	18.30	18.05	40	120	3	10	173
18.30	19.00	18.35	40	120	3	10	173
19.00	19.30	19.05	40	120	3	10	173

19.30	20.00	19.35	40	120	3	10	173
20.00	20.30	20.05	40	120	3	10	173
20.30	21.00	20.35	40	120	3	10	173
21.00	21.30	21.05	40	120	3	10	173
21.30	22.00	21.35	40	120	3	10	173

Table 39: Signal Phase Time Survey at Queen's Statue Intersection on 18/05/2017

SIGNAL PHASE TIME SURVEY							
JUNCTION NAME : QUEEN'S STATUE JUNCTION							
DIRECTION: MINSK SQUARE TO ST.MARKS ROAD							
DATE:18-5-2017						DAY:THURSDAY	
Time		Observed Time	Cycle Time (s)				
From	To		Green	Red	Amber	Pedestrian	Total
6.00	6.30	off					
6.30	7.00	6.41	44	81	3	15	143
7.00	7.30	7.05	44	81	3	15	143
7.30	8.00	7.33	44	81	3	15	143
8.00	8.30	8.05	54	105	3	10	172
8.30	9.00	8.35	54	105	3	10	172
9.00	9.30	9.05	54	105	3	10	172
9.30	10.00	9.35	54	105	3	10	172
10.00	10.30	10.05	54	105	3	10	172
10.30	11.00	10.40	54	105	3	10	172
11.00	11.30	11.05	54	105	3	10	172
11.30	12.00	11.44	54	105	3	10	172
12.00	12.30	12.05	54	105	3	10	172
12.30	13.00	12.38	54	105	3	10	172
13.00	13.30	13.02	54	105	3	10	172
13.30	14.00	13.33	54	105	3	10	172
14.00	14.30	14.02	54	105	3	10	172
14.30	15.00	14.37	54	105	3	10	172
15.00	15.30	15.00	54	105	3	10	172
15.30	16.00	15.35	54	105	3	10	172
16.00	16.30	16.10	54	105	3	10	172
16.30	17.00	16.40	54	105	3	10	172
17.00	17.30	17.05	54	105	3	10	172
17.30	18.00	17.35	54	105	3	10	172
18.00	18.30	18.05	54	105	3	10	172
18.30	19.00	18.35	54	105	3	10	172
19.00	19.30	19.00	54	105	3	10	172
19.30	20.00	19.35	54	105	3	10	172

20.00	20.30	20.05	54	105	3	10	172
20.30	21.00	20.35	54	105	3	10	172
21.00	21.30	21.05	54	105	3	10	172
21.30	22.00	21.35	54	105	3	10	172

SIGNAL PHASE TIME SURVEY

JUNCTION NAME : QUEEN'S STATUE JUNCTION

DIRECTION: ANIL KUMBLE CIRCLE TO KASTURBA ROAD

DATE:18-5-2017 | **DAY:THURSDAY**

Time		Observed Time	Cycle Time (s)				
From	To		Green	Red	Amber	Pedestrian	Total
6.00	6.30	off					
6.30	7.00	6.40	60	68	3	15	146
7.00	7.30	7.15	60	68	3	15	146
7.30	8.00	7.40	60	68	3	15	146
8.00	8.30	8.05	60	68	3	15	146
8.30	9.00	8.40	90	72	3	10	175
9.00	9.30	9.15	90	72	3	10	175
9.30	10.00	9.40	90	72	3	10	175
10.00	10.30	10.15	90	72	3	10	175
10.30	11.00	10.40	90	72	3	10	175
11.00	11.30	11.05	90	72	3	10	175
11.30	12.00	11.40	90	72	3	10	175
12.00	12.30	12.15	90	72	3	10	175
12.30	13.00	12.45	90	72	3	10	175
13.00	13.30	1.10	90	72	3	10	175
13.30	14.00	1.35	90	72	3	10	175
14.00	14.30	2.05	90	72	3	10	175
14.30	15.00	2.35	90	72	3	10	175
15.00	15.30	15.05	80	50	3	10	143
15.30	16.00	15.35	80	50	3	10	143
16.00	16.30	16.05	80	50	3	10	143
16.30	17.00	16.35	80	50	3	10	143
17.00	17.30	17.05	80	50	3	10	143
17.30	18.00	17.35	80	50	3	10	143
18.00	18.30	18.05	90	80	3	10	183
18.30	19.00	18.35	90	80	3	10	183
19.00	19.30	19.05	90	80	3	10	183
19.30	20.00	19.35	90	80	3	10	183
20.00	20.30	20.05	70	60	3	10	143
20.30	21.00	20.35	70	60	3	10	143
21.00	21.30	21.05	70	60	3	10	143
21.30	22.00	21.35	70	60	3	10	143

SIGNAL PHASE TIME SURVEY							
JUNCTION NAME : QUEEN'S STATUE JUNCTION							
DIRECTION: KASTURBA ROAD TO ANIL KUMBLE CIRCLE							
DATE:18-5-2017						DAY:THURSDAY	
Time		Observed Time	Cycle Time (s)				
From	To		Green	Red	Amber	Pedestrian	Total
6.00	6.30	off					
6.30	7.00	6.45	24	100	3	15	142
7.00	7.30	7.05	24	100	3	15	142
7.30	8.00	7.40	24	100	3	15	142
8.00	8.30	8.05	40	120	3	10	173
8.30	9.00	8.45	40	120	3	10	173
9.00	9.30	9.20	40	120	3	10	173
9.30	10.00	9.37	40	120	3	10	173
10.00	10.30	10.15	40	120	3	10	173
10.30	11.00	10.45	40	120	3	10	173
11.00	11.30	11.05	40	120	3	10	173
11.30	12.00	11.50	40	120	3	10	173
12.00	12.30	12.05	40	120	3	10	173
12.30	13.00	12.45	40	120	3	10	173
13.00	13.30	13.05	40	120	3	10	173
13.30	14.00	13.40	40	120	3	10	173
14.00	14.30	14.25	40	120	3	10	173
14.30	15.00	14.40	40	120	3	10	173
15.00	15.30	15.05	40	120	3	10	173
15.30	16.00	15.35	40	120	3	10	173
16.00	16.30	16.05	40	120	3	10	173
16.30	17.00	16.35	40	120	3	10	173
17.00	17.30	17.05	40	120	3	10	173
17.30	18.00	17.35	40	120	3	10	173
18.00	18.30	18.05	40	120	3	10	173
18.30	19.00	18.35	40	120	3	10	173
19.00	19.30	19.05	40	120	3	10	173
19.30	20.00	19.35	40	120	3	10	173
20.00	20.30	20.05	40	120	3	10	173
20.30	21.00	20.35	40	120	3	10	173
21.00	21.30	21.05	40	120	3	10	173
21.30	22.00	21.35	40	120	3	10	173

Table 40: Dead Green/Wastage of Green Survey at Queen's Statue Intersection on 11/05/2017

WASTE/DEAD GREEN SIGNAL SURVEY
JUNCTION NAME : QUEEN'S STATUE JUNCTION

DIRECTION: MINSK SQUARE TO KASTURBA ROAD			
DATE:11-5-2017			DAY:THURSDAY
Time		Dead Green	Wastage of Green
From	To	Occurred	Occurred
6.00	6.30	-	-
6.30	7.00	-	√
7.00	7.30	-	-
7.30	8.00	-	√
8.00	8.30	-	-
8.30	9.00	-	-
9.00	9.30	-	-
9.30	10.00	-	-
10.00	10.30	-	-
10.30	11.00	-	-
11.00	11.30	-	-
11.30	12.00	-	-
12.00	12.30	-	-
12.30	13.00	-	-
13.00	13.30	-	-
13.30	14.00	-	-
14.00	14.30	-	-
14.30	15.00	-	-
15.00	15.30	-	-
15.30	16.00	-	-
16.00	16.30	-	-
16.30	17.00	-	-
17.00	17.30	-	-
17.30	18.00	-	-
18.00	18.30	-	-
18.30	19.00	-	√
19.00	19.30	-	-
19.30	20.00	-	-
20.00	20.30	-	√
20.30	21.00	-	√
21.00	21.30	-	-
21.30	22.00	-	-

WASTE/DEAD GREEN SIGNAL SURVEY			
JUNCTION NAME : QUEEN'S STATUE JUNCTION			
DIRECTION: ANIL KUMBLE CIRCLE TO KASTURBA ROAD			
DATE:11-5-2017			DAY:THURSDAY
Time		Dead Green	Wastage of Green
From	To	Occurred	Occurred

6.00	6.30	-	-
6.30	7.00	-	√
7.00	7.30	-	√
7.30	8.00	-	-
8.00	8.30	-	-
8.30	9.00	-	-
9.00	9.30	-	-
9.30	10.00	-	-
10.00	10.30	-	-
10.30	11.00	-	-
11.00	11.30	-	-
11.30	12.00	-	-
12.00	12.30	-	-
12.30	13.00	-	-
13.00	13.30	-	-
13.30	14.00	-	-
14.00	14.30	-	-
14.30	15.00	-	-
15.00	15.30	-	-
15.30	16.00	-	-
16.00	16.30	-	-
16.30	17.00	-	-
17.00	17.30	-	-
17.30	18.00	-	-
18.00	18.30	-	-
18.30	19.00	-	-
19.00	19.30	-	-
19.30	20.00	-	-
20.00	20.30	-	-
20.30	21.00	-	-
21.00	21.30	-	√
21.30	22.00	-	-

WASTE/DEAD GREEN SIGNAL SURVEY			
JUNCTION NAME : QUEEN'S STATUE JUNCTION			
DIRECTION: KASTURBA ROAD TO ANIL KUMBLE CIRCLE			
DATE:11-5-2017			**DAY:THURSDAY**
Time		**Dead Green**	**Wastage of Green**
From	**To**	**Occurred**	**Occurred**
6.00	6.30	-	-
6.30	7.00	-	√
7.00	7.30	-	√
7.30	8.00	-	√
8.00	8.30	-	√

8.30	9.00	-	-
9.00	9.30	-	-
9.30	10.00	-	-
10.00	10.30	-	-
10.30	11.00	-	-
11.00	11.30	-	-
11.30	12.00	-	-
12.00	12.30	-	-
12.30	13.00	-	-
13.00	13.30	-	-
13.30	14.00	-	-
14.00	14.30	-	-
14.30	15.00	-	-
15.00	15.30	-	-
15.30	16.00	-	-
16.00	16.30	-	-
16.30	17.00	-	-
17.00	17.30	-	-
17.30	18.00	-	-
18.00	18.30	-	-
18.30	19.00	-	-
19.00	19.30	-	-
19.30	20.00	-	-
20.00	20.30	-	-
20.30	21.00	-	-
21.00	21.30	-	-
21.30	22.00	-	-

Table 41: Dead Green/Wastage of Green Survey at Queen's Statue Intersection on 14/05/2017

WASTE/DEAD GREEN SIGNAL SURVEY			
JUNCTION NAME : QUEEN'S STATUE JUNCTION			
DIRECTION: MINSK SQUARE TO KASTURBA ROAD			
DATE:14-5-2017			**DAY:SUNDAY**
Time		**Dead Green**	**Wastage of Green**
From	**To**	**Occurred**	**Occurred**
6.00	6.30	-	-
6.30	7.00	-	-
7.00	7.30	-	-
7.30	8.00	-	-
8.00	8.30	-	-
8.30	9.00	-	-
9.00	9.30	-	-

9.30	10.00	-	-
10.00	10.30	-	-
10.30	11.00	-	-
11.00	11.30	-	-
11.30	12.00	-	-
12.00	12.30	-	-
12.30	13.00	-	-
13.00	13.30	-	-
13.30	14.00	-	-
14.00	14.30	-	-
14.30	15.00	-	-
15.00	15.30	-	-
15.30	16.00	-	-
16.00	16.30	-	-
16.30	17.00	-	-
17.00	17.30	-	-
17.30	18.00	-	-
18.00	18.30	-	-
18.30	19.00	-	-
19.00	19.30	-	-
19.30	20.00	-	-
20.00	20.30	-	-
20.30	21.00	-	-
21.00	21.30	-	-
21.30	22.00	-	-

WASTE/DEAD GREEN SIGNAL SURVEY			
JUNCTION NAME : QUEEN'S STATUE JUNCTION			
DIRECTION: ANIL KUMBLE CIRCLE TO KASTURBA ROAD			
DATE:14-5-2017			**DAY:SUNDAY**
Time		**Dead Green**	**Wastage of Green**
From	**To**	**Occurred**	**Occurred**
6.00	6.30	-	-
6.30	7.00	-	√
7.00	7.30	-	√
7.30	8.00	-	-
8.00	8.30	-	-
8.30	9.00	-	-
9.00	9.30	-	-
9.30	10.00	-	-
10.00	10.30	-	-
10.30	11.00	-	-
11.00	11.30	-	-
11.30	12.00	-	-

12.00	12.30	-	-
12.30	13.00	-	-
13.00	13.30	-	-
13.30	14.00	-	-
14.00	14.30	-	-
14.30	15.00	-	-
15.00	15.30	-	-
15.30	16.00	-	-
16.00	16.30	-	-
16.30	17.00	-	-
17.00	17.30	-	-
17.30	18.00	-	-
18.00	18.30	-	-
18.30	19.00	-	-
19.00	19.30	-	-
19.30	20.00	-	-
20.00	20.30	-	-
20.30	21.00	-	-
21.00	21.30	-	-
21.30	22.00	-	-

WASTE/DEAD GREEN SIGNAL SURVEY			
JUNCTION NAME : QUEEN'S STATUE JUNCTION			
DIRECTION: KASTURBA ROAD TO ANIL KUMBLE CIRCLE			
DATE:14-5-2017			**DAY:SUNDAY**
Time		**Dead Green**	**Wastage of Green**
From	**To**	**Occurred**	**Occurred**
6.00	6.30	-	-
6.30	7.00	-	-
7.00	7.30	-	-
7.30	8.00	-	-
8.00	8.30	-	-
8.30	9.00	-	-
9.00	9.30	-	-
9.30	10.00	-	-
10.00	10.30	-	-
10.30	11.00	-	-
11.00	11.30	-	-
11.30	12.00	-	-
12.00	12.30	-	-
12.30	13.00	-	-
13.00	13.30	-	-
13.30	14.00	-	√
14.00	14.30	-	-

14.30	15.00	-	-
15.00	15.30	-	-
15.30	16.00	-	-
16.00	16.30	-	-
16.30	17.00	-	-
17.00	17.30	-	-
17.30	18.00	-	-
18.00	18.30	-	-
18.30	19.00	-	-
19.00	19.30	-	-
19.30	20.00	-	-
20.00	20.30	-	-
20.30	21.00	-	√
21.00	21.30	-	-
21.30	22.00	-	√

Table 42: Dead Green/Wastage of Green Survey at Queen's Statue Intersection on 18/05/2017

WASTE/DEAD GREEN SIGNAL SURVEY			
JUNCTION NAME : QUEEN'S STATUE JUNCTION			
DIRECTION: MINSK SQUARE TO KASTURBA ROAD			
DATE:18-5-2017			DAY:THURSDAY
Time		Dead Green	Wastage of Green
From	To	Occurred	Occurred
6.00	6.30	-	-
6.30	7.00	-	√
7.00	7.30	-	√
7.30	8.00	-	√
8.00	8.30	-	√
8.30	9.00	-	√
9.00	9.30	-	-
9.30	10.00	-	-
10.00	10.30	-	-
10.30	11.00	-	-
11.00	11.30	-	-
11.30	12.00	-	-
12.00	12.30	-	-
12.30	13.00	-	√
13.00	13.30	-	√
13.30	14.00	-	√
14.00	14.30	-	-
14.30	15.00	-	√
15.00	15.30	-	-
15.30	16.00	-	-

16.00	16.30	-	-
16.30	17.00	-	-
17.00	17.30	-	-
17.30	18.00	-	-
18.00	18.30	-	-
18.30	19.00	-	-
19.00	19.30	-	-
19.30	20.00	-	-
20.00	20.30	-	-
20.30	21.00	-	-
21.00	21.30	-	-
21.30	22.00	-	-

WASTE/DEAD GREEN SIGNAL SURVEY			
JUNCTION NAME : QUEEN'S STATUE JUNCTION			
DIRECTION: ANIL KUMBLE CIRCLE TO KASTURBA ROAD			
DATE:18-5-2017			**DAY:THURSDAY**
Time		**Dead Green**	**Wastage of Green**
From	**To**	**Occurred**	**Occurred**
6.00	6.30	-	-
6.30	7.00	-	√
7.00	7.30	-	√
7.30	8.00	-	√
8.00	8.30	-	√
8.30	9.00	-	√
9.00	9.30	-	√
9.30	10.00	-	-
10.00	10.30	-	-
10.30	11.00	-	-
11.00	11.30	-	-
11.30	12.00	-	-
12.00	12.30	-	√
12.30	13.00	-	-
13.00	13.30	-	√
13.30	14.00	-	-
14.00	14.30	-	√
14.30	15.00	-	-
15.00	15.30	-	-
15.30	16.00	-	-
16.00	16.30	-	√
16.30	17.00	-	√
17.00	17.30	-	-
17.30	18.00	-	-
18.00	18.30	-	-

18.30	19.00	-	-
19.00	19.30	-	√
19.30	20.00	-	√
20.00	20.30	-	√
20.30	21.00	-	-
21.00	21.30	-	√
21.30	22.00	-	-

WASTE/DEAD GREEN SIGNAL SURVEY			
JUNCTION NAME : QUEEN'S STATUE JUNCTION			
DIRECTION: KASTURBA ROAD TO ANIL KUMBLE CIRCLE			
DATE:18-5-2017			**DAY:THURSDAY**
Time		**Dead Green**	**Wastage of Green**
From	**To**	**Occurred**	**Occurred**
6.00	6.30	-	-
6.30	7.00	-	-
7.00	7.30	-	-
7.30	8.00	-	-
8.00	8.30	-	-
8.30	9.00	-	-
9.00	9.30	-	-
9.30	10.00	-	-
10.00	10.30	-	-
10.30	11.00	-	-
11.00	11.30	-	-
11.30	12.00	-	-
12.00	12.30	-	-
12.30	13.00	-	-
13.00	13.30	-	-
13.30	14.00	-	-
14.00	14.30	-	-
14.30	15.00	-	-
15.00	15.30	-	-
15.30	16.00	-	-
16.00	16.30	-	-
16.30	17.00	-	-
17.00	17.30	-	-
17.30	18.00	-	-
18.00	18.30	-	-
18.30	19.00	-	-
19.00	19.30	-	-
19.30	20.00	-	-
20.00	20.30	-	-

20.30	21.00	-	-
21.00	21.30	-	-
21.30	22.00	-	-

Table 43: Vehicle Passing Count Survey at Queen's Statue Intersection on 11/05/2017

PASSING VEHICLE COUNT SURVEY												
JUNCTION NAME : QUEEN'S STATUE JUNCTION												
DIRECTION: ANIL KUMBLE CIRCLE TO KASTURBA ROAD												
DATE:11-5-2017									DAY:THURSDAY			
Time		Observed Time	Total Vehicle Count (s)									
From	To		10	10	10	10	10	10	10	10	10	Total
6.00	6.30	off										
6.30	7.00	6.40	19	8	4	0	0					31
7.00	7.30	7.05	16	13	14	10	3					56
7.30	8.00	7.35	8	6	4	2	1	0				21
8.00	8.30	8.00	9	10	4	1	1	0				25
8.30	9.00	8.34	14	12	10	17	21	5				79
9.00	9.30	9.18	15	10	12	6	15	4				62
9.30	10.00	9.33	13	13	8	10	12	3				59
10.00	10.30	10.05	30	14	16	24	18	10				112
10.30	11.00	11.00	16	8	10	12	7	2				55
11.00	11.30	11.18	12	8	10	11	15	4				60
11.30	12.00	11.38	12	6	8	4	7	2				39
12.00	12.30	12.05	10	7	4	1	0	0				22
12.30	13.00	12.50	12	7	5	3	1	1				29
13.00	13.30	13.05	15	10	7	4	5	2				43
13.30	14.00	13.34	20	11	4	3	10	1				49
14.00	14.30	14.15	20	15	6	4	7	3				55
14.30	15.00	14.37	16	10	4	7	8	2				47
15.00	15.30	15.00	19	25	35	9	11	3				102
15.30	16.00	15.35	32	17	13	16	5	2				85
16.00	16.30	16.10	27	22	21	13	10	2				95
16.30	17.00	16.40	36	29	16	11	7	3				102
17.00	17.30	17.05	41	27	13	18	15	5				119
17.30	18.00	17.35	29	19	21	16	12	6				103
18.00	18.30	18.05	32	21	17	19	16	7				112
18.30	19.00	18.35	37	31	19	12	9	5				113
19.00	19.30	19.00	28	30	21	19	11	3				112
19.30	20.00	19.35	22	24	18	12	9	5				90
20.00	20.30	20.05	31	33	27	17	14	3				125
20.30	21.00	20.35	23	24	19	16	10	2				94
21.00	21.30	21.05	31	27	17	6	12	10				103
21.30	22.00	21.35	21	19	13	15	9	12				89

PASSING VEHICLE COUNT SURVEY

JUNCTION NAME : QUEEN'S STATUE JUNCTION												
DIRECTION: ANIL KUMBLE CIRCLE TO KASTURBA ROAD												
DATE:11-5-2017										DAY:THURSDAY		
Time		Observed Time	Total Vehicle Count (s)									
From	To		10	10	10	10	10	10	10	10	10	Total
6.00	6.30	off										
6.30	7.00	6.45	10	1	2	0	1	0				14
7.00	7.30	7.05	3	0	2	3	1	1				10
7.30	8.00	7.35	8	1	1	0	0	0				10
8.00	8.30	8.05	9	4	0	1	4	8	3	2	2	37
8.30	9.00	8.40	10	8	5	17	8	1	1	0	0	50
9.00	9.30	9.20	8	16	3	14	9	3	20	14	5	111
9.30	10.00	9.40	8	10	5	20	10	2	5	4	3	74
10.00	10.30	10.10	6	9	11	7	10	8	9	8	12	100
10.30	11.00	10.45	10	16	4	14	4	8	1	1	5	69
11.00	11.30	11.20	9	10	9	5	5	7	9	5	1	66
11.30	12.00	11.40	10	7	4	11	12	8	6	2	1	64
12.00	12.30	12.20	9	8	7	7	6	5	6	2	1	54
12.30	13.00	12.45	5	6	3	14	11	7	3	9	9	85
13.00	13.30	13.15	10	7	8	3	6	7	4	9	2	67
13.30	14.00	13.35	12	13	10	9	13	6	1	2	0	68
14.00	14.30	14.15	4	14	9	10	7	9	3	12	11	102
14.30	15.00	14.45	6	7	2	7	13	10	11	7	0	70
15.00	15.30	15.00	23	28	32	21	19	18	16	15		187
15.30	16.00	15.30	29	34	30	26	27	18	34	17		232
16.00	16.30	16.00	35	28	31	26	21	16	28	21		227
16.30	17.00	16.30	21	17	24	28	16	5	7	3		124
17.00	17.30	17.00	11	21	9	8	9	1	1	8		76
17.30	18.00	17.30	5	3	6	4	1	2	7	3		34
18.00	18.30	18.00	6	7	8	2	1	4	8			36
18.30	19.00	18.30	9	16	14	26	7	9	8			89
19.00	19.30	19.00	8	8	9	2	8	4	6			45
19.30	20.00	19.30	9	9	1	8	8	5	4			44
20.00	20.30	20.00	18	15	13	7						53
20.30	21.00	20.30	18	7	14	7						46
21.00	21.30	21.00	18	7	6	0						31
21.30	22.00	21.30	12	8	13	17						50

PASSING VEHICLE COUNT SURVEY
JUNCTION NAME : QUEEN'S STATUE JUNCTION
DIRECTION: KASTURBA ROAD TO ANIL KUMBLE CIRCLE

DATE:11-5-2017							DAY:THURSDAY				
Time		Observed Time	Total Vehicle Count (s)								
From	To		10	10	10	10	10	10	10	10	Total
6.00	6.30	off									
6.30	7.00	6.42	21	5	2						28
7.00	7.30	7.04	9	9	4						22
7.30	8.00	7.32	21	11	3						35
8.00	8.30	8.03	22	11	4	0					37
8.30	9.00	8.40	10	16	15	17					58
9.00	9.30	9.20	22	21	21	20					84
9.30	10.00	9.40	22	15	10	9					56
10.00	10.30	10.10	14	17	11	12					54
10.30	11.00	10.45	22	15	17	13					67
11.00	11.30	11.10	19	21	12	17					69
11.30	12.00	11.40	15	9	17	8					49
12.00	12.30	12.15	20	12	9	12					53
12.30	13.00	12.50	17	9	18	10					54
13.00	13.30	13.10	25	18	14	13					70
13.30	14.00	13.45	22	16	17	21					76
14.00	14.30	14.10	18	18	20	9					65
14.30	15.00	14.45	12	18	16	11					57
15.00	15.30	15.05	19	23	18	24					84
15.30	16.00	15.35	23	15	21	25					84
16.00	16.30	16.05	34	28	24	31					117
16.30	17.00	16.35	28	34	25	40					127
17.00	17.30	17.05	34	21	23	24					102
17.30	18.00	17.35	25	28	19	20					92
18.00	18.30	18.05	28	19	26	21					94
18.30	19.00	18.35	21	24	23	10					78
19.00	19.30	19.05	34	28	19	25					106
19.30	20.00	19.35	28	32	25	29					114
20.00	20.30	20.05	21	23	24	25					93
20.30	21.00	20.35	34	28	17	28					107
21.00	21.30	21.05	28	19	21	24					92
21.30	22.00	21.35	27	23	24	27					101

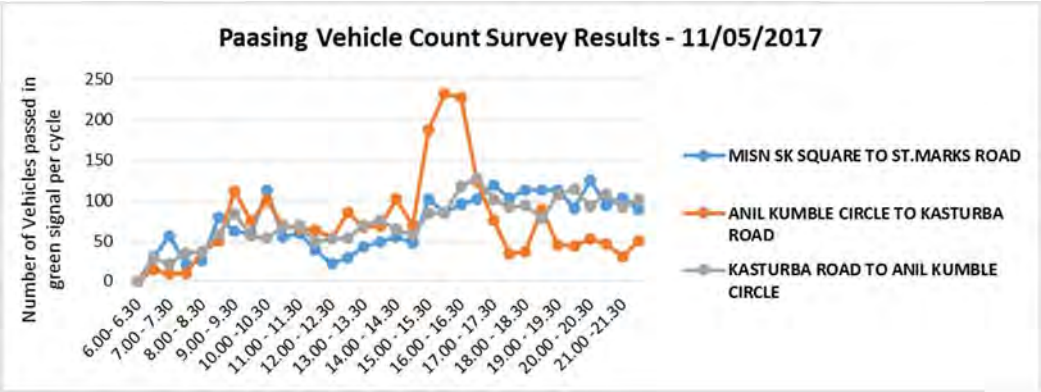


Figure 34: Passing Vehicles at Queens Statue Intersection on 11/05/2017

Table 44: Vehicle Passing Count Survey at Queen's Statue Intersection on 14/05/2017

PASSING VEHICLE COUNT SURVEY												
JUNCTION NAME : QUEEN'S STATUE JUNCTION												
DIRECTION: ANIL KUMBLE CIRCLE TO KASTURBA ROAD												
DATE:11-5-2017								DAY:THURSDAY				
Time		Observed Time	Total Vehicle Count (s)									
From	To		10	10	10	10	10	10	10	10	10	Total
6.00	6.30	off										
6.30	7.00	6.37	4	2	1							7
7.00	7.30	7.00	13	1	1							15
7.30	8.00	7.33	10	1	1							12
8.00	8.30	8.02	12	3	4	2						21
8.30	9.00	8.45	5	5	0	1	0					11
9.00	9.30	9.10	4	3	2	2	3					14
9.30	10.00	9.45	8	4	7	2	0					21
10.00	10.30	10.06	5	7	8	3	6					29
10.30	11.00	10.48	7	12	8	11	5					43
11.00	11.30	11.02	8	4	4	9	6					31
11.30	12.00	11.34	8	6	11	5	7					37
12.00	12.30	12.06	8	4	6	2	5					25
12.30	13.00	12.47	6	10	3	6	1					26
13.00	13.30	13.00	7	3	10	6	8					34
13.30	14.00	13.35	10	5	2	10	8					35
14.00	14.30	14.00	5	12	6	8	3					34
14.30	15.00	14.30	8	3	7	8	6					32
15.00	15.30	15.05	17	13	21	27	14	2				94
15.30	16.00	15.35	20	17	31	35	19	3				125
16.00	16.30	16.10	13	21	29	23	17	1				104
16.30	17.00	16.40	31	33	19	21	16	3				123
17.00	17.30	17.05	27	31	37	23	20	4				142
17.30	18.00	17.35	31	26	19	12	21	5				114
18.00	18.30	18.05	26	22	31	19	12	4				114

18.30	19.00	18.35	29	32	19	17	10	2				109
19.00	19.30	19.00	21	32	37	41	27	3				161
19.30	20.00	19.35	27	30	21	18	13	2				111
20.00	20.30	20.05	27	33	39	42	40	2				183
20.30	21.00	20.35	19	27	32	38	29	3				148
21.00	21.30	21.05	32	37	22	28	31	2				152
21.30	22.00	21.35	31	26	19	23	27	4				130

PASSING VEHICLE COUNT SURVEY

JUNCTION NAME : QUEEN'S STATUE JUNCTION

DIRECTION: ANIL KUMBLE CIRCLE TO KASTURBA ROAD

DATE:14-5-2017 **DAY:SUNDAY**

Time		Observed Time	Total Vehicle Count (s)									
From	To		10	10	10	10	10	10	10	10	10	Total
6.00	6.30	off										
6.30	7.00	6.46	5	0	0	0	0	1				6
7.00	7.30	7.15	9	5	4	0	1	0				19
7.30	8.00	7.40	6	7	3	0	0	0				16
8.00	8.30	8.15	5	2	2	4	0	2				15
8.30	9.00	8.42	7	5	5	4	2	0	0	0	0	23
9.00	9.30	9.00	7	6	11	5	1	0	1	1	1	35
9.30	10.00	9.30	3	0	6	3	1	5	2	0	1	22
10.00	10.30	10.00	9	5	12	7	4	1	0	0	0	38
10.30	11.00	10.50	8	8	2	2	0	2	0	1	4	32
11.00	11.30	11.15	12	7	3	6	3	4	1	0	0	36
11.30	12.00	11.45	13	12	7	7	4	1	3	1	0	49
12.00	12.30	12.10	6	12	9	7	3	5	4	2	4	58
12.30	13.00	12.40	11	8	2	1	10	2	2	1	0	38
13.00	13.30	13.10	7	6	8	10	9	5	0	0	1	47
13.30	14.00	13.45	13	6	2	1	0	0	7	4	1	39
14.00	14.30	14.10	12	8	6	9	4	6	2	0	1	49
14.30	15.00	14.30	10	5	8	7	4	5	0	1	2	45
15.00	15.30	15.00	19	20	29	24	14	13	17	18	1	174
15.30	16.00	15.30	23	27	32	18	20	14	27	19	1	201
16.00	16.30	16.00	33	22	28	27	19	20	17	23	2	216
16.30	17.00	16.30	35	32	28	20	22	19	24	21	1	224
17.00	17.30	17.00	23	30	28	19	20	17	14	20	2	195
17.30	18.00	17.30	7	3	6	3	1	4	8	5		42
18.00	18.30	18.00	12	18	13	9	4	5	0			61
18.30	19.00	18.30	10	16	14	17	9	8	6			80
19.00	19.30	19.00	8	9	12	8	2	4	6			49
19.30	20.00	19.30	9	7	4	5	8	3	2			38
20.00	20.30	20.00	14	13	7	12						46
20.30	21.00	20.30	12	7	15	16						50

21.00	21.30	21.00	20	17	14	8						59
21.30	22.00	21.30	17	13	18	14						62

PASSING VEHICLE COUNT SURVEY

JUNCTION NAME : QUEEN'S STATUE JUNCTION

DIRECTION: KASTURBA ROAD TO ANIL KUMBLE CIRCLE

DATE:14-5-2017 **DAY:SUNDAY**

Time		Observed Time	Total Vehicle Count (s)									
From	To		10	10	10	10	10	10	10	10	10	Total
6.00	6.30	off										
6.30	7.00	6.40	12	1	1							14
7.00	7.30	7.05	16	11	3							30
7.30	8.00	7.35	19	11	3							33
8.00	8.30	8.05	24	12	1							37
8.30	9.00	8.45	21	12	9	0						42
9.00	9.30	9.10	20	10	9	3						42
9.30	10.00	9.45	20	19	11	10						60
10.00	10.30	10.05	19	7	9	2						37
10.30	11.00	10.45	24	13	8	8						53
11.00	11.30	11.05	20	18	15	12						65
11.30	12.00	11.35	20	14	6	10						50
12.00	12.30	12.05	22	9	13	12						56
12.30	13.00	12.45	18	17	15	18						68
13.00	13.30	13.05	13	12	9	18						52
13.30	14.00	13.35	13	16	20	11						60
14.00	14.30	14.05	13	17	11	7						48
14.30	15.00	14.40	20	14	11	12						57
15.00	15.30	15.05	22	29	20	28						99
15.30	16.00	15.35	29	27	19	22						97
16.00	16.30	16.05	25	23	18	26						92
16.30	17.00	16.35	21	19	18	20						78
17.00	17.30	17.05	19	21	20	18						78
17.30	18.00	17.35	20	24	29	21						94
18.00	18.30	18.05	23	24	21	19						87
18.30	19.00	18.35	24	21	15	17						77
19.00	19.30	19.05	19	21	23	25						88
19.30	20.00	19.35	17	15	19	20						71
20.00	20.30	20.05	23	12	15	21						71
20.30	21.00	20.35	15	24	23	10						72
21.00	21.30	21.05	22	15	11	12						60
21.30	22.00	21.35	15	12	5	23						55

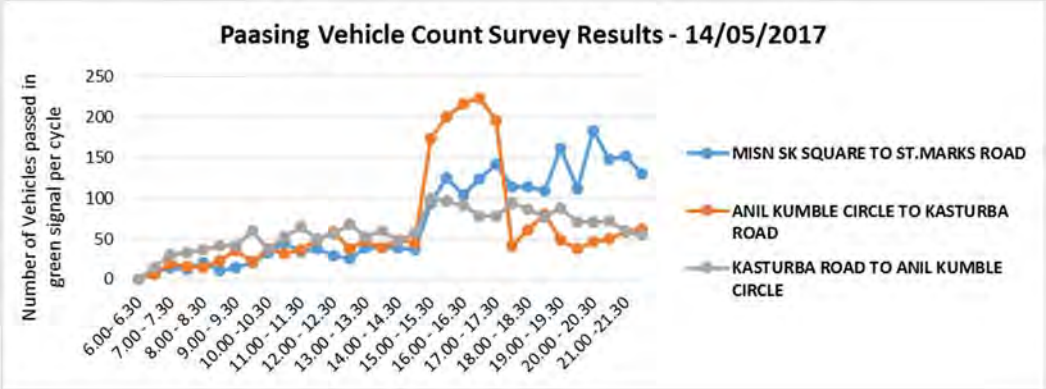


Figure 35: Passing Vehicles at Queens Statue Intersection on 14/05/2017

Table 45: Vehicle Passing Count Survey at Queen's Statue Intersection on 18/05/2017

PASSING VEHICLE COUNT SURVEY												
JUNCTION NAME : QUEEN'S STATUE JUNCTION												
DIRECTION: MISN SK SQUARE TO ST.MARKS ROAD												
DATE:18-5-2017									DAY:THURSDAY			
Time		Observed Time	Total Vehicle Count (s)									
From	To		10	10	10	10	10	10	10	10	10	Total
6.00	6.30	off										
6.30	7.00	6.41	12	5	1	2	0					20
7.00	7.30	7.05	8	5	3	0	0					16
7.30	8.00	7.33	12	10	4	6	0					32
8.00	8.30	8.05	10	7	5	11	2	3				38
8.30	9.00	8.35	12	11	14	7	4	4				52
9.00	9.30	9.05	14	12	9	9	10	11				65
9.30	10.00	9.35	12	14	10	12	8	2				58
10.00	10.30	10.05	12	8	10	10	6	5				51
10.30	11.00	10.40	16	10	7	9	10	12				64
11.00	11.30	11.05	16	12	13	8	7	8				64
11.30	12.00	11.44	11	13	6	4	14	2				50
12.00	12.30	12.05	12	12	9	4	10	4				51
12.30	13.00	12.38	15	9	5	7	2	1				39
13.00	13.30	13.02	6	5	10	2	3	3				29
13.30	14.00	13.33	10	6	7	4	2	1				30
14.00	14.30	14.02	16	7	4	7	11	5				50
14.30	15.00	14.37	11	0	6	2	7	0				26
15.00	15.30	15.00	17	26	32	19	12	6				112
15.30	16.00	15.35	23	29	36	21	16	7				132
16.00	16.30	16.10	18	28	19	25	21	10				121
16.30	17.00	16.40	21	32	22	29	33	6				143
17.00	17.30	17.05	30	25	28	23	17	5				128
17.30	18.00	17.35	32	28	17	23	29	10				139
18.00	18.30	18.05	19	32	29	26	25	7				138

18.30	19.00	18.35	22	27	36	31	28	12				156
19.00	19.30	19.00	16	23	31	37	32	11				150
19.30	20.00	19.35	28	32	31	27	23	9				150
20.00	20.30	20.05	23	35	33	19	16	8				134
20.30	21.00	20.35	19	28	36	32	30	15				160
21.00	21.30	21.05	23	32	37	33	31	10				166
21.30	22.00	21.35	30	33	36	28	22	12				161

PASSING VEHICLE COUNT SURVEY

JUNCTION NAME : QUEEN'S STATUE JUNCTION												
DIRECTION: ANIL KUMBLE CIRCLE TO KASTURBA ROAD												
DATE:18-5-2017									DAY:THURSDAY			
Time		Observed Time	Total Vehicle Count (s)									
From	To		10	10	10	10	10	10	10	10	10	Total
6.00	6.30	off										
6.30	7.00	6.40	1	0	3	5	1	2				12
7.00	7.30	7.15	1	3	0	1	3	1				9
7.30	8.00	7.40	6	4	0	0	0	0				10
8.00	8.30	8.05	4	4	5	5	3	3				24
8.30	9.00	8.40	4	7	8	10	1	11	2	3	2	53
9.00	9.30	9.15	5	8	15	8	9	11	2	3	6	76
9.30	10.00	9.40	6	10	8	8	10	10	5	4	3	71
10.00	10.30	10.15	7	12	10	13	5	8	11	8	8	98
10.30	11.00	10.40	4	5	5	6	7	8	5	8	5	66
11.00	11.30	11.05	15	9	8	5	4	2	2	5	4	63
11.30	12.00	11.40	13	8	6	7	9	5	6	4	3	68
12.00	12.30	12.15	8	13	8	10	14	6	1	0	3	66
12.30	13.00	12.45	11	7	9	8	12	8	5	3	2	70
13.00	13.30	1.10	10	13	8	7	9	3	0	0	1	52
13.30	14.00	1.35	8	6	3	5	9	11	9	8	5	77
14.00	14.30	2.05	12	9	10	13	9	8	5	5	1	78
14.30	15.00	2.35	6	3	5	7	7	10	6	5	8	70
15.00	15.30	15.05	20	18	16	12	10	12	6	2		98
15.30	16.00	15.35	18	12	10	12	8	13	7	2		84
16.00	16.30	16.05	19	6	8	7	9	1	6	2		60
16.30	17.00	16.35	21	7	9	12	10	2	3	5		74
17.00	17.30	17.05	15	9	12	10	9	8	5	2		72
17.30	18.00	17.35	15	8	9	12	11	9	12	14		104
18.00	18.30	18.05	18	11	10	12	8	13	7	5		89
18.30	19.00	18.35	16	7	9	3	8	7	2	3	6	70
19.00	19.30	19.05	16	8	10	4	3	6	3	2	1	56
19.30	20.00	19.35	14	7	9	12	10	2	3	5	4	75
20.00	20.30	20.05	15	8	3	7	2	3	1			39
20.30	21.00	20.35	18	16	12	10	12	6	2			76

21.00	21.30	21.05	15	12	13	10	9	6	3			68
21.30	22.00	21.35	18	10	13	5	7	3	4			60

PASSING VEHICLE COUNT SURVEY

JUNCTION NAME : QUEEN'S STATUE JUNCTION												
DIRECTION: KASTURBA ROAD TO ANIL KUMBLE CIRCLE												
DATE:18-5-2017										DAY:THURSDAY		
Time		Observed Time	Total Vehicle Count (s)									
From	To		10	10	10	10	10	10	10	10	10	Total
6.00	6.30	off										
6.30	7.00	6.45	18	3	2							23
7.00	7.30	7.05	17	6	6							29
7.30	8.00	7.40	17	13	7							37
8.00	8.30	8.05	26	9	13	11						59
8.30	9.00	8.45	30	10	9	10						59
9.00	9.30	9.20	27	11	11	10						59
9.30	10.00	9.37	28	26	22	19						95
10.00	10.30	10.15	17	6	11	11						45
10.30	11.00	10.45	12	17	11	5						45
11.00	11.30	11.05	17	19	8	9						53
11.30	12.00	11.50	18	16	4	18						56
12.00	12.30	12.05	17	17	3	10						47
12.30	13.00	12.45	20	14	16	14						64
13.00	13.30	13.05	17	17	13	18						65
13.30	14.00	13.40	25	13	13	9						60
14.00	14.30	14.25	11	5	12	12						40
14.30	15.00	14.40	13	12	10	14						49
15.00	15.30	15.05	25	21	29	21						96
15.30	16.00	15.35	28	19	22	21						90
16.00	16.30	16.05	22	16	19	13						70
16.30	17.00	16.35	27	23	29	22						101
17.00	17.30	17.05	19	16	17	18						70
17.30	18.00	17.35	20	24	29	21						94
18.00	18.30	18.05	23	24	21	19						87
18.30	19.00	18.35	24	21	16	17						78
19.00	19.30	19.05	19	21	23	25						88
19.30	20.00	19.35	17	15	19	20						71
20.00	20.30	20.05	23	12	15	21						71
20.30	21.00	20.35	15	24	23	10						72
21.00	21.30	21.05	20	17	9	22						68
21.30	22.00	21.35	5	12	5	23						45

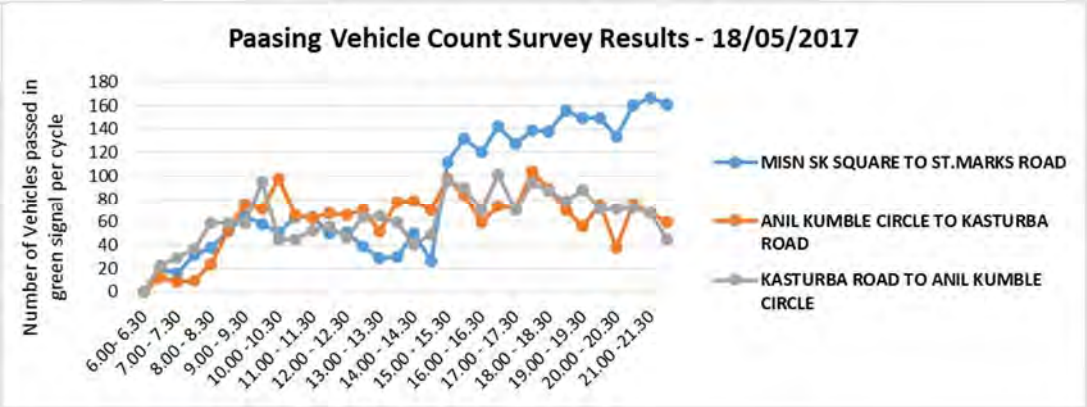


Figure 36: Passing Vehicles at Queens Statue Intersection on 18/05/2017

4.6 Trinity Circle

A pictorial representation of the intersection, with details of approach movements and Signal Posts Locations is shown in the figure below.

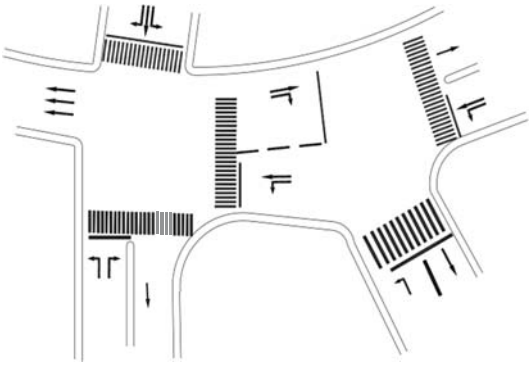


Figure 37: Details of Trinity Intersection

TRINITY CIRCLE Signal Timings													
Date: 10/05/2017 and 17/05/2017													
TRINITY CIRCLE Signal Timings			PHASE										CYCLE TIME
	Road	From	1			2			3			5	
Data	A	MAYOHALL	L	S	R							EXCLUSIVE PEDESTRIAN	
	B	TRINITY CIRCLE		S	L	L			L	S			
	C	BHASKARAN ROAD											
	D	ULSOOR				L	S	R					
	E	DOMLUR							L	S	R		
TIMINGS	06:00	06:30	13			12			13			10	48
	06:30	08:30	110			24			110			10	254
	08:30	12:00	55			30			55			10	150
	12:00	15:00	55			30			55			10	150
	15:00	19:00	55			30			55			10	150
	19:00	22:00	(MANUAL)55			30			55			10	95

Figure 38: Cycle Length of Trinity Intersection on 10th and 17th June 2017

TRINITY CIRCLE Signal Timings													
Date: 21/05/2017													
TRINITY CIRCLE Signal Timings			PHASE										CYCLE TIME
	Road	From	1			2			3			5	
Data	A	MAYOHALL	L	S	R							EXCLUSIVE PEDESTRIAN	
	B	TRINITY CIRCLE		S	L	L			L	S			
	C	BHASKARAN ROAD											
	D	ULSOOR				L	S	R					
	E	DOMLUR							L	S	R		
TIMINGS	06:00	06:30	50			12			30			10	102
	06:30	08:30	50			24			40			10	124
	08:30	12:00	50			30			55			10	145
	12:00	15:00	50			30			5			10	95
	15:00	19:00	50			30			55			10	145
	19:00	22:00	50			30			Manual (50-120)			10	

Figure 39: Cycle Length of Trinity Intersection on 21/05/2017

A three phase signal with exclusive pedestrian signal was operated at Trinity Junction. The cycle length varied from 95-145 seconds. At weekdays, especially at peak hours the cycle length were increased to 250 second.

Table 46: Signal Phase Time Survey at Trinity Intersection on 10/05/2017

SIGNAL PHASE TIME SURVEY							
JUNCTION NAME : TRINITY CIRCLE							
DIRECTION: ULSOOR TO MAYOHALL							
DATE:10-5-2017						DAY:WEDNESDAY	
Time		Observed Time	Cycle Time (s)				
From	To		Green	Red	Amber	Pedestrian	Total
6.00	6.30	6.20	12	51	3	10	76
6.30	7.00	6.40	24	105	3	10	142
7.00	7.30	7.12	24	105	3	10	142
7.30	8.00	7.42	24	105	3	10	142
8.00	8.30	8.05	24	105	3	10	142
8.30	9.00	8.38	30	165	3	9	207
9.00	9.30	9.20	30	165	3	9	207
9.30	10.00	9.30	30	165	3	9	207
10.00	10.30	10.20	30	165	3	9	207
10.30	11.00	10.50	30	165	3	9	207
11.00	11.30	11.09	30	165	3	9	207
11.30	12.00	11.46	30	165	3	9	207
12.00	12.30	12.08	30	165	3	9	207
12.30	13.00	12.36	30	165	3	9	207
13.00	13.30	13.03	30	165	3	9	207
13.30	14.00	13.40	30	165	3	9	207
14.00	14.30	14.11	30	165	3	9	207
14.30	15.00	14.32	30	165	3	9	207
15.00	15.30	15.15	30	165	3	9	207
15.30	16.00	15.36	30	165	3	9	207
16.00	16.30	16.17	30	165	3	9	207

16.30	17.00	16.44	30	165	3	9	207
17.00	17.30	17.08	30	165	3	9	207
17.30	18.00	17.33	30	165	3	9	207
18.00	18.30	18.1	30	165	3	9	207
18.30	19.00	18.32	28	396	3	9	436
19.00	19.30	19.14	34	372	3	9	418
19.30	20.00	19.45	30	166	3	9	208
20.00	20.30	20.1	30	170	3	9	212
20.30	21.00	20.3	30	172	3	9	214
21.00	21.30	21.06	30	148	3	9	190
21.30	22.00	21.41	30	148	3	9	190

SIGNAL PHASE TIME SURVEY

JUNCTION NAME : TRINITY CIRCLE

DIRECTION: MAYOHALL TO ULSOOR (SECOND SIGNAL)

DATE:10-5-2017 | **DAY:WEDNESDAY**

Time		Observed Time	Cycle Time (s)				
From	To		Green	Red	Amber	Pedestrian	Total
6.00	6.30	6.16	13	15	3	10	41
6.30	7.00	6.42	110	30	3	10	153
7.00	7.30	7.04	110	30	3	10	153
7.30	8.00	7.32	110	30	3	10	153
8.00	8.30	8.03	110	30	3	10	153
8.30	9.00	8.40	55	70	3	10	138
9.00	9.30	9.20	55	70	3	10	138
9.30	10.00	9.40	55	70	3	10	138
10.00	10.30	10.10	55	70	3	10	138
10.30	11.00	10.45	55	70	3	10	138
11.00	11.30	11.10	55	70	3	10	138
11.30	12.00	11.40	55	70	3	10	138
12.00	12.30	12.15	55	70	3	10	138
12.30	13.00	12.50	55	70	3	10	138
13.00	13.30	13.10	55	70	3	10	138
13.30	14.00	13.45	55	70	3	10	138
14.00	14.30	14.10	55	70	3	10	138
14.30	15.00	14.45	55	30	3	10	98
15.00	15.30	15.05	55	30	3	10	98
15.30	16.00	15.35	55	30	3	10	98
16.00	16.30	16.05	55	30	3	10	98
16.30	17.00	16.35	55	30	3	10	98
17.00	17.30	17.05	55	30	3	10	98
17.30	18.00	17.35	105	30	2	10	147
18.00	18.30	18.05	105	120	2	10	237
18.30	19.00	18.35	135	30	2	10	177

19.00	19.30	19.05	105	30	2	10	147
19.30	20.00	19.35	55	30	3	10	98
20.00	20.30	20.05	55	30	3	10	98
20.30	21.00	20.35	55	30	3	10	98
21.00	21.30	21.05	55	30	3	10	98
21.30	22.00	21.35	55	30	3	10	98

SIGNAL PHASE TIME SURVEY							
JUNCTION NAME : TRINITY CIRCLE							
DIRECTION: MAYOHALL TO ULSOOR (FIRST SIGNAL)							
DATE:10-5-2017						**DAY:WEDNESDAY**	
Time		**Observed Time**	**Cycle Time (s)**				
From	**To**		**Green**	**Red**	**Amber**	**Pedestrian**	**Total**
6.00	6.30	6.20	30	45	3	10	88
6.30	7.00	6.40	40	98	3	10	151
7.00	7.30	7.12	40	98	3	10	151
7.30	8.00	7.42	40	98	3	10	151
8.00	8.30	8.05	40	98	3	10	151
8.30	9.00	8.38	55	100	3	9	167
9.00	9.30	9.20	55	100	3	9	167
9.30	10.00	9.30	55	100	3	9	167
10.00	10.30	10.20	55	100	3	9	167
10.30	11.00	10.50	55	100	3	9	167
11.00	11.30	11.09	55	100	3	9	167
11.30	12.00	11.46	55	100	3	9	167
12.00	12.30	12.08	55	100	3	9	167
12.30	13.00	12.36	55	100	3	9	167
13.00	13.30	13.03	55	100	3	9	167
13.30	14.00	13.40	55	100	3	9	167
14.00	14.30	14.11	55	100	3	9	167
14.30	15.00	14.32	55	100	3	9	167
15.00	15.30	15.15	55	140	3	9	207
15.30	16.00	15.36	55	140	3	9	207
16.00	16.30	16.17	55	140	3	9	207
16.30	17.00	16.44	55	140	3	9	207
17.00	17.30	17.08	55	140	3	9	207
17.30	18.00	17.33	55	140	3	9	207
18.00	18.30	18.1	138	280	3	9	430
18.30	19.00	18.32	120	280	3	9	412
19.00	19.30	19.14	120	140	3	9	272
19.30	20.00	19.45	75	50	3	9	137
20.00	20.30	20.1	105	30	3	9	147
20.30	21.00	20.3	50	110	3	9	172
21.00	21.30	21.06	48	146	3	9	206

21.30	22.00	21.41	50	146	3	9	208

Table 47: Signal Phase Time Survey at Trinity Intersection on 17/05/2017

SIGNAL PHASE TIME SURVEY							
JUNCTION NAME : TRINITY CIRCLE							
DIRECTION: ULSOOR TO MAYOHALL							
DATE:17-5-2017						DAY:WEDNESDAY	
Time		Observed Time	Cycle Time (s)				
From	To		Green	Red	Amber	Pedestrian	Total
6.00	6.30	6.20	12	51	3	10	76
6.30	7.00	6.40	24	105	3	10	142
7.00	7.30	7.12	24	105	3	10	142
7.30	8.00	7.42	24	105	3	10	142
8.00	8.30	8.05	24	105	3	10	142
8.30	9.00	8.38	30	165	3	9	207
9.00	9.30	9.20	30	165	3	9	207
9.30	10.00	9.30	30	165	3	9	207
10.00	10.30	10.20	30	165	3	9	207
10.30	11.00	10.50	30	165	3	9	207
11.00	11.30	11.09	30	165	3	9	207
11.30	12.00	11.46	30	165	3	9	207
12.00	12.30	12.08	30	165	3	9	207
12.30	13.00	12.36	30	165	3	9	207
13.00	13.30	13.03	30	165	3	9	207
13.30	14.00	13.40	30	165	3	9	207
14.00	14.30	14.11	30	165	3	9	207
14.30	15.00	14.32	30	165	3	9	207
15.00	15.30	15.15	30	165	3	9	207
15.30	16.00	15.36	30	165	3	9	207
16.00	16.30	16.17	30	165	3	9	207
16.30	17.00	16.44	30	165	3	9	207
17.00	17.30	17.08	30	165	3	9	207
17.30	18.00	17.33	30	165	3	9	207
18.00	18.30	18.1	30	165	3	9	207
18.30	19.00	18.32	30	165	3	9	207
19.00	19.30	19.14	30	502	3	9	544
19.30	20.00	19.45	30	300	3	9	342
20.00	20.30	20.1	30	300	3	9	342
20.30	21.00	20.3	30	150	3	9	192
21.00	21.30	21.06	30	150	3	9	192
21.30	22.00	21.41	30	150	3	9	192

SIGNAL PHASE TIME SURVEY
JUNCTION NAME : TRINITY CIRCLE
DIRECTION: MAYOHALL TO ULSOOR (SECOND SIGNAL)

DATE:17-5-2017						DAY:WEDNESDAY	
Time		Observed Time	Cycle Time (s)				
From	To		Green	Red	Amber	Pedestrian	Total
6.00	6.30	6.16	13	15	3	10	41
6.30	7.00	6.42	110	30	3	10	153
7.00	7.30	7.04	110	30	3	10	153
7.30	8.00	7.32	110	30	3	10	153
8.00	8.30	8.03	110	30	3	10	153
8.30	9.00	8.40	70	120	3	10	203
9.00	9.30	9.20	70	120	3	10	203
9.30	10.00	9.40	110	120	3	10	243
10.00	10.30	10.10	110	120	3	10	243
10.30	11.00	10.45	160	50	3	10	223
11.00	11.30	11.10	160	50	3	10	223
11.30	12.00	11.40	160	50	3	10	223
12.00	12.30	12.15	160	50	3	10	223
12.30	13.00	12.50	60	35	3	10	108
13.00	13.30	13.10	60	35	3	10	108
13.30	14.00	13.45	60	35	3	10	108
14.00	14.30	14.10	60	35	3	10	108
14.30	15.00	14.45	60	35	3	10	108
15.00	15.30	15.05	55	30	3	10	98
15.30	16.00	15.35	55	30	3	10	98
16.00	16.30	16.05	55	30	3	10	98
16.30	17.00	16.35	55	30	3	10	98
17.00	17.30	17.05	55	30	3	10	98
17.30	18.00	17.35	55	30	3	10	98
18.00	18.30	18.05	66	170	2	10	248
18.30	19.00	18.35	66	170	2	10	248
19.00	19.30	19.05	115	130	2	10	257
19.30	20.00	19.35	60	30	2	10	102
20.00	20.30	20.05	60	60	2	10	132
20.30	21.00	20.35	90	30	2	10	132
21.00	21.30	21.05	80	44	3	10	137
21.30	22.00	21.35	60	45	3	10	118

SIGNAL PHASE TIME SURVEY

JUNCTION NAME : TRINITY CIRCLE

DIRECTION: MAYOHALL TO ULSOOR (FIRST SIGNAL)

DATE: 17-5-2017						DAY:WEDNESDAY	
Time		Observed Time	Cycle Time (s)				
From	To		Green	Red	Amber	Pedestrian	Total
6.00	6.30	6.20	30	45	3	10	88
6.30	7.00	6.40	40	98	3	10	151
7.00	7.30	7.12	40	98	3	10	151

7.30	8.00	7.42	40	98	3	10	151
8.00	8.30	8.05	55	100	3	10	168
8.30	9.00	8.38	55	100	3	9	167
9.00	9.30	9.20	55	100	3	9	167
9.30	10.00	9.30	55	100	3	9	167
10.00	10.30	10.20	55	100	3	9	167
10.30	11.00	10.50	55	100	3	9	167
11.00	11.30	11.09	55	100	3	9	167
11.30	12.00	11.46	55	100	3	9	167
12.00	12.30	12.08	55	100	3	9	167
12.30	13.00	12.36	55	100	3	9	167
13.00	13.30	13.03	55	100	3	9	167
13.30	14.00	13.40	55	100	3	9	167
14.00	14.30	14.11	55	100	3	9	167
14.30	15.00	14.32	55	100	3	9	167
15.00	15.30	15.15	55	140	3	9	207
15.30	16.00	15.36	55	140	3	9	207
16.00	16.30	16.17	55	140	3	9	207
16.30	17.00	16.44	55	140	3	9	207
17.00	17.30	17.08	55	140	3	9	207
17.30	18.00	17.33	55	140	3	9	207
18.00	18.30	18.1	138	280	3	9	430
18.30	19.00	18.32	120	280	3	9	412
19.00	19.30	19.14	120	140	3	9	272
19.30	20.00	19.45	75	50	3	9	137
20.00	20.30	20.1	105	30	3	9	147
20.30	21.00	20.3	50	110	3	9	172
21.00	21.30	21.06	48	146	3	9	206
21.30	22.00	21.41	50	146	3	9	208

Table 48: Signal Phase Time Survey at Trinity Intersection on 21/05/2017

SIGNAL PHASE TIME SURVEY							
JUNCTION NAME : TRINITY CIRCLE							
DIRECTION: ULSOOR TO MAYOHALL							
DATE:21-5-2017						DAY:SUNDAY	
Time		Observed Time	Cycle Time (s)				
From	To		Green	Red	Amber	Pedestrian	Total
6.00	6.30	6.20					0
6.30	7.00	6.40	30	160	3	10	203
7.00	7.30	7.12	30	160	3	10	203
7.30	8.00	7.42	30	160	3	10	203
8.00	8.30	8.05	30	165	3	10	208
8.30	9.00	8.38	30	165	3	9	207
9.00	9.30	9.20	30	165	3	9	207
9.30	10.00	9.30	30	165	3	9	207

10.00	10.30	10.20	30	165	3	9	207
10.30	11.00	10.50	30	165	3	9	207
11.00	11.30	11.09	30	165	3	9	207
11.30	12.00	11.46	30	165	3	9	207
12.00	12.30	12.08	30	165	3	9	207
12.30	13.00	12.36	30	165	3	9	207
13.00	13.30	13.03	30	165	3	9	207
13.30	14.00	13.40	30	165	3	9	207
14.00	14.30	14.11	30	165	3	9	207
14.30	15.00	14.32	30	165	3	9	207
15.00	15.30	15.15	30	165	3	9	207
15.30	16.00	15.36	30	165	3	9	207
16.00	16.30	16.17	30	165	3	9	207
16.30	17.00	16.44	30	165	3	9	207
17.00	17.30	17.08	30	165	3	9	207
17.30	18.00	17.33	30	165	3	9	207
18.00	18.30	18.1	30	165	3	9	207
18.30	19.00	18.32	30	165	3	9	207
19.00	19.30	19.14	30	165	3	9	207
19.30	20.00	19.45	30	165	3	9	207
20.00	20.30	20.1	30	165	3	9	207
20.30	21.00	20.3	30	165	3	9	207
21.00	21.30	21.06	30	165	3	9	207
21.30	22.00	21.41	30	165	3	9	207

SIGNAL PHASE TIME SURVEY

JUNCTION NAME : TRINITY CIRCLE

DIRECTION: MAYOHALL TO ULSOOR (SECOND SIGNAL) from mayohall

DATE:21-5-2017 **DAY:SUNDAY**

Time		Observed Time	Cycle Time (s)				
From	To		Green	Red	Amber	Pedestrian	Total
6.00	6.30	6.15	50	40	3	10	103
6.30	7.00	6.42	50	40	3	10	103
7.00	7.30	7.04	50	40	3	10	103
7.30	8.00	7.32	50	40	3	10	103
8.00	8.30	8.03	50	40	3	10	103
8.30	9.00	8.40	50	40	3	10	103
9.00	9.30	9.20	50	40	3	10	103
9.30	10.00	9.40	50	40	3	10	103
10.00	10.30	10.10	50	40	3	10	103
10.30	11.00	10.45	50	40	3	10	103
11.00	11.30	11.10	50	40	3	10	103
11.30	12.00	11.40	50	40	3	10	103
12.00	12.30	12.15	50	40	3	10	103

12.30	13.00	12.50	50	40	3	10	103
13.00	13.30	13.10	50	40	3	10	103
13.30	14.00	13.45	50	40	3	10	103
14.00	14.30	14.10	50	40	3	10	103
14.30	15.00	14.45	50	40	3	10	103
15.00	15.30	15.05	50	40	3	10	103
15.30	16.00	15.35	50	40	3	10	103
16.00	16.30	16.05	50	40	3	10	103
16.30	17.00	16.35	50	40	3	10	103
17.00	17.30	17.05	50	40	3	10	103
17.30	18.00	17.35	50	40	3	10	103
18.00	18.30	18.05	50	40	3	10	103
18.30	19.00	18.35	50	40	3	10	103
19.00	19.30	19.05	50	40	3	10	103
19.30	20.00	19.35	50	40	3	10	103
20.00	20.30	20.05	50	40	3	10	103
20.30	21.00	20.35	50	40	3	10	103
21.00	21.30	21.05	50	40	3	10	103
21.30	22.00	21.35	50	40	3	10	103

SIGNAL PHASE TIME SURVEY

JUNCTION NAME : TRINITY CIRCLE

DIRECTION: MAYOHALL TO ULSOOR (FIRST SIGNAL)

DATE: 21-5-2017 **DAY:SUNDAY**

Time		Observed Time	Cycle Time (s)				
From	To		Green	Red	Amber	Pedestrian	Total
6.00	6.30						0
6.30	7.00	6.40	55	140	3	10	208
7.00	7.30	7.12	55	140	3	10	208
7.30	8.00	7.42	55	140	3	10	208
8.00	8.30	8.05	25	170	3	10	208
8.30	9.00	8.38	25	170	3	9	207
9.00	9.30	9.20	25	170	3	9	207
9.30	10.00	9.30	25	170	3	9	207
10.00	10.30	10.20	25	170	3	9	207
10.30	11.00	10.50	55	140	3	9	207
11.00	11.30	11.09	55	140	3	9	207
11.30	12.00	11.46	55	140	3	9	207
12.00	12.30	12.08	55	140	3	9	207
12.30	13.00	12.36	55	140	3	9	207
13.00	13.30	13.03	55	140	3	9	207
13.30	14.00	13.40	55	140	3	9	207
14.00	14.30	14.11	55	140	3	9	207

14.30	15.00	14.32	55	140	3	9	207
15.00	15.30	15.15	55	140	3	9	207
15.30	16.00	15.36	60	30	3	9	102
16.00	16.30	16.17	60	30	3	9	102
16.30	17.00	16.44	60	30	3	9	102
17.00	17.30	17.08	60	30	3	9	102
17.30	18.00	17.33	60	30	3	9	102
18.00	18.30	18.1	30	70	3	9	112
18.30	19.00	18.32	30	70	3	9	112
19.00	19.30	19.14	30	70	3	9	112
19.30	20.00	19.45	30	70	3	9	112
20.00	20.30	20.1	30	70	3	9	112
20.30	21.00	20.3	55	30	3	9	97
21.00	21.30	21.06	55	30	3	9	97
21.30	22.00	21.41	55	30	3	9	97

Table 49: Dead Green/Wastage of Green Survey at Trinity Intersection on 10/05/2017

WASTE/DEAD GREEN SIGNAL SURVEY			
JUNCTION NAME : TRINITY CIRCLE			
DIRECTION: ULSOOR TO MAYOHALL			
DATE:10-5-2017			**DAY:WEDNESDAY**
Time		**Dead Green**	**Wastage of Green**
From	**To**	**Occurred**	**Occurred**
6.00	6.30	-	-
6.30	7.00	-	✓
7.00	7.30	-	-
7.30	8.00	-	-
8.00	8.30	-	-
8.30	9.00	-	-
9.00	9.30	-	-
9.30	10.00	-	-
10.00	10.30	-	-
10.30	11.00	-	-
11.00	11.30	-	-
11.30	12.00	-	-
12.00	12.30	-	-
12.30	13.00	-	-
13.00	13.30	-	-
13.30	14.00	-	-
14.00	14.30	-	-
14.30	15.00	-	-
15.00	15.30	-	✓
15.30	16.00	-	-
16.00	16.30	-	-

16.30	17.00	-	-
17.00	17.30	-	-
17.30	18.00	-	-
18.00	18.30	-	✓
18.30	19.00	-	-
19.00	19.30	-	-
19.30	20.00	-	-
20.00	20.30	-	-
20.30	21.00	-	-
21.00	21.30	-	-
21.30	22.00	-	-

WASTE/DEAD GREEN SIGNAL SURVEY			
JUNCTION NAME : TRINITY CIRCLE			
DIRECTION: MAYOHALL TO ULSOOR (SECOND SIGNAL)			
DATE:10-5-2017			**DAY:WEDNESDAY**
Time		**Dead Green**	**Wastage of Green**
From	**To**	**Occurred**	**Occurred**
6.00	6.30	-	-
6.30	7.00	-	✓
7.00	7.30	-	-
7.30	8.00	-	-
8.00	8.30	-	-
8.30	9.00	-	-
9.00	9.30	-	-
9.30	10.00	-	-
10.00	10.30	-	-
10.30	11.00	-	-
11.00	11.30	-	-
11.30	12.00	-	-
12.00	12.30	-	-
12.30	13.00	-	-
13.00	13.30	-	-
13.30	14.00	-	-
14.00	14.30	-	-
14.30	15.00	-	-
15.00	15.30	-	-
15.30	16.00	-	-
16.00	16.30	-	-
16.30	17.00	-	-
17.00	17.30	-	-
17.30	18.00	-	-
18.00	18.30	-	-
18.30	19.00	-	-

19.00	19.30	-	-
19.30	20.00	-	-
20.00	20.30	-	✓
20.30	21.00	-	-
21.00	21.30	-	✓
21.30	22.00	-	✓

WASTE/DEAD GREEN SIGNAL SURVEY			
JUNCTION NAME:TRINITY CIRCLE			
DIRECTION: MAYOHALL TO ULSOOR (FIRST SIGNAL)			
DATE:10-5-2017			**DAY:WEDNESDAY**
Time		**Dead Green**	**Wastage of Green**
From	**To**	**Occurred**	**Occurred**
6.00	6.30	-	-
6.30	7.00	-	✓
7.00	7.30	-	✓
7.30	8.00	-	✓
8.00	8.30	-	✓
8.30	9.00	-	-
9.00	9.30	-	-
9.30	10.00	-	-
10.00	10.30	-	-
10.30	11.00	-	-
11.00	11.30	-	-
11.30	12.00	-	-
12.00	12.30	-	-
12.30	13.00	-	-
13.00	13.30	-	-
13.30	14.00	-	-
14.00	14.30	-	-
14.30	15.00	-	-
15.00	15.30	-	-
15.30	16.00	-	-
16.00	16.30	-	-
16.30	17.00	-	-
17.00	17.30	-	-
17.30	18.00	-	-
18.00	18.30	-	-
18.30	19.00	-	✓
19.00	19.30	-	-
19.30	20.00	-	-
20.00	20.30	-	-
20.30	21.00	-	✓
21.00	21.30	-	-

21.30	22.00	-	✓

Table 50: Dead Green/Wastage of Green Survey at Trinity Intersection on 17/05/2017

WASTE/DEAD GREEN SIGNAL SURVEY			
JUNCTION NAME : TRINITY CIRCLE			
DIRECTION: ULSOOR TO MAYOHALL			
DATE:17-5-2017			DAY:WEDNESDAY
Time		Dead Green	Wastage of Green
From	To	Occurred	Occurred
6.00	6.30	-	-
6.30	7.00	-	-
7.00	7.30	-	-
7.30	8.00	-	-
8.00	8.30	-	-
8.30	9.00	-	-
9.00	9.30	-	-
9.30	10.00	-	-
10.00	10.30	-	-
10.30	11.00	-	-
11.00	11.30	-	-
11.30	12.00	-	-
12.00	12.30	-	-
12.30	13.00	-	-
13.00	13.30	-	-
13.30	14.00	-	-
14.00	14.30	-	-
14.30	15.00	-	-
15.00	15.30	-	✓
15.30	16.00	-	✓
16.00	16.30	-	-
16.30	17.00	-	✓
17.00	17.30	-	-
17.30	18.00	-	-
18.00	18.30	-	-
18.30	19.00	-	-
19.00	19.30	-	-
19.30	20.00	-	✓
20.00	20.30	-	-
20.30	21.00	-	-
21.00	21.30	-	✓
21.30	22.00	-	✓

WASTE/DEAD GREEN SIGNAL SURVEY
JUNCTION NAME : TRINITY CIRCLE

DIRECTION: MAYOHALL TO ULSOOR (SECOND SIGNAL)			
DATE:17-5-2017			DAY:WEDNESDAY
Time		Dead Green	Wastage of Green
From	To	Occurred	Occurred
6.00	6.30	-	✓
6.30	7.00	-	-
7.00	7.30	-	-
7.30	8.00	-	✓
8.00	8.30	-	✓
8.30	9.00	-	-
9.00	9.30	-	-
9.30	10.00	-	-
10.00	10.30	-	-
10.30	11.00	-	-
11.00	11.30	-	-
11.30	12.00	-	-
12.00	12.30	-	-
12.30	13.00	-	-
13.00	13.30	-	-
13.30	14.00	-	-
14.00	14.30	-	-
14.30	15.00	-	-
15.00	15.30	-	-
15.30	16.00	-	-
16.00	16.30	-	-
16.30	17.00	-	-
17.00	17.30	-	-
17.30	18.00	-	-
18.00	18.30	-	-
18.30	19.00	-	-
19.00	19.30	-	-
19.30	20.00	-	-
20.00	20.30	-	-
20.30	21.00	-	-
21.00	21.30	-	✓
21.30	22.00	-	✓

WASTE/DEAD GREEN SIGNAL SURVEY			
JUNCTION NAME:TRINITY CIRCLE			
DIRECTION: MAYOHALL TO ULSOOR (FIRST SIGNAL)			
DATE:17-5-2017			DAY:WEDNESDAY
Time		Dead Green	Wastage of Green
From	To	Occurred	Occurred
6.00	6.30	-	-

6.30	7.00	-	✓
7.00	7.30	-	✓
7.30	8.00	-	✓
8.00	8.30	-	✓
8.30	9.00	-	-
9.00	9.30	-	-
9.30	10.00	-	-
10.00	10.30	-	-
10.30	11.00	-	-
11.00	11.30	-	-
11.30	12.00	-	-
12.00	12.30	-	-
12.30	13.00	-	-
13.00	13.30	-	-
13.30	14.00	-	-
14.00	14.30	-	-
14.30	15.00	-	-
15.00	15.30	-	✓
15.30	16.00	-	-
16.00	16.30	-	-
16.30	17.00	-	-
17.00	17.30	-	-
17.30	18.00	-	-
18.00	18.30	-	-
18.30	19.00	-	-
19.00	19.30	-	-
19.30	20.00	-	-
20.00	20.30	-	-
20.30	21.00	-	✓
21.00	21.30	-	-
21.30	22.00	-	✓

Table 51: Dead Green/Wastage of Green Survey at Trinity Intersection on 21/05/2017

WASTE/DEAD GREEN SIGNAL SURVEY			
JUNCTION NAME : TRINITY CIRCLE			
DIRECTION: ULSOOR TO MAYOHALL			
DATE:21-5-2017			DAY:SUNDAY
Time		Dead Green	Wastage of Green
From	To	Occurred	Occurred
6.00	6.30	-	-
6.30	7.00	-	✓
7.00	7.30	-	✓
7.30	8.00	-	✓
8.00	8.30	-	-

8.30	9.00	-	-
9.00	9.30	-	-
9.30	10.00	-	-
10.00	10.30	-	-
10.30	11.00	-	-
11.00	11.30	-	-
11.30	12.00	-	-
12.00	12.30	-	-
12.30	13.00	-	-
13.00	13.30	-	-
13.30	14.00	-	-
14.00	14.30	-	-
14.30	15.00	-	-
15.00	15.30	-	-
15.30	16.00	-	-
16.00	16.30	-	-
16.30	17.00	-	-
17.00	17.30	-	-
17.30	18.00	-	-
18.00	18.30	-	-
18.30	19.00	-	-
19.00	19.30	-	-
19.30	20.00	-	-
20.00	20.30	-	-
20.30	21.00	-	✓
21.00	21.30	-	-
21.30	22.00	-	✓

WASTE/DEAD GREEN SIGNAL SURVEY			
JUNCTION NAME : TRINITY CIRCLE			
DIRECTION: MAYOHALL TO ULSOOR (SECOND SIGNAL)			
DATE:21-5-2017			**DAY:SUNDAY**
Time		**Dead Green**	**Wastage of Green**
From	**To**	**Occurred**	**Occurred**
6.00	6.30	-	✓
6.30	7.00	-	-
7.00	7.30	-	-
7.30	8.00	-	✓
8.00	8.30	-	✓
8.30	9.00	-	✓
9.00	9.30	-	-
9.30	10.00	-	✓
10.00	10.30	-	-
10.30	11.00	-	-

11.00	11.30	-	-
11.30	12.00	-	-
12.00	12.30	-	-
12.30	13.00	-	-
13.00	13.30	-	-
13.30	14.00	-	-
14.00	14.30	-	-
14.30	15.00	-	-
15.00	15.30	-	-
15.30	16.00	-	-
16.00	16.30	-	-
16.30	17.00	-	-
17.00	17.30	-	-
17.30	18.00	-	-
18.00	18.30	-	-
18.30	19.00	-	-
19.00	19.30	-	-
19.30	20.00	-	-
20.00	20.30	-	✓
20.30	21.00	-	✓
21.00	21.30	-	✓
21.30	22.00	-	✓

WASTE/DEAD GREEN SIGNAL SURVEY			
JUNCTION NAME:TRINITY CIRCLE			
DIRECTION: MAYOHALL TO ULSOOR (FIRST SIGNAL)			
DATE:21-5-2017			**DAY:SUNDAY**
Time		**Dead Green**	**Wastage of Green**
From	**To**	**Occurred**	**Occurred**
6.00	6.30	-	-
6.30	7.00	-	✓
7.00	7.30	-	✓
7.30	8.00	-	✓
8.00	8.30	-	✓
8.30	9.00	-	-
9.00	9.30	-	-
9.30	10.00	-	-
10.00	10.30	-	-
10.30	11.00	-	-
11.00	11.30	-	-
11.30	12.00	-	-
12.00	12.30	-	-
12.30	13.00	-	-
13.00	13.30	-	-

13.30	14.00	-	-
14.00	14.30	-	-
14.30	15.00	-	-
15.00	15.30	-	-
15.30	16.00	-	-
16.00	16.30	-	-
16.30	17.00	-	-
17.00	17.30	-	-
17.30	18.00	-	✓
18.00	18.30	-	-
18.30	19.00	-	✓
19.00	19.30	-	-
19.30	20.00	-	-
20.00	20.30	-	-
20.30	21.00	-	✓
21.00	21.30	-	-
21.30	22.00	-	✓

Table 52: Passing Vehicle Count Survey at Trinity Intersection on 10/05/2017

PASSING VEHICLE COUNT SURVEY

JUNCTION NAME : TRINITY CIRCLE								
DIRECTION: MAYOHALL TO ULSOOR (FIRST SIGNAL)								
DATE:10-5-2017					DAY:WEDNESDAY			
Time		Observed Time	Total Vehicle Count (s)					
From	To		10	10	10	10	10	Total
6.00	6.30	6.20	5	1	1			7
6.30	7.00	6.40	6	6	2			14
7.00	7.30	7.12	17	9	1			27
7.30	8.00	7.42	9	9	1	2		21
8.00	8.30	8.05	8	4	6	1		19
8.30	9.00	8.38	11	10	6	3	5	35
9.00	9.30	9.20	15	2	7	21	11	56
9.30	10.00	9.30	20	4	9	7	13	53
10.00	10.30	10.20	14	16	10	6	13	59
10.30	11.00	10.50	10	2	6	5	11	34
11.00	11.30	11.09	9	4	14	10	10	47
11.30	12.00	11.46	9	8	18	6	6	47
12.00	12.30	12.08	21	16	6	16	12	71
12.30	13.00	12.36	21	17	12	13	10	73
13.00	13.30	13.03	17	10	12	7	3	49
13.30	14.00	13.40	23	13	5	5	11	57
14.00	14.30	14.11	4	12	27	8	15	66
14.30	15.00	14.32	2	10	5	15	11	43
15.00	15.30	15.15	17	2	4	10	22	55

15.30	16.00	15.36	18	12	10	9	12	61
16.00	16.30	16.17	9	11	6	7	9	42
16.30	17.00	16.44	8	12	16	14	10	60
17.00	17.30	17.08	5	11	9	7	15	47
17.30	18.00	17.33	16	6	7	11	4	44
18.00	18.30	18.1	21	15	14	17	7	74
18.30	19.00	18.32	4	11	23	22	10	70
19.00	19.30	19.14	10	8	10	5	6	39
19.30	20.00	19.45	17	15	15	18	7	72
20.00	20.30	20.1	17	21	27	14	10	89
20.30	21.00	20.3	4	10	4	9	14	41
21.00	21.30	21.06	9	3	4	13	6	35
21.30	22.00	21.41	10	13	3	2	5	33

JUNCTION NAME : TRINITY CIRCLE

DIRECTION: MAYOHALL TO ULSOOR (SECOND SIGNAL)

DATE:10-5-2017 **DAY:WEDNESDAY**

Time		Observed Time	Total Vehicle Count (s)														
From	To		10	10	10	10	10	10	10	10	10	10	10	10	10	10	Total
6.00	6.30	6.16	6	2													8
6.30	7.00	6.42	7	5	3	6	4	3	1	0	4	5	5				38
7.00	7.30	7.04	6	4	3	5	2	1	2	4	5	3	2				35
7.30	8.00	7.32	7	3	4	3	4	2	1	2	2	1	6				29
8.00	8.30	8.03	10	12	7	8	13	15									65
8.30	9.00	8.40	10	2	15	9	4	3									43
9.00	9.30	9.20	12	4	3	10	5	3									37
9.30	10.00	9.40	10	2	7	5	6	4									34
10.00	10.30	10.10	15	13	7	6	7	3									51
10.30	11.00	10.45	15	8	8	13	9	7									60
11.00	11.30	11.10	15	12	15	11	3	8									64
11.30	12.00	11.40	16	3	5	9	8	9									50
12.00	12.30	12.15	21	17	13	10	6	4									71
12.30	13.00	12.50	18	12	14	5	8	6									63
13.00	13.30	13.10	15	11	10	6	3	7									52
13.30	14.00	13.45	16	13	2	6	5	3									45
14.00	14.30	14.10	17	12	6	9	8	5									57
14.30	15.00	14.45	16	15	6	4	21	4									66
15.00	15.30	15.05	24	9	8	13	12	6									72
15.30	16.00	15.35	17	2	24	8	6	7									64
16.00	16.30	16.05	18	13	15	14	9	6									75
16.30	17.00	16.35	13	15	6	7	4	3									48
17.00	17.30	17.05	14	16	8	22	12	5									77
17.30	18.00	17.35	21	10	7	10	15	11	13	11	8	16	15				122
18.00	18.30	18.05	15	10	14	9	7	6	8	6	7	10	7				92
18.30	19.00	18.35	24	18	32	10	14	13	18	21	17	15	23	15	7	8	190
19.00	19.30	19.05	26	14	12	7	18	21	18	16	17	18	15				167

19.30	20.00	19.35	9	6	11	14	13	5									58
20.00	20.30	20.05	12	18	16	19	21	8									94
20.30	21.00	20.35	13	6	3	5	6	4									37
21.00	21.30	21.05	10	8	6	7	3	3									37
21.30	22.00	21.35	7	8	10	11	6	4									46

PASSING VEHICLE COUNT SURVEY

JUNCTION NAME : TRINITY CIRCLE

DIRECTION: ULSOOR TO MAYOHALL

DATE:10-5-2017 **DAY:WEDNESDAY**

Time		Observed Time	Total Vehicle Count (s)				
From	To		10	10	10	10	Total
6.00	6.30	6.20	9	7			16
6.30	7.00	6.40	5	6	4		15
7.00	7.30	7.12	10	12	12		34
7.30	8.00	7.42	11	7	8		26
8.00	8.30	8.05	17	12	10		39
8.30	9.00	8.38	12	7	8		27
9.00	9.30	9.20	21	35	18		74
9.30	10.00	9.30	18	7	10		35
10.00	10.30	10.20	17	8	4		29
10.30	11.00	10.50	17	4	6		27
11.00	11.30	11.09	12	4	7		23
11.30	12.00	11.46	12	6	3		21
12.00	12.30	12.08	13	8	10		31
12.30	13.00	12.36	13	8	6		27
13.00	13.30	13.03	10	6	7		23
13.30	14.00	13.40	7	8	3		18
14.00	14.30	14.11	12	7	6		25
14.30	15.00	14.32	15	4	5		24
15.00	15.30	15.15	15	6	2		23
15.30	16.00	15.36	30	20	10		60
16.00	16.30	16.17	32	2	0		34
16.30	17.00	16.44	18	12	0		30
17.00	17.30	17.08	20	13	0		33
17.30	18.00	17.33	20	8	0		28
18.00	18.30	18.1	26	30	0		56
18.30	19.00	18.32	28	26	0		54
19.00	19.30	19.14	55	36	12		103
19.30	20.00	19.45	38	42	15		95
20.00	20.30	20.1	23	7	2		32
20.30	21.00	20.3	25	19	4		48
21.00	21.30	21.06	29	17	0		46

21.30	22.00	21.41	17	6	1		24

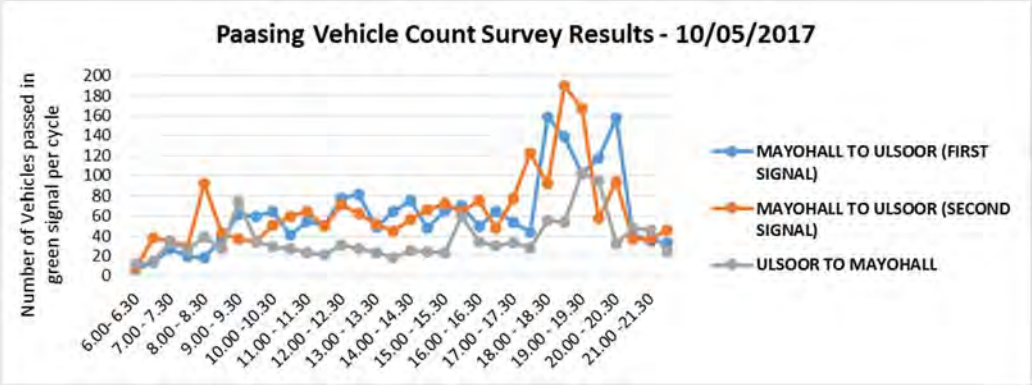


Figure 40: Passing Vehicles at Trinity Intersection on 10/05/2017

Table 53: Passing Vehicle Count Survey at Trinity Intersection on 17/05/2017

PASSING VEHICLE COUNT SURVEY									
JUNCTION NAME : TRINITY CIRCLE									
DIRECTION: MAYOHALL TO ULSOOR (FIRST SIGNAL)									
DATE:17-5-2017								DAY:WEDNESDAY	
Time		Observed Time	Total Vehicle Count (s)						
From	To		10	10	10	10	10	10	Total
6.00	6.30	6.20	5	1	1				7
6.30	7.00	6.40	6	6	2				14
7.00	7.30	7.12	17	9	1				27
7.30	8.00	7.42	9	9	1	2			21
8.00	8.30	8.05	8	4	6	1			19
8.30	9.00	8.38	11	10	6	3	5		35
9.00	9.30	9.20	15	2	7	21	11		56
9.30	10.00	9.30	20	4	9	7	13		53
10.00	10.30	10.20	14	16	10	6	13		59
10.30	11.00	10.50	10	2	6	5	11		34
11.00	11.30	11.09	9	4	14	10	10		47
11.30	12.00	11.46	9	8	18	6	6		47
12.00	12.30	12.08	21	16	6	16	12		71
12.30	13.00	12.36	21	17	12	13	10		73
13.00	13.30	13.03	17	10	12	7	3		49
13.30	14.00	13.40	23	13	5	5	11		57
14.00	14.30	14.11	4	12	27	8	15		66
14.30	15.00	14.32	2	10	5	15	11		43
15.00	15.30	15.15	17	2	4	10	22		55
15.30	16.00	15.36	18	12	10	9	12		61

16.00	16.30	16.17	9	11	6	7	9		42
16.30	17.00	16.44	8	12	16	14	10		60
17.00	17.30	17.08	5	11	9	7	15		47
17.30	18.00	17.33	16	6	7	11	4		44
18.00	18.30	18.1	21	15	14	17	7		74
18.30	19.00	18.32	4	11	23	22	10		70
19.00	19.30	19.14	10	8	10	5	6		39
19.30	20.00	19.45	17	15	15	18	7		72
20.00	20.30	20.1	17	21	27	14	10		89
20.30	21.00	20.3	4	10	4	9	14		41
21.00	21.30	21.06	9	3	4	13	6		35
21.30	22.00	21.41	10	13	3	2	5		33

PASSING VEHICLE COUNT SURVEY

JUNCTION NAME : TRINITY CIRCLE

DIRECTION: MAYOHALL TO ULSOOR (SECOND SIGNAL)

DATE:17-5-2017 **DAY:WEDNESDAY**

Time		Total Vehicle Count (s)																
From	To	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	Total
6.00	6.30	2																2
6.30	7.00	1	1	2	1	2	3	0	3	2	1	2						15
7.00	7.30	4	2	0	0	0	0	1	3	1	0	1						11
7.30	8.00	1	5	2	4	2	5	1	0	3	2	0						23
8.00	8.30	12	10	3	2	12	2	3	2	4	1							50
8.30	9.00	11	5	3	1	4	0	1										25
9.00	9.30	20	20	13	5	2	1	0										61
9.30	10.00	20	15	11	0	2	1	3	2	2	1	2						56
10.00	10.30	15	16	13	7	5	3	3	2	2	2	0						66
10.30	11.00	15	5	5	4	3	7	9	6	7	8	10	5	23	21	1	2	64
11.00	11.30	21	19	13	10	8	9	7	7	5	3	2	2	4	3	1	2	102
11.30	12.00	22	17	13	9	8	5	7	3	3	2	2	2	3	4	2	1	90
12.00	12.30	17	13	12	9	13	8	7	5	3	2	2	2	3	4	1	1	89
12.30	13.00	8	6	1	0	2	5											22
13.00	13.30	11	15	10	7	5	3											51
13.30	14.00	10	8	5	6	7	4											40
14.00	14.30	9	3	4	3	5	6											30
14.30	15.00	3	4	3	5	7	6											28
15.00	15.30	15	17	18	5	6	6											67
15.30	16.00	18	24	6	2	9	2											61

16.00	16.30	13	7	11	2	8	2											43
16.30	17.00	13	6	7	1	2	0											29
17.00	17.30	7	11	6	5	4	0											33
17.30	18.00	17	16	13	12	11	5											74
18.00	18.30	26	21	29	27	14	19	6										142
18.30	19.00	17	16	19	23	14	7	4										100
19.00	19.30	18	21	23	27	29	32	16	28	27	24							221
19.30	20.00	18	12	14	19	17	11											91
20.00	20.30	11	5	3	8	7	13											47
20.30	21.00	17	16	19	6	3	1	2	4	8								76
21.00	21.30	12	11	14	4	2	1	1	3									48
21.30	22.00	20	19	14	9	1	3											66

PASSING VEHICLE COUNT SURVEY

JUNCTION NAME : TRINITY CIRCLE							
DIRECTION: ULSOOR TO MAYOHALL							
DATE:17-5-2017					DAY:WEDNESDAY		
Time		Observed Time	Total Vehicle Count (s)				
From	To		10	10	10	10	Total
6.00	6.30	6.20	5	2			7
6.30	7.00	6.40	11	5			16
7.00	7.30	7.12	14	7			21
7.30	8.00	7.42	16	3			19
8.00	8.30	8.05	20	9	5		34
8.30	9.00	8.38	20	12	6		38
9.00	9.30	9.20	24	11	8		43
9.30	10.00	9.30	24	22	18		64
10.00	10.30	10.20	26	14	12		52
10.30	11.00	10.50	25	6	7		38
11.00	11.30	11.09	25	17	16		58
11.30	12.00	11.46	20	15	12		47
12.00	12.30	12.08	26	13	10		49
12.30	13.00	12.36	28	16	9		53
13.00	13.30	13.03	16	7	15		38
13.30	14.00	13.40	15	12	10		37
14.00	14.30	14.11	23	12	16		51
14.30	15.00	14.32	18	10	10		38
15.00	15.30	15.15	18	6	4		28
15.30	16.00	15.36	22	25	18		65
16.00	16.30	16.17	27	16	7		50
16.30	17.00	16.44	21	2	1		24
17.00	17.30	17.08	15	2	3		20

17.30	18.00	17.33	18	9	7		34
18.00	18.30	18.1	28	15	7		50
18.30	19.00	18.32	30	28	20		78
19.00	19.30	19.14	21	22	16		59
19.30	20.00	19.45	70	30	16		116
20.00	20.30	20.1	22	18	7		47
20.30	21.00	20.3	32	14	5		51
21.00	21.30	21.06	22	12	10		44
21.30	22.00	21.41	20	12	10		42

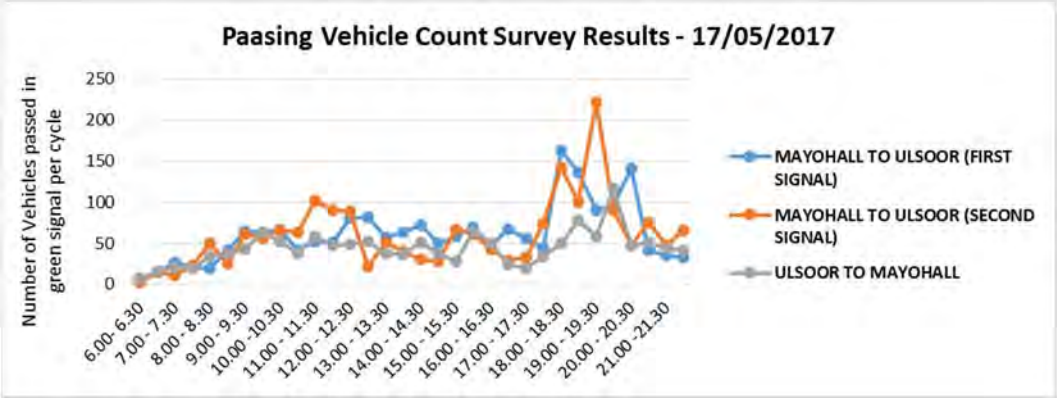


Figure 41: Passing Vehicles at Trinity Intersection on 17/05/2017

Table 54: Passing Vehicle Count Survey at Trinity Intersection on 21/05/2017

PASSING VEHICLE COUNT SURVEY

JUNCTION NAME : TRINITY CIRCLE								
DIRECTION: MAYOHALL TO ULSOOR (FIRST SIGNAL)								
DATE:21-5-2017							DAY:SUNDAY	
Time		Observed Time	Total Vehicle Count (s)					
From	To		10	10	10	10	10	Total
6.00	6.30	6.20	5	1	1			7
6.30	7.00	6.40	6	6	2			14
7.00	7.30	7.12	17	9	1			27
7.30	8.00	7.42	9	9	1	2		21
8.00	8.30	8.05	8	4	6	1		19
8.30	9.00	8.38	11	10	6	3	5	35
9.00	9.30	9.20	15	2	7	21	11	56
9.30	10.00	9.30	20	4	9	7	13	53
10.00	10.30	10.20	14	16	10	6	13	59
10.30	11.00	10.50	10	2	6	5	11	34
11.00	11.30	11.09	9	4	14	10	10	47
11.30	12.00	11.46	9	8	18	6	6	47
12.00	12.30	12.08	21	16	6	16	12	71
12.30	13.00	12.36	21	17	12	13	10	73

13.00	13.30	13.03	17	10	12	7	3	49
13.30	14.00	13.40	23	13	5	5	11	57
14.00	14.30	14.11	4	12	27	8	15	66
14.30	15.00	14.32	2	10	5	15	11	43
15.00	15.30	15.15	17	2	4	10	22	55
15.30	16.00	15.36	18	12	10	9	12	61
16.00	16.30	16.17	9	11	6	7	9	42
16.30	17.00	16.44	8	12	16	14	10	60
17.00	17.30	17.08	5	11	9	7	15	47
17.30	18.00	17.33	16	6	7	11	4	44
18.00	18.30	18.1	21	15	14	17	7	74
18.30	19.00	18.32	4	11	23	22	10	70
19.00	19.30	19.14	10	8	10	5	6	39
19.30	20.00	19.45	17	15	15	18	7	72
20.00	20.30	20.1	17	21	27	14	10	89
20.30	21.00	20.3	4	10	4	9	14	41
21.00	21.30	21.06	9	3	4	13	6	35
21.30	22.00	21.41	10	13	3	2	5	33

PASSING VEHICLE COUNT SURVEY

JUNCTION NAME : TRINITY CIRCLE								
DIRECTION: MAYOHALL TO ULSOOR (SECOND SIGNAL) - FROM MAYOHALL								
DATE:21-5-2017							DAY:SUNDAY	
Time		Observed Time	Total Vehicle Count (s)					
From	To		10	10	10	10	10	Total
6.00	6.30	6.15	2	1	1	2	0	6
6.30	7.00	6.42	2	2	1	2	1	8
7.00	7.30	7.04	5	1	0	0	1	7
7.30	8.00	7.32	13	5	3	2	2	25
8.00	8.30	8.03	2	2	6	2	1	13
8.30	9.00	8.40	12	5	2	2	2	23
9.00	9.30	9.20	3	2	6	2	3	16
9.30	10.00	9.40	10	9	4	2	2	27
10.00	10.30	10.10	12	5	7	0	1	25
10.30	11.00	10.45	14	9	5	3	3	34
11.00	11.30	11.10	13	10	5	3	6	37
11.30	12.00	11.40	4	6	5	7	8	30
12.00	12.30	12.15	15	5	9	7	3	39
12.30	13.00	12.50	8	8	9	5	6	36
13.00	13.30	13.10	10	11	7	8	5	41
13.30	14.00	13.45	12	9	5	3	1	30
14.00	14.30	14.10	20	13	10	6	10	59
14.30	15.00	14.45	15	10	12	4	8	49
15.00	15.30	15.05	10	12	4	7	0	33

15.30	16.00	15.35	23	14	17	9	2	65
16.00	16.30	16.05	15	17	6	3	3	44
16.30	17.00	16.35	20	18	10	1	3	52
17.00	17.30	17.05	30	22	15	17	8	92
17.30	18.00	17.35	25	18	12	14	8	77
18.00	18.30	18.05	25	19	10	14	3	71
18.30	19.00	18.35	28	22	14	2	7	73
19.00	19.30	19.05	27	20	12	4	7	70
19.30	20.00	19.35	30	19	12	14	15	90
20.00	20.30	20.05	32	20	14	9	12	87
20.30	21.00	20.35	30	22	25	22	21	120
21.00	21.30	21.05	25	19	14	12	11	81
21.30	22.00	21.35	23	20	10	11	14	78

PASSING VEHICLE COUNT SURVEY

JUNCTION NAME : TRINITY CIRCLE								
DIRECTION: ULSOOR TO MAYOHALL								
DATE:21-5-2017							DAY:SUNDAY	
Time		Observed Time	Total Vehicle Count (s)					
From	To		10	10	10	10	10	Total
6.00	6.30							0
6.30	7.00	6.40	5	0	0	1	1	7
7.00	7.30	7.12	4	1	0	2	2	9
7.30	8.00	7.42	4	2	0	0	1	7
8.00	8.30	8.05	2	6	1			9
8.30	9.00	8.38	7	4	2			13
9.00	9.30	9.20	5	3	1			9
9.30	10.00	9.30	10	6	3			19
10.00	10.30	10.20	11	7	10			28
10.30	11.00	10.50	10	14	9	6		39
11.00	11.30	11.09	2	10	6	14	11	43
11.30	12.00	11.46	17	10	8	10	1	46
12.00	12.30	12.08	10	7	3	9	4	33
12.30	13.00	12.36	12	10	5	8	3	38
13.00	13.30	13.03	14	13	7	6	3	43
13.30	14.00	13.40	18	12	10	9	2	51
14.00	14.30	14.11	117	10	12	8	4	151
14.30	15.00	14.32	20	4		4	1	29
15.00	15.30	15.15	13	15	8	7	4	47
15.30	16.00	15.36	16	14	9	7	6	52
16.00	16.30	16.17	10	12	8	11	3	44
16.30	17.00	16.44	12	6	4	12	6	40
17.00	17.30	17.08	14	7	9	10	3	43
17.30	18.00	17.33	18	10	6	6	2	42

18.00	18.30	18.1	10	12	9	4	4	39
18.30	19.00	18.32	12	10	9	2	1	34
19.00	19.30	19.14	10	8	9	2	3	32
19.30	20.00	19.45	13	11	8	10		42
20.00	20.30	20.1	17	21	27	14	10	89
20.30	21.00	20.3	4	10	4	9	14	41
21.00	21.30	21.06	9	3	4	13	6	35
21.30	22.00	21.41	10	13	3	2	5	33

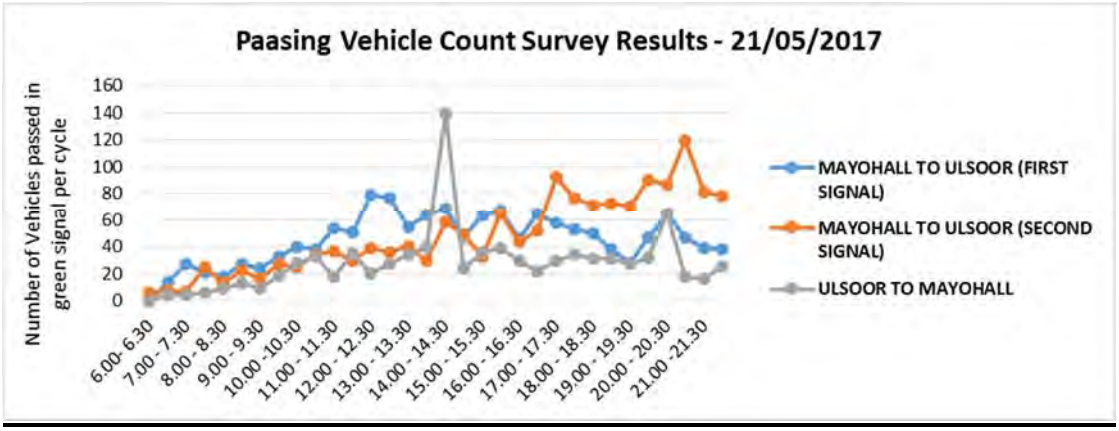


Figure 42: Passing Vehicles at Trinity Intersection on 21/05/2017

4.7 Vellara Intersection

A pictorial representation of the intersection, with details of approach movements and Signal Posts Locations is shown in the figure below.

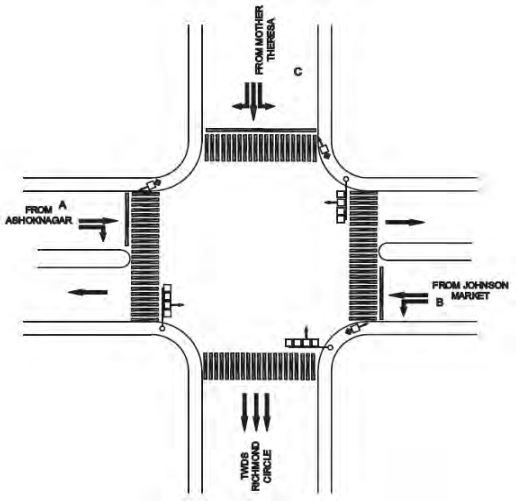


Figure 43: Details of Vellara Intersection

The observed green signal indication timings are entered corresponding to the time intervals in each phase phase and the total cycle length (cycle time) in seconds were calculated. Details are presented in the table below.

Vellara Road Junction Signal Timings													
Weekday (11/05/2017 and 18/05/2017)													
Vellara Road Junction			PHASE										CYCLE TIME
	Road	From	1			2			3			4	
Data	A	Ashok Nagar (Brigade Road)	R		S			S				EXCLUSIVE PEDESTRIAN	
	B	Johnson (Adugodi)					L	S					
	C	Mother Theresa (D'Souza Circle)		P			P		R	L	S		
	06:00	06:30	Signal off										
TIMINGS	06:30	07:30	20			50			30			10	110
	07:30	09:30	40			50			120			10	220
	09:30	10:30	40-100 (Manual)			40-100 (Manual)			40-200 (Manual)*			10	
	10:30	12:30	40-100 (Manual)			40-100 (Manual)			40-200 (Manual)*			10	
	12:30	15:00	40-150 (Manual)			40-150 (Manual)			40-200(Manual)*			10	
	15:00	22:00	30-180 (Manual)			30-180 (Manual)			30-200 (Manual)*			10	

Figure 18: Cycle Length of Vellara Intersection on 11th and 18th June 2017

Vellara Road Junction Signal Timings												
Sunday: 14/05/2017												
Vellara Road Junction			PHASE									CYCLE TIME
	Road	From	1			2			3			4	
Data	A	Ashok Nagar (Brigade Road)	R		S			S				EXCLUSIVE PEDESTRIAN	
	B	Johnson (Adugodi)					L	S					
	C	Mother Theresa (D'Souza Circle)		P			P		R	L	S		
	06:00	06:30	Signal off										
TIMINGS	06:30	07:00	Signal off										
	07:00	11:00	35			35			110			10	190
	11:00	22:00	30-130 (Manual)			30-130 (Manual)			40-180 (Manual)*			10	

Figure 45: Cycle Length of Vellara Intersection on 14/05/2017

A three phase signal with exclusive pedestrian signal was operated at Vellara Junction. The signal was operated manually at most of the times. Manual* timings were not consistent and changed randomly at each cycle. For instance at one cycle the green indication was 50 seconds whereas the next cycle

The green indication timings varied at each cycle. This was in detailed recorded in the vehicle passing count data. An example is shown below. During manual operation the green time varied even to 320 seconds.

Table 55: Signal Phase Time Survey at Vellara Intersection on 11/05/2017

SIGNAL PHASE TIME SURVEY							
JUNCTION NAME : VELLARA JUNCTION							
DIRECTION: ADUGODI TO SHIVAJINAGAR							
DATE:11-5-2017						DAY:THURSDAY	
Time		Observed Time	Cycle Time (s)				
From	To		Green	Red	Amber	Pedestrian	Total
6.00	6.30						
6.30	7.00	6.40	20	30	2	10	62
7.00	7.30	7.12	20	30	2	10	62
7.30	8.00	7.35	40	90	2	10	142
8.00	8.30	8.15	40	90	2	10	142
8.30	9.00	8.37	40	90	2	10	142
9.00	9.30	9.15	40	90	2	10	142

9.30	10.00	9.30	45	135	2	10	192
10.00	10.30	10.17	50	180	2	10	242
10.30	11.00	10.41	40	80	2	10	132
11.00	11.30	11.10	60	195	2	10	267
11.30	12.00	10.36	160	140	2	10	312
12.00	12.30	12.08	80	140	2	10	232
12.30	13.00	12.39	135	70	2	10	217
13.00	13.30	13.15	45	110	2	10	167
13.30	14.00	13.36	45	110	2	10	167
14.00	14.30	14.14	45	110	2	10	167
14.30	15.00	14.33	50	80	2	10	142
15.00	15.30	15.10	40	100	2	10	152
15.30	16.00	15.35	40	100	2	10	152
16.00	16.30	16.10	40	100	2	10	152
16.30	17.00	16.35	140	110	2	10	262
17.00	17.30	17.10	180	160	2	10	352
17.30	18.00	17.35	80	100	2	10	192
18.00	18.30	18.10	150	90	2	10	252
18.30	19.00	18.35	80	130	2	10	222
19.00	19.30	19.10	80	130	2	10	222
19.30	20.00	19.35	90	80	2	10	182
20.00	20.30	20.05	120	190	2	10	322
20.30	21.00	20.35	105	150	2	10	267
21.00	21.30	21.05	50	110	2	10	172
21.30	22.00	21.35	35	90	2	10	137

SIGNAL PHASE TIME SURVEY

JUNCTION NAME : VELLARA JUNCTION

DIRECTION: SHIVAJINAGAR TO ADUGODI

DATE:11-5-2017 | **DAY:THURSDAY**

Time		Observed Time	Cycle Time (s)				
From	To		Green	Red	Amber	Pedestrian	Total
6.00	6.30						
6.30	7.00	6.35	30	30	2	10	72
7.00	7.30	7.10	30	30	2	10	72
7.30	8.00	7.35	40	90	2	10	142
8.00	8.30	8.03	40	90	2	10	142
8.30	9.00	8.05	40	90	2	10	142
9.00	9.30	9.10	40	90	2	10	142
9.30	10.00	9.35	40	115	2	10	167
10.00	10.30	1.10	100	240	2	10	352
10.30	11.00	10.40	40	125	2	10	177
11.00	11.30	11.05	45	90	2	10	147
11.30	12.00	11.35	45	90	2	10	147

12.00	12.30	12.05	45	90	2	10	147
12.30	13.00	12.40	110	140	2	10	262
13.00	13.30	13.05	120	145	2	10	277
13.30	14.00	13.35	40	100	2	10	152
14.00	14.30	14.05	70	150	2	10	232
14.30	15.00	14.40	95	90	2	10	197
15.00	15.30	15.10	80	90	2	10	182
15.30	16.00	15.35	40	90	2	10	142
16.00	16.30	16.15	90	90	2	10	192
16.30	17.00	16.35	40	170	2	10	222
17.00	17.30	17.10	120	130	2	10	262
17.30	18.00	17.36	60	130	2	10	202
18.00	18.30	18.15	50	165	2	10	227
18.30	19.00	18.33	45	190	2	10	247
19.00	19.30	19.10	35	180	2	10	227
19.30	20.00	19.35	95	50	2	10	157
20.00	20.30	20.05	135	375	2	10	522
20.30	21.00	20.34	55	180	2	10	247
21.00	21.30	21.10	30	275	2	10	317
21.30	22.00	21.35	50	60	2	10	122

SIGNAL PHASE TIME SURVEY

JUNCTION NAME : VELLARA JUNCTION

DIRECTION:D'SOUZA CIRCLE TO RICHMOND CIRCLE

DATE:11-5-2017 | **DAY:THURSDAY**

Time		Observed Time	Cycle Time (s)				
From	To		Green	Red	Amber	Pedestrian	Total
6.00	6.30						
6.30	7.00	6.35	25	25	2		52
7.00	7.30	7.10	25	25	2		52
7.30	8.00	7.35	120	55	2	10	187
8.00	8.30	8.03	120	55	2	10	187
8.30	9.00	8.05	120	55	2	10	187
9.00	9.30	9.10	210	55	2	10	277
9.30	10.00	9.35	210	55	2	10	277
10.00	10.30	1.10	260	135	2	10	407
10.30	11.00	10.40	120	55	2	10	187
11.00	11.30	11.05	100	40	2	10	152
11.30	12.00	11.35	120	55	2	10	187
12.00	12.30	12.05	200	205	2	10	417
12.30	13.00	12.40	200	200	2	10	412
13.00	13.30	13.05	120	50	2	10	182
13.30	14.00	13.35	220	230	2	10	462
14.00	14.30	14.05	45	115	2	10	172

14.30	15.00	14.40	35	40	2	10	87
15.00	15.30	15.10	80	80	2	10	172
15.30	16.00	15.35	80	50	2	10	142
16.00	16.30	16.15	120	95	2	10	227
16.30	17.00	16.35	40	50	2	10	102
17.00	17.30	17.10	280	140	2	10	432
17.30	18.00	17.36	290	200	2	10	502
18.00	18.30	18.15	130	80	2	10	222
18.30	19.00	18.20	115	140	2	10	267
19.00	19.30	19.10	200	50	2	10	262
19.30	20.00	19.35	210	210	2	10	432
20.00	20.30	20.05	290	200	2	10	502
20.30	21.00	20.38	150	120	2	10	282
21.00	21.30	21.05	60	60	2	10	132
21.30	22.00	21.04	55	60	2	10	127

Table 56: Signal Phase Time Survey at Vellara Intersection on 14/05/2017

SIGNAL PHASE TIME SURVEY							
JUNCTION NAME : VELLARA JUNCTION							
DIRECTION:D'SOUZA CIRCLE TO RICHMOND CIRCLE							
DATE:14-5-2017						DAY:SUNDAY	
Time		Observed Time	Cycle Time (s)				
From	To		Green	Red	Amber	Pedestrian	Total
6.00	6.30						
6.30	7.00						
7.00	7.30	7.10	110	50	2	10	172
7.30	8.00	7.30	110	50	2	10	172
8.00	8.30	8.10	110	50	2	10	172
8.30	9.00	8.35	110	50	2	10	172
9.00	9.30	9.00	110	50	2	10	172
9.30	10.00	9.35	110	50	2	10	172
10.00	10.30	10.02	110	50	2	10	172
10.30	11.00	10.35	110	50	2	10	172
11.00	11.30	11.05	120	120	3	10	253
11.30	12.00	11.55	60	120	3	10	193
12.00	12.30	12.15	120	210	3	10	343
12.30	13.00	12.40	110	50	3	10	173
13.00	13.30	13.10	70	40	3	10	123
13.30	14.00	13.40	120	140	3	10	273
14.00	14.30	14.10	110	40	3	10	163
14.30	15.00	14.35	110	50	3	10	173
15.00	15.30	15.15	70	45	2	10	127
15.30	16.00	15.40	60	50	2	10	122
16.00	16.30	16.15	65	80	2	10	157

16.30	17.00	16.30	80	75	2	10	167
17.00	17.30	17.15	50	120	3	10	183
17.30	18.00	17.40	110	180	2	10	302
18.00	18.30	18.20	120	140	2	10	272
18.30	19.00	18.40	130	110	2	10	252
19.00	19.30	19.10	180	50	2	10	242
19.30	20.00	19.30	120	40	2	10	172
20.00	20.30	20.02	50	70	2	10	132
20.30	21.00	20.30	140	40	2	10	192
21.00	21.30	21.02	150	50	2	10	212
21.30	22.00	21.30	90	60	2	10	162

JUNCTION NAME : VELLARA JUNCTION							
DIRECTION: SHIVAJINAGAR TO ADUGODI							
DATE:14-5-2017						**DAY:SUNDAY**	
Time		**Observed Time**	**Cycle Time (s)**				
From	**To**		**Green**	**Red**	**Amber**	**Pedestrian**	**Total**
6.00	6.30						
6.30	7.00						
7.00	7.30	7.10	35	85	2	10	132
7.30	8.00	7.30	35	85	2	10	132
8.00	8.30	8.10	35	85	2	10	132
8.30	9.00	8.50	35	85	2	10	132
9.00	9.30	9.00	35	85	2	10	132
9.30	10.00	9.45	35	85	2	10	132
10.00	10.30	10.10	35	85	2	10	132
10.30	11.00	10.45	35	85	2	10	132
11.00	11.30	11.10	120	50	3	10	183
11.30	12.00	11.3	130	80	2	10	222
12.00	12.30	12.15	125	85	2	10	222
12.30	13.00	12.35	50	145	2	10	207
13.00	13.30	13.10	30	130	2	10	172
13.30	14.00	13.40	90	70	2	10	172
14.00	14.30	14.05	40	180	2	10	232
14.30	15.00	14.35	40	70	2	10	122
15.00	15.30	15.04	30	75	2	10	117
15.30	16.00	15.45	40	75	2	10	127
16.00	16.30	16.20	60	40	2	10	112
16.30	17.00	16.40	30	100	2	10	142
17.00	17.30	17.10	70	170	2	10	252
17.30	18.00	17.40	60	130	2	10	202
18.00	18.30	18.15	60	140	2	10	212
18.30	19.00	18.30	60	100	2	10	172
19.00	19.30	19.00	60	110	2	10	182

19.30	20.00	19.35	40	120	2	10	172
20.00	20.30	20.02	80	50	2	10	142
20.30	21.00	20.35	30	140	2	10	182
21.00	21.30	21.07	50	180	2	10	242
21.30	22.00	21.32	40	130	2	10	182

SIGNAL PHASE TIME SURVEY							
JUNCTION NAME : VELLARA JUNCTION							
DIRECTION: ADUGODI TO SHIVAJINAGAR							
DATE:14-5-2017						**DAY:SUNDAY**	
Time		**Observed Time**	**Cycle Time (s)**				
From	**To**		**Green**	**Red**	**Amber**	**Pedestrian**	**Total**
6.00	6.30						
6.30	7.00	6.35					
7.00	7.30	7.10	35	80	2	10	127
7.30	8.00	7.35	35	80	2	10	127
8.00	8.30	8.03	35	80	2	10	127
8.30	9.00	8.37	35	80	2	10	127
9.00	9.30	9.10	35	80	2	10	127
9.30	10.00	9.35	35	80	2	10	127
10.00	10.30	10.05	35	80	2	10	127
10.30	11.00	10.40	35	80	2	10	127
11.00	11.30	11.15	30	25	1	10	66
11.30	12.00	11.35	65	60	3	10	138
12.00	12.30	12.15	115	55	2	10	182
12.30	13.00	12.40	30	80	2	10	122
13.00	13.30	13.05	35	80	2	10	127
13.30	14.00	13.35	140	115	2	10	267
14.00	14.30	14.05	40	110	2	10	162
14.30	15.00	14.40	40	80	2	10	132
15.00	15.30	15.10	30	80	2	10	122
15.30	16.00	15.35	40	80	2	10	132
16.00	16.30	16.15	60	100	2	10	172
16.30	17.00	16.35	30	80	2	10	122
17.00	17.30	17.10	60	80	2	10	152
17.30	18.00	17.36	80	90	3	10	183
18.00	18.30	18.15	40	90	2	10	142
18.30	19.00	18.33	60	160	2	10	232
19.00	19.30	19.10	70	130	3	10	213
19.30	20.00	19.35	50	100	3	10	163
20.00	20.30	20.05	40	150	2	10	202
20.30	21.00	20.34	60	150	2	10	222
21.00	21.30	21.10	50	160	2	10	222
21.30	22.00	21.35	40	170	2	10	222

Table 57: Signal Phase Time Survey at Vellara Intersection on 18/05/2017

SIGNAL PHASE TIME SURVEY							
JUNCTION NAME : VELLARA JUNCTION							
DIRECTION:D'SOUZA CIRCLE TO RICHMOND CIRCLE							
DATE:18-5-2017						DAY:THURSDAY	
Time		Observed Time	Cycle Time (s)				
From	To		Green	Red	Amber	Pedestrian	Total
6.00	6.30	6.15					
6.30	7.00	06:40	30	50	2	10	92
7.00	7.30	7.10	30	50	2	10	92
7.30	8.00	7.35	120	100	2	10	232
8.00	8.30	8.00	120	100	2	10	232
8.30	9.00	8.40	120	100	2	10	232
9.00	9.30	9.05	120	100	2	10	232
9.30	10.00	9.35	85	54	3	10	152
10.00	10.30	10.05	255	186	2	10	453
10.30	11.00	10.40	225	170	2	10	407
11.00	11.30	11.15	185	170	2	10	367
11.30	12.00	11.35	180	170	2	10	362
12.00	12.30	12.15	180	170	2	10	362
12.30	13.00	12.40	170	140	2	10	322
13.00	13.30	13.05	225	180	2	10	417
13.30	14.00	13.35	250	180	2	10	442
14.00	14.30	14.05	225	180	2	10	417
14.30	15.00	14.40	225	180	2	10	417
15.00	15.30	15.10	50	80	2	10	142
15.30	16.00	15.35	60	70	2	10	142
16.00	16.30	16.15	70	50	2	10	132
16.30	17.00	16.35	80	45	2	10	137
17.00	17.30	17.10	120	40	2	10	172
17.30	18.00	17.36	160	35	2	10	207
18.00	18.30	18.15	100	200	2	10	312
18.30	19.00	18.33	180	40	2	10	232
19.00	19.30	19.10	130	48	2	10	190
19.30	20.00	19.35	180	50	2	10	242
20.00	20.30	20.05	150	40	2	10	202
20.30	21.00	20.34	180	135	2	10	327
21.00	21.30	21.10	120	45	2	10	177
21.30	22.00	21.35	75	50	2	10	137

SIGNAL PHASE TIME SURVEY
JUNCTION NAME : VELLARA JUNCTION
DIRECTION: SHIVAJINAGAR TO ADUGODI

DATE:18-5-2017						DAY:THURSDAY	
Time		Observed Time	Cycle Time (s)				
From	To		Green	Red	Amber	Pedestrian	Total
6.00	6.30						
6.30	7.00	6.40	30	50	2	10	92
7.00	7.30	7.15	30	50	2	10	92
7.30	8.00	7.40	120	100	2	10	232
8.00	8.30	8.10	120	100	2	10	232
8.30	9.00	8.35	120	100	2	10	232
9.00	9.30	9.05	120	100	2	10	232
9.30	10.00	9.40	80	80	2	10	172
10.00	10.30	10.05	160	300	2	10	472
10.30	11.00	10.35	160	280	2	10	452
11.00	11.30	11.10	50	120	2	10	182
11.30	12.00	11.35	50	560	2	10	622
12.00	12.30	12.05	150	300	2	10	462
12.30	13.00	12.35	130	350	2	10	492
13.00	13.30	13.10	150	290	2	10	452
13.30	14.00	13.40	140	330	2	10	482
14.00	14.30	14.10	130	300	2	10	442
14.30	15.00	14.35	140	300	2	10	452
15.00	15.30	15.02	40	80	2	10	132
15.30	16.00	15.30	50	85	2	10	147
16.00	16.30	16.08	40	90	2	10	142
16.30	17.00	16.35	40	80	2	10	132
17.00	17.30	17.00	100	80	2	10	192
17.30	18.00	17.35	100	100	2	10	212
18.00	18.30	18.07	80	80	2	10	172
18.30	19.00	18.35	90	70	2	10	172
19.00	19.30	19.10	40	90	2	10	142
19.30	20.00	19.30	50	60	2	10	122
20.00	20.30	20.10	50	80	2	10	142
20.30	21.00	20.35	40	270	2	10	322
21.00	21.30	21.05	30	60	2	10	102
21.30	22.00	21.30	50	140	2	10	202

SIGNAL PHASE TIME SURVEY							
JUNCTION NAME : VELLARA JUNCTION							
DIRECTION: ADUGODI TO SHIVAJINAGAR							
DATE:18-5-2017						DAY:THURSDAY	
Time		Observed Time	Cycle Time (s)				
From	To		Green	Red	Amber	Pedestrian	Total
6.00	6.30						
6.30	7.00	6.40	20	30	2		52

7.00	7.30	7.12	30	20	2		52
7.30	8.00	7.35	45	90	2	10	147
8.00	8.30	8.15	45	19	2	10	76
8.30	9.00	8.37	45	110	2	10	167
9.00	9.30	9.15	40	200	2	10	252
9.30	10.00	9.30	40	170	2	10	222
10.00	10.30	10.17	40	170	2	10	222
10.30	11.00	10.41	175	255	2	10	442
11.00	11.30	11.10	120	200	2	10	332
11.30	12.00	10.36	150	195	2	10	357
12.00	12.30	12.08	125	300	2	10	437
12.30	13.00	12.39	250	70	2	10	332
13.00	13.30	13.15	240	70	2	10	322
13.30	14.00	13.36	180	190	2	10	382
14.00	14.30	14.14	130	125	2	10	267
14.30	15.00	14.33	155	130	2	10	297
15.00	15.30	15.10	50	75	2	10	137
15.30	16.00	15.35	40	85	2	10	137
16.00	16.30	16.10	45	80	2	10	137
16.30	17.00	16.35	60	145	2	10	217
17.00	17.30	17.10	40	90	2	10	142
17.30	18.00	17.35	48	90	2	10	150
18.00	18.30	18.10	190	100	2	10	302
18.30	19.00	18.35	75	110	2	10	197
19.00	19.30	19.10	60	70	2	10	142
19.30	20.00	19.35	50	270	2	10	332
20.00	20.30	20.05	120	180	2	10	312
20.30	21.00	20.35	120	150	2	10	282
21.00	21.30	21.05	40	110	2	10	162
21.30	22.00	21.35	35	100	2	10	147

Table 58: Dead Green/Wastage of Green Survey at Vellara Intersection on 11/05/2017

WASTE/DEAD GREEN SIGNAL SURVEY			
JUNCTION NAME : VELLARA JUNCTION			
DIRECTION: ADUGODI TO SHIVAJINAGAR			
DATE:11-5-2017			DAY:THURSDAY
Time		Dead Green	Wastage of Green
From	To	Occurred	Occurred
6.00	6.30	-	-
6.30	7.00	-	-
7.00	7.30	-	-
7.30	8.00	-	-
8.00	8.30	-	-
8.30	9.00	-	-

9.00	9.30	-	√
9.30	10.00	-	-
10.00	10.30	-	-
10.30	11.00	-	-
11.00	11.30	-	-
11.30	12.00	-	-
12.00	12.30	-	-
12.30	13.00	-	-
13.00	13.30	-	-
13.30	14.00	-	-
14.00	14.30	-	-
14.30	15.00	-	-
15.00	15.30	-	-
15.30	16.00	-	-
16.00	16.30	-	-
16.30	17.00	-	-
17.00	17.30	-	-
17.30	18.00	-	-
18.00	18.30	-	-
18.30	19.00	-	-
19.00	19.30	-	-
19.30	20.00	-	-
20.00	20.30	-	-
20.30	21.00	-	-
21.00	21.30	-	-
21.30	22.00	-	-

WASTE/DEAD GREEN SIGNAL SURVEY			
JUNCTION NAME : VELLARA JUNCTION			
DIRECTION: SHIVAJINAGAR TO ADUGODI			
DATE:11-5-2017			**DAY:THURSDAY**
Time		**Dead Green**	**Wastage of Green**
From	**To**	**Occurred**	**Occurred**
6.00	6.30	-	-
6.30	7.00	-	√
7.00	7.30	-	√
7.30	8.00	-	√
8.00	8.30	-	√
8.30	9.00	-	√
9.00	9.30	-	-
9.30	10.00	-	-
10.00	10.30	-	-
10.30	11.00	-	-
11.00	11.30	-	-

11.30	12.00	-	-
12.00	12.30	-	-
12.30	13.00	-	-
13.00	13.30	-	√
13.30	14.00	-	-
14.00	14.30	-	-
14.30	15.00	-	-
15.00	15.30	-	-
15.30	16.00	-	-
16.00	16.30	-	-
16.30	17.00	-	-
17.00	17.30	-	-
17.30	18.00	-	-
18.00	18.30	-	-
18.30	19.00	-	-
19.00	19.30	-	-
19.30	20.00	-	-
20.00	20.30	-	-
20.30	21.00	-	√
21.00	21.30	-	-
21.30	22.00	-	√

WASTE/DEAD GREEN SIGNAL SURVEY			
JUNCTION NAME : VELLARA JUNCTION			
DIRECTION: D'SOUZA CIRCLE TO RICHMOND CIRCLE			
DATE:11-5-2017			**DAY:THURSDAY**
Time		**Dead Green**	**Wastage of Green**
From	**To**	**Occurred**	**Occurred**
6.00	6.30	-	-
6.30	7.00	-	√
7.00	7.30	-	√
7.30	8.00	-	-
8.00	8.30	-	-
8.30	9.00	-	-
9.00	9.30	-	-
9.30	10.00	-	-
10.00	10.30	-	-
10.30	11.00	-	-
11.00	11.30	-	-
11.30	12.00	-	-
12.00	12.30	-	-
12.30	13.00	-	-
13.00	13.30	-	-
13.30	14.00	-	-

14.00	14.30	-	-
14.30	15.00	-	-
15.00	15.30	-	-
15.30	16.00	-	-
16.00	16.30	-	-
16.30	17.00	-	-
17.00	17.30	-	-
17.30	18.00	-	-
18.00	18.30	-	-
18.30	19.00	-	-
19.00	19.30	-	-
19.30	20.00	-	-
20.00	20.30	-	-
20.30	21.00	-	-
21.00	21.30	-	-
21.30	22.00	-	-

Table 59: Dead Green/Wastage of Green Survey at Vellara Intersection on 14/05/2017

WASTE/DEAD GREEN SIGNAL SURVEY			
JUNCTION NAME : VELLARA JUNCTION			
DIRECTION: D'SOUZA CIRCLE TO RICHMOND CIRCLE			
DATE:14-5-2017			DAY: SUNDAY
Time		Dead Green	Wastage of Green
From	To	Occurred	Occurred
6.00	6.30	-	-
6.30	7.00	-	-
7.00	7.30	-	√
7.30	8.00	-	√
8.00	8.30	-	-
8.30	9.00	-	-
9.00	9.30	-	-
9.30	10.00	-	-
10.00	10.30	√	-
10.30	11.00	√	-
11.00	11.30	-	-
11.30	12.00	-	-
12.00	12.30	-	-
12.30	13.00	√	-
13.00	13.30	√	-
13.30	14.00	-	-
14.00	14.30	-	-
14.30	15.00	-	-
15.00	15.30	-	-
15.30	16.00	-	-

16.00	16.30	-	-
16.30	17.00	-	-
17.00	17.30	-	-
17.30	18.00	-	-
18.00	18.30	-	-
18.30	19.00	√	-
19.00	19.30	-	-
19.30	20.00	-	-
20.00	20.30	-	-
20.30	21.00	-	-
21.00	21.30	-	-
21.30	22.00	-	-

WASTE/DEAD GREEN SIGNAL SURVEY			
JUNCTION NAME : VELLARA JUNCTION			
DIRECTION: SHIVAJINAGAR TO ADUGODI			
DATE:14-5-2017			**DAY: SUNDAY**
Time		**Dead Green**	**Wastage of Green**
From	**To**	**Occurred**	**Occurred**
6.00	6.30	-	-
6.30	7.00	-	-
7.00	7.30	-	-
7.30	8.00	-	-
8.00	8.30	-	-
8.30	9.00	-	-
9.00	9.30	-	-
9.30	10.00	-	-
10.00	10.30	-	-
10.30	11.00	-	-
11.00	11.30	√	-
11.30	12.00	√	-
12.00	12.30	-	√
12.30	13.00	-	-
13.00	13.30	√	-
13.30	14.00	-	-
14.00	14.30	-	-
14.30	15.00	-	-
15.00	15.30	-	-
15.30	16.00	√	-
16.00	16.30	√	-
16.30	17.00	√	-
17.00	17.30	√	-
17.30	18.00	-	-
18.00	18.30	√	-

18.30	19.00	-	-
19.00	19.30	√	-
19.30	20.00	-	-
20.00	20.30	√	-
20.30	21.00	-	-
21.00	21.30	-	-
21.30	22.00	-	-

WASTE/DEAD GREEN SIGNAL SURVEY			
JUNCTION NAME : VELLARA JUNCTION			
DIRECTION: ADUGODI TO SHIVAJINAGAR			
DATE:14-5-2017			**DAY: SUNDAY**
Time		**Dead Green**	**Wastage of Green**
From	**To**	**Occurred**	**Occurred**
6.00	6.30	-	-
6.30	7.00	-	-
7.00	7.30	-	-
7.30	8.00	-	√
8.00	8.30	-	√
8.30	9.00	-	-
9.00	9.30	-	-
9.30	10.00	-	-
10.00	10.30	-	-
10.30	11.00	-	-
11.00	11.30	-	-
11.30	12.00	-	-
12.00	12.30	-	-
12.30	13.00	-	-
13.00	13.30	-	-
13.30	14.00	-	-
14.00	14.30	-	-
14.30	15.00	-	-
15.00	15.30	-	-
15.30	16.00	-	-
16.00	16.30	-	-
16.30	17.00	-	-
17.00	17.30	-	-
17.30	18.00	-	-
18.00	18.30	-	-
18.30	19.00	-	-
19.00	19.30	-	-
19.30	20.00	-	-
20.00	20.30	-	-
20.30	21.00	-	-

21.00	21.30	-	-
21.30	22.00	-	-

Table 60: Dead Green/Wastage of Green Survey at Vellara Intersection on 18/05/2017

WASTE/DEAD GREEN SIGNAL SURVEY			
JUNCTION NAME : VELLARA JUNCTION			
DIRECTION: D'SOUZA CIRCLE TO RICHMOND CIRCLE			
DATE:18-5-2017			DAY:THURSDAY
Time		Dead Green	Wastage of Green
From	To	Occurred	Occurred
6.00	6.30	-	-
6.30	7.00	-	√
7.00	7.30	-	√
7.30	8.00	-	-
8.00	8.30	-	-
8.30	9.00	-	-
9.00	9.30	-	-
9.30	10.00	-	-
10.00	10.30	-	-
10.30	11.00	-	-
11.00	11.30	-	-
11.30	12.00	-	-
12.00	12.30	-	-
12.30	13.00	-	-
13.00	13.30	-	-
13.30	14.00	-	-
14.00	14.30	-	-
14.30	15.00	-	-
15.00	15.30	-	-
15.30	16.00	-	-
16.00	16.30	-	-
16.30	17.00	-	-
17.00	17.30	-	-
17.30	18.00	-	-
18.00	18.30	-	-
18.30	19.00	-	-
19.00	19.30	-	-
19.30	20.00	-	-
20.00	20.30	-	-
20.30	21.00	-	-
21.00	21.30	-	-
21.30	22.00	-	-

WASTE/DEAD GREEN SIGNAL SURVEY

JUNCTION NAME : VELLARA JUNCTION			
DIRECTION: SHIVAJINAGAR TO ADUGODI			
DATE:18-5-2017			DAY:THURSDAY
Time		Dead Green	Wastage of Green
From	To	Occurred	Occurred
6.00	6.30	-	-
6.30	7.00	-	-
7.00	7.30	-	-
7.30	8.00	-	-
8.00	8.30	-	-
8.30	9.00	√	-
9.00	9.30	√	-
9.30	10.00	-	√
10.00	10.30	√	-
10.30	11.00	√	-
11.00	11.30	-	-
11.30	12.00	√	-
12.00	12.30	√	-
12.30	13.00	-	-
13.00	13.30	√	-
13.30	14.00	√	-
14.00	14.30	√	-
14.30	15.00	√	-
15.00	15.30	-	-
15.30	16.00	-	-
16.00	16.30	-	-
16.30	17.00	-	-
17.00	17.30	-	-
17.30	18.00	√	-
18.00	18.30	√	-
18.30	19.00	-	-
19.00	19.30	-	-
19.30	20.00	-	-
20.00	20.30	√	-
20.30	21.00	√	-
21.00	21.30	-	-
21.30	22.00	√	-

WASTE/DEAD GREEN SIGNAL SURVEY			
JUNCTION NAME : VELLARA JUNCTION			
DIRECTION: ADUGODI TO SHIVAJINAGAR			
DATE:18-5-2017			DAY:THURSDAY
Time		Dead Green	Wastage of Green
From	To	Occurred	Occurred

6.00	6.30	-	-
6.30	7.00	-	√
7.00	7.30	-	√
7.30	8.00	-	-
8.00	8.30	-	-
8.30	9.00	-	-
9.00	9.30	-	-
9.30	10.00	-	-
10.00	10.30	-	-
10.30	11.00	-	-
11.00	11.30	-	-
11.30	12.00	-	-
12.00	12.30	-	-
12.30	13.00	-	-
13.00	13.30	-	-
13.30	14.00	-	-
14.00	14.30	-	-
14.30	15.00	-	-
15.00	15.30	-	-
15.30	16.00	-	-
16.00	16.30	-	-
16.30	17.00	-	-
17.00	17.30	-	-
17.30	18.00	-	-
18.00	18.30	-	-
18.30	19.00	-	-
19.00	19.30	-	-
19.30	20.00	-	-
20.00	20.30	-	-
20.30	21.00	-	-
21.00	21.30	-	-
21.30	22.00	-	-

Table 61: Passing Vehicle Count Survey at Vellara Intersection on 11/05/2017

PASSING VEHICLE COUNT SURVEY

JUNCTION NAME : VELLARA JUNCTION																			
DIRECTION: ADUGODI TO SHIVAJINAGAR																			
DATE:11-5-2017												**DAY:THURSDAY**							
Time		**Total Vehicle Count (s)**																	
From	**To**	**10**	**10**	**10**	**10**	**10**	**10**	**10**	**10**	**10**	**10**	**10**	**10**	**10**	**10**	**10**	**10**	**10**	**Total**
6.00	6.30																		
6.30	7.00	10	12																22
7.00	7.30	11	15																26

7.30	8.00	15	9	16	22															62
8.00	8.30	23	19	13	10															65
8.30	9.00	25	11	9	23															68
9.00	9.30	32	24	12	0															68
9.30	10.00	21	19	23	20	19														102
10.00	10.30	24	24	13	20	20														101
10.30	11.00	32	22	17	22															93
11.00	11.30	23	17	21	19	18	21													119
11.30	12.00	23	20	10	7	23	16	19	22	24	20	18	21	9	18	14	11			275
12.00	12.30	26	23	17	16	16	18	22	21											159
12.30	13.00	17	18	10	15	12	21	16	26	16	18	13	11	15	8					216
13.00	13.30	17	22	12	18	21														90
13.30	14.00	35	19	9	5	15														83
14.00	14.30	16	15	15	15	10														71
14.30	15.00	18	10	14	10	10														62
15.00	15.30	15	18	12	20															65
15.30	16.00	14	13	9	10															46
16.00	16.30	26	23	20	10															79
16.30	17.00	26	30	22	20	11	18	12	15	17	22	25	19	17	16					270
17.00	17.30	26	18	21	18	15	21	10	19	21	24	12	17	15	14	18	11	10	9	299
17.30	18.00	22	12	15	20	23	32	16	24											164
18.00	18.30	32	15	12	13	20	21	6	12	11	18	8	11	9	11	7				206
18.30	19.00	28	17	22	19	14	17	13	12											142
19.00	19.30	24	21	19	17	16	11	9	15											132
19.30	20.00	22	14	7	9	12	14	13	14	11										116
20.00	20.30	17	20	14	19	17	14	12	10	9	11	7	11							161
20.30	21.00	32	25	19	17	20	19	18	12	14	10	11								197
21.00	21.30	19	17	13	15	14														78
21.30	22.00	22	19	14	9															64

PASSING VEHICLE COUNT SURVEY

JUNCTION NAME : VELLARA JUNCTION																
DIRECTION: SHIVAJINAGAR TO ADUGODI																
DATE:11-5-2017											DAY:THURSDAY					
Time		Total Vehicle Count (s)														
From	To	10	10	10	10	10	10	10	10	10	10	10	10	10	10	Total
6.00	6.30															
6.30	7.00	10	2	0												12
7.00	7.30	10	7	0												17
7.30	8.00	13	35	16	9											73
8.00	8.30	27	18	6	2											53
8.30	9.00	16	13	12	8											49
9.00	9.30	19	31	6	9											65
9.30	10.00	21	25	12	2											60
10.00	10.30	32	25	28	18	22	21	19	17	25	15					222
10.30	11.00	36	29	12	15											92
11.00	11.30	16	9	13	19	11										68
11.30	12.00	18	14	19	17	15										83
12.00	12.30	13	21	10	9	11										64
12.30	13.00	23	25	43	22	20	14	16	10	17	11	12				213
13.00	13.30	32	16	19	0	0	7	18	9	12	8	9	7			137
13.30	14.00	17	21	19	18											75
14.00	14.30	15	14	23	12	7	9	20								100
14.30	15.00	21	28	17	4	8	7	9	10	7	5					116
15.00	15.30	12	23	22	8	15	20	12	9							121
15.30	16.00	15	21	15	8											59
16.00	16.30	13	21	27	20	13	0	5	4	0						103
16.30	17.00	18	23	20	15											76
17.00	17.30	17	20	18	10	13	15	8	2	6	7	8	4			128
17.30	18.00	32	24	26	22	15	8									127
18.00	18.30	20	24	20	30	7										101
18.30	19.00	26	30	23	10	5										94
19.00	19.30	23	22	18	10											73
19.30	20.00	23	29	17	20	14	11	8	7	8	6					143
20.00	20.30	18	26	23	18	15	10	27	17	22	20	16	18	15	11	256
20.30	21.00	15	30	22	11	10	4									92
21.00	21.30	20	15	20												55
21.30	22.00	12	6	7	3	0										28

PASSING VEHICLE COUNT SURVEY

JUNCTION NAME : VELLARA JUNCTION

DIRECTION: D'SOUZA CIRCLE TO RICHMOND CIRCLE

DATE:11-5-2017 **DAY:THURSDAY**

Time		Total Vehicle Count (s)																													
From	To	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	Total
6.00	6.30																														
6.30	7.00	4	6	3																											13
7.00	7.30	7	7	8																											22
7.30	8.00	10	26	10	22	22	17	21	22	15	26	24	25																		240
8.00	8.30	8	21	11	12	6	5	16	30	17	15	18	21																		180
8.30	9.00	10	16	14	26	20	26	15	6	11	15	12	18																		189
9.00	9.30	15	10	19	11	20	21	26	22	12	15	16	18	16	14	26	20	26	15	6	11	14									205
9.30	10.00	20	25	20	20	25	21	24	16	22	24	18	17	23	22	27	33	25	18	27	13	10									252
10.00	10.30	21	17	16	17	20	31	22	20	20	19	23	20	16	20	23	20	15	18	24	26	11	15	10	27	22	17				246
10.30	11.00	16	22	14	22	22	28	17	8	16	22	22	23																		232
11.00	11.30	21	23	30	22	25	13	13	17	16	11																				191
11.30	12.00	10	18	19	18	20	17	18	24	25	26	22	20																		237
12.00	12.30	8	16	22	22	23	15	21	19	20	19	23	20	16	20	23	20	13	19	21	25										228
12.30	13.00	10	11	23	21	23	22	27	33	25	18	27	13	17	31	19	16	15	23	16	20										253
13.00	13.30	23	21	21	19	26	25	16	21	18	19	21	12																		242
13.30	14.00	20	25	21	10	12																									88
14.00	14.30	13	21	13	10	11																									68
14.30	15.00	18	25	20	22																										85
15.00	15.30	25	27	22	24	15	18	17	20																						168
15.30	16.00	22	28	18	28	27	17	20	22																						182
16.00	16.30	25	20	20	21	22	17	18	24	25	26	22	20																		260
16.30	17.00	20	21	21	23																										85

17.00	17.30	20	10	21	20	23	16	20	23	20	18	15	13	14	12	18	22	28	12	15	22	20	15	11	10	17	19	15	17		219
17.30	18.00	10	27	12	30	28	26	19	20	15	11	12	15	17	22	10	15	18	24	26	11	15	17	11	10	19	16	15	14	11	225
18.00	18.30	25	13	8	17	13	22	18	18	14	17	22	25	12																	212
18.30	19.00	28	10	12	30	25	23	21	25	12	16	18	20																		240
19.00	19.30	10	27	12	30	28	26	19	20	15	17	22	10	15	18	24	26	11	15	17	11										236
19.30	20.00	20	19	23	20	16	20	23	20	15	18	24	26	11	15	10	27	12	30	28	26	11									244
20.00	20.30	10	27	12	30	28	26	19	20	15	11	12	15	17	22	10	15	18	24	26	11	15	17	11	10	19	16	15	14	11	225
20.30	21.00	20	17	16	18	28	20	17	18	11	15	16	21	9	10	11															217
21.00	21.30	16	11	19	16	16	14																								92
21.30	22.00	12	16	15	12	10	12																								77

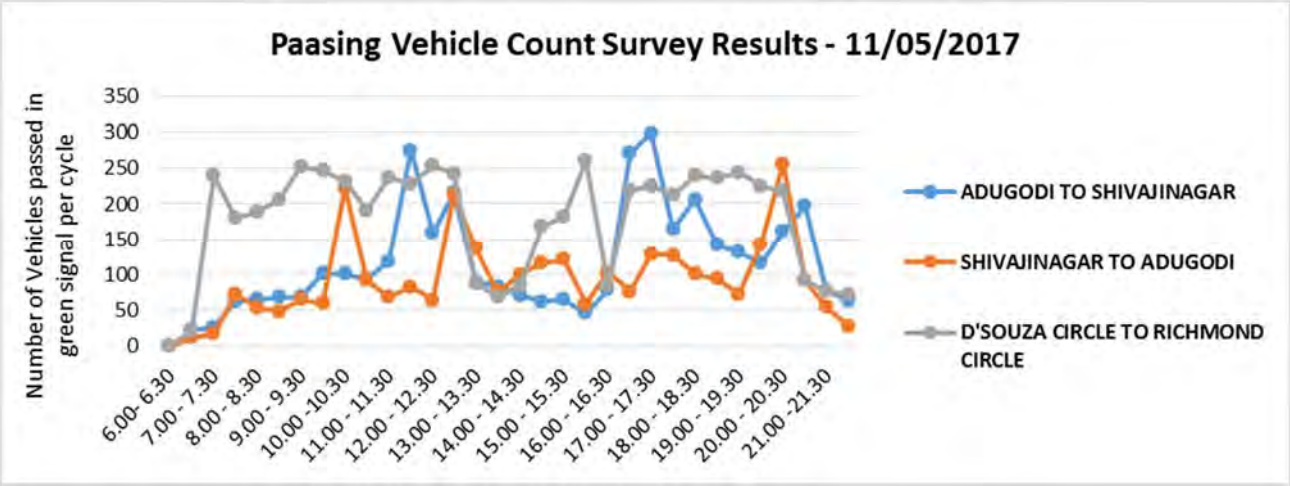


Figure 19: Passing Vehicles at Vellara Intersection on 11/05/2017

Table 62: Passing Vehicle Count Survey at Vellara Intersection on 14/05/2017

PASSING VEHICLE COUNT SURVEY																		
JUNCTION NAME : VELLARA JUNCTION																		
DIRECTION: D'SOUZA CIRCLE TO RICHMOND CIRCLE																		
DATE:14-5-2017																DAY:SUNDAY		
Time		Observed Time	Total Vehicle Count (s)															
From	To		10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	Total
6.00	6.30																	
6.30	7.00																	
7.00	7.30	7.10	9	12	18	13	12	4	5	3	4	1						81
7.30	8.00	7.30	10	15	8	2	2	0	2	0	0	0						39
8.00	8.30	8.10	11	13	19	7	12	7	3	1	2	0						75
8.30	9.00	8.35	8	16	10	10	7	12	14	16	14	13						120
9.00	9.30	9.00	15	18	14	11	11	12	8	7	9	5						110
9.30	10.00	9.35	6	20	15	24	20	11	6	5	4	3						114
10.00	10.30	10.02	13	24	20	17	6	7	5	3	4	1						100
10.30	11.00	10.35	23	24	16	25	30	11	1	0	0	0						130
11.00	11.30	11.05	16	22	20	18	18	26	19	22	24	20	17	19				241
11.30	12.00	11.55	17	17	25	26	29	31	18	17	17	19	18	16				250
12.00	12.30	12.15	20	25	30	14	14	22	17	15	14	12	11	9				203
12.30	13.00	12.40	0	0	16	15	9	27	23	21	19	17	15					162
13.00	13.30	13.10	19	20	18	19	21	22	8									127
13.30	14.00	13.40	16	21	21	24	14	26	19	9	8	7	4	8				177
14.00	14.30	14.10	18	18	17	30	8	9	11	12	10	6	9					148
14.30	15.00	14.35	8	20	22	15	11	11	8									95
15.00	15.30	15.15	18	17	15	16	11	8	10									95
15.30	16.00	15.40	20	17	20	16	14	19										106

16.00	16.30	16.15	25	22	19	14	21	17										118
16.30	17.00	16.30	30	22	19	20	14	25	19									149
17.00	17.30	17.15	24	19	20	17	14											94
17.30	18.00	17.40	25	24	20	25	14	21	17	25	18	19	21					229
18.00	18.30	18.20	30	27	18	22	19	23	20	17	25	19	17	20				257
18.30	19.00	18.40	30	29	18	27	24	19	14	22	18	23	21	19	20			284
19.00	19.30	19.10	27	19	22	14	13	22	19	18	20	21	20	19	20	14	17	285
19.30	20.00	19.30	19	22	14	22	23	19	18	11	17	18	16	19				218
20.00	20.30	20.02	22	19	20	14	25											100
20.30	21.00	20.30	22	20	19	14	11	17	20	19	14	12	13	8	11	9	6	215
21.00	21.30	21.02	27	19	13	10	15	19	14	20	22	26	19	18	17	14	19	272
21.30	22.00	21.30	25	14	17	20	14	13	9	7	11							130

PASSING VEHICLE COUNT SURVEY												
JUNCTION NAME : VELLARA JUNCTION												
DIRECTION: SHIVAJINAGAR TO ADUGODI												
DATE:14-5-2017											DAY:SUNDAY	
Time		Observed Time	Total Vehicle Count (s)									
From	To		10	10	10	10	10	10	10	10	10	Total
6.00	6.30											
6.30	7.00											
7.00	7.30	7.10	22	4	6	1						33
7.30	8.00	7.30	15	8	4	5						32
8.00	8.30	8.10	8	6	3	2						19
8.30	9.00	8.50	11	10	5							26
9.00	9.30	9.00	26	11	4	1						42
9.30	10.00	9.45	42	8	6	2						58
10.00	10.30	10.10	36	12	3							51
10.30	11.00	10.45	24	17	11	5						57
11.00	11.30	11.10										0
11.30	12.00	11.3	16									16
12.00	12.30	12.15	18	16	12							46
12.30	13.00	12.35	22	34	11	8	2					77
13.00	13.30	13.10	13	32								45
13.30	14.00	13.40	13	14	4	2	12	11	6	9	8	79
14.00	14.30	14.05	16	17	31	5						69
14.30	15.00	14.35	19	13	10	17	1					60
15.00	15.30	15.04	14	13	15							42
15.30	16.00	15.45	12	9	7	11						39
16.00	16.30	16.20	12	8	11	12						43
16.30	17.00	16.40	27	20	14	9						70
17.00	17.30	17.10	20	19	15	10	9	12	18			103
17.30	18.00	17.40	24	15	13	17	18	20				107
18.00	18.30	18.15	20	14	12	17	18	12				93
18.30	19.00	18.30	27	19	18	20	14	20				118
19.00	19.30	19.00	19	20	9	11	8	21				88
19.30	20.00	19.35	22	19	20	17						78
20.00	20.30	20.02	23	18	22	11	9	12	13			108
20.30	21.00	20.35	22	19	13							54
21.00	21.30	21.07	24	18	22	11	14					89
21.30	22.00	21.32	22	24	19	14						79

PASSING VEHICLE COUNT SURVEY																		
JUNCTION NAME : VELLARA JUNCTION																		
DIRECTION: ADUGODI TO SHIVAJINAGAR																		
DATE:14-5-2017																DAY:SUNDAY		
Time		Observed Time	Total Vehicle Count (s)															
From	To		10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	Total
6.00	6.30																	
6.30	7.00	6.35																
7.00	7.30	7.10	17	8	8	7												40
7.30	8.00	7.35	18	12	11	6												47
8.00	8.30	8.03	14	9	6	7												36
8.30	9.00	8.37	21	16	14	7												58
9.00	9.30	9.10	28	15	12	13												68
9.30	10.00	9.35	21	15	6	5												47
10.00	10.30	10.05	21	12	6	1												40
10.30	11.00	10.40	11	17	4	5												37
11.00	11.30	11.15	14	12	9													35
11.30	12.00	11.35	9	12	15	9	15	17	3									80
12.00	12.30	12.15	19	18	17	17	16	13	10	11	12	9	14	11				167
12.30	13.00	12.40	26	17	8													51
13.00	13.30	13.05	26	17	8													51
13.30	14.00	13.35	18	12	6	13	11	12	11	5	9	12	9	13	11	8		150
14.00	14.30	14.05	12	12	9	10												43
14.30	15.00	14.40	13	14	9	11												47
15.00	15.30	15.10	12	10	8													30
15.30	16.00	15.35	22	18	17	14												71
16.00	16.30	16.15	24	19	22	17	14	15										111
16.30	17.00	16.35	22	17	19													58

17.00	17.30	17.10	30	22	24	23	17	19										135
17.30	18.00	17.36	22	19	24	25	14	20	17	14								155
18.00	18.30	18.15	27	20	19	22												88
18.30	19.00	18.33	28	19	24	23	17	15										126
19.00	19.30	19.10	24	17	13	20	18	23	25									140
19.30	20.00	19.35	13	18	26	18	16											91
20.00	20.30	20.05	22	19	22	13												76
20.30	21.00	20.34	22	19	18	25	17	25										126
21.00	21.30	21.10	25	22	18	29	17											111
21.30	22.00	21.35	22	27	19	14												82

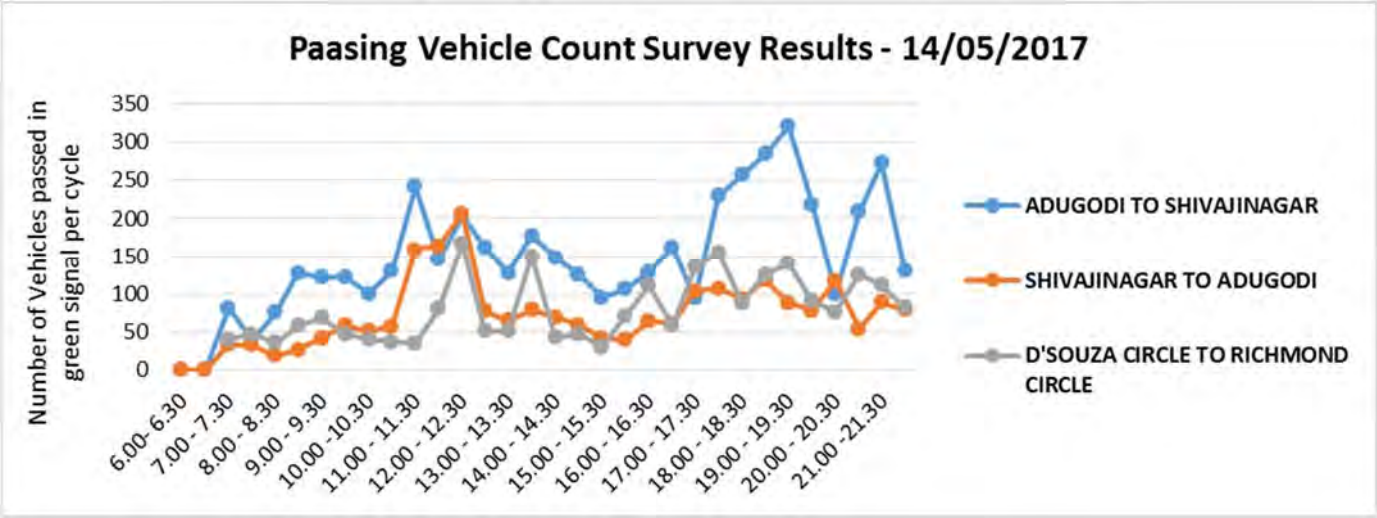


Figure 20: Passing Vehicles at Vellara Intersection on 14/05/2017

Table 63: Passing Vehicle Count Survey at Vellara Intersection on 18/05/2017

PASSING VEHICLE COUNT SURVEY																		
JUNCTION NAME : VELLARA JUNCTION																		
DIRECTION: D'SOUZA CIRCLE TO RICHMOND CIRCLE																		
DATE:18-5-2017																	DAY:THURSDAY	
Time		Observed Time	Total Vehicle Count (s)															
From	To		10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	Total
6.00	6.30	6.15																
6.30	7.00	06:40	5	11	7													23
7.00	7.30	7.10	16	14	7													37
7.30	8.00	7.35	9	3	3	5	11	20	14	3	4	6	8	12				98
8.00	8.30	8.00	20	16	14	21	16	5	1	0	0	0	0	0				93
8.30	9.00	8.40	24	22	20	18	21	22	32	18	23	15	16	19				250
9.00	9.30	9.05	26	21	24	27	19	13	12	17	9	19	20	16				223
9.30	10.00	9.35	18	21	18	14	32	28	21	25								177
10.00	10.30	10.05	21	22	23	28	21	24	31	26	36	11	22	21	16	15	10	327
10.30	11.00	10.40	24	29	17	27	32	28	38	19	21	16	19	25	17	16	14	342
11.00	11.30	11.15	18	21	33	28	32	20	19	26	32	18	12	21	22	26	28	356
11.30	12.00	11.35	19	15	19	22	31	22	28	36	18	20	16	18	26	22	24	336
12.00	12.30	12.15	20	14	22	22	24	30	26	18	8	18	17	19	26	32	18	314
12.30	13.00	12.40	20	18	22	12	8	7	6	4	10	18	14	22	16	24	8	209
13.00	13.30	13.05	24	26	20	18	16	18	19	23	21	28	29	32	36	42	22	374
13.30	14.00	13.35	11	18	34	36	27	25	31	21	18	21	32	36	22	19	18	369
14.00	14.30	14.05	13	27	18	14	20	20	17	13	11	15	15	17	14	17	11	242
14.30	15.00	14.40	16	10	11	18	14	27	14	17	21	19	15	13	16	7	9	227
15.00	15.30	15.10	18	20	24	19	18											99
15.30	16.00	15.35	25	19	21	17	13	20										115
16.00	16.30	16.15	23	18	20	19	22	23	20									145

16.30	17.00	16.35	24	27	23	19	20	25	23	18								179
17.00	17.30	17.10	23	27	19	17	20	14	22	25	19	20	17	13				236
17.30	18.00	17.36	22	17	19	23	17	20	18	17	20	18	14	19	16	13	11	264
18.00	18.30	18.15	23	19	20	17	22	20	24	18	20	22	18	20	24	19	16	302
18.30	19.00	18.33	24	22	17	20	18	19	23	20	19	18	18	20	24	19	18	299
19.00	19.30	19.10	22	20	19	22	23	17	18	20	19	17	12	16	14			239
19.30	20.00	19.35	24	27	18	23	22	19	16	17	15	13	15	13	11	8	6	247
20.00	20.30	20.05	27	24	22	19	13	17	20	19	14	18	16	18	13	11	10	261
20.30	21.00	20.34	25	22	24	19	17	16	20	14	18	13	15	17	11	10	8	249
21.00	21.30	21.10	23	19	14	15	18	20	19	14	21	19	14	17				213
21.30	22.00	21.35	22	17	14	18	20	19	20	21								151

PASSING VEHICLE COUNT SURVEY

JUNCTION NAME : VELLARA JUNCTION

DIRECTION: SHIVAJINAGAR TO ADUGODI

DATE:18-5-2017 **DAY:THURSDAY**

Time		Observed Time	Total Vehicle Count (s)															
From	To		10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	Total
6.00	6.30																	
6.30	7.00	6.40	18	9	8													35
7.00	7.30	7.15	21	12														33
7.30	8.00	7.40	21	8	3	9	0	2	4	6	9	8	4	6				80
8.00	8.30	8.10	17	9	6	5	11	10	7	13	16	5	7	8				114
8.30	9.00	8.35	12	2	9	11	7	12	20	13	17	11	10	7				131
9.00	9.30	9.05	10	25	22	26	18	15	11	10	9	12	10	12				180
9.30	10.00	9.40	15	30	21	12	7	11	7	16								119
10.00	10.30	10.05	38	33	24	16	15	20	22	14	9	11	7	12	14	8	16	259
10.30	11.00	10.35	37	22	24	24	18	22	24	19	20	17	16	10	15	12	9	289

11.00	11.30	11.10	24	15	34	19	8											100
11.30	12.00	11.35	17	34	45	22	26											144
12.00	12.30	12.05	26	19	20	17	9	8	12	11	10	16	18	14	9	11	7	207
12.30	13.00	12.35	15	24	38	27	18	14	15	21	12	17	9	8	11			229
13.00	13.30	13.10	23	19	7	22	24	18	16	15	20	22	14	9	11	7	12	239
13.30	14.00	13.40	21	18	14	23	37	22	24	18	22	24	19	20	17	16		295
14.00	14.30	14.10	26	19	20	14	23	22	19	17	20	18	11	9	13			231
14.30	15.00	14.35	15	17	14	11	9	20	21	18	11	10	16	18	14	12		206
15.00	15.30	15.02	15	18	14	17												64
15.30	16.00	15.30	20	14	15	13												62
16.00	16.30	16.08	22	28	19	17	14											100
16.30	17.00	16.35	27	30	18	9	2											86
17.00	17.30	17.00	24	27	19	23	17	20	14	19	20	17						200
17.30	18.00	17.35	22	15	20	22	14	9	11	7	12	20						152
18.00	18.30	18.07	22	24	19	20	17	9	8	12								131
18.30	19.00	18.35	24	20	14	23	22	19	17	20	18							177
19.00	19.30	19.10	22	19	20	17												78
19.30	20.00	19.30	24	23	21	19	17											104
20.00	20.30	20.10	18	14	19	8	12											71
20.30	21.00	20.35	15	19	11	9												54
21.00	21.30	21.05	20	17	18													55
21.30	22.00	21.30	10	7	3	5	18											43

PASSING VEHICLE COUNT SURVEY			
JUNCTION NAME : VELLARA JUNCTION			
DIRECTION: ADUGODI TO SHIVAJINAGAR			
DATE:18-5-2017			**DAY:THURSDAY**
Time	**Observed**	**Total Vehicle Count (s)**	

From	To	Time	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	Total
6.00	6.30																										
6.30	7.00	6.40	18	13																							31
7.00	7.30	7.12	11	23	12																						46
7.30	8.00	7.35	23	9	8	20	12																				72
8.00	8.30	8.15	20	18	13	14	9																				74
8.30	9.00	8.37	17	21	9	6	7																				60
9.00	9.30	9.15	20	23	21	27																					91
9.30	10.00	9.30	27	25	20	14																					86
10.00	10.30	10.17	27	28	30	19																					104
10.30	11.00	10.41	32	26	21	9	30	15	19	19	23	16	17	18	22	18	19	11	9	7							331
11.00	11.30	11.10	26	32	12	19	15	8	4	16	12	14	13	14													185
11.30	12.00	10.36	21	15	19	26	24	15	15	13	16	14	13	17	13	12	15										248
12.00	12.30	12.08	15	25	15	16	32	12	30	11	10	11	14	13	11												215
12.30	13.00	12.39	18	16	15	15	12	18	14	11	18	11	13	9	10	11	18	21	15	19	26	24	15	15	13	16	373
13.00	13.30	13.15	21	12	10	12	18	17	25	15	19	18	19	17	15	19	16	19	18	20	19	23	17	22	16		407
13.30	14.00	13.36	14	22	21	6	8	13	10	15	7	9	11	13	7	17	12	10	9								204
14.00	14.30	14.14	8	18	12	19	24	12	16	8	3	7	9	8	5												149
14.30	15.00	14.33	18	11	20	13	10	10	15	9	6	7	11	9	14	16	13	11									193
15.00	15.30	15.10	22	18	14	17	19																				90
15.30	16.00	15.35	18	17	20	19																					74
16.00	16.30	16.10	22	19	23	21	19																				104
16.30	17.00	16.35	25	23	18	14	21	17																			118
17.00	17.30	17.10	27	25	23	17																					92
17.30	18.00	17.35	27	18	22	19	20																				106
18.00	18.30	18.10	22	20	19	18	20	19	23	17	22	16	15	15	12	18	14	11	18	11	13						323
18.30	19.00	18.35	22	23	19	18	20	19	20	9																	150
19.00	19.30	19.10	23	20	17	21	18	20																			119
19.30	20.00	19.35	25	22	19	14	18																				98

20.00	20.30	20.05	19	20	18	17	20	19	14	15	12	12	19	15													200
20.30	21.00	20.35	33	25	19	22	14	18	13	19	13	19	26	24													245
21.00	21.30	21.05	20	19	17	13																					69
21.30	22.00	21.35	22	17	14	12																					65

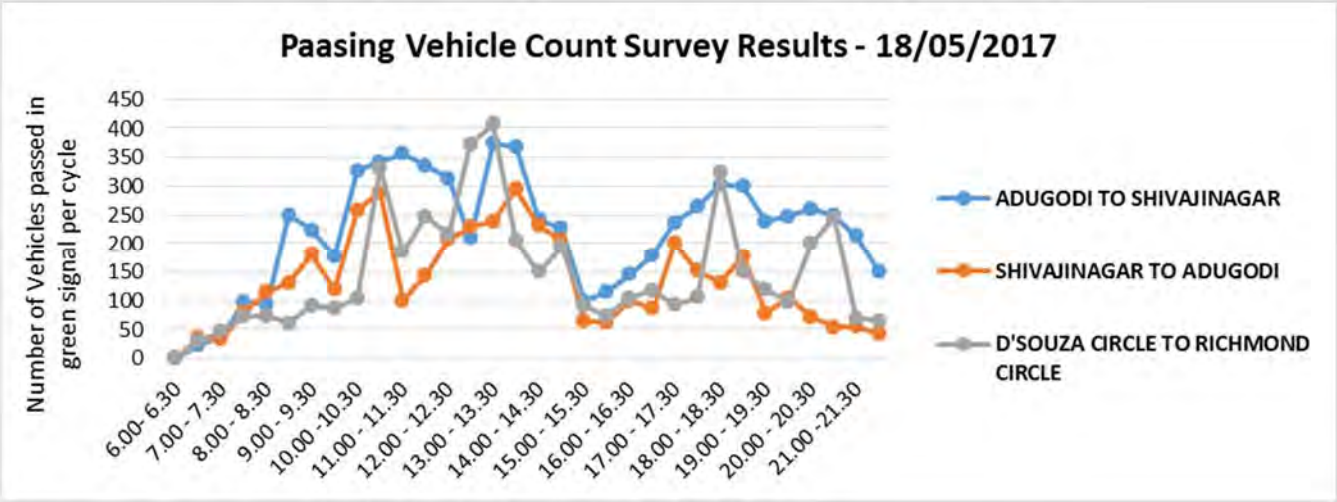


Figure 21: Passing Vehicles at Vellara Intersection on 18/05/2017

資料　7-2

試掘調査報告書

PREPARATORY SURVEY
ON THE PROJECT
FOR
BENGALURU METROPOLITAN REGION ITS
IN
THE REPUBLIC OF INDIA

TEST PIT SURVEY REPORT

AUGUST 2017

JAPAN INTERNATIONAL COOPERATION AGENCY

NIPPON KOEI CO., LTD.

EAST NIPPON EXPRESSWAY COMPANY LIMITED

Test Pit Survey Report

1. General

JICA Study Team performed the Test Pit Survey (hereinafter referred to as **"Trial Digging"**) activity to know the status of underground facility (existing communication cables, power line and water supply pipes, etc.) at Signal pole and VMS foundation locations. Trial digging is the part preparatory survey to decide the location for Signal pole and VMS foundation. The underground facility clear known status shall be useful in future for construction.

2. Location Finalization

JICA Study Team conducted all field survey with twenty nine (29) signals (signalized intersection) and locations of three (3) VMS. The underground facility survey of proposed locations was confirmed by **"Pipe-Locator"**. The JICA Study Team sorted the issue at some locations by relocating the as per the site feasibility. The JICA Study Team didn't find any alternate at seven (7) signals and one (1) VMS foundation location. These locations were chosen for the trial digging to know the underground facility status. The below mentioned tables represents the locations decided for trial digging:

No	Test Pit Location (Junction Location)	Road Name	Proposed ITS Component	No. of Pits
1	Begum Mahal Junction, Ulsoor	Old Madras Road	Area Traffic Signal Control System (ATCC)	1
2	Tamari kannan Junction, Ulsoor	Old Madras Road	Area Traffic Signal Control System (ATCC)	1
3	Anjeneya temple Junction, Ulsoor	Old Madras Road	Area Traffic Signal Control System (ATCC)	2
4	OM Rd & Indiranagar 100ft Junction, Old Madras Road	Old Madras Road	Area Traffic Signal Control System (ATCC)	1
5	D'souza Circle Junction, Ashok Nagar	MG Road	Area Traffic Signal Control System (ATCC)	1
6	Anil Kumble Circle	MG Road	Area Traffic Signal Control System (ATCC)	1
7	Near Trinity Metro Station	MG Road	Variable Message Sign System (VMS)	1

Note; The dimensions of test pit are as follows:

1) Signal Pole (Area Traffic Signal Control System)
   = 1.0m (Length) x 1.0m (Width) x 2.0m (Depth)
2) VMS Foundation (Variable Message Sign System)
   = 2.5m (Length) x 4.0m (Width) x 3.0m (Depth)

3. Trial Digging Approval

Trial digging locations were proposed at major traffic junctions inside the city area. The prior approval from BBMP (Bangalore city Municipality) and Police was required to perform it. JICA Study Team applied for the approval request through DULT. BBMP approved only five (5) Signal Locations and one (1) VMS locations for trial digging. The two (2) Junctions- Anil Kumble junction and D'souza Circle junction were recently constructed. Hence trial digging not approved for these two (2) locations.

The Law and order police approved the excavation request. They instructed to execute the work at night time only because of heavy traffic in day time.

The below mentioned table has the final locations decided for trial digging with pit dimension:

No	Test Pit Location (Junction Location)	Road Name	No. of Pits	Pit dimension (Length x Width x Depth)
1	Begum Mahal Junction, Ulsoor	Old Madras Road	1	1.0m x 1.0m x 2.0m
2	Tamari kannan Junction, Ulsoor	Old Madras Road	1	1.0m x 1.0m x 2.0m
3	Anjeneya temple Junction, Ulsoor	Old Madras Road	2	1.0m x 1.0m x 2.0m
4	OM Rd & Indiranagar 100ft Junction, Old Madras Road	Old Madras Road	1	1.0m x 1.0m x 2.0m
5	Near Trinity Metro Station	MG Road	1	2.5m X 4.0m X3.0m

4. Trial Digging Subcontractor

JICA Study Team hired the Subcontractor "**Sai-Trisha Infra-engineering Pvt Ltd"** to execute the trial digging works.

The scope of works of Subcontractor are as follows:

a) The construction site is surrounded by security facilities (barricades & safety rope).
b) Removing the existing concrete tiles, concrete pavement and cubble stones from the proposed excavation location.
c) Manual pit excavation with carefully handling of underground facility.
d) The survey by JICA Study Team.
e) Backfilling of excavated Pit.
f) Restoration of the original condition of footpath (concrete tiles, concrete pavement & cubble stone)

5. Execution of Work

The trial execution started on 08th Aug 2016. The subcontrctor with prpoer safety arrangement started the manually excavtion work.

The location wise survey detail and underground facility are mentioned below:

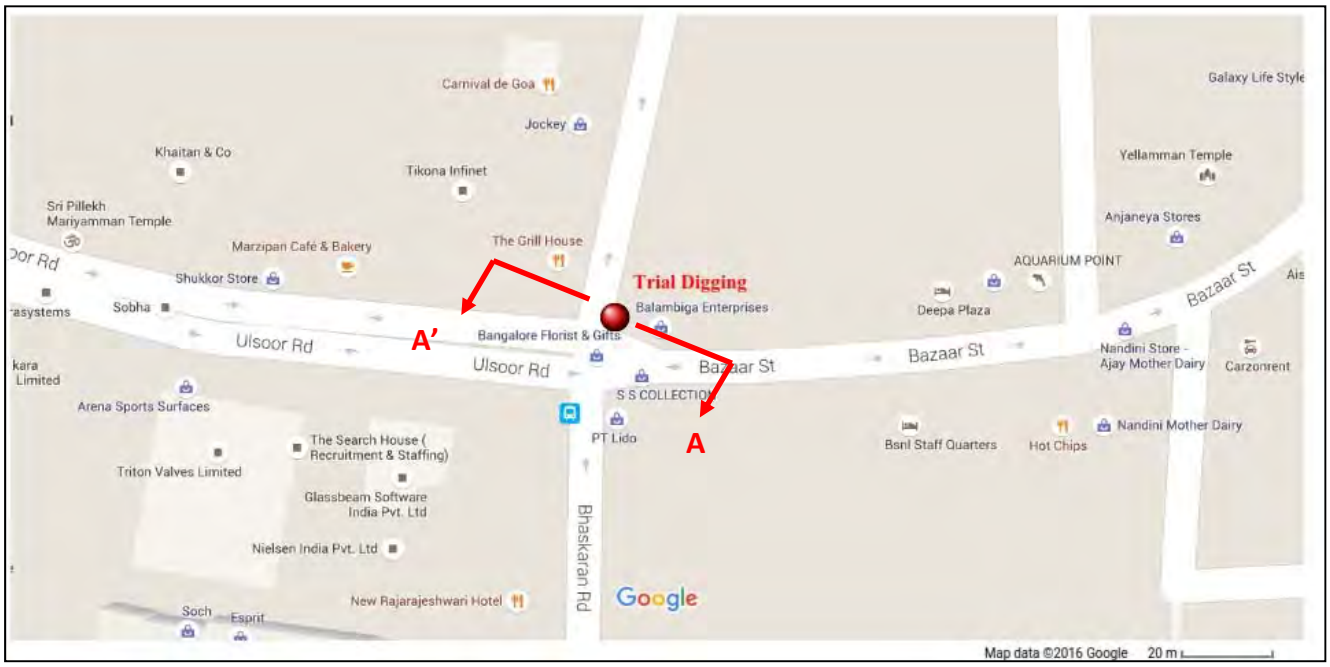
6. Trial Digging Result

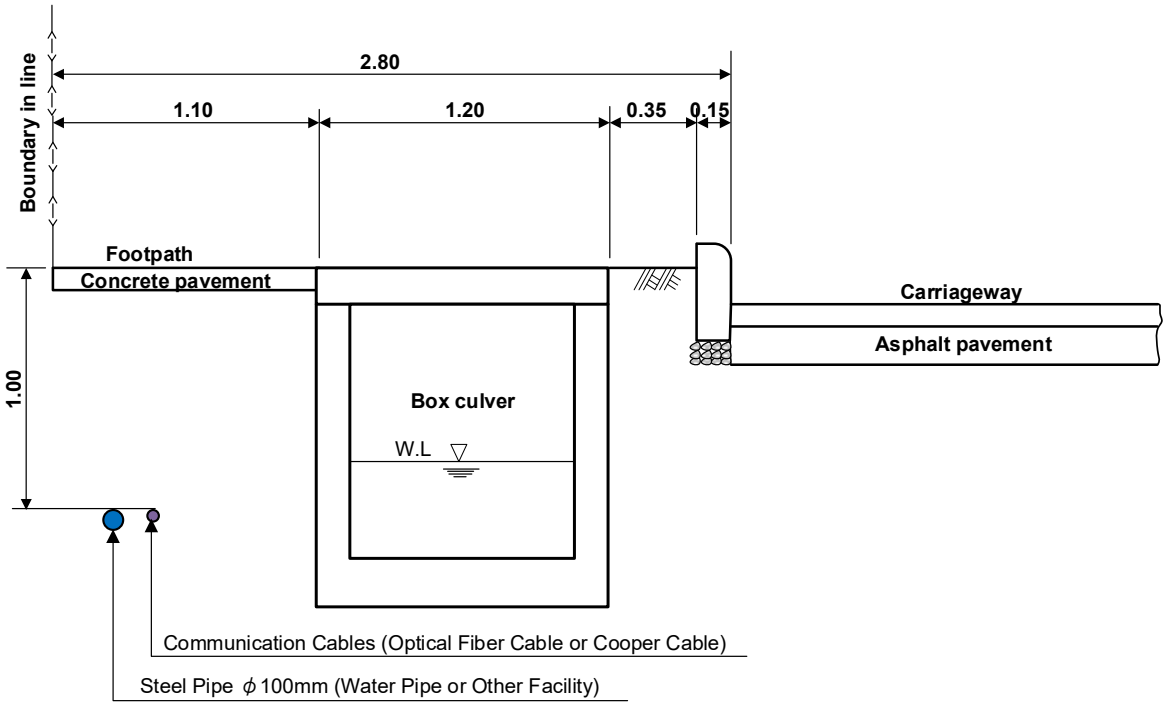
The result of trial digging is mentioned under the respective location.

6.1 Begum Mahal Junction

There were steel pipe and communication cable were found on 1.0m depth. We kept continue digging below 1.0m depth there were no utility found up to 2.0m depth.The location was checked properly by JICA Study Team and backfilled by Subcontractor.

The site survey location and survey pohtographs are shown in below:





SECTION A – A'

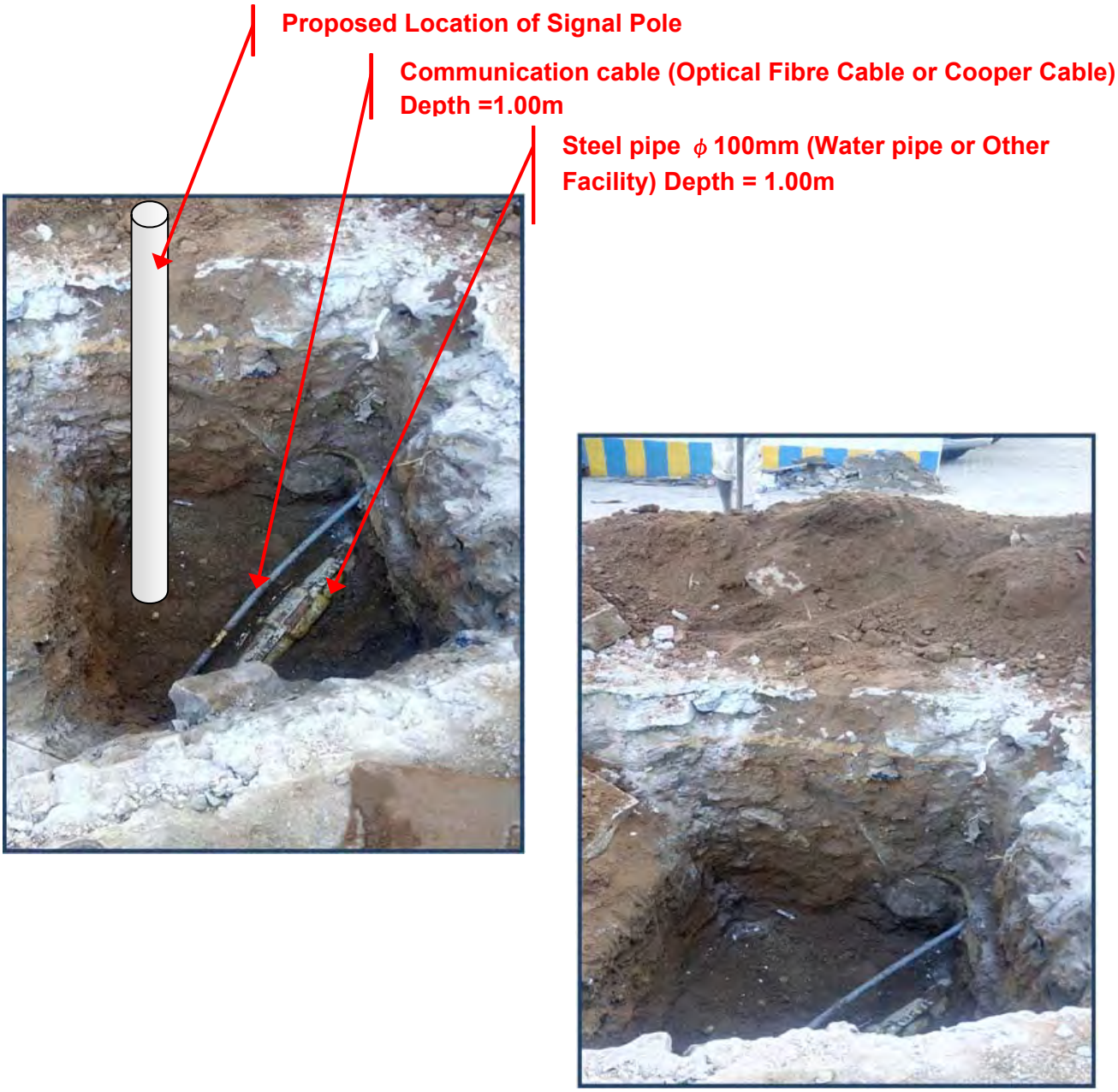
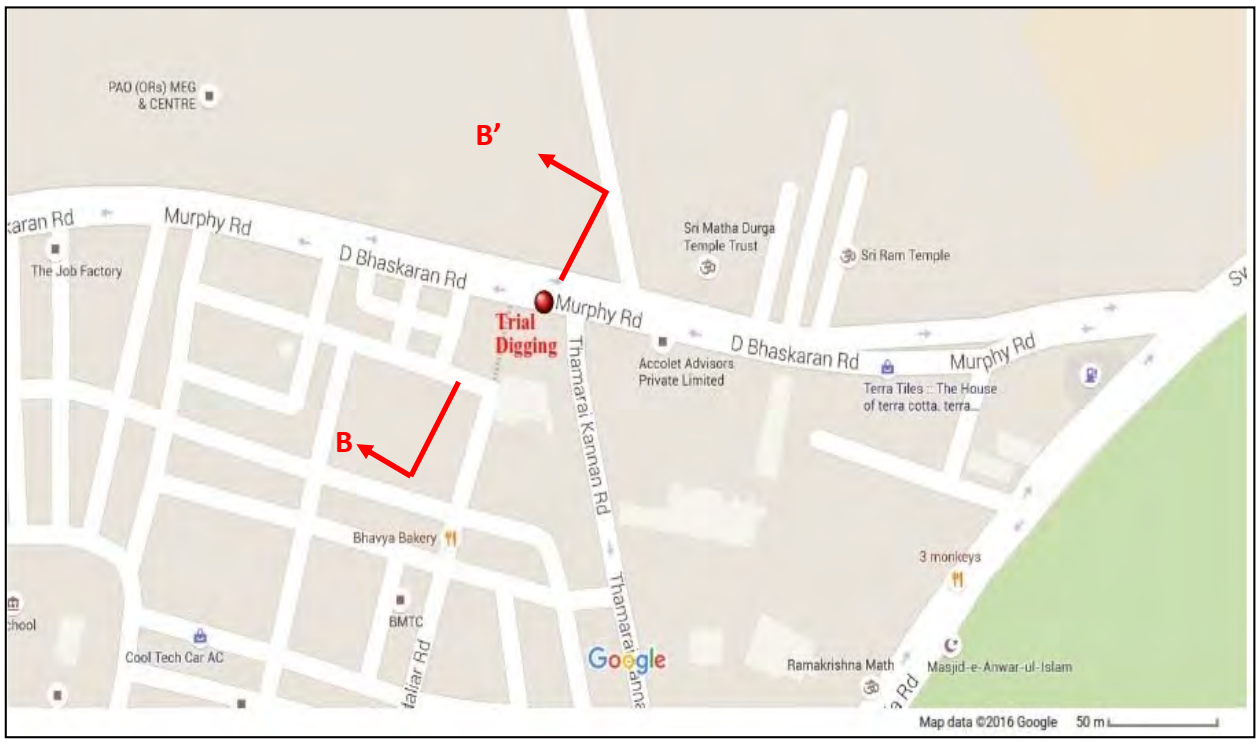


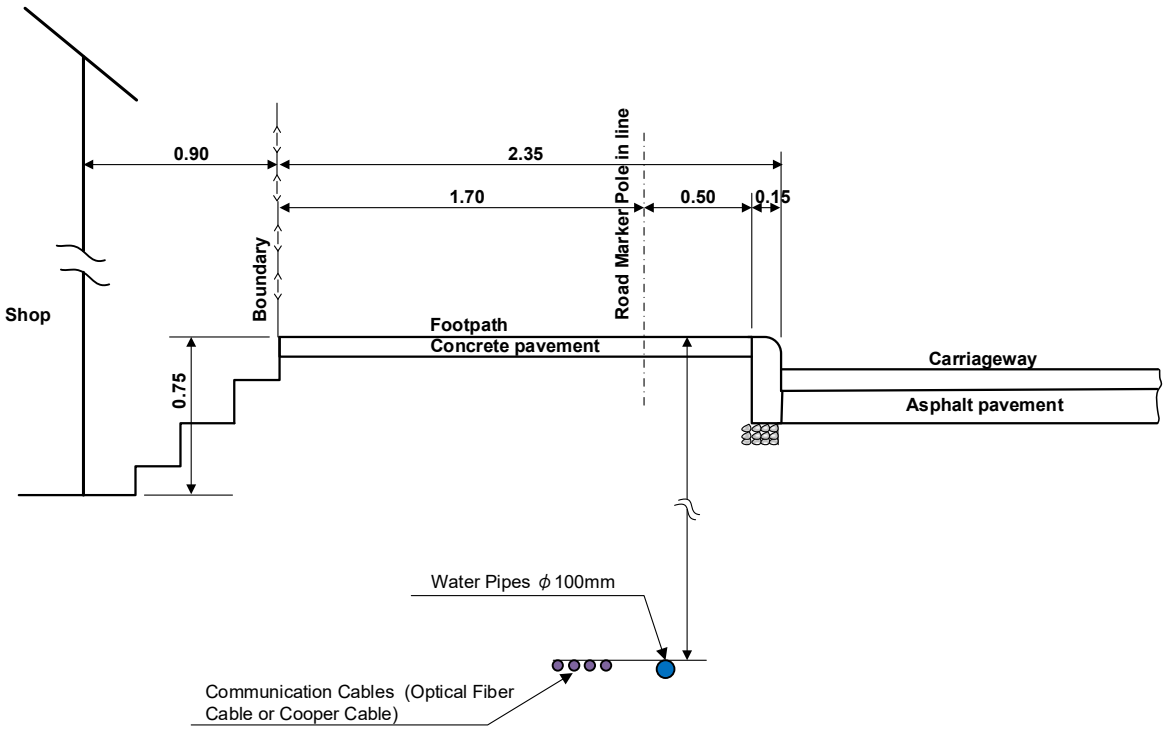
Figure 1 Begam Mahal Junction

6.2 Tamari Kanna Junction

There were water pipe and communication cable detected at Tamari Kannan Junction. Subcontractor excavated up to 2.0m depth. This has no effect on signal foundation height. The location was checked properly by JICA Study Team and backfilled by Subcontractor.

The site survey location and survey pohtographs are shown in below:





SECTION B – B'

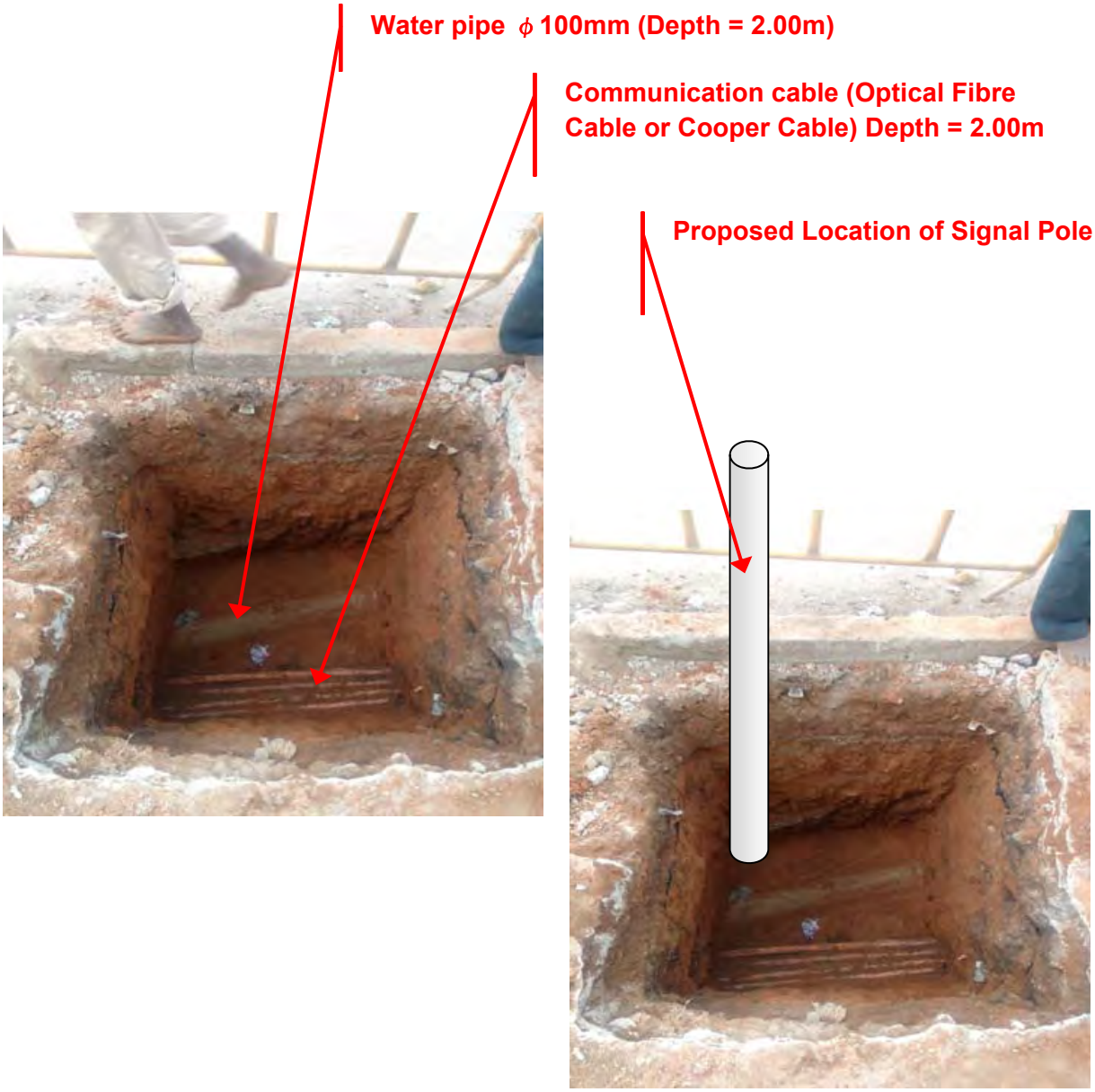
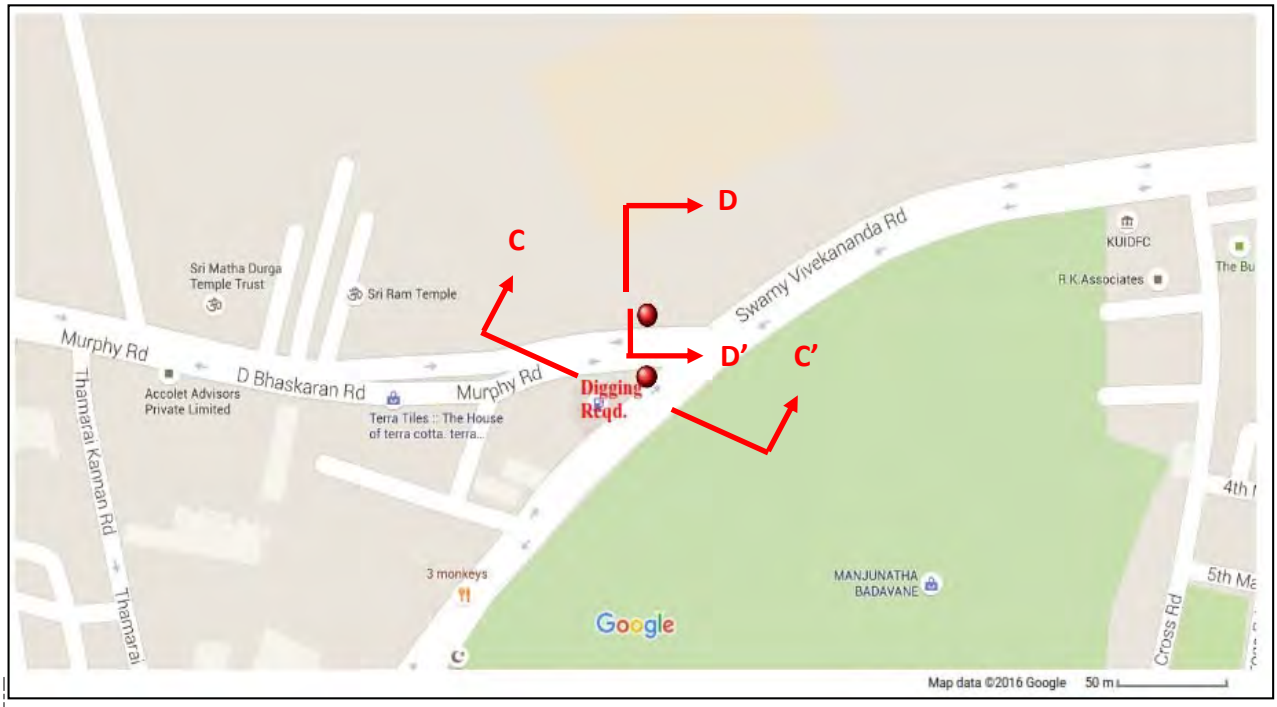
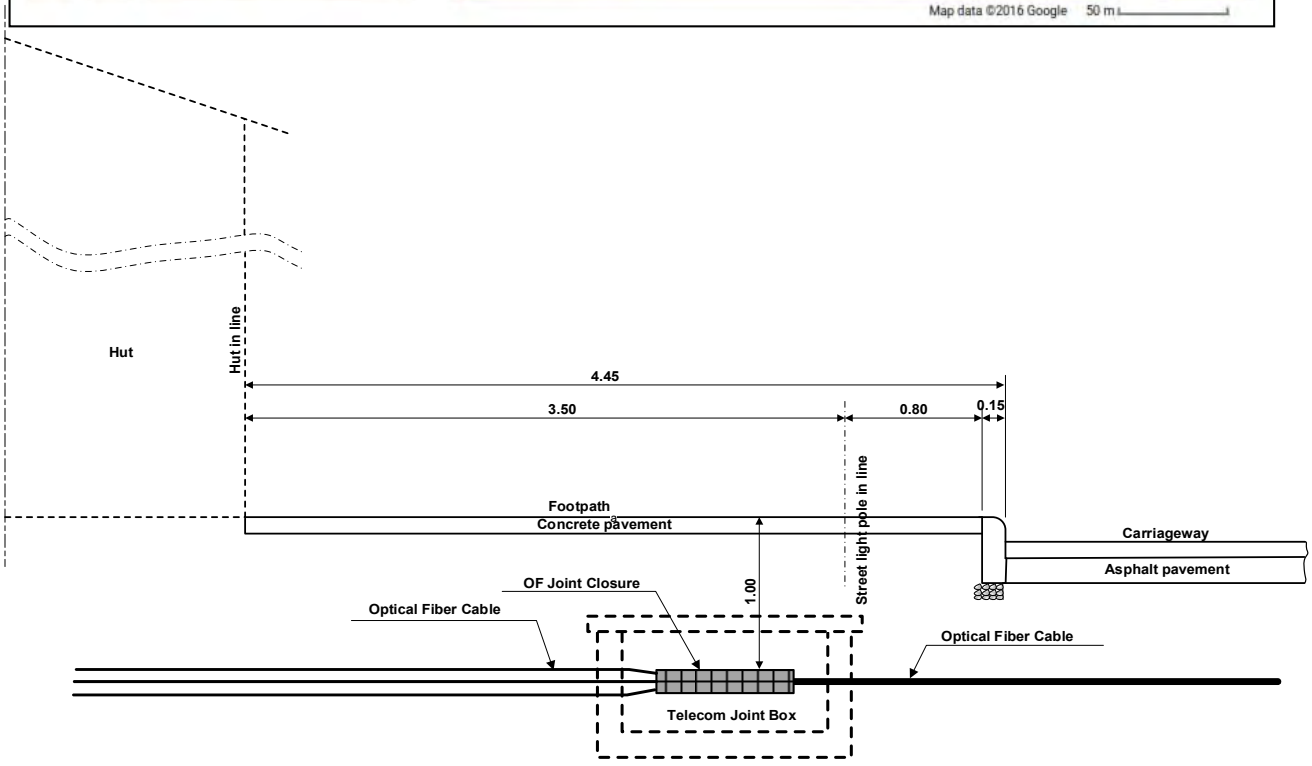


Figure 2 Tamari Kanna Junction

6.3 Anjeneya Temple Junction

This junction is spotted for 2 trial digging locations. The both locations were on Old Madras Road. The first location was near to petrol station at this junction. In this location we found Optical fibre Cable and Joint Box with OF joint closure on the depth of 1.0m. On the other side, we haven't found any detection up to 2.0m depth. The location was checked properly by JICA Study Team and backfilled by Subcontractor. The site survey location and survey photographs are shown in below:

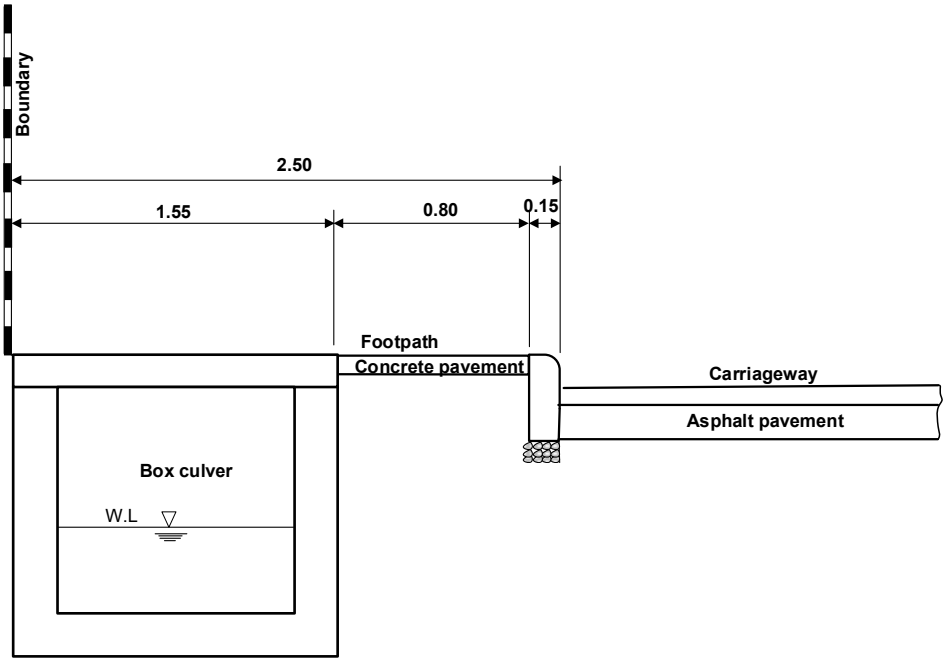




SECTION C - C'

Figure 3 Anjeneya Temple Junction

(Location No.1: Near the Petrol Station)



Proposed Location of Signal Pole

SECTION D -D'

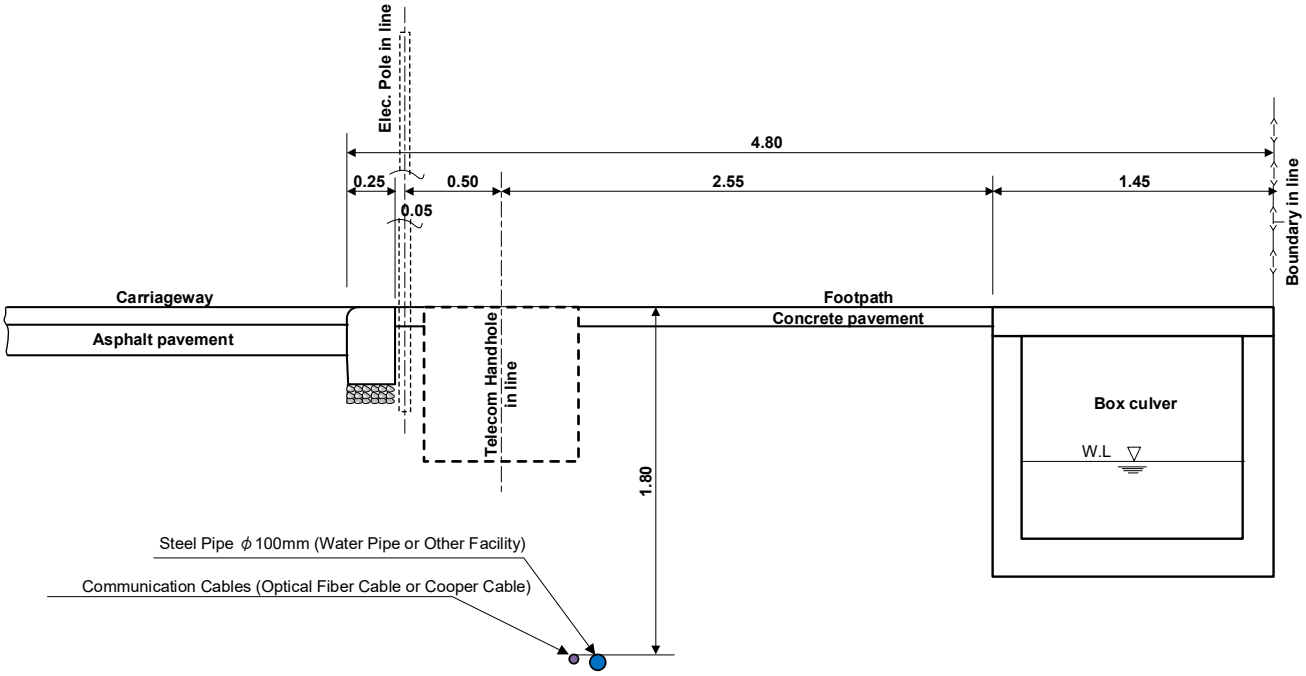
On the other side, we haven't found any detection up to 2.0m depth. The site survey location and survey photographs are shown in below:

Figure 4 Anjeneya Temple Junction

(Location No.2: Opposite side to Petrol Station)

6.4 OM Rd & Indiranagar 100ft Junction

There were steel pipe and communication cable were found on 1.80m depth. The communication cable is crossing from the same location where signal foundation is proposed. The location was checked properly by JICA Study Team and backfilled by Subcontractor. The site survey location and photographs are show in below:



SECTION E – E'

Figure 5 OM Rd & Indiranagar 100ft Junction

6.5 D’souza Circle Junction, Ashok Nagar

The Pipe-Locator detected the underground facility at signal location but digging was not approved by BBMP. Therefore, the contractor should investigate the existing undergrad facility when construction starts.

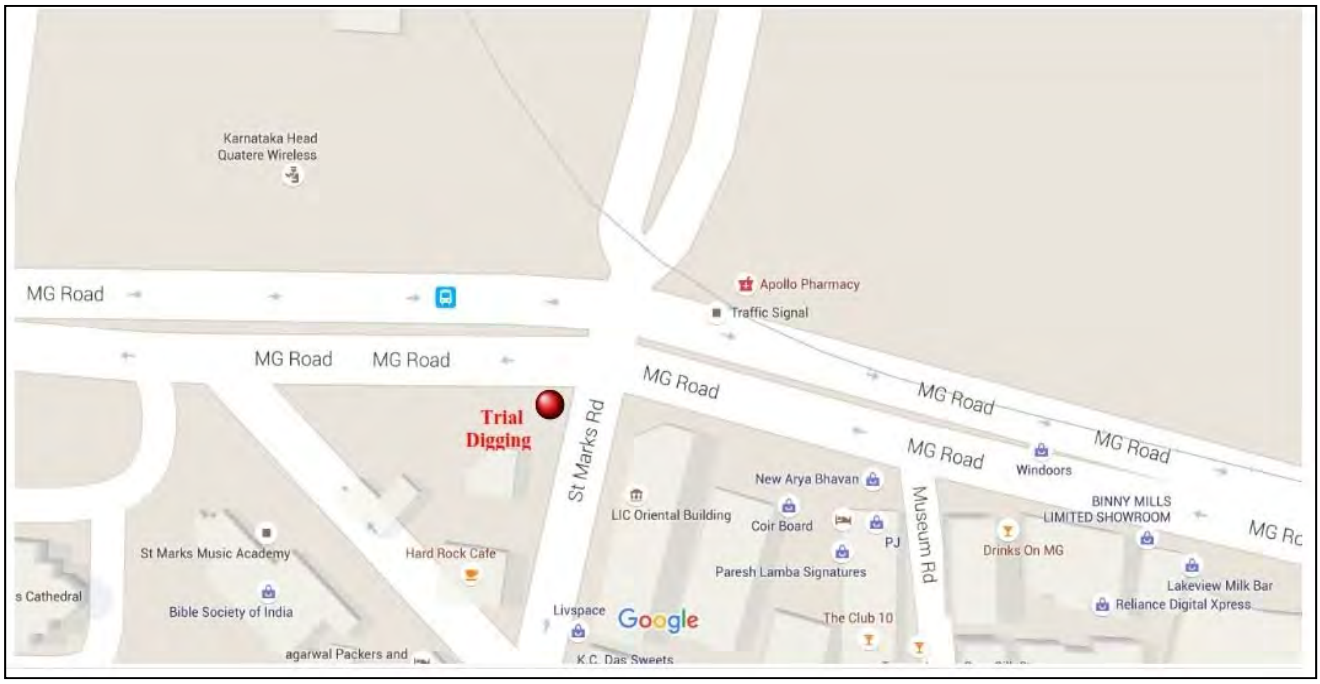
The map location is mentioned below:

Trial Digging Not Approved by BBMP.

6.6 Anil Kumble Circle

The Pipe-Locator detected the underground facility at signal found location but digging was not approved by BBMP**.** Therefore, the contractor should investigate the existing undergrad facility when construction starts.

The map location is mentioned below:



Trial Digging Not Approved by BBMP.

6.7 Near Trinity Metro Station, MG Road

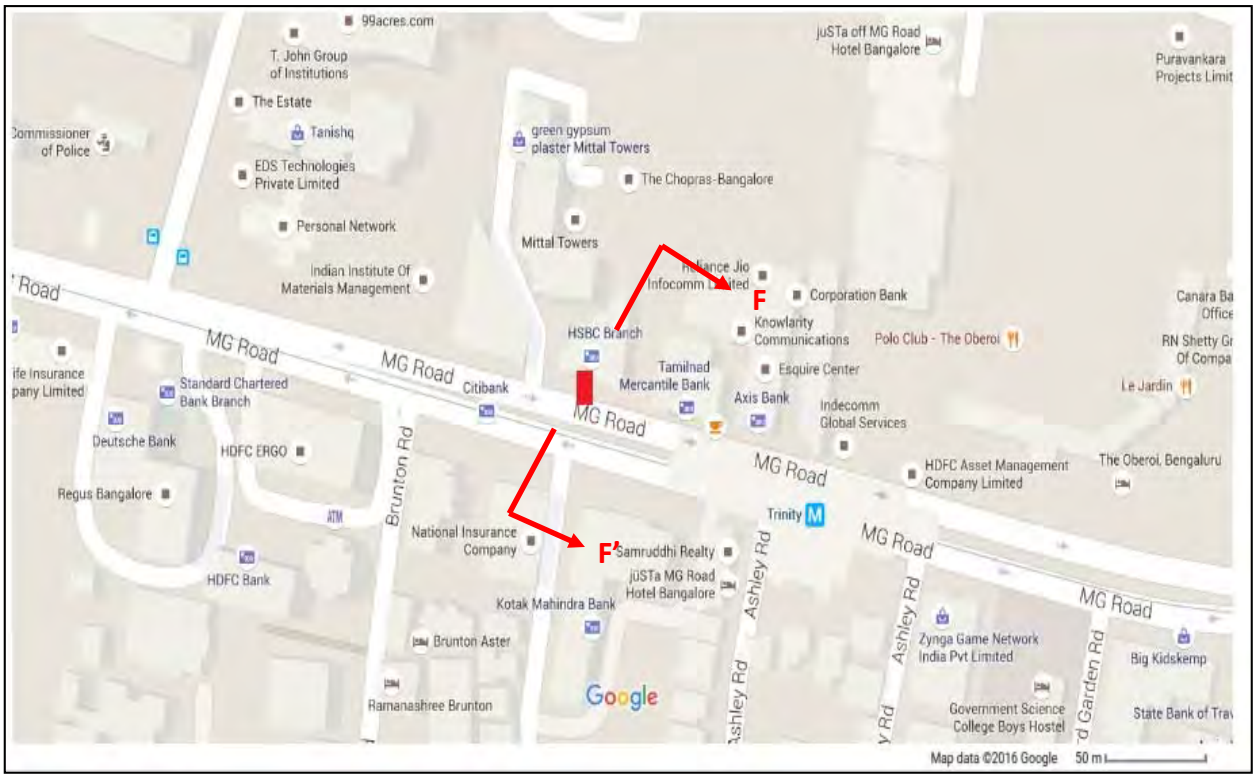
This VMS location was most big and important for Trial digging. MG road has lot off underground facility passing on both side of the road. The Pipe-Locator already detected huge number of underground facility at the proposed VMS foundation location. As expected so many underground facility detected at this location.

The underground facility confirmed in this survey are as follows:

1) High Capacity Power Cable (Direct buried cable x 4 Cables & Depth 0.30m)
2) Communication Cable (Optical fibre cable and Cooper cable x 18 Cables)
3) Double Wall Corrugated Pipe (ϕ 100mm x 2 Pipes & Depth 0.30m)
4) Water Pipe (ϕ 100mm x 1 Pipe)

The dimensions of test pit trench are as follows:
Length 4.0m x Width 2.5m x Depth 3.0m.

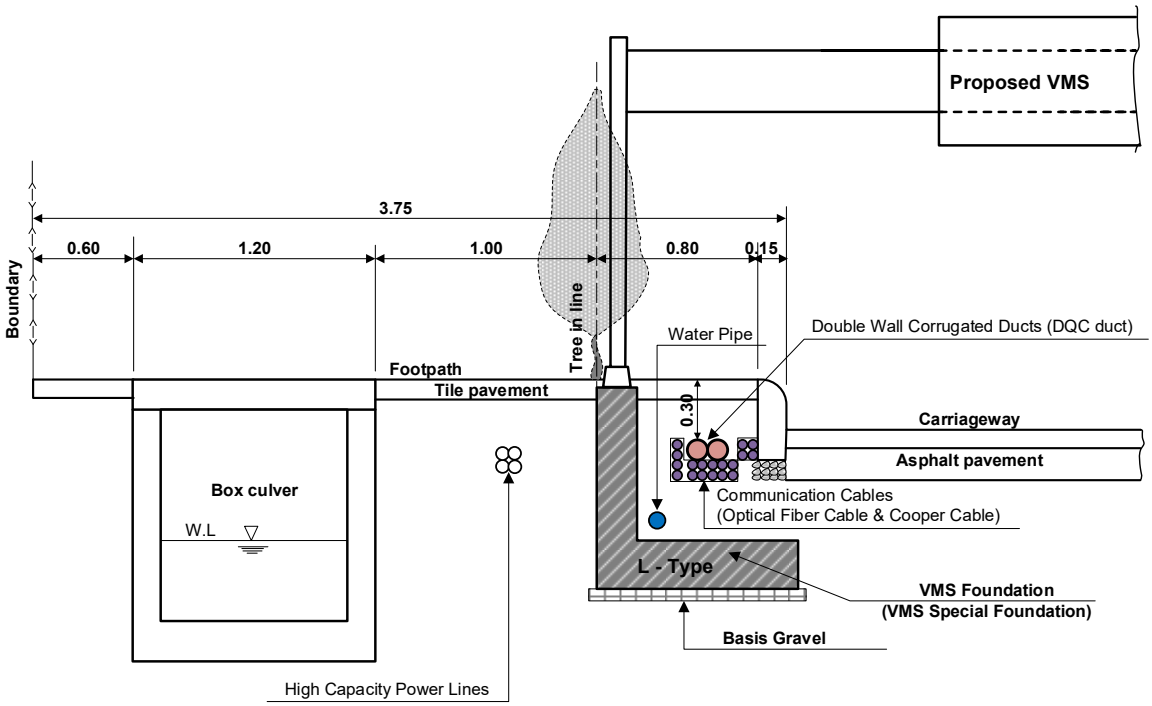
The site survey location and photographs are show in below:



6.7.1 About Notes on Construction

The Contractor will conduct a test pit survey again and consider the following matters on the VMS foundation.

1) Check the underground facility on the carriageway side
2) Reconfirmation of underground facility on the footpath side
3) Study the VMS special foundation



SECTION F – F'

Proposed Location of VMS Pole

Figure 6 Near Trinity Metro Station / MG Road

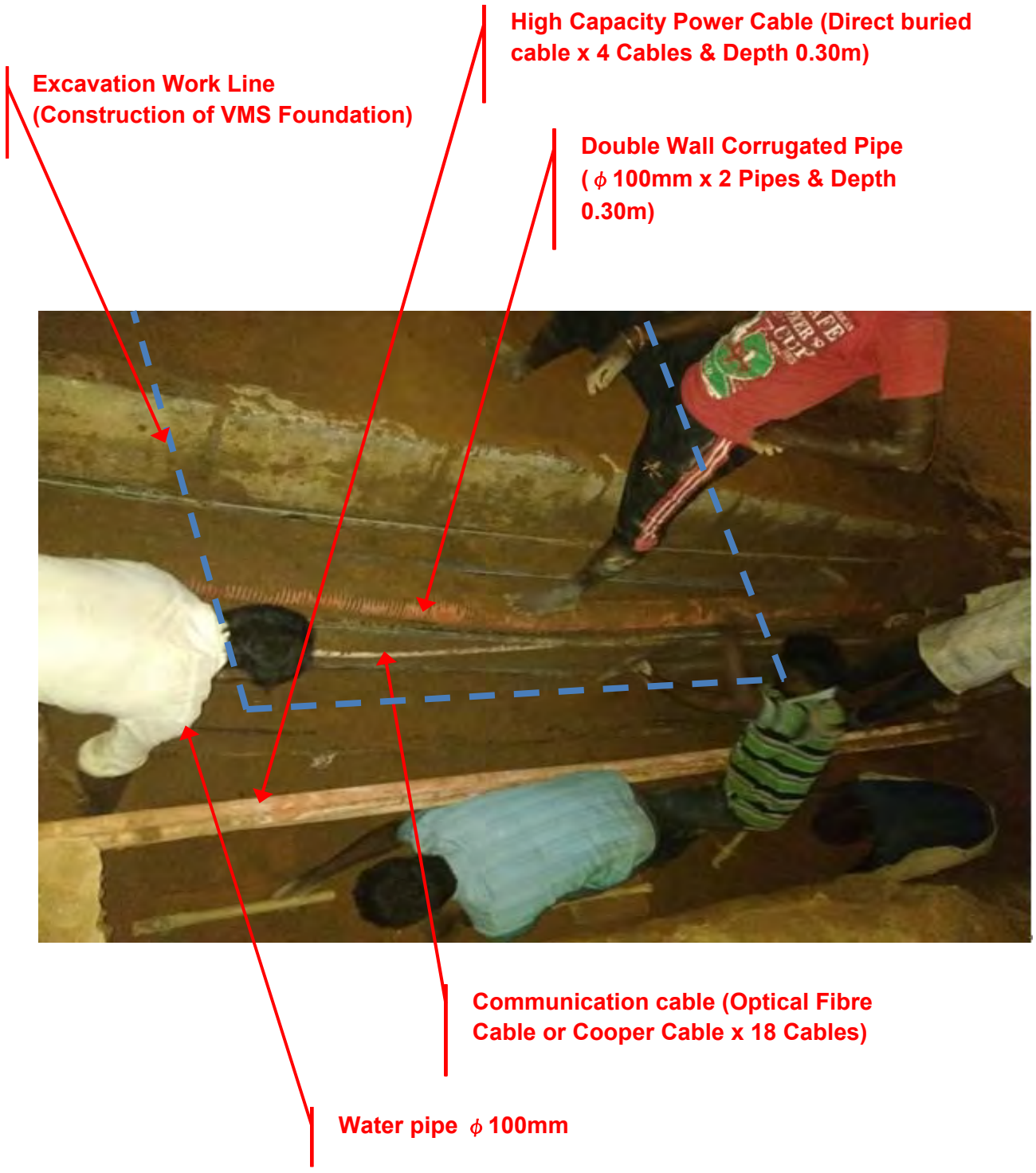


Figure 7 Near Trinity Metro Station / MG Road

High Capacity Power Cable (Direct buried cable x 4 Cables & Depth 0.30m)

Communication cable (Optical Fibre Cable or Cooper Cable x 18 Cables)

Water pipe ϕ 100mm

Double Wall Corrugated Pipe (ϕ 100mm x 2 Pipes & Depth 0.30m)

Water pipe ϕ 100mm

Communication cable (Optical Fibre Cable or Cooper Cable x 18 Cables)

Figure 8 Near Trinity Metro Station / MG Road

END of Documents

資料　7-3

税制調査報告書

インド共和国
ベンガルール都市圏 ITS 機器供与計画
準備調査

税制調査報告書

2017 年 11 月

日本工営株式会社
東日本高速道路株式会社

略　語　集

略語	英語	日本語
APA	Advanced Pricing Agreement	事前確認制度
CBDT	Central Board of Direct Taxes	直接税中央委員会
CBEC	Central Board of Excise and Customs	物品税関税中央委員会
CGST	Central GST	中央政府 GST
GST	Good and Service Tax	物品サービス税
GSTIN	GST Identification Number	GST 登録番号
GSTN	GST Network	GST ネットワーク
GSTR	GST Return	GST 申告書
HSN	Harmonized System of Nomenclature	HSN コード
IGST	Integrated GST	統一 GST
MAT	Minimum Alternative Tax	最低代替税
NR	Non-Resident	非居住者
PAN	Permanent Account Number	納税者番号
RNOR	Resident but Not Ordinarily Resident	非通常の居住者
ROR	Residents and Ordinarily Resident	通常の居住者
SAC	Service Accounting Code	SAC コード
SEZ	Special Economic Zone	経済特区
SGST	State GST	州 GST
UTGST	Union Territory GST	連邦直轄地 GST

目次

別添

1．本報告書の目的

本報告書は、本計画に参加した日本企業及びインド国企業(以下、「事業者」)に対して 2017 年 7 月 1 日にインドが導入した「建国後最大の税制改革」とさえいわれる大型間接税「物品・サービス税(Good and Service Tax 以下、GST)」がどのような影響を与えるかを調査するとともに、GST の基本的なコンプライアンス上の事項について整理することを目的とする。

GST は、広く物品やサービスの提供に対して課される点、地方(州)の税と中央政府の税が一体化している点、流通経路に関与する各納税者に対し、取引の各段階で加えられた付加価値に対して課税が生じる点、最終的な税の負担者が消費者である点、などにおいて日本における消費税に類似した性格を有するものの、以下のような点について特徴的な面を有しており、消費税に比べてきわめてコンプライアンスの要請が複雑なものとなっている。

- 物品、サービスごとに 5 段階の税率
- 登録、申告、納税手続きが全てオンライン上でのみ行われる
- インド国内に州を越えて複数の拠点（支店など）を有する場合、原則として拠点ごとの登録・申告が必要である
- インド国内の州を越える拠点間の取引も課税対象になる
- 一の拠点ごとに最低各年度 37 回の申告が必要
- コンプライアンスの不遵守が取引相手先の課税に影響を与えるなど、納税者による自主的なコンプライアンス遵守が図られるメカニズムの導入

GST 導入前は、以下のとおり国・州政府の各レベルで多数の間接税が存在しており、取引に対してある間接税が課された後の価格に対して更に別の間接税が課されることによる税の累積化、調達の場所により税負担が異なったり、税負担の軽減のために特定の流通手段を採用せざるを得なかったりといった取引の非効率化、それぞれの税において課税の時点や対象が異なることによる複雑化が生じていた。GST の導入により、今後はこのような障害の改善が期待されている。

なお、GST は上記 2017 年 7 月 1 日より発効したものの、その後も税率の変更や申告方法などについて継続的にルールの明確化や変更が行われており、また、いまだに明確化がなされていない事項も存在する。更に、GST の申告についても暫定的な措置が継続している一方で、オンラインシステムの障害なども報告されていることから、実際の申告や納税等にあたっては、今後の継続的なアップデートをふまえた現地専門家のサポートが必要であることに留意されたい。

２． GST の概要

GST は、特定の取引（ガソリン、天然ガス、酒など）を除くあらゆる物品及びサービスの提供に対して課税される、日本における消費税に類似する間接税であり、税率は、0%から 28%までの 5 段階が定められている。

[適用税率及び主たる物品、サービス]

税率	主な物品	主なサービス
免税	生乳、新聞、図書等	道路の通行料、住宅の賃貸
0%	物品の輸出、SEZ への供給	サービスの輸出、SEZ への供給
5%	茶、コーヒー、石炭、石油など	物品輸送（鉄道、物品輸送機関、インド国外からの船舶輸送）、旅客輸送（寝台車以外の鉄道・無線タクシー・エコノミークラス航空）、レンタカー
12%	万年筆やボールペのインク、ろうそく、フルーツジュース、カレンダー	インド国鉄以外の鉄道コンテナ物品輸送、エコノミークラス以外の旅客輸送、AC なし/酒類免許なしレストラン、一泊 1,000～2,500 ルピーの宿泊
18%	ミネラルウオーター、アイスクリーム、封筒、カメラ、スピーカー、モニター	AC 付き/酒類免許ありレストラン、一泊 2,500 ルピー～7,500 ルピーの宿泊
28%	パンマサラ、炭酸飲料、シャンプー、洗濯機、掃除機、自動車	5 スターホテルの宿泊、一泊 7,500 ルピー超の宿泊

なお、0%が適用される売上と、免税(Exempt)売上については、税額の計算上きわめて大きな相違がある。0%売上とは、基本的には物品又はサービスの輸出又は Special Economic Zone(SEZ)への供給が該当し、売上に対しては GST が課されず、0%売上に関連する支出に伴い支払った GST は還付が可能である。他方、免税売上については、GST が課されない点は同一であるが、免税売上に関連する支出に伴い支払った GST の還付は認められない。これは、日本の消費税における取り扱いと同様である。

各物品やサービスに適用される税率は、これまでの間接税の算定において利用されていたコードにより決定される。物品について用いられる Harmonized System of Nomenclature (HSN)コード、サービスについての Service Accounting Code(SAC)の詳細や、それぞれの物品・サービスに適用される税率はインド政府財務省ホームページ

(http://www.cbec.gov.in/htdocs-cbec/gst/index)で確認可能であるが、別添２に、本計画に関係の大きい製品の税率を挙げる。

GST の基本的な考え方は、物品やサービスの付加価値に対して各段階での徴収を行い、税負担を最終消費者に帰するものであり、この点は日本における消費税の課税に類似する。例えば、事業者 B が、税率 18%の物品を、本体価格 100 で事業者 A から購入して、次の取引段階の事業者 C に本体価格 200 で販売し、かつ、事業者 C が最終消費者に本体価格 300 で販売すると、税負担と納税額は次のようになる。

- 事業者 A：売上に係る仮受 GST18（納税額）
- 事業者 B：売上に係る仮受 GST36 - 仕入に係る仮払 GST18＝18（納税額）
- 事業者 C：売上に係る仮受 GST54 - 仕入に係る仮払 GST36＝18（納税額）
- 消費者の負担：本体価格 300 に対する GST54

従って、事業者においては、消費者に対して GST を転嫁できる限りにおいて、税の負担が生じることはない。これは、GST 導入前は複数の間接税が州・国のレベルで課されていたため、上記のように前段階の取引で課された税の控除が事業者に生じる余地が極めて限られ、複数の税がコストとして処理されていた点からは大きな改善である。

[GST に統合された間接税と GST 導入後も存続する間接税]

<table>
<tr><th colspan="2">GST に統合された間接税</th></tr>
<tr><th>国税</th><th>州税</th></tr>
<tr><td>追加関税</td><td>付加価値税</td></tr>
<tr><td>特別追加関税</td><td rowspan="2">州政府による奢侈品に対する税、入市税、入境税、購買税その他の税</td></tr>
<tr><td>物品税</td></tr>
<tr><td>サービス税</td><td rowspan="2">州政府による付加税、目的税でロイヤリティや物品の供給に関するもの</td></tr>
<tr><td>売上税</td></tr>
<tr><td>付加税、目的税で物品やサービスの供給に関するもの</td><td rowspan="2">宝くじ、賭け及びギャンブルに関する税</td></tr>
<tr><td>1955 年医薬品及び衛生品法 (Medicinal and Toilet Preparations Act, 1955)に基づく物品税</td></tr>
<tr><th colspan="2">GST に統合されなかった間接税</th></tr>
<tr><td>基本関税及び関税上の目的税</td><td>州政府による物品税</td></tr>
<tr><td>印紙税</td><td>電気に係る税</td></tr>
<tr><td>飲酒用のアルコールに係る税</td><td>タバコ及びタバコ製品に係る付加税</td></tr>
</table>

輸入物品に対しては、引き続き基本関税(Basic Custom Duty:BCD)及び目的税(Custom Cess)が課されるが、GST を含めた実効税率は次の算式により計算できる。

[Car Sensor (HSN:852580) の関税及び GST の計算例]

内容	計算	税率	金額
課税標準 (CIF 価格に対して 1% の landing charges を付加した金額)	**A**	-	100.00
Basic Customs Duty	**B=A*税率**	10.00%	10.00
関税教育目的税(Education Cess and Secondary and Higher Education cess of customs)	**C=B*税率**	3.00%	0.30
小計	**D=A+B+C**	-	110.30
IGST	**E=D*税率**	18.00%	19.85
税額総額 (課税標準(A)に対する実効税率)	**F=B+C+E**	**-**	30.15 (30.15%)

３．<u>GST に含まれる税の種類</u>

GST には次の種類の税が含まれる。

- Integrated GST(IGST)：州又は国境を越える取引に課される国税
- Central GST(CGST)：同一州内又は同一連邦直轄地の取引に課される国税
- State GST(SGST)：同一州内の取引に課される州税
- Union Territory GST(UTGST)：同一連邦直轄地(Chandigarh, Lakshadweep, Daman and Diu, Dadra and Nagar Haveli, Andaman and Nicobar Islands)内の取引に課される国税
- Compensation cess：GST 法に基づき特定の商品に上乗せして課される税

(注) 以下、特に断らない限り、UTGST と Compensation Cess は考慮しない。

例えば、日本からインドへ輸入する税率 18%の物品に対しては、輸入時に 18%の IGST が課される。これを同一州内で販売する場合、それぞれ 9%の CGST と SGST が課される。同一の物品に対する IGST の税率と CGST+SGST の税率は同一であり、かつ、同一の物品に対する CGST と SGST の税率も同一である。

４． 課税の時期及び課税対象取引

GST は物品やサービスの「Supply（供給）」に対して課される。供給は販売、交換、リース等を含み、関係者（従業員を含む）に対する無償の供給も課税の対象となる。

また、州を越える本店・支店等の同一法人内の物品やサービスの供給も課税の対象となる。後述するが、GST は各州の拠点ごとに登録・申告・納税をする必要があるため、取引が行われた場所（供給地）の決定が、課税計算上重要な意味を有する。

[物品の供給地]

供給の種類	供給地
輸出	輸出地（インド国外）
国内での供給	• 物品の移動を伴う場合：物品が受取人への配達のための移動が終了した場所 • 物品の移動を伴わない場合：供給の時点でその物品が所在していた場所
受取人の指示による第三者への供給	• 受取人の指示により物品が第三者へ輸送された場合、受取人の所在地

[サービスの供給地]

供給の種類	登録事業者に対する供給地	消費者等への供給地
基本	事業者の登録地	受益者の住所の記録がある場合、その住所地。それ以外の場合、供給者の住所
不動産に関係するサービス	不動産の所在地	不動産の所在地
宿泊（ホテルなど）	宿泊施設の所在地	宿泊施設の所在地
トレーニング	事業者の登録地	サービスが行われた場所
レストラン、ケータリング、フィットネス、医療	サービスが行われた場所	サービスが行われた場所
物品の輸送	事業者の登録地	輸送のために物品が引き渡された場所
旅客の輸送	乗客の搭乗地	乗客の搭乗地

[供給の時期]

物品の供給	サービスの供給
次のうち最も早い日	代金の支払又は次のうち最も早い日

• 請求書(Invoice)の発行 • 物品の引渡し • 代金の支払	• 請求書の発行日 • 請求書の発行がサービスの提供から 30 日以内に行われない場合、サービスの提供日

(注) 前受金(Advance)の取り扱いについて

前受金の受領は GST の課税対象となる。前受金の対象となる取引が特定されている場合、その取引に適用される税率を用いるが、それ以外の場合には、いったん 18%での課税が行われる。また、取引の供給地が特定されている場合、課される GST の種類はそれに従うが、そうでない場合には、IGST の課税対象となる。税率、税目とも実際の物品又はサービスの供給が生じた時点での申告書で調整される。

なお、以下で述べるとおり、税額控除を行うには実際の取引が行われており、タックスインボイスが発行されている必要があるため、前受金を下請業者や仕入先に支払った段階では税額控除ができないことに注意する必要がある。

５．税額控除のメカニズム

登録業者は、売上に係る GST から仕入等の支出にかかる GST を控除することができるが、GST の種類ごとに控除可能な範囲が定められている。免税売上に対応する支出に係る GST には税額控除は認められない。

支払った IGST は、売上に係る税目が IGST、CGST、SGST のいずれであっても税額控除が可能であるが、CGST と SGST 間では税額控除を行うことができない。また、支払った Compensation Cess は受取った Compensation Cess からのみ控除が可能である。また、GST は州ごとに計算を行うため、ある州で生じた支払 GST は、基本的にはその州の仮受 GST からしか控除することができない。

機械等の資本財（会計上資産として表示されるもの）についても、事業上利用されるものである限り基本的には税額控除が可能である。ただし、資本財の購入の際に支払った GST を本体価格に含めて減価償却の対象としている場合には、その減価償却の対象となった GST については税額控除を行うことができない。

一般的な税額控除のための留意点は以下のとおり。

- 税額控除のためには、物品・サービス供給者が発行したタックスインボイス、Bill of Entry(輸入の場合)等の証憑を有していることが必要である。
- 税額控除は、物品・サービスの提供が実際に行われるまでは行うことができない。したがって、前払金は税額控除の対象とならない。

- 一のタックスインボイスに係る物品の供給が複数回にわたって行われる場合、最後の供給が行われたときが税額控除時期となる。
- 物品の配送先が第三者の所在地である場合、その第三者がその物品の供給を受けた時点が税額控除の時期となる。
- 仕入等に係る支払が Invoice 日付から 180 日以上遅延した場合、控除した GST を売上げに係る GST にいったん加算しなければならない（後日支払が行われた際に再度税額控除を行う）。

具体的な控除税額の計算上、Matching Concept が導入されている。後で述べるとおり、GST の申告は全て GSTN と呼ばれる GST の電子申告用オンラインネットワークにデータをアップロードする形で、月単位で行われなければならないが、仮に納入業者が事業者の仕入物品に対する売上データをアップロードしていない場合（つまり、納入業者が当該売上に係る GST の申告をしていない場合）、事業者の税額控除は、その納入業者が売上のアップロードをするまでは認められない。したがって、納入業者が適切にコンプライアンスを実施しない場合、事業者の税額控除の機会が失われることとなる点に注意する必要がある。

なお、以下の取引については支払った GST の税額控除が認められない。

- 自動車等の輸送手段（再販売目的の場合、輸送サービスの提供のための取得の場合等を除く）
- 飲食、ケータリング
- タクシー（法律上従業員のために提供しなければならない場合を除く）
- 不動産（工場及び機械を除く）の建築のための外注
- 物品の紛失、盗難、破損、除却又は無料サンプルとしての提供

６． GST 事業者としての登録、申告及び納付

売上（免税等売上含む）が 200 万ルピーを超える事業者及び州を越える物品の提供による課税売上を有する事業者は、全て GST 事業者としての登録をする必要がある。事業者が複数の拠点をインド国内に有する場合、その拠点ごとに登録を行う（同一の州に複数拠点がある場合は、主たる拠点のみを登録）。

GST の申告は拠点ごとに、全て GSTN を通じて電子申告の形で行われる。GST の税目ごとの申告は不要。主たる申告書の種類と提出期限等は以下のとおり。

申告書名	申告書の内容	申告書提出期限
GSTR-1	課税売上（物品及びサービスの双方を含む。また、同一企業内での在庫	翌月 10 日

	の移転等を含む）取引に係るインボイスレベルの情報(注１)の申告	
GSTR-2	課税仕入取引に係るインボイスレベルの情報の申告	翌月 15 日
GSTR-3	月次の納税額の申告	翌月 20 日
GSTR-9	年次申告	翌会計年度の 12 月 31 日

例えば、2017 年 11 月分の申告書作成の流れは以下のとおりとなる(注 2)。

1. 翌月(12 月)10 日までに各月の課税売上げに係るインボイス情報のデータを GSTN にアップロードする(GSTR-1)。
2. 同時に、各納入業者が、事業者に対する課税売上情報をアップロードする。このデータは自動的に集約され、GSTR-2A という様式で事業者に送信される。このデータを 12 月 15 日までに修正し、課税仕入に係るデータをアップロードする(GSTR2)。
3. 自らが入力した GSTR-1 のデータが 12 月 15 日までに各売上先により修正され、GSTR-1A という様式で事業者に送信されるため、修正されたデータの確認を 12 月 17 日までに行う。
4. 上記のデータに基づき、11 月の納税額関する申告書(GSTR-3)が自動的に作成されるため、これを 12 月 20 日に送信する。
5. 2018 年 3 月までの会計年度全体の集約データは、2018 年 12 月末に GSTR-9 として申告が行われる。

上記 1.から 3.のとおり、納入業者が事業者に対する課税売上を正確に入力しない限り、実際に納入業者に対して GST を支払っていたとしても、その支払を税額控除することができないこととなる。そのため、相互の GST に関連する情報（名称、所在地、GSTIN 等）を取引先との間で共有する必要がある。

(注 1)　インボイスレベルの情報とは、次を意味する。

1) 発行者の名称、住所（州の名前を含む）及び GST 登録番号
2) インボイス番号、発行日付
3) 売上先の名称、住所及び GST 登録番号
4) 取引に係る物品又はサービスの詳細と HSN
5) 取引量、取引総額
6) 課税対象となる取引の額
7) GST 税目毎の税率及び税額
8) 供給地
9) 物品の配送先（供給地と異なる場合）

(注 2)　上の流れは 2017 年 10 月現在での GST 関連法規に基づくものであるが、2017 年 10 月時点で各種申告書のオンライン提出システムは適切に稼動しているとは言い難い。また、一部の業者は申告データの入力を行ったものの次のようなエラーが報告されている。

- アップロードされた取引詳細とポータル上で表示される内容の不一致
- ポータルが申告書を処理/提出できない
- ポータル上で保存したデータを保存できない
- オンラインでの納税が反映されない

納税の管理も GSTN 上で作成される各種勘定(Ledger)に基づき行われる。

- Form GST PMT-05 ：金銭勘定(Electronic Cash Ledger)と呼ばれるもので、事業者がインターネットバンキング、クレジットカード、銀行送金、銀行店頭での現金預入等を行うことにより、金銭勘定の額がリアルタイムで増加する。この勘定残高を用いて GST の納税を行い、納付書(Challan)を作成する。GST に関連して発生したペナルティ等、本税以外の支払いもこの勘定を用いて行う。
- Form GST PMT－02：仮払勘定(Electronic Credit Ledger)と呼ばれるもので、申告書に反映されたベンダー等に支払われた仮払 GST の額がこの勘定に反映される。この勘定の金額を仮受 GST の金額から控除することができる。
- Form GST PMT-01：仮受勘定(Electronic Liability Ledger)と呼ばれるもので、納税されるべき税額が GST の税目ごとに表示される。

基本的な納税の流れは、売上から生じた仮受 GST から、支払に伴って生じた仮払勘定上の仮払 GST 残高を控除した差額を、金銭勘定を用いて納付し、その納付した結果を納付書として受領することとなる。納付は、GSTR-3 の申告期限である翌月 20 日までに行われなければならない。

7．　GST の還付

日本の消費税においては、消費税の支払額が受取額よりも多額な場合にはその差額は基本的には還付されるが、GST においては、基本的には次月へ繰越されるのみで還付は発生しない。GST の還付が行われるのは基本的に次の二つの場合に限定されている。

- 0%取引の場合。つまり、輸出(SEZ への供給を含む)の場合の仕入等経費に生じた GST の還付
- Inverted Duty Structure の場合。これは、例えば仕入物品に係る税率が 28%であり、売上により顧客から回収する税率が 12%である場合な

ど、インプットとアウトプットの税率差により構造的に控除対象税額が過大に発生するようなケースである。

政府はGST導入前には輸出業者に対して還付申告提出から7日以内に90%の税金の還付を実施すると明言していたが、実際には還付の仕組みがいまだ整備されておらず、導入以降の還付が行われずに輸出業者の資金の逼迫、インド製品の国際的な競争力の低下、輸出の低下を招いているとの指摘が行われていた。これを受けて、2017年10月6日にデリーで開催された第22回GST評議会において、財務大臣から2017年10月に7月、8月分の還付を行う旨が表明された。

８．リバースチャージ

特定の取引に係るGSTの納税義務は、本来的には物品又はサービスを供給する者が負うのであるが、購入者側が納税義務を負うこととなる場合がある。これをリバースチャージという。具体的には以下の3つの場合がある。

- 事業者がリバースチャージ方式の納税が法定されている特定のサービス（法的サービスなど）に対する支払を行う場合
- 事業者が海外からサービスの提供を受ける場合（サービスの輸入）
- 事業者がGSTの登録をしていない業者から物品又は役務の供給を受ける場合

リバースチャージによる納税を行った事業者は、自己宛インボイスを発行する等の条件を備えることにより、その納税を行った月に発生した仮受GSTからその納付税額を控除することができる。

(注) 2017年10月13日付でCBECが発行した通知(Notification No. 38/2017 – Central Tax (Rate) and Notification No. 32/2017 – Integrated Tax (Rate))により、リバースチャージによる納税は2018年3月31日まで行われないこととなった。

９．その他

GST導入から現時点までにおいて、無償供与案件に関するGSTの免税措置が取られた例は確認できない。ただし、被援助国の実施機関が事業者に対して税の負担をする（事業者から提供を受けた物品・サービスに法定のGST税率を上乗せしたものを支払う）限りにおいて、事業者に追加的な負担は発生しない（実施機関から受取るGSTから調達において負担したGSTの差額を納税するのみ）。

GST法上、国連機関等特定団体に対して税還付の特典が与えられている（別添３参照）。これによれば、国連等機関は、いったん調達に要するGSTを負担するものの、調達が行われた四半期の末から半年以内に還付請求を行うことができる。しかし、必ず適用されるものではなく、実際の運用はケースバイケースであることを留意し、案件ごとに確認をする必要がある。

別添１　インドにおける直接税（法人所得税及び個人所得税）の概要

インドにおいては、法人税及び個人所得税は財務省の下にある直接税中央委員会(CBDT)が所掌している。この基礎となる法律は所得税法(Income Tax Act,1961)及び同規則(Income Tax Rules)である。

法人税

課税事業年度はあらゆる企業において 4 月 1 日から翌年の 3 月 31 日となっており、課税事業年度が終了した年の 9 月末まで（移転価格報告書を提出する必要のある企業については、課税事業年度が終了した年の 11 月末まで）に申告書を提出する必要がある。インド国内源泉所得を有する法人（居住者に限らない）は納税者番号（PAN）の取得が義務付けられている。

インド居住者である企業についてはその全世界所得が課税対象となり、外国法人については、以下の所得についてのみ課税される。

- インドで発生した所得
- インドで受領された、または受領されたと見なされた所得
- インド国内に所在する資産から発生した所得、インド国内源泉所得、インド国内の事業に関連して発生した所得、インド国内に所在する資本資産の移転によって発生した所得（給与、利息、ロイヤリティ、技術サービス料など）

法人所得税率は以下のとおり。

法人の区分	税率
インド居住法人で 2015-16 年度の総売上高が 5 億ルピー以下の法人	25%
上記に該当しない全てのインド居住法人	30%
外国法人	40%

(注 1) これに加えて、サーチャージ（インド居住法人は 0%～12%、外国法人は 0%～5%）及び 3%の教育目的税が課される。
(注 2) 通常の規定により計算された税額が、一定の調整後の会計利益の 18.5%を下回る会社については、調整後の会計利益の 18.5%の最低代替税(MAT)および付加税、教育目的税が課される。

移転価格税制

関連者との間で行う国際取引は移転価格税制の対象となり、その取引が独立企業間価格に基づいて行われていない場合、その取引価格を独立企業間価格に引きなおした上で課税所得の計算が行われる。

関連者とは、他者が直接的・間接的に、経営、支配、資本に参加している場合又は同一の者が両者の経営、支配、資本に参加している場合の他者をいう。なお、外国法人のインドにおける恒久的施設(PE)は当該外国法人にとっての関連者となり、その外国法人の本店とインドにおける PE との間の取引は移転価格税制の対象取引に含まれる。さらに、第三者との取引であっても、その取引に関して関連者と第三者との間で何らかの合意がある場合、または取引条件が実質的には関連者と第三者との間で決められていると考えられる場合には、その取引は関連者との取引とみなされる可能性がある。

独立企業間価格の算定方法は、OECD 移転価格ガイドラインにおおむね準拠した形で規定されている。優先される算定方法は存在せず、取引の性質や種類、関連者やその機能、およびその他の要因を考慮して最も適正な算定方法が決められる（ベスト・メソッド・ルール）。

納税者は関連者との間で行われた全ての国際取引について、法人税申告書の提出期限（11 月 30 日）までに会計士の証明書を電子申告の形で提出することが義務付けられている。また、移転価格税制の対象となる国際取引の合計が 1,000 万ルピーを越える場合、当該国際取引に関する情報と文書（ローカルファイル）を事業年度ごとにその法人税申告書の提出期限までに備え付ける必要がある。これは、インド国内源泉所得を稼得している外国企業（PE の有無を問わない）にも適用される。

移転価格による課税リスクを回避するために、2012 年から事前確認(Advance Pricing Agreement:APA)制度が導入されている。これについての年次報告書(APA レポート)によれば、制度導入から 2017 年 3 月末までの申請件数は 815 件であり、同期間に 152 件(申請件数の約 19%)が合意されている。また、合意に至るまでの平均期間は、ユニラテラル APA で約 29 ヶ月、二国間 APA で約 39 ヶ月であるなど、一定の実効性が期待できるものとなっている。詳細については以下の年次報告書を参照。

http://www.incometaxindia.gov.in/Lists/Latest%20News/Attachments/161/Advance-Pricing-Agreement-01-05-2017.pdf

(注) APA とは、納税者が税務当局に申し出た独立企業間価格の算定方法等について税務当局が確認を行うことをいい、納税者が確認された内容に基づき申告を行っている限り移転価格課税は行われない。一国の税務当局のみの確認を求めるものをユニラテラル APA、取引の当事者双方を所轄する税務当局間で確認を行うものを二国間(バイラテラル)APA と呼ぶ。

個人所得税

課税所得は、対象となる課税年度（4 月 1 日から翌年 3 月 31 日まで）の居住ステータスに基づいて決定される。居住ステータスには、非居住者（NR）、非通常の居住者（RNOR）及び通常の居住者（ROR）があり、次に基づいて決定される。

- NR：次のいずれの条件も満たさない者
  - 課税年度において 182 日以上滞在している（182 日ルール）
  - 課税年度において 60 日以上滞在しており、かつ過去 4 年間の滞在期間が 365 日以上（60 日ルール）
- RNOR：非居住者以外で、次のいずれかを満たす者
  - 過去 10 年のうち 9 年はインド非居住者
  - 過去 7 年間のインドでの滞在が 729 日以下
- ROR：上記いずれにも該当しない者

(注) 入国日・出国日、休日及び観光等目的の滞在日数は上記計算上カウントされることに留意。

居住ステータスによる課税範囲は以下のとおり。

- NR: インドで受領した所得及びインドで発生した所得
- RNOR: インドで受領した所得、インドで発生した所得、インドからコントロールされているビジネスから発生した所得、及びインドにおける専門的職業からの所得
- ROR: 全世界所得

個人も法人と同様に納税者番号(PAN)を取得する必要がある。

インドでの役務提供の対価として得た給与所得に対しては、それを受領する場所にかかわらずインドで課税される。給与所得に対しての源泉徴収は、給与が支払われた月の翌月 7 日までに納付される必要がある（3 月分のみ納付期限は 4 月 30 日）。

個人所得税率は以下のとおり(2017-18 年度)。

課税所得区分	税率
250,000 ルピーまで	0%
250,001 ルピーから 500,000 ルピーまで	5%
500,001 ルピーから 1,000,000 ルピーまで	20%
1,000,001 ルピーから 5,000,000 ルピーまで	30%
5,000,001 ルピーから 10,000,000 ルピーまで	30%+サーチャージ 10%
10,000,000 ルピー以上	30%+サーチャージ 15%

上記に加えて、3%が教育目的税として課される。課税所得 1 千万ルピーを超える場合の実効税率の計算は以下のとおりとなる。

基本税率 30%+サーチャージ(30%×15%)+教育目的税(30%×(1+15%)×3%)＝35.54%

確定申告は、課税年度末（3 月末）から 4 ヶ月後の 7 月末であり、申告期限を遅れた場合、その年の 12 月 31 日までに申告した場合は 5,000 ルピー、その日よりも遅れた場合は 10,000 ルピーが追加で徴収される。ROR には申告書上で海外の口座や資産の開示が求められている。

別添２　本計画に関係する物品、サービスへの適用税率

[輸入物品]

物品	HSN コード	BCD 税率	Custom Cess 税率	IGST 税率	実効税率
Color/ black and white printer (single function)	8443 32	Nil	Nil	18%	18%
Signal control console	8471 30	Nil	Nil	18%	18%
Central controller	8471 50	Nil	Nil	18%	18%
Server, network monitoring software, recorder, prove server, internet server	8471 41	Nil	Nil	18%	18%
Operator console	8471 49	Nil	Nil	18%	18%
Audio recorder, wireless equipment, media converter	8517 62	Nil	Nil	18%	18%
Media converter	8517 67	Nil	Nil	18%	18%
UPS	8504 40	10%	3%	18%	30.15%
Video switch	8521 90	10%	3%	18%	30.15%
Car sensor	8525 80	10%	3%	28%	41.18%
Video wall	8528 49	10%	3%	28%	41.18%
Car sensor, local controller, Console, Variable display, Signal,	8530 80	7.5%	3%	28%	37.89%
Cabinet	8537 10	10%	3%	28%	41.18%

[国内調達品]

物品	HSN コード	IGST
Sand	2505	5%
Ballast	2517	5%
Cenemt	8474/6810	18%/28%
Ready-mix Concrete	3816	18%
Steel Pole	7213/7215	18%
Gantry	8426	18%
Tile	6902/6810	18%/28%
Curbstone	6801	28%

[サービス]

役務	内容	供給地	IGST 税率
インド下請業者から元受業者への役務提供	インドにおける下請け業者がインド国内で行う組立て、設置	具体的なサービスの提供場所（役務提供の対象となる物品の所在地）	18%
コンサルティング	プロジェクト実行のために日本からインドへ提供されるコンサルティング	サービスを受ける者の所在地	18%（リバースチャージ）
コンサルティング	プロジェクト実行のために日本国内で提供されるコンサルティング	サービスを受ける者の所在地	なし（サービスを提供する者及び受ける者のどちらもインド国外）
補修及びメンテナンス	インド国内の業者が行うインドで設置された機器の補修及びメンテナンス	具体的なサービスの提供場所（役務提供の対象となる物品の所在地）	18%

(注)　別添２の IGST 税率は、表に示された HSN コードが適用されることを前提とした税率であり、他の HSN コードが適用される場合には税率が異なる場合がある。また、税率は、2017 年 6 月 28 日現在の政府発表資料に基づくものであり、変更の可能性がある。

別添３　CGST Act 2017　Chapter XI　55 の特定の団体に関する税還付に関する規定

Refund in certain cases.

55. The Government may, on the recommendations of the Council, by notification, specify any specialised agency of the United Nations Organisation or any Multilateral Financial Institution and Organisation notified under the United Nations (Privileges and Immunities) Act, 1947, Consulate or Embassy of foreign countries and any other person or class of persons as may be specified in this behalf, who shall, subject to such conditions and restrictions as may be prescribed, be entitled to claim a refund of taxes paid on the notified supplies of goods or services or both received by them. 46 of 1947.

別添４－１）　インド財務省が発遣した関税を免税とする Notification の例

[TO BE PUBLISHED IN THE GAZETTE OF INDIA, EXTRAORDINARY, PART II, SECTION 3, SUB-SECTION (i)]

GOVERNMENT OF INDIA
MINISTRY OF FINANCE
(DEPARTMENT OF REVENUE)

Notification No. 40/2017 - Customs

New Delhi, the 30th June, 2017

G.S.R. (E)- - In exercise of the powers conferred by sub-section (1) of section 25 of the Customs Act, 1962 (52 of 1962), the Central Government, on being satisfied that it is necessary in the public interest so to do, hereby exempts goods of the description specified in column (2) of the Table below and falling within the First Schedule of the Customs Tariff Act, 1975 (51 of 1975), when imported into India, from the whole of the duty of customs leviable thereon which is specified in the said First Schedule.

TABLE

Sl.No.	**Description of Goods**
(1)	**(2)**
1.	Goods of Bhutanese or Indian origin imported from Bhutan into India.
2.	Semi-tanned cow hides, low gran image paper, kapok and handloom products, when imported into India from Bangladesh.
3.	Goat skin, sheep skin horses, goats, sheep, wool, butter, common salt, raw silk, yak tail, yak hair, china clay, borax, szaibelyite, goat cashmere, Readymade Garments, Shoes, quilt or blankets, Carpets and Local Herbal Medicines when imported into India from China through Gunji in Pithoragarh district of Uttaranchal along the Gunji Pulan (Tibet) land route or through village Namgaya Shipkila in Kinnaur district of Himachal Pradesh along the Namgaya-Shipkila-Shipki Jui Jiub a land route or through Sherathang land route between Sherathang in the East Sikkim district of Sikkim in India and Renqinggang in the Tibet Autonomous Region of China through Nathula Pass.

2 This notification shall come into force with effect from the 1st day of July, 2017.

[F.No.354/119/2017-TRU]

(Gunjan Kumar Verma) Under Secretary to
the Government of India

別添４－２）　道路建設のための輸入資材に対する関税を免除した例

GENERAL EXEMPTION NO. 26

Exemption to materials required for the manufacture of the final goods when imported against on import licence or release order on the canalising agency:

[Notfn No.128/94-Cus. dt.10-6-1994 as amended by Notfn Nos.185/94, 101/95, 144/95, 22/96, 33/97and 67/ 04]

In exercise of the powers conferred by sub-section (1) of section 25 of the Customs Act, 1962 (52 of 1962), the Central Government, being satisfied that it is necessary in the public interest so to do, hereby exempts materials required for the manufacture of the final goods when imported into India, from **whole of the duty of Customs** leviable thereon, under the First Schedule to the Customs Tariff Act, 1975 (51 of 1975), and from the **whole of the additional duty** leviable thereon under section 3 of the said Customs Tariff Act, subject to the following conditions, namely:-

(1) that the importer has been granted necessary **import license or release order on the canalizing**

agency (hereinafter called the said license) by the Licensing Authority for the import or release of the said materials for the aforesaid purpose in terms of para 56 of the Export and Import Policy, 1st April, 1992 - 31st March, 1997 and the said license is produced at the time of clearance for debit by the proper officer of the Customs;

(2) that the import license contains the endorsements specifying, inter-alia-

(a) the description, quantity and the value of materials allowed to be imported under the said license;
(b) the description and quantity of materials allowed to be imported duty free; and
(c) the description and quantity of final goods to be manufactured out of, or with, the imported materials;

(3) Omitted

(4) the importer executes a bond with such surety or security and in such form and for such sum as may

be specified by the Assistant Commissioner or Deputy Commissioner of Customs binding himself to pay on demand, an amount equal to the duty leviable on the imported materials but for the exemption contained herein, in respect of which the conditions specified in this notification have not been complied with together with interest at the rate of 24% per annum from the date of clearance of materials;

(5) that the importer produces evidence of having discharged obligation to supply final goods to the

satisfaction of the said Assistant Commissioner or Deputy Commissioner of Customs within a period of thirty days from the expiry of period allowed for fulfilment of

obligation to supply final goods or from such extended period as the Assistant Commissioner of Customs or Deputy Commissioner of Customs may allow; and

(6) that the exempt materials are utilized for the manufacture of final goods and no portion of such

materials shall be loaned, transferred, sold or disposed of in any other manner;

Provided that where final goods in respect of which the said materials have been imported have already been manufactured and supplied as required under this notification, the importer may use the said materials for the manufacture of any other goods.

(7) that the imports and exports are undertaken through sea ports at Bombay, Calcutta, Cochin, Kandla,
Mangalore, Marmagoa, Madras, Nhava Sheva, Paradeep, Tuticorin and Visakhapatnam, or through any of the airports at the Ahmedabad, Bangalore, Bombay, Calcutta, Coimbatore, Delhi, Hyderabad, Jaipur, Madras, Srinagar, Trivandrum and Varanasi or through any of the Inland Container Depots at Bangalore, Coimbatore, Delhi, Gauhati, Hyderabad, Kanpur, Ludhiana, Moradabad, Pimpri(Pune) and Pitampur (Indore):

Provided that the Commissioner of Customs may by special order and subject to such conditions as may be specified by him, permit import and export through any other sea port, airport or Inland Container Depot or through a land customs station

(8) that the exemption from the whole of the additional duty leviable under section 3 of the said Customs
Tariff Act shall not apply to materials required for manufacture of capital goods for supply to fertilizer plants under the procedure of international competitive bidding.

Explanation :- In this notification -

(i) *"Licensing Authority"* means the Director General of Foreign Trade appointed under section

6 of the Foreign Trade (Development and Regulation) Act, 1992 (22 of 1992) or an officer authorized by him to grant a license under the said Act;

(ii) *"materials"* means -

(a) raw materials, components, intermediates, consumable, computer software and
parts required for the manufacture of final goods;

(b) packing material required for the packing of final goods to be supplied;

(iii) *"final goods"* means

(a) Supplies made to United Nations Organizations or under the aid programmed of the
United Nations or other multilateral agencies and paid for in foreign exchange;

(b) Supplies made to projects financed by multilateral or bilateral agencies/Funds as
notified by the Department of Economic Affairs, Ministry of Finance under international competitive bidding or under limited tender system in accordance with the procedures of those agencies/Funds where the legal agreements provide for tender evaluation without including the customs duty;

(c) Supplies made to units in the free trade zones and hundred percent export oriented
undertakings (excluding free trade zone units/export oriented undertakings engaged in Diamond, Gem and Jewelry);

(d) Supply of capital goods for fertilizer plants if the supply is made under the procedure of international competitive bidding; and

(e) supplies of goods to any project or purpose in respect of which the Ministry of Finance, by a notification, on or after 20th June, 1994, permits the import of such goods at zero customs duty, coupled with the extension of benefits under Chapter VII of the Export and Import Policy 1st April, 1997- 31st March, 2002 published by the Government of India under Ministry of Commerce Notification No.1/1997-2002 dated 31st March, 1997 as amended from time to time for domestic supplies.

(iv) *"free trade zone"* and *"hundred percent export oriented undertaking"* have the same

meaning as in Explanation 2 to sub-section (1) of section 3 of the Central Excise and Salt Act, 1944 (1 of 1944)

別添４－３）　国連等のプロジェクトに用いる資材の輸入に係る関税を免除する Notification の例

Seeks to Exempt Imports by United Nations or International organization for execution of projects in India.

11-11-1997

Notification No. 84/97-Customs

In exercise of the powers conferred by sub-section (1) of section 25 of the Customs Act, 1962 (52 of 1962), read with sub-section (4) **of** section 68 of the Finance (No. 2) Act, 1996 (33 of 1996), the Central Government, being satisfied that it is necessary in the public interest so to do, hereby exempts all the **goods imported into India for execution of projects financed by the United Nations or an International Organization** and approved by the Government of India, from the **whole of the duty of customs** leviable thereon under First Schedule to the Customs Tariff Act, 1975 (51 of 1975), the **whole of the additional duty of customs** leviable thereon under section 3 of the said Customs Tariff Act and the **whole of the special duty of customs** leviable under section 68 of the Finance (No. 2) Act 1996 (33 of 1996):

Provided that the importer, at the time of clearance of the goods, produces before the Assistant Commissioner of Customs or Deputy Commissioner of Customs, as the case may be, having jurisdiction, -

(i) in case the said goods are -

(a) Imported by an international organization listed in the Annexure appended to this notification and intended to be used in a project that has been approved by the Government of India and financed (whether by a loan or a grant) by such an organization, a certificate from such organization that the said goods are required for the execution of the said project and that the said project has duly been approved by the Government of India; or

(b) imported for use in a project that has been approved by the Government of India and financed (whether by a loan or a grant) by an international organization listed in the said Annexure, a certificate from an officer not below the rank of Deputy Secretary to the Government of India, in the Ministry of Finance (Department of Economic Affairs) that the said goods are required for the execution of the said project and that the said project has duly been approved by the Government of India;

(ii) in case the said goods are intended to be used in a project financed (whether by a loan or a grant) by the World Bank, the Asian Development Bank or any other international organization other than those listed in the Annexure, and the said project has been approved by the Government of India, a certificate from the executive head of the Project Implementing Authority and countersigned by an officer not below the rank of a Joint Secretary to the Government of India, in the concerned Line Ministry in the Government of India, that the said goods are required for the execution of the said project and that the said project has duly been approved by the Government of India, and

(iii) in case the said goods are intended to be used in a project financed (whether by a loan or a grant) by the World Bank, the Asian Development Bank or any other international organization, other than those listed in the Annexure and the said project has been approved by the Government of India for implementation by the Government of a State or a Union Territory, a certificate from the executive head of the Project Implementing Authority and countersigned by the Principal Secretary or the Secretary (Finance), as the case may be, in the concerned State Government or the Union Territory, that the said goods are required for the execution of the said project, and that the said project has duly been approved by the Government of India for implementation by the concerned State Government.

Explanation. - For the purposes of this notification, -

(a) "international organization" means an international organization to which the Central Government has declared, in pursuance of section 3 of the United Nations (Privileges and Immunities) Act, 1947 (46 of 1947), that the provisions of the Schedule to the said Act shall apply;

(b) "Line Ministry" means a Ministry in the Government of India, which has been so nominated with respect to a project, by the Government of India, in the Ministry of Finance (Department of Economic Affairs).

ANNEXURE

1. United Nations Development Program,

2. United Nations International Children's" Fund,

3. Food and Agricultural Organization,

4. International Labor Organization,

5. World Health Organization,

6. United Nations Population Fund.

7. United Nations World Food Programmed.

8. United Nations Industrial Development Organization.

Notification No. 84/97-Cus.,dated 11-11-1997 as amended by Notification No. 85/99-Cus.,dated 6-7-1999 and No.119/99-Cus.,dated 2-11-1999.and Notification No.75/2001 dt.0-07-01 and Notification No. 107/2001-Cus.,dated 12.10.2001.

別添５　Custom Act 1962　セクション 25（関税の免除に関する規定）

SECTION 25. Power to grant exemption from duty. - (1) If the Central Government is satisfied that it is necessary in the public interest so to do, it may, by notification in the Official Gazette, exempt generally either absolutely or subject to such conditions (to be fulfilled before or after clearance) as may be specified in the notification goods of any specified description from the whole or any part of duty of customs leviable thereon.

[30] [(2) If the Central Government is satisfied that it is necessary in the public interest so to do, it may, by special order in each case, exempt from the payment of duty, under circumstances of an exceptional nature to be stated in such order, any goods on which duty is leviable.

[31] [(2A) The Central Government may, if it considers it necessary or expedient so to do for the purpose of clarifying the scope or applicability of any notification issued under sub-section (1) or order issued under sub-section (2), insert an explanation in such notification or order, as the case may be, by notification in the Official Gazette, at any time within one year of issue of the notification under sub-section (1) or order under sub-section (2), and every such explanation shall have effect as if it had always been the part of the first such notification or order, as the case may be.]

[32][(3) An exemption under sub-section (1) or sub-section (2) in respect of any goods from any part of the duty of customs leviable thereon (the duty of customs leviable thereon being hereinafter referred to as the statutory duty) may be granted by providing for the levy of a duty on such goods at a rate expressed in a form or method different from the form or method in which the statutory duty is leviable and any exemption granted in relation to any goods in the manner provided in this sub-section shall have effect subject to the condition that the duty of customs chargeable on such goods shall in no case exceed the statutory duty.

Explanation. - "Form or method", in relation to a rate of duty of customs, means the basis, namely, valuation, weight, number, length, area, volume or other measure with reference to which the duty is leviable.]

[33][(4) Every notification issued under sub-section (1) or sub-section (2A) shall, unless otherwise provided, come into force on the date of its issue by the Central Government for publication in the Official Gazette.]

[34][***].

[35][(6) Notwithstanding anything contained in this Act, no duty shall be collected if the amount of duty leviable is equal to, or less than, one hundred rupees.]

[36][(7) The mineral oils (including petroleum and natural gas) extracted or produced in the continental shelf of India or exclusive economic zone of India as referred to in section 6 and section 7, respectively, of the Territorial Waters, Continental Shelf, Exclusive Economic Zone and Other Maritime Zones Act, 1976 (80 of 1976), and imported prior to the 7th day of February, 2002 shall be deemed to be and shall always be deemed to have been exempted from the whole of the duties of customs leviable on such mineral oils and accordingly, notwithstanding anything contained in any judgement, decree or order of any court, tribunal or other authority, no suit or other proceedings in respect of such mineral oils shall be maintained or continued in any court, tribunal or other authority.]

[36] [(8) Notwithstanding the exemption provided under sub-section (7), no refund of duties of customs paid in respect of the mineral oils specified therein shall be made.]

資料　7 - 4

O&M サービス仕様書（案）

SECTION VII. EMPLOYER'S REQUIREMENTS

PART C: OPERATION & MAINTENANCE SERVICE SPECIFICATIONS

Operation & Maintenance Service Specifications

Table of Contents

1. General

1.1 Definitions

The terms used in The Employer's Requirements Part C: Operation &Maintenance (hereinafter referred to as "O&M") Service Specifications shall have the meaning described hereunder.

Table 1.1 Definitions of Terms

Availability	It is the ratio of the time period for which the System is normally in operation and available to the Employer and users. It is calculated according to downtime responsible for the Contractor on quarterly basis by the following formula; $Availability = (1 - \frac{Downtime - Permissive\,Downtime}{Totaltime - Permissive\,Downtime}) * 100$
BMTC	It is the abbreviation of Bengaluru Metropolitan Transport Corporation
BTIC	It is the abbreviation of Bengaluru Traffic Information Centre where the BTIC System is operated under DULT.
BTP	It is the abbreviation of Bengaluru Traffic Police
BTIC System	It is the System implemented by the Project and operated at BTIC under DULT, consist of Centre System, Probe System, ATCC System, Que length Measurement System, Internet System within the Traffic Information System, without VMS System. BTIC System is subjected to O&M Service by the Contractor.
Downtime	It is a total time during the System is not available.
DULT	It is the abbreviation of Directorate of Urban Land Transport of Karnataka State Government
Emergency Response	It is the measure taken by the Contractor to identify the situation and the causes of the malfunctions to replace the defective parts or repair the malfunction in case of the failure and/or incident with respect to the System.
Existing Signal System	It is an Existing Signal System operating at TMC
Existing TMC System	It is an operating system already at TMC under Traffic Police, consist of Existing Signal System, Existing VMS System and Existing CCTV System. Existing TMC System is not subject to O&M Service by the Contractor.
Existing VMS System	It is an Existing VMS System operating at TMC
Final Acceptance Certificate	It is the certificate issued by the Employer to the Contractor of the Project on the date that the System go live and start operation. The O&M will start from the date on which Final Acceptance Certificate is issued.
JICA	It is the abbreviation of Japan International Cooperation Agency
KSDC	It is the abbreviation of Karnataka State Data Centre
Local Training	The training should be provided by the Contractor on annual basis to improve O&M technology to DULT and BTP officials. It is consisted of the lecture and on-site training.
Maintenance Team	It is the Contractor's staff mainly stationing at the Contractor's office for O&M Service, but also including Supporting Japanese Staff who support the O&M Service remotely from Japan and in India if necessary. The O&M Service have to give Periodic Inspection, Preventive Maintenance, Emergency Response for the System and conduct local training and Seminar whenever necessary.
On-site Service	It is the work conducted by the Maintenance Team not by the remote service but at site where equipment of the System is installed such as road side, TMC, BTIC and KSDC to identify and replace or repair the defective/damaged equipment and parts in case of the failure or incident.

Operation & Maintenance (O&M) Period	It is the time period of O&M Service from the date of issuance of the Final Acceptance Certificate of the Project to the end of the contract period of O&M Service which is five years.
Operator	It is the Contractor's staff stationing at BTIC and TMC who carries out the operation of the System and the Primary Response in case of the failure or incident.
O & M	It is the abbreviation of Operation and Maintenance work conducted by Employer and Contractor
O & M Service	It is the abbreviation of Operation and Maintenance service conducted by the Contractor to operate the System effectively and to keep the System in good condition
Performance Target	It is the Performance Target of the O&M Service that the Contractor shall attain, which is composed of the Availability, Response Time and Resolution Time. Performance Target of Availability is 99%. Performance Target of Response Time and Resolution Time are specified by the Severity, i.e. Critical, Major and Minor.
Periodic Inspection	It is the maintenance work, including but not limited to detailed inspection, conducted by the Maintenance Team on regular basis to maintain the performance of the system.
Permissive Downtime	It is Downtime resulted from periodic inspection, preventive maintenance, instruction by Employer and repair works for the damage caused by the Employer and the third parties (e.g. traffic accident, black out, surge caused by thunder storm, fire, failure of communication lines, vandalism, etc)
Preventive Maintenance	It is the maintenance work conducted by the Maintenance Team which is necessary for preventing the failures of the system and equipment including, but not limited to, cleaning, replacing the damaged parts, adjusting the position of detecting equipment, etc.
Primary Response	It is the primary measure taken by the Operator at BTIC and TMC in case of the failure or incident. It is to identify the situations and causes of the malfunctions and to request the Maintenance Team to respond and take necessary actions for further emergency situations.
Quarterly Billing Value (QBV)	It is the price amount claimed by the Contractor for every quarter for delivering the O&M services as specified in the Employer's requirement.
Remote Service	It is the work conducted by the Maintenance Team and/or Supporting Japanese Engineer to identify the situations and causes of the malfunctions and rectify the malfunctions through remote control of software of the System in case of failure or incident.
Resolution Time	It is the time period within which the systems/equipment shall be recovered permanently or on the temporally remedial basis. It is counted from the time of completion of the Response Time to the time of completion of the permanent or temporary remedial measure.
Response Time	It is the time period within which the Contractor shall arrive at the site of the failure. It is counted from the time of notification of the failure to the time of arrival at the site of the failure.
Supporting Japanese Engineer	It is the Contractor's Japanese Engineer, to support Local Training, Seminar, Evaluation and Adjustment at India, and to support O&M service through Remote Service from Japan as needed.
Seminar	It is the seminar held by the Contractor on annual basis to the public and local company to transfer the ITS technologies and know-how.
Severity	It is a degree of seriousness of an incident to define the Response Time and

	Resolution Time which are determined according to the risks to the road users. Three severity levels are set forth, i.e. “Critical”, “Major” and “Minor”.
Signal System	It is implemented by the project to control the traffic signal based on the real time traffic information.
The Contractor	It is the Contractor who conducts O&M service
The Project	It is the Project for Implementation of Advanced Traffic Information and Management System in Core Bengaluru, of which The Government of Republic of India has received a grant from JICA toward the cost.
The System	It is the system which is installed by the Project. The system consists of Traffic Information System and Signal System.
TMC	It is the abbreviation of Traffic Management Centre where the Signal System, VMS system, Existing Signal System, Existing VMS System and Existing CCTV are operated under Bengaluru Traffic Police.
Total Time	It is the evaluation period, which is three months (2,160 hours), for the Target Availability.
Traffic Information System	It is the Traffic Information System implemented by the project to collect the information from Probe, ATCC and Que length Measurement System, and analyse at Centre system, and disseminate Traffic Information through Internet and VMS. Traffic Information System consists of Centre system, Probe System, ATCC System, Que Length Measurement System, Internet System and VMS System.
TMC System	It is the System implemented by the project and operated at TMC under Traffic Police; consist of Signal System and VMS. TMC System is subject to O&M Service by the contractor.
VMS System	It is the abbreviation of Variable Message Sign System, implemented by the project.

1.2 Background

Effective utilization of road infrastructure are becoming more important to mitigate traffic congestion and normalize traffic flow. Intelligent Transport System (hereinafter referred to as "ITS") is an important non-structural measure, whereby information technology is applied in the field of road transportation, and there are high expectations from the development of ITS in the Bengaluru Metropolitan Area.

For the purpose of above, the Government of India have received a grant from Japan International Cooperation Agency (hereinafter to as "JICA") towards the cost of the Project for Implementation of Advanced Traffic Information and Management System in Core Bengaluru (hereinafter referred to as "the Project").

The software, equipment, cables and facilities to be implemented by the Project is called "the System", composed of Traffic Information System and Signal System. And Traffic Information System is composed of six (6) sub systems such as Center System, ATCC System, Que Length Measurement System, Probe System, Internet System, and VMS System.

According to view point of operation, there are two (2) operation center named Bengaluru Traffic Information Centre (hereinafter referred to as "BTIC") under Directorate of Urban Land Transport (hereinafter referred to as "DULT") and Traffic Management Centre (hereinafter referred to as "TMC") under Bengaluru Traffic Police (hereinafter referred to as "BTP"). BTIC is newly developed for the Project but TMC is already operating with existing Signal System, existing VMS System and existing CCTV Systems.

Within Traffic Information System, only VMS System is operated at TMC. Therefore, the System is categorized as follows according to jurisdiction of operating agency and center:

- "BTIC System" operated at BTIC under DULT composed of Centre System, ATCC System, Que Length Measurement System, Probe System and Internet System; and
- "TMC System" operated at TMC under BTP composed of Signal System and VMS System.

Table 1.2 Category of the System and major equipment

System	*Sub system*	*Server Equipment* (at KSDC)	*Centre Equipment*		*Roadside Equipment*	*System Name for each Centre*	*O/M by*
Traffic Information System	*Centre System*	BTIC Server	Operator Console Video Wall	*at BTIC*		*BTIC System*	*DULT*
	ATCC System	ATCC Server			ATCC Sensor Controller		
	Que Length Measurement System	Que Length Measurement Server			Que length Sensor Controller		
	Probe System	Probe Server					
	Internet System	Internet Server					
	VMS System	VMS System Server	Operator Console	*at TMC*	VMS Controller	*TMC System*	*BTP*
Signal System	*Signal System*	Signal System Server	Operator Console		Signal/Sensor Controller		

1.3 General Requirements

The purpose of Operation and Maintenance of the System is to keep the System in operation in the manner originally intended, that is to collect traffic status data, process and analyse the data into useful information, disseminate the information to road users, or to moderate traffic congestion and to prolong the life of the system.

Operation and Maintenance of the System shall be conducted suitably and effectively by Employer and the Contractor. And the service conducted by the Contractor for Operation and Maintenance of the System is called Operation and Maintenance Service (hereinafter to as "O&M Service") .

The specifications described herein shall be considered the minimum standards to be followed for O&M Service of the System under the Contract. Unless otherwise specified, the standards for the System and performance of the System shall be in accordance with Employer's Requirements Part A: General Technical Specifications and Part B: Particular Technical Specifications.

1.4 Scope of Work

Apart from implementation of the Project, the scope of work also includes O&M Service of the System for a period of 5 years from the date of Final Acceptance Certificate of the Project.

Except otherwise specified in Employer's Requirements Part C: O&M Service Specifications, it is the Contractor's responsibility to provide sufficient organization and manpower to implement flawless O&M Service of the System in operation in the manner originally intended, that is to collect traffic status data, process and analyse the data into useful information, disseminate the information to road users, or to moderate the traffic congestion and undertake the services that are not specifically mentioned in these requirements but essential for the safe and efficient traffic operation on roads of Bengaluru central area.

The Contractor shall maintain qualified staff at BTIC, TMC and the Contractor's office, and also maintain tools, equipment, consumables, and materials in good condition to perform all O&M Service for the System necessary in good working manner.

1.4.1 Basic concept of scope and payment for O&M Service

O&M Services are required to cover centre system such as operator console and video wall at BTIC and TMC, Servers at Karnataka State Data Centre (KSDC), road side equipment for the System, including network equipment and cables implemented under the Project.

The Contractor shall prepare an Equipment List to be covered by the O&M Service based on the actual configuration and quantity of the equipment. If the Contractor provides any additional equipment not specified in Employer's Requirements to complete the O&M Service required, they shall be included in the scope of O&M Service and the Contractor shall submit the revised Equipment List to Employer's Representative for approval.

The Contractor shall perform the following services as lump sum basis under the Contract:

- Operation;
- Primary Response;
- Emergency Response (including resolution cost for damaged facilities);
- Periodic Inspection and Preventive Maintenance (including Update and Debugs of the Installed Software);
- Local Training and Seminar; and
- Annual Evaluation and Adjustment of the System.

The Contractor can claim invoice of following items according to the unit price prescribed in the

O&M Contract:

- Purchasing additional equipment/system and supporting facilities for upgrade and expansion according to instructions of the Employer； and
- Purchasing new equipment and parts if retrieved defective/damaged equipment and parts is impossible to be repaired.

In case the Employer requests to upgrade software by adding new function, the price for the upgrading is subject to negotiation.

1.4.2 O&M management by DULT and BTP

The Systems to be introduced by the Project for O&M Service is composed of BTIC System and TMC System. BTIC will be established under DULT as a new organization while TMC is already operating existing facilities such as Signal System, VMS, CCTV.

The Employer of the O&M Service Contract is DULT. However, BTP is responsible for management of TMC System including supervision of O&M Service while DULT is responsible for management of BTIC System. For the purpose of supervising O&M Service for each System, the Employer shall assign one (1) DULT official and one (1) BTP official as Employer's Representative for each System.

1.3.4 O&M of the System for BTIC and TMC

O&M work of Employer and the Contractor are shown in Table 1.3 and Table 1.4.

Table 1.3 O&M for BTIC

Position	Roles and Responsibilities	Contents
Director and his/her staff @ BTIC	Director: is responsibe for supervising and controlling all activities of BTIC Staff is responsible for data analysis and supporting the director.	- Coordination of all activities between BTIC and other related Gov. agencies especially Traffic Police. - Planning and coordinating system update - Compiling , analysis and providing the proceeded data/information - Responding to enquiries from related Gov. agencies - Requesting related Gov. agencies to provide information for BTIC if necessary. - Checking the report submitted by the Contractor
The Operator (An O&M Contractor's staff @ BTIC)	Operation ***-Lump Sum basis-***	- Responding to enquiries from general public. - Observing operating status of ATCC and Queue Length Measurement System. - Observing traffic status on schematic map of video wall. - Observing operation status of server installed at KSDC from operator console. - Checking the error log of each server and ask according to the instruction of the representative of the Contractor - Comparing the inventory and spare parts periodically. - Establishing supplementary plan for spare part - Preparing and submitting daily, monthly and quarterly reports of the Contractor's activity to the Employer. - Culculation of Availability quarterly based on incident reports.
	Primary Response (at fault) ***-Lump Sum basis-***	- Identifying situations and couses of system malfunctions. - Requesting Maintenance Team of O&M Contractor for responce, in case of failure and incident. - Reporting the status of system/equipment to the Employer in case incidents occurs and are resolved. - Preparing and submitting incident reports to the Employer.
Maintenance Team (O&M Contractor's staffs @ local office) ***To be supported by engineers from Japan as needed.***	Emergency Response ***-Lump Sum basis-***	(Remote Service) - Identifying situations and couses of system malfunctions. - Rectifying malfunction remotely. - Providing necessary information about incidentsas per request from BTIC operators. (On-site Service) - Identifying the defective/damaged equipment and parts and replacing defective/damaged equipment and parts with spare parts - Replacement and resolution of damaged facility - Repairing retrieved defective/damaged parts if reparing is possible.
	Periodic Inspection and Preventive Maintenance ***-Lump Sum basis-***	- Establishing Periodic Inspection and Preventive Maintenance plan and submit to the Employer - Carrying out inspection and preventive maintenance such as cleaning periodically according to a submitted plan. - Conducting of remote diagonostics periodically Confirming operation status of server at KSDC from PC at contractor's office. - Submitting reports of Periodic Inspection and Preventive Maintenance work to the Employer - Maintaining spare parts and inventory and report - Fixing bugs and upgrading software version - Annual Updating of Digital Road Map
	Local Training and Seminor ***-Lump Sum basis-***	- Carrying out trainings for DULT officials annually - Carrying out seminor to transfer the ITS technologies and know-how for public and private sectors in India.
	Evaluation and Adjustment of Equipment/System ***-Lump Sum basis-***	- Detecting actual travel time along major roads by probe cars and evaluating the reliability of the probe system - Revise software and/or parameter of the probe system according to results of incorporate the latest digital road maps into the probe system annually.
	Purchasing new Equipment and Parts ***-Quotation basis-***	- Additional equipment/system and supporting facilities for upgrade and expansion according to instructions of the Employer - New equipment and parts if retrieved defective/damaged equipment and parts is impossible to be repaired

Role of Operator

Role of Maintenance Team of the Contractor

Table 1.4 O&M for TMC

Position	Roles and Responsibilities	Contents
Traffic Police Director and his/her staff @ Traffic Management Centre (TMC)	Director: is responsibe for supervising and controlling all activities of TMC Staff is responsible for data analysis and supporting the director.	- Coordination of all activities between TMC and other related Gov. agencies especially BTIC. - Planning and coordinating system update - Compiling , analysis and providing the proceeded data/information - Responding to enquiries from related Gov. agencies - Requesting related Gov. agencies to provide information for TMC if necessary. - Instructing to the operator to revise signal parameter (cycle, split, offset) according to monitoring results and requests from local residents. - Instructing manual operations to the operator as required - Inputting necessary messages on VMSs if necessary. - Instructing to the Contractor response and resolution during off-time in case of incidents during off-time. - Checking the report submitted by the Contractor
The Operator (An O&M Contractor's staff @TMC)	Operation ***-Lump Sum basis-***	- Observing operating status of signal and VMS system. - Observing operation status of server installed at KSDC from operator console. - Checking the error log of each server and ask according to the instruction of the representative of the Contractor - Comparing the inventory and spare parts periodically. - Establishing supplementary plan for spare part - Preparing and submitting daily, monthly and quarterly reports of the Contractor's activity to the representative of the Employer. - Culculation of Availability quarterly based on incident reports.
	Primary Response (at Fault) ***-Lump Sum basis-***	- Identifying situations and couses of system malfunctions. - Requesting Maintenance Team of O&M Contractor for responce, in case of failure and incident. - Reporting the status of system/equipment to the Employer in case incidents occurs and are resolved. - Preparing and submitting incident reports to the representative of the Employer.
Maintenance Team (O&M Contractor's staffs @ local office) ***To be supported by engineers from Japan as needed.***	Emergency Response ***-Lump Sum basis-***	(Remote Service) - Identifying situations and couses of system malfunctions. - Rectifying malfunction remotely. - Providing necessary information about incidentsas per request from TMC operators. (On-site Service) - Identifying the defective/damaged equipment and parts and replacing defective/damaged equipment and parts with spare parts - Replacement and resolution of damaged facility - Repairing retrieved defective/damaged parts if reparing is possible.
	Periodic Inspection and Preventive Maintenance ***-Lump Sum basis-***	- Establishing Periodic Inspection and Preventive Maintenance plan and submit to the representative of the Employer - Carrying out inspection and preventive maintenance such as cleaning periodically according to a submitted plan. - Conducting of remote diagonostics periodically Confirming operation status of server at KSDC from PC at contractor's office. - Submitting reports of Periodic Inspection and Preventive Maintenance work to the representative of the Employer - Maintaining spare parts and inventory and report - Fixing bugs and upgrading software version
	Local Training and Seminor ***-Lump Sum basis-***	- Carrying out trainings for BTP officials annually - Carrying out seminor to transfer the ITS technologies and know-how for public and private sectors in India.
	Evaluation and Adjustment of Equipment/System ***-Lump Sum basis-***	- Review the current traffic condition and adjust each equipment/system accordingly by revising control parameter annually.
	Purchasing new Equipment and Parts ***-Unit Price basis-***	- Additional equipment/system and supporting facilities for upgrade and expansion according to instructions of the Employer - New equipment and parts if retrieved defective/damaged equipment and parts is impossible to be repaire.

Role of Operator

Role of Maintenance Team of the Contractor

2. Employer's Requirements for O&M Service

The system shall be in operation for 24 hours a day and 7 days a week without interruption. The Contractor shall not divert and modify the procedure without written approval by The Employer.

2.1 Operation of the System

2.1.1 Operation of BTIC System

BTIC will be newly established under DULT which has no experiences of operation and maintenance of such sophisticated system as Traffic Information System. Under these circumstances, any operation of BTIC System shall be carried out by the Contractor except following operations to be conducted by the Employer's staff:

- Coordination of all activities between BTIC and other related Gov. Agencies especially Traffic Police;
- Planning and coordinating system update;
- Compiling, analyzing and providing the proceeded data/information;
- Responding to enquiries from related Gov. agencies;
- Requesting related Gov. Agencies to provide information for BTIC if necessary; and
- Checking the report submitted by the Contractor.

2.1.2 Operation of TMC System

TMC of Traffic Police is already existing and operating existing signal system, existing VMS System, and existing CCTV System etc. Under these circumstances, any operation of TMC system shall be carried out by the Contractor except following operations to be conducted by the Employer's staff:

- Coordination of all activities between TMC and other related Gov. Agencies especially BTIC;
- Planning and coordinating system update;
- Compiling, analysis and providing the proceeded data/information;
- Responding to enquiries from related Gov. agencies;
- Requesting related Gov. Agencies to provide information for TMC if necessary;
- Instructing to the operator to revise signal parameter (cycle, split, offset) according to monitoring results and request from local residents;
- Instructing manual operations to the operator as required;
- Inputting necessary messages on VMSs if necessary;
- Instructing to the Maintenance Team of the Contractor for response and resolution in case incidents happens during off-time of the Operator at TMC; and
- Checking the report submitted by the Contractor.

2.1.3 Operation of Automatic Traffic Counter-cum-Classifier (ATCC) System at BTIC

2.1.3.1 Identification of abnormal traffic data

If abnormal traffic data is identified, the Operator shall further examine the data and determine whether the actual traffic condition became abnormal due to an incident or the abnormal condition of ATCC equipment by checking the System including data collected by probe system or queue length measurement system. If any abnormality attribute to the system and/or equipment, the Operator shall inform the Maintenance Team for further investigation.

2.1.3.2 Monthly review

At the end of every month, the Operator shall go through the data collected by ATCC to make a static data of traffic volume at each monitoring spots and record these static data. If any abnormality that is attributable to erroneous system operation is found, the Operator shall inform the Maintenance Team for further investigation.

2.1.3.3 Failure of Equipment

If operator console receives fault signal or no diagnosis signal response from ATCC at roadside, the Operator shall contact the Maintenance Team and report the location and status of equipment with failure for proper maintenance action.

2.1.4 Operation of Queue Length Measurement System at BTIC

2.1.4.1 Identification of Abnormal traffic data

If abnormal traffic data are identified, the Operator shall confirm whether the actual traffic flow is different from the normal or the data is erroneous. If the data is identified erroneous, the Operator shall inform the Maintenance Team for further investigation.

2.1.4.2 Monthly review

At the end of every month, the Operator shall go through the data collected to make a static data of queue length at each monitoring spots and record these static data. If any abnormality that is attributable to erroneous system operation is found, the Operator shall inform the Maintenance Team for further investigation.

2.1.4.3 Failure of Equipment

If operator console receives fault signal or no diagnosis signal response from Queue Length Measurement System at roadside, the Operator shall contact the Maintenance Team and report the location and status of equipment with failure for proper maintenance action.

2.1.5 Operation of Schematic Map at BTIC

2.1.5.1 Information Displayed

Schematic Map on Video Wall at BTIC displays following items:

- Road networks (ORR, IRR, NH, SH and other arterial roads);
- Location of road side equipment (ATCC, VMS);
- Traffic congestion status; and
- Regulation (Lane closure, Road closure) if BTIC receives information from Traffic Police or Municipal Corporation.

The Operator at BTIC shall maintain any change/adding/removal of location of road side equipment and any information which will display on schematic map.

The Operator confirm the regular update of Digital Road Map (DRM) provided by the DRM supplier once a year, and surely carried out and properly reflect DRM update.

2.1.5.2 Operation

When any information such as accident, road works and traffic enforcement, which should be shown on the schematic map, received from related agencies, the Operator shall operate console and confirm the correct information need to be displayed on schematic map.

When future road work information is received from related agencies, the Operator input that information into operation console.

2.1.5.3 Identification of abnormal situation

If abnormal traffic data is identified, the Operator shall further examine the data and determine whether the actual traffic condition became abnormal due to an incident or the abnormal condition of ATCC equipment by checking the System including data collected by probe system or queue length measurement system.

If abnormal situation identified on the System for visible information, the Operator shall inform the Maintenance Team for further investigation.

If any discrepancy occurs between provided DRM and schematic map, the Operator shall inform the Maintenance Team for further investigation.

2.1.6 Operation of Probe System at BTIC

2.1.6.1 Update of System

Probe server of BTIC establish the traffic congestion status information automatically based on obtained bus tracking data of Bengaluru Metropolitan Transport Corporation（BMTC）at an interval of less than one (1) minutes. In order to increase accuracy to analyze and establish traffic congestion information, location of bus stops is important since data cancellation is required at bus stops to match actual traffic status. Thus, BTIC system operator contacts to BMTC frequently and whenever changes of bus stop location on each bus route are founded such as Shifting/Adding/Removal of bus stops, the Contractor shall update the system in advance of commencement of changes.

2.1.6.2 Monthly review

At the end of every month, the system operator shall make the monthly traffic status report, which can describe and organize the traffic data by location, day, week, time and direction wise.

2.1.7 Operation of VMS System at TMC

2.1.7.1 Type of information provided

Three different schematic maps with major destination according to each location shall be used as background of display. Time to destination and traffic congestion status of route by different colors shall be overlapped on schematic map freely. In the lower part of VMS, space for displaying any inputting messages is also required. The following types of information shall be displayed:

- Easily identifiable route map of downstream according to each VMS locations;

- Traffic congestion status of each link by different colors (Red color: massive traffic congestion, Orange color: congestion, Green color: smooth) ;
- Travel time to major destination;
- Any incident such as road/lane closure, road work, accident, etc; and
- Any messages on message line.

2.1.7.2 Language used

Three languages, English, Hindi, and Kannada will be used for VMS. Thus, the Operator shall be fluent in these languages. Except message on message line, messages will be displayed in one of the three languages. Message shall carry the same meaning regardless of the language used and express in one line.

2.1.7.3 Process of Information Provision

When any information such as accident, road works and traffic enforcement, the Operator at TMC operates the operator console to input message on massage place of VMS and input information on schematic map of VMS in accordance with instruction of Traffic Police Officer.

2.1.8 Operation of Signal System at TMC

2.1.8.1 Manual operation of Signal System

Signal System is made as full automatic. However, when Traffic Police intend to control the traffic manually, system operator at TMC change the signal control mode to manual and signal can be controlled manually in accordance with instruction of Traffic Police officer.

2.1.8.2 Failure of Equipment

If TMC receives fault signal or no diagnosis signal response from Signal Equipment at road side, the Operator shall contact the Maintenance Team and report the location and status of equipment with failure for proper maintenance action.

2.2 Primary Response

During the operation of the System, if the Operator detects any abnormality and faulty of the System, the Operator shall conduct following activity for further and proper maintenance action as emergency response:

- Identifying location, situations and causes of abnormal and faulty situation of the System;
- Requesting Maintenance Team of the Contractor for further Emergency Response;
- Reporting the status of system/equipment to the Employer; and
- Preparing and submitting incident reports to the Employer.

The Operator shall refrain from operating the System including modifying operating parameters, reloading software or other action without instruction by the engineer of the Maintenance Team when abnormal or defective behavior of the System is found.

2.3 Emergency Response

Once the Operator report the location and status of abnormal and faulty situation of the System to the Maintenance Team as primary response, the Maintenance Team starts the activity of emergency response.

The Maintenance Team shall be available for repair work on a 24-hour a day, 7-day a week basis. As emergency response, upon reception of a failure notice by the Operator or the Contractor shall log the notice and determine the nature and severity of the failure, and dispatch the Maintenance Team to the site. Immediate action for response and resolution shall be taken to safeguard the public at any time if the failure is of nature that causes hazardous condition.

Following are the major activity for emergency response:

(Remote Service)

- To identify situations and causes of system malfunctions;
- To rectify malfunction remotely; and
- To provide necessary information about incidents as per req uest from the Operator.

(On site Service)

- To identify the defective/damaged equipment and parts;
- To replace defective/damaged equipment and parts with spare parts;
- To replace and resolution of damaged facility; and
- To repair retrieved defective/damaged parts if repair is possible.

If the fault cannot be measured the permanent repair immediately, a temporary repair or remedial measure sufficient to safeguard the operation of the System shall be effected by the Contractor and the Employer shall be so notified. Permanent repairs shall be completed as soon as possible, and in all cases within 96 hours of notification unless extended in unusual circumstances, such as lack of a particular foreign spare part.

2.3.1 Spare parts, consumables and materials

The Contractor shall maintain sufficient inventory of spare parts (equipment and facility), consumables and materials in order to keep required performance to maintain effective operation of the System. And the Contractor shall repair the retrieved defective/damaged parts if repairing is possible after replacement of defective/damaged parts to spare parts.

The cost of repair of spare parts of equipment and preparation of consumable for the System shall be by the Contractor's own cost, but purchase of new spare parts will be paid by Employer after approval.

Following are the major activity for keeping spare parts, consumables and materials:

- To keep the suitable material for resolution and repair of the equipment/parts and facility;
- To manage the inventory of the spare parts including necessary equipment/parts and facilities;
- To repair the damaged equipment of the System after replacement for emergency response;
- To request Employer to purchase new equipment of spare parts of the System when damaged equipment/parts cannot be repaired, according to the unit price of equipment/parts in the contract; and
- To request Employer to repair or renew the spare parts of facility such as pole for equipment.

2.3.2 Diagnosis of Faulty Parts

The Contractor shall diagnosis the faulty part and decides the method to recover from fault to normal operation and identify the cause including whether attributable to the Contractor or not.

2.4 Periodic Inspection and Preventive Maintenance

The Contractor shall perform the Periodic Inspection and Preventive Maintenance of all equipment and software of the System in accordance with the Preventive Maintenance Plan submitted and approved by Employer at the beginning stage of O&M Service.

The actual schedule, Check list and method of each Periodic Inspection and Preventive Maintenance shall be submitted to Employer at least one month before the start of each activity for Periodic Inspection and Preventive Maintenance.

Basic concept for Periodic Inspection and Preventive Maintenance are shown below;

Table 2.1Basic Concept of Periodic Inspection and Preventive Maintenance

Frequency	Server	Roadside Equipment	Basic Participants
Semi-annual	Check + Cleaning	Check + Cleaning	Local engineer
Annual	Evaluation and Adjustment	Detail Check	Local engineer/ Japanese engineer

2.4.1 Check and Cleaning

The Contractor shall carry out Check and Cleaning semi-annually by local engineer according to the Check List, including to check appearance condition, heating generation, voltage measurement and other normal check.

2.4.2 Detail Check

Contractor shall carry out Detail Check annually by local engineer and Japanese engineer if necessary according to the Check List, including to check sensitivity condition, insulation condition, the detail function, sensor calibration if necessary and other detail check.

2.4.3 Software Preventive Maintenance

The Contractor shall perform preventive maintenance of software of the Equipment as part of the maintenance work. The Contractor shall exert the utmost care not to inadvertently damage the software and database and not to cause erroneous or abnormal operation of the BTIC System and TMC System during the preventive maintenance of software.

The items for software maintenance shall include but not be limited to the following:

- Monitoring of CPU, memory and disk space utilization;
- Monitoring of system availability over TCP/IP;
- Monitoring of anti-virus and security system operation;
- Backup of the system and restoration of the system when necessary;
- Monitoring and review of software system;
- Update to latest version and debugs of software; and
- Evaluation of the System and adjustment of parameter.

As every server for both BTIC System and TMC System shall be placed at Karnataka State Data Centre (KSDC) which provides security and incident management service, they are protected under multi-layer security blanket from malicious attacks or theft from external (through internet) and internal (through intranet) hackers.

As security system other than above, anti-virus and security system software is installed by the Project, and the Operator shall update the security files periodically.

In case the Employer requests to upgrade software by adding new function, the price for the upgrading is subject to negotiation.

Minor modifications of the system software (e.g. Improvement of visibilities of system console, web site design of traffic condition information of internet system, etc.) can be done by the Contractor without clamming any additional cost within one (1) year after the completion of the Project according to bilateral negotiations to avoid impartial and excessive burden of the Contractor.

2.5 Local Training and Seminar

2.5.1 General

The Contractor shall provide the local training and the seminar to the engineers of DULT and BTP. The training curriculum shall be sufficient to facilitate transfer of knowledge on the technologies to assure the quality of the O&M service. The local training and the seminar shall be provided once a year in the same period.

The training program is consisted of the local training and seminar and the Contractor shall propose the details of the following training program.

Table 2.4 Minimum Requirement of Training Program

Items		Minimum Number of Days	Participants
Local Training	Lecture	7 working days (2 days for Basic Course and 5 days for Advanced Course)	DULT: Five (5) engineers BTP : Five (5) engineers
	On-site Training	5 days	
Seminar		2 days	DULT: Five (5) engineers (*) BTP : Five (5) engineers (*) The local companies engaged in ITS related operation, maintenance, and system integration

Note (*): The number of participants in the seminar is not limited to the described in the table.

The above training program shall be provided for the O&M of BTIC System for DULT and TMC System for BTP. All above training shall be provided in Bengaluru. The local training shall be provided to each group, i.e. DULT and BTP respectively. The Contractor shall propose the details of the curriculum of the local training and seminar. The Contractor shall prepare all materials required for the above training program in English and furnish the required number of the copies, which include at least five (5) copies for DULT and five (5) copies for BTP. The venue and seminar arrangement shall be paid by the Contractor, but the venue for Local Training will be arranged at Employer's office by Employer.

The Contractor shall prepare the sufficiently knowledgeable personnel including Japanese engineer to provide the above training program.

2.5.2 Local Training: Lecture

The lecture shall consist of two stages i.e. Basic Training Course and Advanced Training Course as described below and the contents shall include, but not limited to, the followings:

1) Basic Course

- Outline of BTIC System;
- Outline of TMC System;
- Console Operation; and
- System Management.

2) Advanced Course

- Concept of Signal Cycle;
- Process of finding optimal signal cycle;
- Evaluation and Adjustment of the System;
- Calibration of sensor and measurement equipment;
- Concept of Probe System;
- Process of finding the time to destination;
- Data cancellation of systems;
- Concept and calculation of Availability;
- Response and Resolution of Failure;
- Data Analyze Procedure;
- Recording and Reporting;
- Methodology to find failure; and
- Power supply equipment operation.

The training shall not be limited to the above subjects.

2.5.3 Local Training: On Site Training

The Contractor shall carry out the preventive maintenance and periodic inspection together with trainees for five (5) days to transfer the knowledge on the maintenance of the System. The contents of On Site Training shall include, but not limited to, the following:

- Checking the periodical maintenance plan submitted by Contractor to DULT;
- Checking the check sheet for utilizing periodical maintenance and emergency response;
- Checking the tools and wear helmet, safety jacket before initiate the maintenance work;
- How to use the various measurement tools;
- How to identify the failure;
- How to use the remote inspection;
- How to clean the equipment and system at roadside, BTIC and TMC;
- Evaluation and Adjustment of the System; and
- Calibration of sensor and measurement equipment.

2.5.4 Seminar

Two (2) days seminar shall be held by the Contractor. The purpose of seminar is to transfer the knowledge on the ITS technologies and know-how to BPT and DULT officials, the employees at TMC, other state government employees and local private companies in the ITS sector which include the manufactures, operators and maintenance firms. The lecturers of the seminar shall include the Japanese engineers of the Contractor.

2.6 Evaluation and Adjustment

The Contractor shall carry out Evaluation and Adjustment of the System annually by local engineer and Japanese engineer.

Supporting Japanese Engineer comes to India to conduct the Evaluation and Adjustment of the System annually for Preventive Maintenance and also conducts the training and seminar at the same time.

1) Traffic Information System

Contractor shall conduct following site survey, system evaluation and adjustment

- Site Survey

  Contractor shall conduct the driving test using probe car to a major road showing on a Variable Message Board to check the deference between showing travel time on VMS and measured travel time. And also record the estimated travel time displayed on the Variable Massage Board and capture the road situation in the running direction with a drive recorder.

  The above driving test is conducted at 3 Variable Massage Boards at the morning and the evening (both peak time and none peak time) for 2 days (weekday) and for 1 day (holiday).

- System Evaluation and Adjustment

  Based on the above site survey result, compare the estimated travel time calculated by the system and the actual required travel time, and confirm whether they are boldly separated. When they are boldly separated, inspect the cause, and conduct system adjustment as necessary.

2) Signal System

Some consultant will be hired to conduct site survey for evaluation of the short-term index such as travel time, delay time, traffic volume and outgoing traffic volume during green signal. And the Contractor shall conduct the system evaluation and adjustment based on the information of above site survey by consultant.

- Site Survey by Consultant

  The description of the site survey is shown in the following table. The result of the survey shall be given to the O&M contractor and utilized for the system adjustment.

Table 2.2 Site Survey

Survey name corresponding to short-term index	Content
Travel Time / Delay Time Survey	Measuring travel time and delay time (stop time at junctions) on the target routes for introduction of Signal System
Junction Traffic Volume Survey in each direction	Counting traffic volume of approaching roads at the key junctions (7 junctions)
Passing Traffic Volume survey during Green Signal	Counting passing traffic volume per unit of time during green indication at the key junctions (7 junctions)

- System Evaluation and Adjustment

  Contractor conduct the system evaluation and adjustment for signal control parameters (Cycle, Sprit and Offset) according to the Contractor's analysis based on the result of the site survey by the consultant and system log.
  The following items shall be confirmed for the system adjustment.

Table 2.3 Confirmation Item for the System Adjustment

Purpose	Confirmation Item	The acquisition source of data
Improve the traffic flow situation	Travel time/Delay time	(Site Survey)
Improve the wasted green signal time	Passing Traffic Volume	(Site Survey)
Improve the death green signal time	Passing Traffic Volume	(Site Survey)
Smooth the traffic flow at intersections	Passing Traffic Volume	(Site Survey)
Improve the queue length	Queue length(*1)	Contractor (*2)

(*1) Key intersections（7 intersections） in each direction

(*2) Obtained from system log

- Data offer to Consultant

  Contractor shall offer the system log regarding to the queue length data at key intersections in each direction to the consultant for evaluation of the short-term index for the system introduction effect.

2.7 Mandatory Document for O&M

Within two (2) month before the Final Acceptance Certificate of the Project, the Contractor shall submit following Mandatory Document such as Operation Manual, Preventive Maintenance Plan, Local Training and Seminar Plan, and Emergency Response Plan for approval.

The Employer can request the Contractor to revise the plan if there is doubt about the effectiveness of the plan.

Each Mandatory Document shall include but not be limited to the following items:

1) Operation Manual

- Detail organization including related agency;
- Equipment list of the system;
- Operation Method of operation Console;
- Operation Method of other equipment including manual operation; and
- Action and communication flow for operation activity including report and approval of Employer.

2) Preventive Maintenance Plan

- Outline schedule of periodic inspection and preventive maintenance for semi-annually and annually:
- Equipment location, Inspection Item and Inspection personnel;
- Check list of each equipment for Visual check and Detail Check;
- Method of Evaluation and Adjustment for the System;
- Method of Calibration of sensor equipment; and
- Permissive downtime for each periodic inspection and preventive maintenance.

3) Local Training and Seminar schedule

- Local Training Schedule and agenda; and
- Seminar Schedule and agenda.

4) Emergency Response Plan

- Detail organization including sub contractor and related agency;
- Action and communication flow including report and approval of Employer for day time and night time; and
- Contact number list / Communication Chart.

5) Check List

Typical Check List is presented in Attachment 1 for Check of the Equipment including Detail Check.

The Contractor shall develop and prepare Check List to be used for preventive maintenance for each type of equipment and software of the System, and submit them to the Employer for approval. The check list shall be used for all periodical inspection of the equipment and results of the inspection shall be recorded together with other detailed information.

The Contractor is required to submit a copy of all recorded check lists and as requested by the Employer's Representative at any time. Failure to maintain or submit the check lists shall be a sufficient cause for suspension / termination of the Contract and / or withholding of payments due the Contractor. Check List shall include but not be limited to the following items:

- Equipment and Equipment ID;
- Location;
- Check item;
- Check cycle (semi-annually / annually);
- Check method (outline); and
- Date of inspection and name of inspector for report.

2.8 Records and Reports for O&M

The Contractor shall submit following records and report to Employer as stipulated herein in a form mutually agreed with Employer respectively and the reports mentioned bellow are the minimum requirement. The Employer reserves the right to reasonably demand more reports other than those listed above after the commencement of O&M Service.

2.8.1 Operation Records and Reports

The Operator at BTIC and TMC shall prepare and submit the followings:

1) Daily report

- Daily attendance record with In-time and Out-Time for all Contractor's staff working;
- Contact summary (numbers and content) with calls from public;
- Operation activity; and
- Any abnormality and/or failure of the System, and every action history against such abnormality and/or failure of the system.

2) Monthly report

- Number by category of contact with caller from public; and
- Number and kinds of failures of system/equipment/communication line

  Spare parts inventory after the monthly check.

2.8.2 Records and Reports by Contractor

The Contractor shall prepare the followings:

1) Incident Report

- Location of failure;
- Time record for response, attending and resolution;
- Contact record;
- Dispatch record;
- Elapsed time until resolution;
- Cause of incident and/or failure;
- Measure for resolution;
- Used spare parts for resolution; and
- Work order for repair the retrieved parts or purchase new parts.

2) Report for Periodic Inspection and Preventive Maintenance

- Location and date;
- Check list with comment;
- Status and modified item;
- Evaluation and Adjustment item; and
- Spare parts inventory.

3) Quarterly report

- Summary of operation;
- Summary of incident;
- Summary of Periodic Inspection and Preventive Maintenance;
- Availability of the system of last three months; and
- Spare parts inventory

A copy of Quarterly Report shall be submitted with the Quarterly Invoice. No payment shall be made without submitting the completed Quarterly Report.

2.9 Employer's Equipment and Property

2.9.1 Provision of Equipment and Property

In order to enable the Contractor to discharge its duties of Operation Services efficiently and uninterruptedly, the Employer shall provide infrastructural facilities such as meeting room if necessary.

2.9.2 Care of Equipment

The Contractor shall use Employer's equipment and property that the Contractor is allowed to use with utmost care and attention. If the equipment or property under custody of the Contractor becomes inoperative or defective due to the inappropriate operation or use of them by the Contractor's staff, the Contractor shall repair or replace them at his own cost after obtaining the instruction from the Employer as to the remedial measure to be taken.

If any liability or obligation with regard to the repair or replacement of Employer's equipment and property is remained unfulfilled by the Contractor at the time of return upon termination of the Contract, the amount necessary for the repair or replacement shall be deducted from the payment due to the Contractor.

All consumables including but not limited to the printer paper and printer toner shall be arranged and purchased by the Contractor at his own cost at BTIC.

2.9.3 Power supply

The Employer will provide the electric power to the facilities and equipment that the Contractor allowed to use or to the equipment owned by the Contractor and installed within The Employer's premises for the purpose of the Contract at no cost to the Contractor. The electric power will be uninterruptible power supply backed up by a generator. The Contractor shall take no responsibility in case the electric power is interrupted due to the reason whatsoever.

The Contractor shall not misuse the electric power supplied by The Employer and try to save the energy. The Employer reserves the right to inspect the usage of electric power by the Contractor, in case the Employer has any doubt with regard to the usage.

2.10 Safety, Security and Working Environment

Throughout the period of Contract, the Contractor shall have full regard for safety of all persons working for O&M and for the avoidance of danger to such persons specially from moving traffic.

All staff employed by the Contractor shall receive the training on the work area safety before assigned to the position. The Contractor shall provide all necessary safety equipment such as reflective vests, helmets, shoes, gloves to the Contractor’s staff.

3. Performance Target and Payment Reduction

3.1 Performance Target of Response Time and Resolution Time

3.1.1 Performance Target

The Contractor shall endeavour to attain the performance target according to severity levels of incidents shown in table 3.1. Severity (Critical, Major, Minor) of incidents are defined according to risks to road user and required Response Time and Resolution Time are defined according to the severity. In case of incidents, the Contractor shall perform less than the indicated time period in the table 3.1.

Table 3.1 Definition by Severity of incidents

Severity of Incidents	Definitions	Response Time	Resolution Time	
			System Failure	Facility Incident at Site
Critical	Incidents which have high possibility of immediately impairing road user's safety.	<1 hour	<6 hours	<24 hours
Major	Incidents which may impair road user's safety.	<1 hour	<12 hours	
Minor	Failures of control system that does not have any possibility to impair road users' safety	<2 hours	<24 hours	

3.1.2 Category of Severity

The Contractor is responsible for categorizing severity although the Contractor shall consult with the Employer in case the Contractor finds difficulties to judge it.

Examples of the incidents of each severity for BTIC and TMC are shown in the below table.

Table 3.2 Examples of Incidents by Severity for BTIC System

Severity	Example
Critical Incident	• Seriously damaged ATCC (Automatic Traffic Counter Classifier) /Que length pole(s) by traffic accident, which has already collapse and/or will probably collapse
Major Incident	• Damaged ATCC/Que length pole(s) by traffic accident, which will not probably collapse immediately
Minor Incident	• Slight damage on ATCC/Que length pole(s) by traffic accident, which will not collapse; • Discommunication among BMTC System/BTIC/Sensors; and • Sending abnormal data from BTIC to TMC/Internet;

Table 3.3 Examples of Incidents by Severity for TMC System (Signal System and VMS System)

Severity	Example
Critical Incident	• Green-Green Conflict of signal • Red and yellow blinking of signal • Light out of signal lamp • Lighting plural number of signal lamp simultaneously • Seriously damaged signal pole(s) and/or VMS gantry by traffic accident, which

	has already collapse and/or will probably collapse
Major Incident	• Damaged signal pole(s) and/or VMS gantry by traffic accident, which will not probably collapse immediately • Light out of some signal ramp due to halt of signal system, which makes road users have difficulties to identify the signal phase
Minor Incident	• Slight damage on pole(s) or gantry(s) by traffic accident, which will not collapse; • Discommunication among BTIC/TMC/controller/signal/VMS; • Sending abnormal data from TMC to signal/VMS; • Insufficient illuminance of signal ramp/VMS; and • Light out of VMS screen.

The Contractor is responsible for categorizing severity although the Contractor shall consult with the Employer in case the Contractor finds difficulties to judge it.

3.2 Performance Target of Availability

3.2.1 Performance Target

Availability of the System is evaluated quarterly and its Performance Target is 99%.

3.2.2 Evaluation Method

Availability is calculated according to down time responsible for the Contractor.

The formula of calculation of availability is shown as follows

$$Availability = (1 - \frac{Downtime - PermissiveDowntime}{Totaltime - PermissiveDowntime}) * 100$$

Downtime (hours): Total time while the System is not available.

Downtime is calculated based on the following unit:

BTIC System

(1) ATCC/Que length sensors: Site basis;

(2) Operator consoles: Console basis; and

(3) Servers: Server basis.

TMC System

(1) Signals: Junction basis (when some signals are not available at one junction, the Down time is not calculated to each signal but to one junction);

(2) VMSs: Site basis;

(3) Operator consoles: Console basis; and

(4) Servers: Server basis.

Total time (hours): Total time of evaluation period (3 month; 2,160 hours).

Permissive downtime (hours): The time period required for periodic inspection, preventative maintenance, repair works for damages caused by the third parties (e.g. traffic accidents, black out, surge caused by thunder storm, fire, failure of communication lines, vandalism, etc.) and works instructed by the Employer.

The Permissive Downtime of emergency response that is not attributable to the Contractor will be determined by mutual confirmation. The Contractor shall report Downtime including response time and resolution time, and cause of the Downtime including whether attributable to the Contractor or not. And the Employer shall assess the Downtime and permit the Contractor to consider the Downtime and Permissive Downtime for the calculation of the availability.

The Contractor shall show sufficient cause for the Employer to authorize when Availability fail to meet the Performance Target

3.2.3 Payment Reduction

The Contractor's performance is evaluated based on the difference between target availability and actual availability to be calculated quarterly. When the availability does not reach the target availability, the Employer can deduct calculated amount from O&M payment according to the following formula.

Payment Reduction = Lump sum portion of Payment*(Target availability (%) - Availability (%))/50

Eg.) Downtime: 110hr, Total time: 2160hr (24*90), Permissive Downtime: 60hr, Target availability: 99%, Payment for 3months: INR 80 Lakh

Availability= (1-((110-60)/(2160-60)))*100, Availability = 97.62%

Payment Reduction = 80*(99-97.62)/50,

Payment Reduction = INR 2,88,000

The total reduction shall not exceed 10% of the Quarterly Billing Value (QBV).

Three consecutive quarterly reductions of more than 20% of the applicable fee on account of any reasons will be deemed to be an event of default and termination.

The certifications would be obtained by the Contractor latest by end of third quarter of the operations phase failing which the subsequent QBVs will deferred till the certifications is obtained.

3.3 Performance Review Process

Either the Employer or Contractor may raise an issue by documenting the problem, which presents a reasonably objective summary of both points of view and identifies specific points of disagreement with possible solutions

A meeting or TV conference will be conducted to resolve the issue in a timely manner. The documented issues will be distributed to the participants at least 24 hours prior to the discussion if the issue is not an emergency requiring immediate attention.

The Employerand the Contractor shall develop an interim solution, if required, and subsequently the permanent solution for the problem at hand. The Contractor will then communicate the resolution to all interested parties

3.4 Supervision by Employer

The Employer reserves the right to conduct inspection of the Contractor's work at any time without prior notice, to check, observe, and witness the activities of the Contractor.

The Contractor shall permit the the Employer's Representative at any time or times during the execution of the Contract to enter upon any place where the Contractor is allowed to access within Employer's premises for the purpose of inspection or for any other legitimate purpose. The Contractor shall give all required information and inspection of records to the Employer's Representative regarding the Maintenance of the O&M service, if asked for.

The purpose of the inspection is to monitor the Contractor's activities and to ensure that all the activities required under the Contract are being carried out properly by the personnel deployed by the Contractor.

The Employer may exercise any check control to ensure discharge of various obligations by the Contractor under the Contract including but not limited to following:

- Performance of Response Time and Resolution Time;
- Performance of Availability;
- Adherence to operation procedure stipulated in the Operation Manual;
- Adherence to maintenance procedure stipulated in the maintenance plan;
- Promptness and appropriateness of communication of the Operator;
- Promptness of operation and maintenance of the System by the Contractor;
- Cleanness and tidiness of operating room of BTIC and TMS used by the Contractor;
- Adequate management of record keeping, files and reports;
- Work Safety awareness; and
- Any other check or control as considered appropriate by the Employer.

4. O&M Personnel

4.1 Requirement for Contractor's Personnel

The Contractor shall provide all personnel necessary for performing the O&M service at BTIC, TMC, contractor's office and other locations as necessary.

The list of manpower provided herein is a minimum requirement, and the Contractor shall provide sufficient qualified technical and non-technical hierarchical network of staff for round the clock for O&M Service.

4.1.1 Contractor's Key Personnel

For the purpose of discharging its obligations under the Contract, the Contractor shall recruit and deploy the specified number of key personnel of suitable qualification and experience, and shall be involved in the installation, testing and training for the Employer's staff.

Key personnel to be assigned are follows:

- Contractor's Representative;
- Operator;
- Call Operator;
- Chief Engineer for Periodic Inspection & Preventive Maintenance; and
- Team Leader for road side service.

Key personnel shall be involved in the installation, adjustment, test on completion and training of the Employer's staff of the O&M service to be supplied under the Contract.

The Contractor shall ensure that the key personnel deployed are of good health, highest integrity, punctual, well dressed, and well behaved, and shall meet the qualification and experience of key personnel prescribed hereunder.

The frequent replacement of key personnel is not desirable unless they are found involved in malpractices or non-compliances. However, a permission of replacement of key personnel shall be obtained from The Employer in advance together with the request for approval for replacement. The Employer, if satisfied with the reasons submitted to him, may allow such replacement after verifying the CVs strictly in accordance with the requirements.

4.1.2 Deployment of Personnel

The Contractor shall employ the suitable number of personnel for O&M Service. The minimum number of these staff and the tasks assigned to them shall be as shown in the Table 4.1. The role of O&M Staff. It shall be noted that the number indicated in the table is the minimum requirements and it is the Contractor's responsibility to provide high quality service seamlessly and additional staff shall be recruited if necessary.

The Contractor shall furnish to the Employer, in addition to the list of key personnel provided with the tender, a list of persons deployed for the purpose of discharging its obligations under the Contract, containing all the details like their educational qualifications, experience, training undergone, health condition, personal residential addresses and recent photograph.

The personnel to be appointed shall not have any previous criminal record. A certificate to this effect from concerned State Police Authorities shall be made obligatory for verification prior to appointment at O&M service Centre.

The Employer reserves its right to object to the deployment of any personnel for any reason. In such case, the person or persons being objected to by The Employer shall be removed by the Contractor forthwith and replaced within a day from such removal.

The Employer shall not be liable for any misconduct or misdeeds or any act or incident involving the Contractor or any of its personnel in any criminal or civil case. The Contractor shall be responsible for consequences and if any such incident takes place, the Contractor shall forthwith intimate the incident to The Employer.

4.1.3 Relationship between Contractor's staff and the Employer

The Contractor will not in any way claim employment with the Employer. The Contractor shall be solely responsible for any dispute raised by the personnel either during the term of the Contractor or thereafter.

In all circumstances it shall be clearly understood that the personnel deployed by the Contractor shall have no connection whatsoever with the Employer and the relationship of the Employer. Employee shall be only between the Contractor and the personnel deployed by the Contractor.

4.1.4 Welfare of Contractor's Employee

The Contractor shall be solely responsible and liable for complying with statutory liability for welfare of the employees such as workmen's compensation, wages, bonus medical leave, etc.

However, if considered necessary, The Employer shall have every right to enquire and seek documentary evidence from the Contractor to confirm, whether all the statutory dues like ESI, EPF, minimum wages, weekly offs, bonus, medical leave, workman compensation and any other entitlements, in accordance with the statutory dues applicable in the area are being paid.

4.1.5 Uniform and Nameplate

The Contractor shall provide suitable uniforms to the persons engaged in O&M service at BTIC and TMC as approved by the Employer. All staff personnel of the Contractor shall wear the uniform and nameplate when on duty without exception. The nameplate shall bear the name and designation.

4.1.6 Close coordination with other organizations

O&M service must be conducted with close coordination and cooperation with other agencies concerned. Liaison and coordination among related agencies such as traffic police, ambulance and fire brigades must be maintained all the time.

4.1.7 Briefing at shift change

Shift time for System Operator in Traffic Police must be arranged in such a way that there will be an overlapping period of at least 15 minutes. During the overlapped period, new team shall be briefed by the previous operation team as to the following:

- General traffic condition;
- Weather condition;
- Existing incidents and accident being disposed of;
- Messages being displayed on VMS;
- Equipment malfunctioned and the status of maintenance work; and
- Other matters that need attention of the operation team.

4.2 Requirement for key Personnel

4.2.1 Contractor's Representative

The Contractor's Representative shall be responsible for supervising and managing all O&M activities and O&M teams in such a way that the O&M service will operate efficiently all the time and all the maintenance works are carried out expeditiously.

He shall have a minimum ten (10) years of professional experience of ITS projects of similar nature and minimum five (5) years of experience in the maintenance of such system as team leader, project manager, chief engineer or equivalent position.

4.2.2 Operator

The Contractor shall provide personnel who had experience in system administration, troubleshooting and networking. The personnel shall have at least eight (8) years of IT experience.

Perform the operation at the following location:

- Location-1: B-TIC (Bengaluru Traffic Information Centre) ; and
- Location-2 : TMC (Traffic Management Centre)

4.2.3 Call Operator

The Contractor shall provide personnel who enable to understand three (3) languages (English, Hindi and Kannada) for Call Operator at Contractor's office.

4.2.4 Chief Engineer for Periodic Inspection & Preventive Maintenance

He shall have a minimum ten (10) years of professional experience of ITS projects of similar nature and minimum five (5) years of experience in the maintenance of such system as project manager, chief engineer or equivalent position.

4.2.5 Team Leader for road side service

The Team Leader for road side service shall be responsible for oversight and management of the road side service team so that all onsite work can be performed quickly.

The Contractor shall provide personnel who had experience in troubleshooting of network and electric system. The personnel shall have at least ten (10) years of system and/or electricity experience.

4.3 The Roles of O&M Personnel

Table 4.1 Role of O&M Staff

No.	Position	Main functions	Remarks
1	Contractor's Representative	- Communication with Employer and Employer's representative - Decision and Direction to key stuff of O&M contractor - Receive report from key stuff of O&M contractor	One(1) Person
2	Operator at BTIC (10:00-17:30 on weekdays and Saturday except for the 2nd Saturday with 1 Shift)	(Operation) - Responding to enquiries from general public. - Observing operating status of ATCC and Queue Length Measurement System. - Observing traffic status on schematic map of video wall. - Observing operation status of server installed at KSDC from operator console. - Checking the error log of each server and ask according to the instruction of the representative of the Contractor - Comparing the inventory and spare parts periodically. - Establishing supplementary plan for spare part - Preparing and submitting daily, monthly and quarterly reports of the Contractor's activity to the Employer. - Calculation of Availability quarterly based on incident reports.	One(1) Person / Shift
		(Primary Response; when incident occurs) - Identifying situations and causes of system malfunctions. - Requesting Maintenance Team of Contractor for response, in case of failure and incident. - Reporting the status of system/equipment to the Employer in case incidents occurs and is resolved. - Preparing and submitting incident reports to the Employer.	
3	Operator at TMC (8:00-20:00 including Saturday, Sunday, Holiday with 2 shift)	(Operation) - Observing operating status of signal and VMS system. - Observing operation status of server installed at KSDC from operator console. - Checking the error log of each server and ask according to the instruction of the representative of the Contractor - Comparing the inventory and spare parts periodically. Establishing supplementary plan for spare part - Preparing and submitting daily, monthly and quarterly reports of the Contractor's activity to the representative of the Employer. - Calculation of Availability quarterly based on incident reports.	Two (2) Persons /Two (2) Shifts
		(Primary Response; when incident occurs) - Identifying situations and causes of system malfunctions. - Requesting Maintenance Team of O&M Contractor for response, in case of failure and incident. - Reporting the status of system/equipment to the Employer in case incidents occurs and is resolved. - Preparing and submitting incident reports to the representative of the Employer.	
4	Call Center Operator at Contractor's	- Receiving phone call information/data from System Operator and related party at O&M local office - Record the call information/data	One(1) Person

	local office	- Providing necessary information/data to related party	
5	Chief Engineer for Periodic Inspection & Preventive Maintenance	- Lead the Periodic Inspection & Preventive Maintenance activity and Team	One(1) Person for BTIC System and One(1) Person for TMC System
6	Maintenance Team for Periodic Inspection & Preventive Maintenance	- Establishing Periodic Inspection and Preventive Maintenance plan and submit to the representative of the Employer - Carrying out inspection and preventive maintenance such as cleaning periodically according to a submitted plan. - Submitting reports of Periodic Inspection and Preventive Maintenance work to the representative of the Employer - Maintaining spare parts and inventory and report - Fixing bugs and upgrading software version	Routine Operation
7	Local Staff (Remote service from O&M local office)	(Routine Operation) - Remote diagnostics periodically for confirming operation status of server at KSDC from PC at contractor's office. (Emergency) - Identifying situations and causes of system malfunctions. - Rectifying malfunction remotely. - Providing necessary information about incidents as per request from TMC operators.	Routine Operation and Emergency
8	Supporting Japanese Staff (Remote service from Japan HQ)	- Remote service from O&M local office to inspect the system - Remote service from Japan HQ to resolve the problem - Support to Local stuff (Remote service from O&M local office)	If necessary
9	Team Leader for road side service	- Oversight and management of the on-site service team	Operation when failure occurs One(1) Person for BTIC System and One (1) Person for TMC System
10	Local Engineer for road side service	- Identifying the defective/damaged equipment and parts and replacing defective/damaged equipment and parts with spare parts - Replacement and resolution of damaged facility - Repairing retrieved defective/damaged parts if repairing is possible.	when failure occurs

4.3.1 Maintenance Equipment and Tools

The Contractor shall maintain required set of maintenance equipment and tool, and monitoring and testing software normally required for the maintenance of the electrical and server system. The maintenance equipment and tools shall be maintained in good workable condition so that they shall be available all the time. If periodical calibration is required, it shall be calibrated at the regular interval as specified by the supplier of the maintenance equipment. The maintenance staff shall be trained as to the use of the maintenance equipment and tools. The purchase or depreciation cost of the maintenance equipment and tools shall be deemed to be included in the appropriate cost item in

the Tender and no separate payment shall be made.

4.3.2 O&M local Office

The Contractor shall have a local office for O&M Service near to BTIC and TMC, and Call operator and key staff of Maintenance Team shall be deployed at the office.

The Contractor shall prepare at their own cost O&M local office, desks, chairs, shelves, cabins, telephone, Internet access, other furniture and facilities necessary for the efficient maintenance operation.

All the cost to keep the O&M office shall be included in the Contract.

4.3.3 Maintenance Vehicle for O&M

The Contractor shall provide at least one (1) vehicle for their operation & maintenance use. The vehicle type shall be suitable for transportation of staffs and equipment for maintenance work. The vehicle shall meet the relevant government regulations and registered under the name of the Contractor. The vehicles shall be maintained usually in good condition. The vehicle shall display clearly as "M**aintenance Vehicle"** on both sides of the vehicle and a yellow flashing light shall be provided on the roof of the vehicle. A set of traffic safety devices consisting of safety cones, stand-alone flashing light, and reflective guide and warning signs shall be provided to the vehicle. The cost of obtaining and maintaining the maintenance vehicle shall be included in the Contract.

Check List

1.Equipment at KSDC

(1) Servers

Equipment	Inspection Object	Frequency of Inspection		Inspection Method	Inspection Item
		Bi-Annual	Annual		
Each Servers ・B-TIC ・ATCC ・Probe ・Queue Length ・Internet ・VMS ・Signal System	Appearance condition	○		Visual check	To check condition of dirt, rusting, damage, deformation, and abrasion of coating. Cleaning.
	Heat generation	○		Visual and handling check	To checking whether heat is generated of not.
	System server and other equipment	○		Check by tool and visual	To checking condition of damage, overheating and disconnection of wire. The screw should be tightened if necessary.
	Measuring voltage	○		Check with instrument	To check whether input voltage is within regulated value or not.

(2) Firewall & Network equipment

Equipment	Inspection Object	Frequency of Inspection		Inspection Method	Inspection Item
		Bi-Annual	Annual		
Firewall	Appearance condition	○		Visual check	To check condition of dirt, rusting, damage, deformation, and abrasion of coating. Cleaning.
	Measuring voltage	○		Check with instrument	To check whether input voltage is within regulated value or not.
Network equipment	Appearance condition	○		Visual check	To check condition of dirt, rusting, damage, deformation, and abrasion of coating. Cleaning.
	Measuring voltage	○		Check with instrument	To checking whether input voltage is within regulated value or not.

2. BTIC System

(1) Video wall

Equipment	Inspection Object	Frequency of Inspection		Inspection Method	Inspection Item
		Bi-Annual	Annual		
Display	Appearance condition	○		Visual check	To check condition of dirt, rusting, damage, deformation, and abrasion of coating. Cleaning.
	Working condition	○		Visual and handling check	To check display status by handling and update of latest inform
	Measuring voltage	○		Check with instrument	To check whether input voltage is within regulated value or not.
Video Switch	Appearance condition	○		Visual check	To check condition of dirt, rusting, damage, deformation, and abrasion of coating. Cleaning.
	Working condition	○		Visual and handling check	To check display status by handling and update of latest inform
	Measuring voltage	○		Check with instrument	To check whether input voltage is within regulated value or not.

(2) Operator Console

Equipment	Inspection Object	Frequency of Inspection		Inspection Method	Inspection Item
		Bi-Annual	Annual		
Operator Console	Appearance condition	○		Visual check	To checking condition of dirt, rusting, damage, deformation, and abrasion of coating Cleaning.
	Heat generation	○		Visual and handling check	To check whether heat is generated of not.
	Measuring voltage	○		Check with instrument	To check whether input voltage is within regulated value or not.
	Image quality of display	○		Visual and operation check	To adjust image quality of display, if necessary.

(3) Firewall & Network equipment

Equipment	Inspection Object	Frequency of Inspection		Inspection Method	Inspection Item
		Bi-Annual	Annual		
Firewall	Appearance condition	○		Visual check	To check condition of dirt, rusting, damage, deformation, and abrasion of coating. Cleaning.
	Measuring voltage	○		Check with instrument	To check whether input voltage is within regulated value or not.
Network equipment	Appearance condition	○		Visual check	To check condition of dirt, rusting, damage, deformation, and abrasion of coating. Cleaning.
	Measuring voltage	○		Check with instrument	To checking whether input voltage is within regulated value or not.

(4) UPS

Equipment	Inspection Object	Frequency of Inspection		Inspection Method	Inspection Item
		Bi-Annual	Annual		
UPS	Appearance condition	○		Visual check	To check condition of rusting and damage.
	Fixed condition of cable connectivity.		○	Visual check	To check the loose of cable connectivity. The screw should be tightened if necessary.
	Checking voltage, specific gravity and temperature of liquid		○	Check with instrument	To check whether input voltage specific gravity and temperature of liquid is within regulated value or not.

(5) ATCC (Road side Equipment)

Equipment	Inspection Object	Frequency of Inspection		Inspection Method	Inspection Item
		Bi-Annual	Annual		
ATCC	Appearance condition	○		Visual check	To check condition of trace of rusting, damage and deformation. To clean lens with using fabric and brush.
	Focusing condition	○		Operation check	Adjustment of focus
	Video output condition		○	Visual and operation check	To check condition of image and quality
	Sensitivity condition		○	Visual and operation check	Adjustment of sensitivity condition
	Measuring voltage	○		Check with instrument	To check whether input voltage is within regulated value or not.
	Condition of insulation resistance and ground resistance		○	Check with instrument	To check the condition of insulation resistance and ground resistance whether it is within regulated level or not.
	Rusting and damage of support and foundation		○	Visual check	To check condition of rusting, crack or damage of support and foundation including anchor.

Network equipment	Appearance condition	○		Visual check	To check condition of dirt, rusting, damage, deformation, and abrasion of coating. Cleaning.
	Measuring voltage	○		Check with instrument	To check whether input voltage is within regulated value or not.

(6) Queue Length Measurement System (Road side Equipment)

Equipment	Inspection Object	Frequency of Inspection		Inspection Method	Inspection Item
		Bi-Annual	Annual		
Ultrasonic sensor	Appearance condition	○		Visual check	To checking condition of trace of rusting, damage and cleaning lens with using fabric and brush.
	Working condition	○		Visual check	To check measuring condition and calibration of observation instrument
	Sensitivity condition		○	Visual and operation check	Adjustment of sensitivity condition
	Measuring voltage	○		Check with instrument	To check whether input voltage is within regulated value or not.
	Condition of insulation resistance and ground resistance		○	Check with instrument	To check the condition of insulation resistance and ground resistance weather it is within regulated level or not.
	Rusting and damege of support and foundation		○	Visual check	To check condition of rusting, crack or damage of support and foundation including anchor.
Network equipment	Appearance condition	○		Visual check	To check condition of dirt, rusting, damage, deformation, and abrasion of coating. Cleaning.
	Measuring voltage	○		Check with instrument	To check whether input voltage is within regulated value or not.

3. TMC System

(1) Operator Console

Equipment	Inspection Object	Frequency of Inspection		Inspection Method	Inspection Item
		Bi-Annual	Annual		
Operator Console	Appearance condition	○		Visual check	To checking condition of dirt, rusting, damage, deformation, and abrasion of coating Cleaning.
	Heat generation	○		Visual and handling check	To check whether heat is generated of not.
	Measuring voltage	○		Check with instrument	To check whether input voltage is within regulated value or not.
	Image quality of display	○		Visual and operation check	To adjust image quality of display, if necessary.

(2) Variable Message Sign System (Road side Equipment)

Equipment	Inspection Object	Frequency of Inspection		Inspection Method	Inspection Item
		Bi-Annual	Annual		
Variable message sign	Appearance condition	○		Visual check	To check condition of trace of dewfall or leaking water, rusting, damage, lock, opening and shutting of door. Cleaning
	Working condition of Lighting Function		○	Visual and operation check	To check the luminance and color tone condition.
	Condition of Breaker, Transformer and Surge Protection Device		○	Visual, odor, handling and abnormal noise check	To check condition of defacement, damage, odor, abnormal noise and overheat. Cleaning

	Fixed condition and abnormality check of printed board and relay		○	Visual, odor, handling and abnormal noise check	To check the loose of fixed condition. It should be tightened if necessary. To checking condition of defacement, damage, odor, abnormal noise and overheat.
	Loose of each terminal parts		○	Visual and handling check	To check the condition of loose of terminal parts. The screw should be tightened if necessary.
	Display condition of LED		○	Visual and handling check	To check the loose of fixed condition. It should be tightened if necessary.
	Measuring voltage	○		Check with instrument	To check whether input voltage is within regulated value or not.
	Condition of insulation resistance and ground resistance		○	Check with instrument	To check the condition of insulation resistance and ground resistance whether it is within regulated level or not.
	Rusting and damage of support and foundation		○	Visual check	To check condition of rusting, crack or damage of support and foundation including anchor.
Network equipment	Appearance condition	○		Visual check	To check condition of dirt, rusting, damage, deformation, and abrasion of coating. Cleaning.
	Measuring voltage	○		Check with instrument	To check whether input voltage is within regulated value or not.

(3) Signal System (Road side Equipment)

Equipment	Inspection Object	Frequency of Inspection		Inspection Method	Inspection Item
		Bi-Annual	Annual		
Local Controller Traffic Signal Lantern Vehicle detector	Appearance condition	○		Visual check	To checking condition of trace of rusting, damage and cleaning lens with using fabric and brush.
	Working condition	○		Visual check	To check measuring condition and calibration of observation instrument
	Sensitivity condition		○	Visual and operation check	Adjustment of sensitivity condition
	Measuring voltage	○		Check with instrument	To check whether input voltage is within regulated value or not.
	Condition of insulation resistance and ground resistance		○	Check with instrument	To check the condition of insulation resistance and ground resistance weather it is within regulated level or not.
	Rusting and damege of support and foundation		○	Visual check	To check condition of rusting, crack or damage of support and foundation including anchor.
Network equipment	Appearance condition	○		Visual check	To check condition of dirt, rusting, damage, deformation, and abrasion of coating. Cleaning.
	Measuring voltage	○		Check with instrument	To check whether input voltage is within regulated value or not.

資料　7-5

O&M サービス契約書（案）

Section VIII - General Conditions of Contract

[Name of Employer*]*

[Name of Contract]

Section VIII - General Conditions of Contract

General Conditions of Contract

1. Definition and Interpretation

1.1 Definitions

In the Contract the following words and expressions shall have the meanings stated below, unless otherwise required by the context.

1.1.1 The Contract

(a) "Contract" means the General Conditions, the Particular Conditions which include Part A and Part B, the Letter of Acceptance, the Letter of Bid, the Schedules, and any Addenda.

(b) "Contract Data" means the pages completed by the Employer entitled Contract Data which constitute Part A of the Particular Conditions.

(c) "Letter of Acceptance" means the letter of formal acceptance, signed by the Employer, of the Letter of Bid, including any annexed memoranda comprising agreements between and signed by both Parties. If there is no such letter of acceptance, the expression "Letter of Acceptance" means the Contract Agreement and the date of issuing or receiving the Letter of Acceptance means the date of signing the Contract Agreement.

(d) "Letter of Bid" means the document entitled Letter of Bid, which was completed by the Contractor and includes the signed offer to the Employer for the Services.

(e) "Schedules" means the documents entitled Schedule of Services Requirements, included in Section VII of the bidding document used to award the Contract.

(f) "Bid" means the Letter of Bid.

1.1.2 Parties and Persons

(a) "Bank" means the financing institution (if any) **named in the Contract Data**.

(b) "Borrower" means the person (if any) **named as the borrower in the Contract Data**.

(c) "Contractor" means the person(s) named as contractor in the Letter of Bid and the legal successors in title to this person(s).

(d) "Contractor's Personnel" means the Contractor's Representative and all personnel whom the Contractor utilizes on the Facilities, who may include the staff, labor and other employees of the Contractor and of each Subcontractor (including Key Subcontractors); and any other personnel assisting the Contractor in the execution of the Services.

(e) "Contractor's Representative" means the person named by the Contractor in the Contract or appointed from time to time by the Contractor under Sub-Clause 3.2 [Contractor's Representative], who acts on behalf of the Contractor.

(f) "Employer" means the person **named as employer in the Contract Data** and the legal successors in title to this person.

(g) "Employer's Representative" means the person named by the Employer in accordance with Sub-Clause 3.3 (a) to represent and act for the Employer at all times during the performance of the Contract.

(h) "Employer's Personnel" means all staff employed by the Employer.

(i) "Government" means the Government of the Country.

(j) "Independent Expert" means the person appointed in accordance with Sub-Clause 20.1.2 [Independent Expert].

(k) "Key Staff" means those individuals listed as Key Staff in the Bid, or any person appointed, with the agreement of the Employer, as a Key Staff, for a part of the Services; and the legal successors in title to each of these persons.

(l) "Key Subcontractor" means those Subcontractors listed as Key Subcontractors in the Bid, or any person appointed, with the agreement of the Employer, as a Key Subcontractor, for a part of the Services; and the legal successors in title to each of these persons.

(m) "Party" means the Employer or the Contractor, as the context requires, and "Parties" means both.

(n) "Subcontractor" means any person named in the Contract as a subcontractor, or any person appointed as a subcontractor, for a part of the Services; and the legal successors in title to each of these persons.

(o) "Third Party" means a person or an entity other than a Party, the Utility, the Utility Board, the Government, the Borrower or the Bank.

(p) "Utility" means the utility (if any) **named in the Contract Data**.

(q) "Utility Board" means the Board or other body with governance and management supervision responsibilities over the Utility specified in the Contract Data pursuant to Sub-Clause 1.1.2(p).

1.1.3 Dates, Tests, Periods and Completion

(a) "Base Date" means the date 28 days prior to the latest date for submission of the Bid.

(b) "Commencement Date" means the date defined under Sub-Clause 2.2 [Commencement].

(c) "Day" means a calendar day and "year" means 365 days.

(d) "Effective Date" has the meaning given in Sub-Clause 2.1 [Conditions of Effectiveness].

1.1.4 Money and Payments

(a) "Contractor's Account" means paid for the by the Contractor, as defined in Sub-Clause 12.5.1.

(b) "Contractor's Base Remuneration" means the Remuneration specified in Schedule G (G.1) to be the Contractor's Base Remuneration.

(c) "Contractor's Remuneration" means the price defined in Clause 12.1 [Contractor's Remuneration], and includes adjustments in accordance with the Contract.

(d) "Cost" means all expenditure reasonably incurred (or to be incurred) by the Contractor, whether on or off the Facilities, including overhead and similar charges, but does not include profit.

(e) "Foreign Currency" means a currency in which part (or all) of the Contractor's Remuneration is payable, but not the Local Currency.

(f) "Liquidated Damages on Termination by the Contractor for Cause" means the amount specified in the Contract Data pursuant to Sub-Clause 21.10(f)(i) to be payable in the

event of Termination by the Contractor for Cause pursuant to Sub-Clauses 21.7 and 21.10.

(g) "Local Currency" means the currency of the Country.

(h) "Utility's Account" means paid for the by the Utility, as defined in Sub-Clause 12.6.1.

1.1.5Services and Goods

(a) "Contractor's Equipment" means all apparatus, machinery, vehicles and other things required for the execution and completion of the Services and the remedying of any defects. But excludes Employer's Equipment (if any), Plant, Materials and any other things intended to form or forming part of the Facilities.

(b) "Goods" means Contractor's Equipment, Materials, Plant, or any of them as appropriate.

(c) "Services" has the meaning given in Clause 4.1 [Services to be Performed and Other Obligations].

1.1.6 Fraud and Corruption

(a) The Bank requires compliance with the Bank's Anti-Corruption Guidelines and its prevailing sanctions policies and procedures as set forth in the WBG's Sanctions Framework, as set forth in Appendix to the GCC.

(b) The Employer requires the Contractor to disclose any commissions or fees that may have been paid or are to be paid to agents or any other party with respect to the Bidding process or execution of the Contract. The information disclosed must include at least the name and address of the agent or other party, the amount and currency, and the purpose of the commission, gratuity or fee.

1.1.7 Other Definitions

(a) "Arbitration" means the process described as arbitration in Sub-Clause 20.1.4 [Arbitration].

(b) "Capital Works" means construction work or the procurement and installation of capital equipment intended to extend, rehabilitate or replace the Facilities.

(c) "Condition Precedent" means one of the Conditions of Effectiveness listed in Sub-Clause 2.1 [Conditions of Effectiveness].

(d) "Contractor's Documents" means the calculations, computer programs and other software, drawings, manuals, models and other documents of a technical nature (if any) supplied by the Contractor under the Contract.

(e) "Country" means the country in which the Facilities (or most of it) is located, where the Services are to be executed.

(f) "Cure Period" means, in respect of a Default Notice given to the Contractor under Sub-Clause 21.1 [Notification and Cure Plans], the period specified in the Default Notice (or if no such period is specified 10 Business Days from the date of the Default Notice) as varied or extended under Sub-Clause 21.2 [Remedying the Default within the Applicable Cure Period].

(g) "Default" means a failure by a Party to perform its obligations under the Contract.

(h) "Delegation of Management Authority" means the delegation to the Contractor of authority to manage the Facilities and the Utility which is granted under Clause 11 [Delegation of Management Authority to the Contractor].

(i) "Pre-Conditions" means something the Employer, the Utility or a third party shall do or provide, on which performance of the Service is contingent, and which is listed as a dependency in Schedule B.

(j) "Employer's Equipment" means the apparatus, machinery and vehicles (if any) made available by the Employer for the use of the Contractor in the execution of the Services, as stated in the Specification; but does not include Plant which has not been taken over by the Employer.

(k) "Facilities" means all assets of the Employer which are to be managed by the Contractor, and any other places as may be specified in the Contract as forming part of the Facilities.

(l) "Force Majeure" is defined in Sub-Clause 17.1 [Definition of Force Majeure].

(m) "Laws" means all national (or state) legislation, statutes, ordinances and other laws, and regulations and by-laws of any legally constituted public authority.

(n) "Objectives" has the meaning given under Sub-Clause 1.6.2 [Objectives].

(o) "Performance Security" means the security (or securities, if any) under Sub-Clause 16.3 [Performance Security].

(p) "Proposed Substitute Key Staff Member or Key Subcontractor" have the meaning given in Sub-Clause 8.2 [Substitution of Contractor's Key Staff Member or Key Subcontractor].

(q) "Recitals" has the meaning given under Sub-Clause 1.6.1 [Recitals].

(r) "Specified Capital Works" means Capital Works which are the responsibility of the Contractor under Sub-Clause 9.2 [Responsibilities for Specified Capital Works].

(s) "Substitution Fee" is the amount to be paid by the Employer for substituting another person in place of a Key Staff Member or Key Subcontractor, in accordance with Sub-Clause 8.2 [Substitution of Contractor's Key Staff Member or Key Subcontractor].

(t) "Unforeseeable" means not reasonably foreseeable and against which adequate preventive precautions could not reasonably be taken by an experienced contractor by the date for submission of the Bid.

(u) "Utility Capital Works" means Capital Works which are not Specified Capital Works.

(v) "Value Management Proposal" has the meaning given under Sub-Clause 19.2 [Value Management].

(w) "Variation" means any change to the Services, which is instructed or approved as a variation under Clause 19.1 [Employer Variations].

(x) "Variation Proposal" has the meaning given under Sub-Clause 19.1.1 [Decision on Employer's Variation Request].

(y) "Variation Request" has the meaning given under Sub-Clause 19.1 [Employer Variations].

1.2 Interpretation

In the Contract, except where the context requires otherwise:

(a) words indicating one gender include all genders;

(b) words indicating the singular also include the plural and words indicating the plural also include the singular;

(c) provisions including the word “agree”, “agreed” or “agreement” require the agreement to be recorded in writing;

(d) “written” or “in writing” means hand-written, type-written, printed or electronically made, and resulting in a permanent record;

(e) the word “Bid” is synonymous with “bid” and “Bidder” with “bidder” and “Bid Document” with “bidding document”.

(f) the marginal words and other headings shall not be taken into consideration in the interpretation of these Conditions.

1.3 Communications

Wherever these Conditions provide for the giving or issuing of approvals, certificates, consents, determinations, notices, requests and discharges, these communications shall be:

(a) in writing and delivered by hand (against receipt), sent by mail or courier, or transmitted using any of the agreed systems of electronic transmission **as stated in the Contract Data**; and

(b) delivered, sent or transmitted to the address for the recipient’s communications **as stated in the Contract Data**. However:

(i) if the recipient gives notice of another address, communications shall thereafter be delivered accordingly; and

(ii) if the recipient has not stated otherwise when requesting an approval or consent, it may be sent to the address from which the request was issued.

Approvals, certificates, consents and determinations shall not be unreasonably withheld or delayed. When a certificate is issued to a Party, the certifier shall send a copy to the other Party. When a notice is issued to a Party, by the other Party or the Independent Expert, a copy shall be sent to the Employer’s Representative or the other Party, as the case may be.

1.4 Law and Language

The Contract shall be governed by the law of the country or other jurisdiction **stated in the Contract Data**.

The ruling language of the Contract shall be that **stated in the Contract Data**.

The language for communications shall be that **stated in the Contract Data**. If no language is stated there, the language for communications shall be the ruling language of the Contract.

1.5 Priority of Documents

The documents forming the Contract (as attached hereto) are to be taken as mutually explanatory of one another. For the purposes of interpretation, the priority of the documents shall be in accordance with the following sequence:

(a) the Contract Agreement (if any),

(b) the addenda Nos. (if any)

(c) the Letter of Acceptance,

(d) the Particular Conditions,

(e) these General Conditions,

(f) the Schedules of Services Requirements

(g) the Letter of Bid

If an ambiguity or discrepancy is found in the documents, the Independent Expert appointed in accordance with Sub-Clause 20.1.2 [Independent Expert] will rule as to the interpretation. This ruling will be binding, unless one of the Parties refers it to Arbitration with 30 days of the ruling being given.

1.6 Recitals and Objectives

1.6.1 Recitals

The Recitals are the background facts about the Parties, the provision of utility services in the Country, and other facts and intentions set out in Schedule A (A.1). The Recitals are not legally binding, but may be used as context to assist in interpretation of the contract.

1.6.2 Objectives

The Objectives the Employer wishes to achieve by entering the Contract are set out in Schedule A (A.2)

2. Commencement and Duration

2.1 Conditions of Effectiveness

This Contract shall become effective from the date, or Effective Date, on which all the following Conditions of Effectiveness are fulfilled, except for Sub-Clause 2.1 [Conditions of Effectiveness], Sub-Clause 19.5 [Extension and Subsequent Bidding], and Clauses 1 [Definitions and Interpretations] and 3 [General Provisions], which become effective on the date of signature of the Letter of Acceptance.

(a) If the Contractor is an unincorporated joint venture, notification to the Employer by the member of a joint venture of their leader, as required by Sub-Clause 3.9 [Joint and Several Liability]

(b) Notification of the Contractor's Representative to the Employer by the Contractor as required by Sub-Clause 3.2 [Contractor's Representative].

(c) Notification of the Employer's Representative to the Contractor by the Employer as required by Sub-Clause 3.3 [Employer's Representative].

(d) Appointment of the Independent Expert in accordance with Sub-Clause 20.1.2 [Independent Expert].

(e) Delivery of the Performance Security to the Employer by the Grantor in accordance with Sub-Clause 16.3 [Performance Security].

(f) Other conditions **listed in the Contract Data.**

2.2 Commencement

(a) Within (7) days of the satisfaction of the conditions specified in Sub-Clause 2.1 [Conditions of Effectiveness], the Employer shall issue the Certificate of Commencement to the Contractor. The date of issue of the Certificate of Commencement shall be the "Commencement Date".

(b) The Contractor shall commence the provision of the Services no later than 3 days after receipt of the Certificate of Commencement and the Employer shall return the Bid Security to the Contractor on such Date.

(c) The Contractor and the Employer shall use their best effort and endeavors to procure the satisfaction of the Conditions of Effectiveness specified in Sub-Clause 2.1 [Conditions of Effectiveness] as soon as practicable and in any event no later than sixty (60) days after the date hereof.

(d) If the conditions specified in Sub-Clause 2.1 [Conditions of Effectiveness] are not fulfilled or waived by mutual agreement of the Parties within ninety (90) days of the date hereof, each Party shall have the right to terminate this Contract immediately and neither Party hereto shall be liable to the other for any damages or losses in respect thereof, except that if the Contractor has intentionally failed to fulfill any of these conditions, the Contractor shall forfeit the Bid Security.

2.3 Duration

Unless terminated earlier in accordance with Clause 21 [Default and Termination], this Contract shall remain in effect until the period **stated in the Contract Data** has passed after the Commencement Date.

3. General Provisions

3.1 Assignment

Neither Party shall assign the whole or any part of the Contract or any benefit or interest in or under the Contract. However, either Party:

(a) may assign the whole or any part with the prior agreement of the other Party, at the sole discretion of such other Party, and

(b) may, as security in favour of a bank or financial institution, assign its right to any moneys due, or to become due, under the Contract.

3.2 Contractor's Representative

The Contractor shall appoint a Contractor's Representative and shall give him all authority necessary to act on the Contractor's behalf under the Contract. If the Contractor is an unincorporated Joint Venture, the Contractor's Representative shall have the authority to bind all members of the Joint Venture.

The Contractor's Representative may delegate any powers, functions and authority to any competent person, and may at any time revoke the delegation. Any delegation or revocation shall not take effect until the Employer Representative has received prior notice signed by the Contractor's Representative, naming the person and specifying the powers, functions and authority being delegated or revoked.

The Contractor's Representative shall be fluent in the language for communications defined in Sub-Clause 1.4 [Law and Language]. If these other persons are not fluent in the said language, the Contractor shall make competent interpreters available during all working hours in a number deemed sufficient by the Employer's Representative.

3.3 Employer's Representative

(a) The Employer shall name its representative before the Effective Date.

(b) The Employer may change its representative from time to time and shall give notice of the change without delay. The Employer shall not change its representative at a time and in such a manner as to impede the progress of the Services.

(c) The Employer's Representative shall represent and act for the Employer at all times during the performance of the Contract. All notices, instructions, orders, certificates, approvals and all other communications under the Contract by the Employer shall be given by the Employer's Representative otherwise provided.

3.4 Communications by the Contractor

All notices, instructions, information and other communications given by the Contractor to the Employer under the Contract shall be given to the Employer's Representative except as herein otherwise provided.

3.5 Subcontractors

The Contractor shall not subcontract the whole of the Services.

The Contractor shall be responsible for the acts or defaults of any Subcontractor, his agents or employees, as if they were the acts or defaults of the Contractor. **Unless otherwise stated in the Contract Data**:

(a) the Contractor shall not be required to obtain consent to suppliers solely of Materials, or to a subcontract for which the Subcontractor is named in the Contract;

(b) the prior consent of the Employer's Representative shall be obtained to other proposed Subcontractors;

(c) the Contractor shall give the Employer's Representative not less than 28 days' notice of the intended date of the commencement of each Subcontractor's work, and of the commencement of such work on the Facilities; and

(d) each subcontract shall include provisions which would entitle the Employer to require the subcontract to be assigned to the Employer under Sub-Clause 3.7 [Assignment of Benefit of Subcontract] (if or when applicable) or in the event of termination under Sub-Clause 21.5 [Termination by Employer for Convenience].

The Contractor shall ensure that the requirements imposed on the Contractor by Sub-Clause 15.3 [Confidentiality Obligations of the Contractor] apply equally to each Subcontractor.

Where practicable, the Contractor shall give fair and reasonable opportunity for contractors from the Country to be appointed as Subcontractors.

3.6 Key Subcontractors

The Contractor shall use the services of any Key Subcontractor specified in its Bid, unless the Employer is reasonably satisfied that the:

(a) The Key Subcontractor is not available; or

(b) The performance of the Services will not suffer if the Subcontractor is not used.

The Contractor may provide another person (the "Proposed Substitute Key Subcontractor") in substitution for a Key Subcontractor (as identified in Schedule E) only on fulfillment of the following conditions:

(a) Proving to the reasonable satisfaction of the Employer that the Key Subcontractor is not available;

(b) Proving to the reasonable satisfaction of the Employer that the Proposed Substitute Key Subcontractor is as suitable for the services as the Key Subcontractor that is not available.

(c) Payment by the Contractor of a Substitution Fee of the amount specified in Schedule E.

3.7 Assignment of Benefit of Subcontract

If a Subcontractor's obligations extend beyond the expiry date of the Contract and the Employer, prior to this date, instructs the Contractor to assign the benefit of such obligations to the Employer, then the Contractor shall do so. Unless otherwise stated in the assignment, the Contractor shall have no liability to the Employer for the work carried out by the Subcontractor after the assignment takes effect.

3.8 Compliance with Laws

The Contractor shall, in performing the Contract, comply with applicable Laws. **Unless otherwise stated in the Contract Data:**

(a) the Employer shall have obtained (or shall obtain) the planning, zoning, resource abstraction, environmental discharge permission for the normal operation of the Facilities, and the Employer shall indemnify and hold the Contractor harmless against and from the consequences of any failure to do so; and

(b) the Contractor shall give all notices, pay all taxes, duties and fees, and obtain all permits, licenses and approvals, as required by the Laws in relation to the execution and completion of the Services in so far as these relate to the Services themselves and not to the operation of the Facilities, and the Contractor shall indemnify and hold the Employer harmless against and from the consequences of any failure to do so.

3.9 Joint and Several Liability

If the Contractor constitutes (under applicable Laws) a Joint Venture of two or more persons:

(a) these persons shall be deemed to be jointly and severally liable to the Employer for the performance of the Contract;

(b) these persons shall notify the Employer of their leader who shall have authority to bind the Contractor and each of these persons; and

(c) the Contractor shall not alter its composition or legal status without the prior consent of the Employer.

3.10 Inspections and Audit by the Bank

(a) The Contractor shall keep, and shall make all reasonable efforts to cause its Subcontractors and subconsultants to keep, accurate and systematic accounts and records in respect of the Services in such form and details as will clearly identify relevant time changes and costs.

(b) The Pursuant to paragraph 2.2 e. of Appendix to the General Conditions the Contractor shall permit and shall cause its subcontractors and subconsultants to permit, the Bank and/or persons appointed by the Bank to inspect the Site and/or the accounts and records relating to the performance of the Contract and the submission of the bid, and to have such accounts and records audited by auditors appointed by the Bank if requested by the Bank. The Contractor's and its Subcontractors' and subconsultants' attention is drawn to Sub-Clause 1.1.6 which provides, inter alia, that acts intended to materially impede the exercise of the Bank's inspection and audit rights constitute a prohibited practice subject

to contract termination (as well as to a determination of ineligibility pursuant to the Bank's prevailing sanctions procedures).

4. Obligations of the Contractor

4.1 Services to be Performed and Other Obligations

The Contractor shall perform the Services set out in Schedule B:Services and the other obligations described in Clauses 4, 5, 6, 7, 8, and 9.

4.2 Pre-Conditions

The performance by the Contractor of its obligations under the Contract shall be contingent on the availability of the Pre-Conditions listed in Schedule B.

4.3 Non Availability of the Pre-Conditions

Unless Schedule B provides a different mechanism for determining the implications of non-availability of the Services, in the event that any of the Pre-Conditions pursuant to Sub-Clause 4.2 [Pre-Conditions] are not available to the extent that, in the opinion of the Independent Expert, the non-availability of such Pre-Conditions:

(a) makes it unreasonable to expect the Contractor to perform some or all of the Services, the Contractor shall be relieved of its responsibilities to perform those services, or

(b) affects the achievement of any of the Performance Targets, such Performance Targets shall be reduced for the duration for which the Pre-Conditions are not available to the extent that the Independent Expert determines at its sole discretion.

4.4 Cost of Performing the Services

The performance of the Services shall be at the cost of the Contractor, unless otherwise specified in Schedule B.

5. Conflict of Interest

5.1 General

The Contractor shall hold the Employer's interests paramount, without any consideration for future work, and strictly avoid conflict with other assignments or their own corporate interests.

5.2 Contractor not to benefit from commissions, discounts, etc.

(a) The payment of the Contractor pursuant to Sub-Clause 12.1 [Contractor's Remuneration] shall constitute the Contractor's only payment in connection with this Contract and, subject to Sub-Clause 5.3 [Contractor and Affiliates not to Engage in Certain Activities] hereof, the Contractor shall not accept for its own benefit any trade commission, discount or similar payment in connection with activities pursuant to this Contract or in the discharge of its obligations hereunder, and the Contractor shall use its best efforts to ensure that any Sub-Contractors, as well as the Personnel and agents of either of them, similarly shall not receive any such additional payment.

(b) Furthermore, if the Contractor, as part of its obligations under the Contract, has the responsibility of advising the Employer on the procurement of goods, works or services, the Contractor shall comply with the Bank's applicable Procurement Regulations, and shall at all times exercise such responsibility in the best interest of the Employer. Any discounts or commissions obtained by the Contractor in the exercise of such procurement responsibility shall be for the account of the Employer.

5.3 Contractor and Affiliates not to engage in certain activities

The Contractor agrees that, during the term of this Contract and after its termination, the Contractor and any entity affiliated with the Contractor, as well as any Subcontractor and any entity affiliated with such Subcontractors, shall be disqualified from subsequently providing goods, works or services (other than consulting services) for a project resulting from or directly related to the Contractor's Services for the preparation or implementation of such project.

5.4 Prohibition of conflicting activities

The Contractor shall not engage, and shall cause its Personnel as well as their Sub-Contractors and their Personnel not to engage, either directly or indirectly, in any business or professional activities that would conflict with the activities assigned to them under this Contract.

6. Know-How Transfer and Training

6.1 Requirement to transfer know-how and systems

The Contractor shall:

(a) Transfer such know-how, management systems, manuals, utility management software and similar knowledge, tools and capacity for managing a utility as are specified in Schedule C.

(b) Leave with the Utility such, at the Termination or expiration of the Contract, management systems, manuals, utility management software and similar tools as are specified in Schedule C.

6.2 Requirement to provide training

The Contractor shall provide such training and development of Utility Personnel as is specified in Schedule C.

6.3 Cost of know-how transfer and training

The performance of the obligations under this Clause 5 shall be at the cost of the Contractor, unless otherwise specified in Schedule C.

7. Performance Targets

The Performance Targets will be the targets for key indicators set out in Schedule D.

In performing the Services and exercising its Delegated Management Authority, the Contractor shall use its best endeavors to achieve or exceed the Performance Targets.

Achieving the Performance Targets is not to result in any additional remuneration to the Contractor, except to the extent specified in Schedule G (G.2).

Failure to achieve the Performance Targets is not to result in any penalty, or create ground for termination of the Contract, except to the extent specified in Schedule C or Schedule G.

8. Staff to be Provided by the Contractor

8.1 Provision of Contractor's Personnel

The Contractor shall provide the Contractor's Personnel set out in Schedule E, to fill the positions listed in Schedule E, for the periods or days specified in Contractor's Personnel.

All costs of providing the Staff specified in Schedule E are to be for the Contractor's Account, unless otherwise specified in Schedule E.

8.2 Substitution of Contractor's Key Staff Member or Key Subcontractor

The Contractor may provide another person (the "Proposed Substitute Key Staff Member" or "Proposed Substitute Key Subcontractor") in substitution for a Key Staff or a Key Subcontractor (as identified in Schedule E) only on fulfillment of the following conditions:

(a) Proving to the reasonable satisfaction of the Employer that the Key Staff Member or Key Subcontractor is not available because of ill-heath, death, or because he is no longer employed or subcontracted by the Contractor

(b) Proving to the reasonable satisfaction of the Employer that the Proposed Substitute Key Staff Member or Key Subcontractor is as suitable for the job as the Key Staff Member or Key Subcontractor who is not available. To satisfy itself as to the suitability of the Proposed Substitute Key Staff Member or Proposed Substitute Key Subcontractor, the Employer may, among other things:

  (i) check the references of the Proposed Substitute Key Staff Member or Proposed Key Subcontractor, and/or

  (ii) require the Proposed Substitute Key Staff Member or Proposed Substitute Key Subcontractor to attend an interview with the Employer in the Country. Any costs incurred in the Proposed Substitute Key staff Member or Proposed Substitute Key Subcontractor attending the interview will be for the Contractor's Account.

(c) Payment by the Contractor of a Substitution Fee of the amount specified in Schedule E.

8.3 Labor Laws

The Contractor shall comply with all the relevant labor Laws applicable to the Contractor's Personnel, including Laws relating to their employment, health, safety, welfare, immigration and emigration, and shall allow them all their legal rights.

The Contractor shall require the Contractor's Personnel to obey all applicable Laws, including those concerning safety at work. The Contractor shall also require its Subcontractors to do the same with their respective personnel.

8.4 Health and Safety

The Contractor shall at all times take all reasonable precautions to maintain the health and safety of the Contractor's Personnel.

8.5 Contractor's Personnel Qualifications

The Contractor's Personnel shall be appropriately qualified, skilled and experienced in their respective trades or occupations. The Employer's Representative may require the Contractor to remove (or cause to be removed) from the Facilities or the performance of the Services, any Contractor's Personnel, including the Contractor's Representative if applicable, who:

(a) persists in any misconduct or lack of care,

(b) carries out duties incompetently or negligently,

(c) fails to conform with any provisions of the Contract, or

(d) persists in any conduct which is prejudicial to safety, health, or the protection of the environment.

If requested by the Employer, the Contractor shall then substitute the person removed with another person. This substitution must be in accordance with Sub-Clause 8.2.

8.6 Foreign Personnel

The Contractor may bring in to the Country any foreign personnel who are necessary for the execution of the Services except for the categories of staff **specified in the Contract Data** that, in accordance with applicable Country Laws, must be hired locally if and to the extent that a sufficient number of appropriately qualified staff is locally available. The Contractor shall ensure that these personnel are provided with the required residence visas and work permits. The Employer will, if requested by the Contractor, use his best endeavours in a timely and expeditious manner to assist the Contractor in obtaining any local, state, national, or government permission required for bringing in the Contractor's personnel.

The Contractor shall be responsible for the return of these personnel to the place where they were recruited or to their domicile. In the event of the death in the Country of any of these personnel or members of their families, the Contractor shall similarly be responsible for making the appropriate arrangements for their return or burial.

9. Procurement and Management of Capital Works and Finance

9.1 Responsibility to Manage Utility Capital Works and Finance

Unless otherwise specified in Schedule F, the Contractor will not be directly responsible for Capital Works or sourcing finance, but will be responsible for managing the Utility Personnel responsible for these functions, to the extent that this is within the definition of Services to be performed, and the Delegation of Management Authority.

9.2 Responsibilities for Specified Capital Works

The Contractor will be responsible for designing, procuring, managing and supervising Capital Works to the extent set out in Schedule F.

The cost of Specified Capital Works will be to the Utility's Account, unless otherwise specified in Schedule F.

The Contractor will not receive any remuneration for discharging its responsibilities under this Sub-Clause 9.2, unless otherwise specified in Schedule G.

9.3 Responsibilities for Specified Finance

The Contractor will be responsible for sourcing, negotiating or otherwise procuring finance for the Utility as specified in Schedule F.

The Contractor will not receive any remuneration for discharging its responsibilities under this Sub-Clause, unless otherwise specified in Schedule G.

9.4 Procurement Rules

Procurement for Utility operations

In discharging its responsibilities to procure, or manage the procurement of, materials, supplies and services for the operations of the Utility, the Contractor will follow good commercial practice designed to ensure fairness, transparency and value for money, including any specific procurement rules set out in Schedule H.

Procurement for Provision of the Services

The Contractor is free to procure anything required for the provisions of Services as it wishes provided that:

(a) This Contract was awarded competitively to the satisfaction of the Bank, and

(b) The thing being procured is for the Contractor's Account.

Except that if there are any provisions governing the procurement of things required for the provisions of the Services stated in Schedule H, the Contractor shall comply with those provisions.

Procurement for Utility Capital Works and Specified Capital Works

In discharging its responsibilities to procure, or manage the procurement of anything required for Utility Capital Works and Specified Capital Works, the Contractor will follow good commercial practice designed to ensure fairness, transparency and value for money, including any specific procurement rules set out in Schedule H.

10. Contractor's reporting

10.1 Contractor's reporting requirements

Unless otherwise stated in Schedule K, monthly progress reports shall be prepared by the Contractor and submitted to the Employer's Representative in six copies. The first report shall cover the period up to the end of the first calendar month following the Commencement Date. Reports shall be submitted monthly thereafter, each within 7 days after the last day of the period to which it relates. The Contractor shall comply with all other reporting requirements specified in Schedule K.

11. Delegation of Management Authority to the Contractor

11.1 Delegation of Management Authority

Regardless of the relationship and interdependency between the Utility Board and the Employer, as may be defined by the Utility's charter or other internal documents, for the purpose of this Contract, the Employer is the Party to the Contract and is deemed to act on behalf and with the authorization of the Utility Board. In this capacity, the Employer confers on the Contractor the Delegated Management Authority over the areas and to the extent specified in Schedule I**.** This delegation is irrevocable during the term of the Contract.

11.2 Contractor to be advisor on other management matters

All management authority not explicitly delegated to the Contractor is retained by the Employer.

If in the Contractor's opinion it would be beneficial to the performance of the Services and achievement of the Objectives for such management authority to be exercised in a particular way, the Contractor shall advise the Employer of this, and provide reasons in writing. The Employer will give the Contractor written notice of its decision within the period **specified in the Contract Data**. If the Employer decides not to follow the Contractor's advice, it will give written reasons for its decision when it informs the Contractor.

The Contractor shall comply with the decisions of the Employer in management matters which are not the subject of Delegated Management Authority, to the extent that this is consistent with this Contract, and in particular with Schedule B, Schedule F, and Schedule H.

11.3 Further Delegation during the term of the Contract

The Employer may delegate further powers to the Contractor during the term of the Contract. Such further delegations are to be in writing. The delegations may be revocable or irrevocable, as specified in the delegation. Such delegations will be effective unless the Contractor refuses to accept the delegation. To be effective, such refusal must be given in writing within 30 days of receiving the notice of delegation.

11.4 Purpose of Exercise of Delegated Management Authority

The Contractor shall exercise any Delegated Management Authority to perform the Services and meet the Performance Targets, in accordance with good utility management practices.

11.5 Suspension of Delegated Management Authority

The delegation of powers shall be suspended during periods of Suspension of the Service, in accordance with Sub-Clause 18.2 [Employer's Entitlement to Suspend the Services and Delegated Management Authority].

11.6 Utility's Personnel

The Utility's Personnel will continue to be employed by the Utility. They will not become employees of the Contractor by virtue of this Contract.

The Contractor's Personnel will not be employees of the Utility by virtue of this Contract.

The Contractor's power to manage the Utility's Personnel will be as set out in the delegation of management authority to the Contractor under this Clause.

11.7 Utility Personnel Retrenchment

Provisions related to staff retrenchment set out in Schedule L will be binding on the Parties.

12. Contractor's Remuneration and Costs

12.1 Contractor's Remuneration

Amount and conditions of payment

The amount and conditions of payment of the Contractor's Remuneration shall be as specified in Schedule G.

Responsibility for Payment

Payment of the Remuneration shall be the responsibility of the Employer, unless otherwise specified in Schedule G.

Payment to be made without penalty or deduction

The Remuneration shall be paid in full without penalty or deduction unless otherwise provided in Schedule G, or this Contract.

Dates for payment

The dates for payment of the Contractor's Remuneration shall be as specified in Schedule G.

Currencies of Payment

The Contractor Remuneration shall be paid in the currency or currencies named in Schedule G.

Adjustment of Remuneration for Inflation

The Contractor Remuneration shall be adjusted as stated in Schedule G.

12.2 Advance Payment

The Advance Payment or payment to the Contractor in advance of work done, if any, shall be as specified in Schedule G.

Any advance payment shall be paid as an interest-free loan for mobilization, when the Contractor submits a guarantee in accordance with this Sub-Clause. The total Advance Payment, the number and timing of installments (if more than one), and the applicable currencies and proportions, shall be as stated in Schedule G.

The guarantee shall be in amounts and currencies equal to the Advance Payment. This guarantee shall be issued by an entity and from within a country (or other jurisdiction) approved by the Employer, and shall be in the form annexed to the Particular Conditions or in another form approved by the Employer.

The Contractor shall ensure that the guarantee is valid and enforceable until the advance payment has been repaid, but its amount may be progressively reduced by the amount repaid by the Contractor. If the terms of the guarantee specify its expiry date, and the advance payment has not been repaid by the date 28 days prior to the expiry date, the Contractor shall extend the validity of the guarantee until the advance payment has been repaid.

Unless stated otherwise in Schedule G, the advance payment shall be repaid through equal percentage deductions from the Contractor's Base Remuneration.

If the advance payment has not been repaid prior to the Termination of the Contract, the whole of the balance then outstanding shall immediately become due and payable by the Contractor to the Employer.

12.3 Delayed Payment

If the Contractor does not receive payment in accordance with Sub-Clause 12.1 [Contractor's Remuneration], the Contractor shall be entitled to receive financing charges compounded monthly on the amount unpaid during the period of delay. This period shall be deemed to commence on the date for payment.

Unless otherwise stated in Schedule G, these financing charges shall be calculated at the annual rate of three percentage points above the discount rate of the central bank in the country of the currency of payment, and shall be paid in such currency.

The Contractor shall be entitled to this payment without formal notice or certification, and without prejudice to any other right or remedy.

12.4 Sufficiency of the Contractor Remuneration

The Contractor shall be deemed to have satisfied himself as to the correctness and sufficiency of the Contractor Remuneration, taking into account all available data, and fully understanding the Services to be provided, and the conditions in which the Services are to be performed.

12.5 Contractors Costs and Account

12.5.1 Contractor's Account

An item which is expressed to be "for the Contractor's Account" shall be paid for by the Contractor from its own funds and not from the funds of the Employer or the Utility. The Contractor will be responsible for meeting the cost of items for the Contractor's Account whether or not the Contractor's Remuneration is sufficient to cover the cost, or whether or not the cost was anticipated, and whether or not the Contractor has the funds available.

12.6 Utility Financial Issues

12.6.1 Utility's Account

An item which is expressed to be "for the Utility's Account" shall be paid for by the Employer.

All costs which are not specified by this Contract to be for the Contractor's Account, or the responsibility of another person, shall be for the Employer's Account.

12.6.2 Procedure if the Utility's incomings are not sufficient to cover its outgoings

The Utility shall cause the Parties responsible for its financial management to manage it prudently and in accordance with good commercial practice, and attempt to pay the obligations of the Utility as they fall due.

In the event that the Utility is unable to pay its obligations as they fall due, the Utility shall cause the Parties responsible for its financial management to follow the rules and processes set out in Schedule J.

13. Obligations and Rights of the Employer

13.1 Access to land

The Employer hereby grants free of charge to the Contractor, as from the Commencement Date, access to all land within the Service Area in respect of which access is required for the performance of the Services by the Contractor.

13.2 Right to use facilities

The Employer hereby grants free of charge to the Contractor, as from the Commencement Date, the right to access and use the Facilities.

If the Contractor suffers delay and/or incurs Cost as a result of a failure by the Employer to give any such right, the Contractor shall be entitled on request to an adjustment in the Operator Remuneration sufficient to put it in the same position it would have been in had the Employer honoured its obligations under this Sub-Clause.

13.3 Payments by the Employer

The Employer shall make payments to the Contractor in accordance with the terms of this Contract.

13.4 Support by the Employer

The Employer shall use its best efforts to ensure that the Government shall provide the Contractor such assistance as may be required (e.g., issuance of permits, licenses, approvals, authorizations, etc.) during the term of this Contract.

The Employer shall use its best efforts to ensure adequate finance pursuant to the Project as defined herein to fund any capital investment program and shall keep the Contractor informed of the progress of such applications and negotiations.

13.5 Supervision by the Employer

(a) The Employer shall supervise the Contractor in the performance of its obligations under this Contract.

(b) The Employer shall review and approve or comment upon all reports submitted by the Contractor pursuant Clause 14 [Employer's Reporting].

(c) The Employer shall be given reasonable access during normal working hours to premises, works and sites of the Contractor for the purposes of inspection and certification. For the avoidance of doubt the term "Employer" as used herein shall include duly authorized officers, employees, representatives of the Employer and the Financial and Technical Auditors.

13.6 Permits, Licenses or Approvals

The Employer shall (where he is in a position to do so) provide reasonable assistance to the Contractor at the request of the Contractor:

(a) by obtaining copies of the Laws of the Country which are relevant to the Contract but are not readily available, and

(b) for the Contractor's applications for any permits, licenses or approvals required by the Laws of the Country:

(i) which the Contractor is required to obtain

(ii) for the delivery of Goods, including clearance through customs, and

(iii)for the export of Contractor's Equipment when it is removed from the Facilities.

13.7 Utility's Personnel Cooperation

The Employer and the Utility shall be responsible for ensuring that the Utility's Personnel and other contractors on the Facilities co-operate with the Contractor's efforts in performance of the Services.

13.8 Employer's Financial Arrangements

The Employer shall submit, within 28 days after receiving any request from the Contractor, reasonable evidence that financial arrangements have been made and are being maintained which will enable the Employer to pay the Contractor Remuneration (as estimated at that time) in accordance with Clause 12 [Contractor's Remuneration]. Before the Employer makes any material change to his financial arrangements, the Employer shall give notice to the Contractor with detailed particulars.

In addition, if the Bank has notified to the Borrower that the Bank has suspended disbursements under its loan, which finances in whole or in part the execution of the Services, the Employer shall give notice of such suspension to the Contractor with detailed particulars, including the date of such notification, with a copy to the Independent Expert, within 7 days of the Borrower having received the suspension notification from the Bank. If alternative funds will be available in appropriate currencies to the Employer to continue making payments to the Contractor beyond a date 60 days after the date of Bank notification of the suspension, the Employer shall provide reasonable evidence in such notice of the extent to which such funds will be available.

14. Employer's Reporting

14.1 Employer's reporting requirements

The Employer shall comply with the reporting requirements specified in Schedule K.

15. Intellectual and Industrial Property Rights

15.1 Intellectual Property and Copyright

As between the Parties, the Contractor shall retain the copyright and other intellectual property rights in any technical or Employer's Representative inventions or innovations made by or on behalf of the Contractor in providing the Services and in the Contractor's, Parent's and Shareholders' proprietary software, as applicable, that the Contractor modified for use in connection with the Services (the "Contractor's Innovations and Software").

The Contractor, by signing the Contract, gives the Employer a non-terminable, transferable, non-exclusive, royalty-free license to copy, use and communicate the Contractor's Innovations and Software and any other software used or purchased by the Contractor in the performance of the Services (the "Other Software"), including making and using modifications of them. This license shall,

(a) apply throughout the actual or intended working life, whichever is longer, of the relevant parts of the Facilities;

(b) entitle any person in proper possession of the relevant part of the Facilities to copy, use and communicate the Contractor's Innovations and Software and the Other Software for the purposes of managing, operating and maintaining the Facilities;

(c) in the case of Contractor's Innovations and Software and the Other Software which are in the form of computer programs and other software, permit their use on any computer at the Facilities and other places as envisaged by the Contract, including replacements of any computers supplied by the Contractor; and

(d) entitle the Employer to make the Contractor's Innovations and Software and the Other Software available for inspection by a prospective Bidder who may be involved in the process to select a Subsequent Contractor.

As between the Parties, the Employer owns and will continue to own all data with respect to the Facilities and Customers.

15.2 Intellectual Property Infringements

15.2.1 Meaning of Infringement and Claim

In this Sub-Clause, "infringement" means an infringement (or alleged infringement) of any patent, registered design, copyright, trade mark, trade name, trade secret or other intellectual or industrial property right relating to the Services; and "claim" means a claim (or proceedings pursuing a claim) alleging an infringement.

15.2.2 Notice of Claims

Whenever a Party does not give notice to the other Party of any claim within 28 days of receiving the claim, the first Party shall be deemed to have waived any right to indemnity under Sub-Clause 15.2 [Intellectual Property Infringement].

15.2.3 Contractor to Indemnify Employer

The Contractor shall indemnify and hold the Employer and the Utility harmless against and from any other claim which arises out of or in relation to the performance of the Services or the Contractor's management of the Utility.

15.2.4 Employer to indemnify Contractor

The Employer shall indemnify and hold the Contractor harmless against and from any claim alleging an infringement which is or was:

(a) an unavoidable result of the Contractor's compliance with the Contract, or

(b) a result of any Services being used by the Employer:

  (i) for a purpose other than that indicated by, or reasonably to be inferred from, the Contract, or

  (ii) in conjunction with anything not supplied by the Contractor, unless such use was disclosed to the Contractor prior to the Base Date or is stated in the Contract.

15.2.5 Right to manage settlement and litigation

If a Party is entitled to be indemnified under this Sub-Clause 15.2 [Intellectual Property Infringement], the indemnifying Party may (at its cost) conduct negotiations for the settlement of the claim, and any litigation or arbitration which may arise from it. The other Party shall, at the request and cost of the indemnifying Party, assist in contesting the claim. This other Party (and its

Personnel) shall not make any admission which might be prejudicial to the indemnifying Party, unless the indemnifying Party failed to take over the conduct of any negotiations, litigation or arbitration upon being requested to do so by such other Party.

15.3 Confidentiality Obligations of the Contractor

15.3.1 Confidentiality

The Contractor shall keep confidential and shall not, without the written consent of the Employer, divulge to any Third Party any documents, data or other information arising directly or indirectly from the performance of Services under the Contract, whether such information has been furnished prior to, during or following termination of the Contract.

However, the Contractor may furnish to its Subcontractors such documents, data and other information to the extent required for the Subcontractors to perform their work under the Contract, in which event the Contractor shall obtain from such Subcontractors an undertaking of confidentiality similar to that imposed on the Contractor under this Sub-Clause 15.3 [Confidentiality Obligations of the Contractor].

15.3.2 Use of information

The Contractor shall not use such documents, data and other information received from the Employer for any purpose other than as are required for the performance of the Contract. The Contractor shall not publish, permit to be published, or disclose any particulars of the Contract, Assets or Facilities in any trade or technical paper or advertising materials without the prior written consent of the Employer.

15.3.3 Exceptions for publicly available information

The obligations of the Contractor under Sub-Clause 15.3 [Confidentiality Obligations of the Contractor] shall not apply to that information which,

(a) now or hereafter enters the public domain through no fault of the Contractor;

(b) can be proven to have been possessed by the Contractor at the time of disclosure and which was not previously obtained, directly or indirectly, from the Employer; or

(c) otherwise lawfully becomes available to the Contractor from a Third Party that has no obligation of confidentiality.

15.4 Confidentiality and Publication Obligations of the Employer

Unless otherwise stated in the Contract Data, the Employer has the right and intention to:

(a) Publish the Contract in its entirety in the World Bank Private Participation in Infrastructure Database, and such other media as it deems appropriate, and

(b) Publish the Performance Targets and the progress against those Performance Targets in appropriate mass circulation media in the Country.

16. Liability, Risk Allocation, Securities, Bonds and Insurance

16.1 Limitation of Liability

Neither Party shall be liable to the other Party for loss of use of any Services, loss of profit, loss of any contract or for any indirect or consequential loss or damage which may be suffered by the other Party in connection with the Contract, whether in contract, tort or otherwise, other than as specifically provided in Sub-Clause 21.9 [Payment on Termination by the Employer for Cause]; Sub-Clause 16.2 [Indemnities]; Sub-Clause 16.7 [Consequences of Employer's Risks] and Sub-Clause 15.1 [Intellectual Property and Copyright].

The total liability of the Contractor to the Employer, under or in connection with the Contract, whether in contract, tort or otherwise, shall not exceed the sum **stated in the Contract Data**, or (if such multiplier or other sum is not so stated), the Contractor Base Remuneration.

This Sub-Clause shall not limit liability in any case of fraud, deliberate default, gross negligence, or reckless misconduct by the defaulting Party.

16.2 Indemnities

The Contractor shall indemnify and hold harmless the Employer, the Employer's Personnel, and their respective agents, against and from all claims, damages, losses and expenses (including legal fees and expenses) in respect of:

(a) bodily injury, sickness, disease or death, of any person whatsoever arising out of or in the course of or by reason of the execution and completion of the Services, unless attributable to any negligence, willful act or breach of the Contract by the Employer, the Employer's Personnel, or any of their respective agents, and

(b) damage to or loss of any property, real or personal, to the extent that such damage or loss arises out of or in the course of or by reason of the Contractor's performance or non-performance of the Services and the remedying of any defects, unless and to the extent that any such damage or loss is attributable to any negligence, willful act or breach of the Contract by the Employer, the Employer's Personnel, their respective agents, or anyone directly or indirectly employed by any of them.

The Employer shall indemnify and hold harmless the Contractor, the Contractor's Personnel, and their respective agents, against and from all claims, damages, losses and expenses (including legal fees and expenses) in respect of (1) bodily injury, sickness, disease or death, which is attributable to any negligence, willful act or breach of the Contract by the Employer, the Employer's Personnel, or any of their respective agents.

16.3 Performance Security

Unless an amount is **not stated in the Contract Data**, the Contractor shall obtain (at his cost) a Performance Security for proper performance, in the form, amount and currencies **stated in the Contract Data**.

The Contractor shall deliver the Performance Security to the Employer within 28 days after receiving the Letter of Acceptance, and shall send a copy to the Independent Expert The Performance Security shall be issued by an entity and from within a country (or other jurisdiction) approved by the Employer, and shall be in the form annexed to the Particular Conditions or in another form approved by the Employer. If the institution issuing the Performance Security is located outside the country of the Employer, it shall have a corresponding financial institution located in the country of the Employer to make it enforceable.

The Contractor shall ensure that the Performance Security is valid and enforceable until the Contractor has executed and completed the Services and been released from liability under this Contract. If the terms of the Performance Security specify its expiry date, and the Contractor has not become entitled to receive the Performance Certificate by the date 28 days prior to the expiry date, the Contractor shall extend the validity of the Performance Security until the Services have been completed and any defects have been remedied.

The Employer shall not make a claim under the Performance Security, except for amounts to which the Employer is entitled under the Contract.

The Employer shall not make a claim under the Performance Security unless the Independent Expert first certifies that there are "prima facie" grounds for making a claim.

The Employer shall indemnify and hold the Contractor harmless against and from all damages, losses and expenses (including legal fees and expenses) resulting from a claim under the Performance Security to the extent to which the Employer was not entitled to make the claim.

The Employer shall return the Performance Security to the Contractor within 21 days after receiving a copy of the Performance Certificate.

16.4 General Requirements for Insurances

In this Clause, "insuring Party" means, for each type of insurance, the Party responsible for effecting and maintaining the insurance specified in the relevant Sub-Clause.

Wherever the Contractor is the insuring Party, each insurance shall be effected with insurers and in terms approved by the Employer. These terms shall be consistent with any terms agreed by both Parties before the date of the Letter of Acceptance. This agreement of terms shall take precedence over the provisions of this Clause.

Wherever the Employer is the insuring Party, each insurance shall be effected with insurers and in terms consistent with the details annexed in Schedule M.

If a policy is required to indemnify joint insured, the cover shall apply separately to each insured as though a separate policy had been issued for each of the joint insured. If a policy indemnifies additional joint insured, namely in addition to the insured specified in this Clause, (i) the Contractor shall act under the policy on behalf of these additional joint insured except that the Employer shall act for Employer's Personnel, (ii) additional joint insured shall not be entitled to receive payments directly from the insurer or to have any other direct dealings with the insurer, and (iii) the insuring Party shall require all additional joint insured to comply with the conditions stipulated in the policy.

Each policy insuring against loss or damage shall provide for payments to be made in the currencies required to rectify the loss or damage. Payments received from insurers shall be used for the rectification of the loss or damage.

The relevant insuring Party shall, within the respective periods **stated in the Contract Data** (calculated from the Commencement Date), submit to the other Party:

(a) evidence that the insurances described in this Clause have been effected, and

(b) copies of the policies for the insurances as required by Schedule M.

When each premium is paid, the insuring Party shall submit evidence of payment to the other Party.

Each Party shall comply with the conditions stipulated in each of the insurance policies. The insuring Party shall keep the insurers informed of any relevant changes to the execution of the Services and ensure that insurance is maintained in accordance with this Clause.

Neither Party shall make any material alteration to the terms of any insurance without the prior approval of the other Party. If an insurer makes (or attempts to make) any alteration, the Party first notified by the insurer shall promptly give notice to the other Party.

If the insuring Party fails to effect and keep in force any of the insurances it is required to effect and maintain under the Contract, or fails to provide satisfactory evidence and copies of policies in accordance with this Sub-Clause, the other Party may (at its option and without prejudice to any other right or remedy) effect insurance for the relevant coverage and pay the premiums due. The insuring Party shall pay the amount of these premiums to the other Party, and the Contractor Remuneration shall be adjusted accordingly.

Nothing in this Clause limits the obligations, liabilities or responsibilities of the Contractor or the Employer, under the other terms of the Contract or otherwise. Any amounts not insured or not recovered from the insurers shall be borne by the Contractor and/or the Employer in accordance with these obligations, liabilities or responsibilities. However, if the insuring Party fails to effect and keep in force an insurance which is available and which it is required to effect and maintain under the Contract, and the other Party neither approves the omission nor effects insurance for the coverage relevant to this default, any moneys which should have been recoverable under this insurance shall be paid by the insuring Party.

16.5 Insurance Required

Each Party shall effect and maintain insurance as specified in Schedule M.

16.6 Employer's Risks

The risks referred to in Sub-Clause 16.7 [Consequences of Employer's Risks] below, insofar as they directly affect the execution of the Services in the Country, are:

(a) war, hostilities (whether war be declared or not), invasion, act of foreign enemies,

(b) rebellion, terrorism, sabotage by persons other than the Contractor's Personnel and other employees of the Contractor and Subcontractors, revolution, insurrection, military or usurped power, or civil war, within the Country,

(c) riot, commotion or disorder within the Country by persons other than the Contractor's Personnel and other employees of the Contractor and Subcontractors,

(d) munitions of war, explosive materials, ionizing radiation or contamination by radio-activity, within the Country, except as may be attributable to the Contractor's use of such munitions, explosives, radiation or radio-activity,

(e) pressure waves caused by aircraft or other aerial devices traveling at sonic or supersonic speeds,

(f) use or occupation by the Employer of any part of the Permanent Services, except as may be specified in the Contract,

(g) any operation of the forces of nature which is Unforeseeable.

16.7 Consequences of Employer's Risks

Notwithstanding anything contained in the Contract, the Contractor shall have no liability whatsoever for or with respect to,

(a) destruction of or damage to the Facilities or any part thereof;

(b) destruction of or damage to property of the Employer or any Third Party; or

(c) injury or loss of life,

if such destruction, damage, injury or loss of life is caused by any Employer's Risks, and the Employer shall indemnify and hold the Contractor harmless from and against any and all claims, liabilities, actions, lawsuits, damages, costs, charges or expenses arising on consequence of or in connection with the same.

If the Facilities or any property of the Contractor used or intended to be used for the purposes of the Services sustains destruction or damage by reason of any Employer's Risks, the Employer shall pay for,

(a) replacing or making good any property or investments of the Contractor so destroyed or damaged; and

(b) replacing or making good any such destruction or damage to the Facilities or any part thereof,

so far as may be required by the Employer, and as may be necessary for completion of the Services.

If the Employer does not require the Contractor to replace or make good any such destruction or damage to the Facilities, the Employer shall either request a change in accordance with Sub-Clause 19.1 [Employer Variations] excluding the performance of the Services in respect of that part of the Facilities thereby destroyed or damaged or, where the loss, destruction or damage affects a substantial part of the Facilities, shall terminate the Contract, pursuant to Sub-Clause 17.7 [Release from Performance].

Notwithstanding anything contained in the Contract, the Employer shall pay the Contractor for any increased Costs that are in any way attributable to, consequent on, resulting from, or in any way connected with any Employer's Risks, if the Contractor notifies the Employer in writing of any such increased cost as soon as practicable.

If, during the term of the Contract, any Employer's Risks occur that financially or otherwise materially affect the execution of the contract by the Contractor, the Contractor shall use its reasonable efforts to execute the Contract with due and proper consideration given to the safety of its and its Subcontractors' personnel engaged in the work on the Services. If the execution of the Services becomes impossible or is substantially prevented for a single period of more than 60 days or an aggregate period of more than 120 days on account of any Employer's Risks, the Parties will attempt to develop a mutually satisfactory solution, failing which either Party may terminate the Contract by giving a notice to the other.

In the event of termination pursuant to this Sub-clause, the rights and obligations of the Employer and the Contractor shall be as specified in Sub-Clause 17.7 [Release from Performance].

17.Force Majeure

17.1 Definition of Force Majeure

In this Clause, "Force Majeure" means an exceptional event or circumstance:

(a) which is beyond a Party's control,

(b) which such Party could not reasonably have provided against before entering into the Contract,

(c) which, having arisen, such Party could not reasonably have avoided or overcome, and

(d) which is not substantially attributable to the other Party.

Force Majeure may include, but is not limited to, exceptional events or circumstances of the kind listed below, so long as conditions (a) to (d) above are satisfied:

(i) war, hostilities (whether war be declared or not), invasion, act of foreign enemies,

(ii) rebellion, terrorism, sabotage by persons other than the Contractor's Personnel and other employees of the Contractor and Subcontractors, revolution, insurrection, military or usurped power, or civil war,

(iii) riot, commotion, disorder, strike or lockout by persons other than the Contractor's Personnel and other employees of the Contractor and Subcontractors, or the Employer's Personnel

(iv) munitions of war, explosive materials, ionizing radiation or contamination by radio-activity, except as may be attributable to the Contractor's use of such munitions, explosives, radiation or radio-activity, and

(v) natural catastrophes such as earthquake, hurricane, typhoon or volcanic activity.

17.2 Notice of Force Majeure

If a Party is or will be prevented from performing its substantial obligations under the Contract by Force Majeure, then it shall give notice to the other Party of the event or circumstances constituting the Force Majeure and shall specify the obligations, the performance of which is or will be prevented. The notice shall be given within 14 days after the Party became aware, or should have become aware, of the relevant event or circumstance constituting Force Majeure.

The Party shall, having given notice, be excused performance of its obligations for so long as such Force Majeure prevents it from performing them.

Notwithstanding any other provision of this Clause, Force Majeure shall not apply to obligations of either Party to make payments to the other Party under the Contract

17.3 Duty to Minimize Delay

Each Party shall at all times use all reasonable endeavors to minimize any delay in the performance of the Contract as a result of Force Majeure.

A Party shall give notice to the other Party when it ceases to be affected by the Force Majeure.

17.4 Consequences of Force Majeure

If the Contractor is prevented from performing its substantial obligations under the Contract by Force Majeure of which notice has been given under Sub-Clause 17.2 [Notice of Force Majeure], and suffers delay and/or incurs Cost by reason of such Force Majeure, the Contractor shall be entitled to:

(a) an extension of time for any such delay, if completion of the services is or will be delayed, and

(b) if the event or circumstance is of the kind described in sub-paragraphs (i) to (iv) of Sub-Clause 17.1 [Definition of Force Majeure] and, in the case of sub-paragraphs (ii) to (iv), occurs in the Country, payment of any such Cost.

17.5 Force Majeure Affecting Subcontractor

If any Subcontractor is entitled under any contract or agreement relating to the Services to relief from force majeure on terms additional to or broader than those specified in this Clause, such additional or broader force majeure events or circumstances shall not excuse the Contractor's non-performance or entitle him to relief under this Clause.

17.6 Optional Termination, Payment and Release

If the execution of substantially all the Services in progress is prevented for a continuous period of 84 days by reason of Force Majeure of which notice has been given under Sub-Clause 17.2 [Notice of Force Majeure], or for multiple periods which total more than 140 days due to the same notified Force Majeure, then either Party may give to the other Party a notice of termination of the Contract. In this event, the termination shall take effect 7 days after the notice is given, and the Contractor shall proceed in accordance with Sub-Clause 21.12 [Actions on Termination].

17.7 Release from Performance

Notwithstanding any other provision of this Clause, if any event or circumstance outside the control of the Parties (including, but not limited to, Force Majeure) arises which makes it impossible or unlawful for either or both Parties to fulfill its or their contractual obligations or which, under the law governing the Contract, entitles the Parties to be released from further performance of the Contract, then upon notice by either Party to the other Party of such event or circumstance:

(a) the Parties shall be discharged from further performance, without prejudice to the rights of either Party in respect of any previous breach of the Contract, and

(b) the sum payable by the Employer to the Contractor shall be the same as would have been payable under Sub-Clause 21.11 [Payment on Termination for Prolonged Force Majeure] if the Contract had been terminated under Sub-Clause 17.6 [Optional Termination, Payment and Release].

18. Suspension of Services

18.1.1 Suspension for non-payment

If the Employer:

(a) fails to pay the Contractors any sum due under the Contract within the period specified in the Contract;

(b) fails to approve any invoice or supporting documents without just cause under the Contract;

(c) commits a substantial breach of the Contract, including preventing the exercise of the Contractor's Delegated Management Authority

(d) fails to provide possession of or access to the Facilities

the Contractor may, after giving not less than 14 days' notice to the Employer, suspend work (or reduce the rate of work) unless and until the failure or breach which gave rise to the suspension has been rectified.

18.1.2 Suspension in the event of loan suspension

Notwithstanding the above, if the Bank has suspended disbursements under the loan or credit from which payments to the Contractor are being made, in whole or in part, for the execution of the Services, and no alternative funds are available as provided for in Sub-Clause 13.8 [Employer's Financial Arrangements], the Contractor may by notice suspend work or reduce the rate of work at any time, but not less than 7 days after the Borrower having received the suspension notification from the Bank.

18.1.3 No prejudice to other remedies

The Contractor's action shall not prejudice his entitlements to financing charges under Sub-Clause 12.3 [Delayed Payment] and to termination under Sub-Clause 21.7 [Termination by the Contractor for Cause].

18.1.4 Compensation for costs from suspension

If the Contractor suffers delay and/or incurs Cost as a result of suspending work (or reducing the rate of work) in accordance with this Sub-Clause, the Contractor shall be entitled to:

(a) an extension of time for any such delay, and

(b) payment of a costs actually and reasonably incurred as a result of the suspension

18.2 Employer's Entitlement to Suspend the Services and Delegated Management Authority

The Employer may suspend the Services and Delegation of Management Authority, if this is necessary in the public interest, by notice to the Contractor. Such notice shall specify the effective date of the suspension, the reasons for the suspension, and the date on which the suspension will end.

If the Employer suspends the Services in accordance with this Sub-Clause 18.2, the Contractor shall then cease to perform its obligations under the Contract. However, the Contractor shall still be entitled to the Contractor Remuneration under the Contract.

If the suspension continues for more than 90 days, the Contractor may, by notice to the Employer, treat the suspension as Termination.

19.Contract Variation, Extension and Rebidding

19.1 Employer Variations

At any time during the Term of the Contract the Employer's Representative may request a Variation by giving to the Contractor a Variation Request. A Variation Request shall specify

(a) A brief description of the Change to the Services

(b) the effect on any other provisions of the Contract

(c) a reasonable period within which the Contractor is required to respond.

19.1.1 Decision on Employer's Variation Request

On receiving a Variation Request the Contractor shall respond in writing as soon as practicable, and in any event within the period stipulated in accordance with Sub-Clause 19.1 [Employer Variations], either by giving reasons why he cannot comply (if this is the case) or by submitting a Variation Proposal containing:

(a) a description of the proposed work to be performed and a program for its execution,

(b) an estimate of the adjustment in Operator Remuneration which would be necessary to put the Contractor in the same financial position as if the Variation were not implemented

The Employer shall then:

(a) Accept the Variation Proposal, which shall then modify the Contract so far as is specified in the Variation Proposal; or

(b) Notify the Contractor that is has decided not to proceed with Variation or

(c) Notify the Contractor that it does not agree with the proposed adjustment in Operator Remuneration or other terms of the Contract, and refer the issue for determination through the Dispute Resolution procedure under Sub-Clause 20.1 [Dispute Resolution].

19.2 Value Management

The Contractor may, at any time, submit to the Employer's Representative a written Value Management Proposal which (in the Contractor's opinion) will, if adopted: (i) reduce the cost of providing the services; or (ii) further the Objectives of the Contract; or (iii) otherwise be of benefit to the Employer or the Utility.

The Value Management Proposal shall be prepared at the cost of the Contractor and shall include:

(a) description of the proposed Change to the Services

(b) a description of the proposed work to be performed and a program for its execution,

(c) any proposed adjustment in Operator Remuneration

(d) the effect on any other provisions of the Contract.

If the Value Management Proposal would allow the same Services to be performed at lower cost, then the proposed adjustment in the Operator Remuneration shall be such as to share the benefits of the savings equally between the Contractor and the Employer.

If the effect of the Value Management Proposal would be to increase both the scope of the Services and the cost of the Services, then the proposed adjustment in the Operator Remuneration shall be such as to put the Contractor in the same financial position as it would be if the Value Management Proposal were not implemented

19.3 Decision on Value Management Proposal

On receiving a Value Management Proposal the Employer shall either:

(a) Accept the Value Management Proposal, which shall then modify the Contract so far as is specified in the Value Management Proposal; or

(b) Decline to accept the Value Management Proposal.

19.4 Adjustments for Changes in Law

"Change in Law" means a change in the Laws of the Country (including the introduction of new Laws and the repeal or modification of existing Laws) or in the judicial or official governmental interpretation of such Laws, made after the Base Date, which affect the Contractor in the performance of obligations under the Contract.

If the Contractor incurs additional Cost as a result of a Change in Law, the Operator Remuneration shall be adjusted so as put the Contractor in the same financial position as it would be if the Change in Law had not occurred.

If the Parties cannot agree on the required adjustment to the Operator Remuneration, either Party may refer the issue for determination through the procedure under Sub-Clause 20.1 [Dispute Resolution].

19.5 Extension and Subsequent Bidding

Extension of the Contract

Unless otherwise provided for in Schedule N, the Contract may be extended for an additional period of no more than the initial term of the Contract. Such an extension may be requested by the Employer, following the process set out in 19.1 [Employer Variation], or by the Contractor following the process set out in 19.2 [Value Management], must be agreed by the Parties, and may not be determined under the Dispute Resolution process.

However, the Parties may agree to refer the request for an extension to the Independent Expert. If the parties refer the request for an extension to the Independent Expert they shall agree, prior to the referral, whether the Independent Expert's recommendation will be advisory only, or binding.

If requested to make a recommendation under this section, the Independent Expert shall be guided by:

(a) The Objectives of the Contract

(b) Such additional objectives as the Employer may inform him of which appear to him to be reasonable

(c) The need for the Contractor to make a fair profit on its efforts, which he may assess by reference to the profits actually achieved or expected to be achieved under the Contract

(d) The desirability of rewarding the Contractor for success in achieving the Employer's objectives.

Subsequent Bidding for a Similar Contract

Unless otherwise provided in Schedule N, the contractor shall not be precluded from Bidding for any similar contract which is offered by the Employer or the Utility after the termination or expiration of this contract. In case of such a subsequent Bidding, the Contractor will be requested by the Employer to provide in due time a detailed report satisfactory to the Employer about the Services under this Contract, such Report to be made available by the Employer to all other potential Bidders.

20. Dispute Resolution

20.1 Dispute Resolution

20.1.1 Amicable Settlement

(a) If any dispute arises out of or in connection with this Contract, either Party may give notice to the other Party of the same, whereupon the Parties shall meet promptly and in a good faith attempt to reach an amicable settlement.

(b) In the event that the Parties do not resolve a dispute in accordance with this Sub-Clause within twenty (20) days of notice of the dispute being given, then either Party may refer the dispute to the Independent Expert for determination pursuant to the procedure set forth in Sub-Clause 20.1.2 [Independent Expert].

20.1.2 Independent Expert

(a) By the date of Contract signing, the Contractor shall indicate to the Employer in writing its acceptance of one of the potential Independent Experts **proposed in the Contract Data** by the Employer or otherwise present to the Employer for its acceptance, a counter-proposal with the names of one or more individuals. The Employer shall respond in writing to the Contractor by the date **stated in the Contract Data**, and in case of a negative response, with a copy to the appointing entity or official **named in the Contract Data**, who shall then appoint the Independent Expert after due consultation with both Parties. If the Contractor fails to indicate its acceptance of one of the Employer-proposed individuals or present a counter-proposal, or if the Employer fails to respond to the Contractor's counterproposal by the due dates indicated above for each event, or if the Parties fail to agree upon the appointment of a replacement person within 42 days after the date on which the Independent Expert declines to act or is unable to act as a result of death, disability, resignation or termination of appointment, then the appointing entity or official **named in the Contract Data** shall, upon request of either or both of the Parties and after due consultation with both Parties, appoint the Independent Expert. The appointment(s) made by the appointing entity or official shall be final and conclusive. Each Party shall be responsible for paying one-half of the remuneration of the appointing entity or official.

(b) The Independent Expert shall be a professional experienced in the type of services covered under the Contract and with the interpretation of contractual documents, and

shall be fluent in the language for communications defined in the Contract. The Independent Expert shall be (and the terms of this appointment shall so provide that he or she is) independent of the Parties and shall act impartially. The Independent Expert's appointment may be terminated only by mutual agreement between the Parties. The Expert's terms of appointment shall expire as the Parties may mutually agree.

(c) In making its determination, the Independent Expert shall:

(i) have regard to the Services required to be performed hereunder and the terms and conditions of this Contract; and

(ii) ensure that the position of the Parties is restored to the position they would have been in if the event triggering the dispute under this Section had not occurred and all the Parties had complied with the Contract.

(d) The Party who initially issued the notice of intention to refer the dispute to the Independent Expert shall within ten (10) days of such notice submit to the Independent Expert and to the other Party the following documents:

(i) A description of the dispute;

(ii) A statement of that Party's position; and

(iii) Copies of relevant documentary evidence in support.

(e) Within ten (10) days of receipt of the above documents, the other Party shall submit:

(i) A description of the dispute;

(ii) A statement of that Party's position; and

(iii) Copies of relevant documentary evidence in support.

(f) The Independent Expert may call for such further documentary evidence and/or interview such persons as it deems necessary in order to reach their decision.

(g) The expert shall give notice to the Parties of its decision within twenty (20) days of receipt of the documents provided under Section d) or e) as the case may be.

(h) Unless this Contract has already been terminated or abandoned, the Parties shall in every case continue to proceed with the performance of their rights and obligations under this Contract with all due diligence whilst the Independent Expert is reviewing the dispute

(i) The decision of the Independent Expert shall be binding unless and until one Party, within ten (10) days of the date of such decision, issues a notice of intention to refer the matter to arbitration in accordance with Sub-Clause 20.1.4 [Arbitration].

(j) Each Party shall bear its own costs of preparing the materials for and making presentations to the Expert.

20.1.3 Payment of the Independent Expert

The costs of engaging the Independent Expert shall be borne equally by the Parties. The Independent Expert shall be paid as follows, in the currency **named in the Contract Data** or as otherwise indicated in the appointment notice issued in accordance with Sub-Clause 20.1.2 [Independent Expert]:

(a) a retainer fee per calendar month, which shall be considered as payment in full for:

(i) being available on 28 days' notice for all site visits and hearings;

(ii) becoming and remaining conversant with all project developments and maintaining relevant files;

(iii) all office and overhead expenses including secretarial services, photocopying and office supplies incurred in connection with his duties; and

(iv) all services performed hereunder except those referred to in sub-paragraphs (b) and (c) of this Sub-Clause.

The retainer fee shall be paid with effect from the last day of the calendar month in which the appointment becomes effective; until the last day of the calendar month in which the Contract expires, unless the Independent Expert resigns or his appointment is otherwise terminated by the Parties.

(b) a daily fee which shall be considered as payment in full for:

(i) each day or part of a day up to a maximum of two days' travel time in each direction for the journey between the Independent Expert's home and the site, or another location of a meeting that the Independent Expert is required to attend;

(ii) each working day on Site visits, hearings or preparing decisions; and

(iii) each day spent reading submissions in preparation for a hearing.

(c) all reasonable expenses including necessary travel expenses (air fare in less than first class, hotel and subsistence and other direct travel expenses) incurred in connection with the Independent Expert's duties, as well as the cost of telephone calls, courier charges, faxes and telexes: a receipt shall be required for each item in excess of five percent of the daily fee referred to in sub-paragraph (b) of this Sub-Clause;

(d) any taxes properly levied in the Country on payments made to the Independent Expert (unless a national or permanent resident of the Country) under this Sub-Clause.

20.1.4 Arbitration

All disputes arising out of or in connection with this Contract, not settled by amicable settlement or by the Independent Expert, in respect of which the Independent Expert's determination has not become final and binding, shall be finally settled by arbitration. Unless otherwise agreed by both Parties:

(a) For contracts with foreign contractors:

(i) international arbitration with proceedings administered by the international arbitration institution **appointed in the Contract Data**, in accordance with the rules of arbitration of the appointed institution;

(ii) the place of arbitration shall be the city where the headquarters of the appointed arbitration institution is located or such other place selected in accordance with the applicable arbitration rules; and

(iii) the arbitration shall be conducted in the language for communications defined in Sub-Clause 1.4; and

(b) For contracts with domestic contractors, arbitration with proceedings conducted in accordance with the laws of the Employer's Country.

The arbitrators shall have full power to open up, review and revise any determination of the Independent Expert, relevant to the dispute. Nothing shall disqualify representatives of the Parties from being called as a witness and giving evidence before the arbitrators on any matter whatsoever relevant to the dispute.

Neither Party shall be limited in the proceedings before the arbitrators to the evidence or arguments previously put before the Independent Expert to obtain its determination, or to the reasons for dissatisfaction given in its notice of dissatisfaction. Any decision of the Independent Expert shall be admissible in evidence in the arbitration.

Arbitration may be commenced prior to or after completion of the Services. The obligations of the Parties and the Independent Expert shall not be altered by reason of any arbitration being conducted during the progress of the Services.

20.1.5 Survival

The dispute resolution provisions contained in Sub-Clause 20.1.4 [Arbitration] shall survive termination of this Contract.

21. Default and Termination

21.1 Notification and Cure Plans

If a Default occurs, the Party not in Default may, in addition to any other remedies it has, give the Defaulting Party a notice in writing ("**Default Notice**") specifying:

(a) that a Default has occurred;

(b) the events or circumstances constituting the Default; and

(c) if the Default is capable of being cured or remedied, a reasonable Cure Period in which to cure or remedy the Default.

The Party not in Default may specify in the Default Notice:

(a) that it requires the Defaulting Party to provide to the Party not in Default a written plan ("Cure Plan") which specifies the reason the Default occurred, how the Defaulting Party intends to remedy the Default, the time that the Defaulting Party will require to remedy the Default and includes additional information on such matters as the Party not in Default requires; and

(b) a reasonable time by which the Defaulting Party must provide the Cure Plan to the Party not in Default.

The Party not in Default may, by notice to the Defaulting Party, vary the Cure Period having regard to information provided to it in relation to a Cure Plan.

21.2 Remedying the Default within the Applicable Cure Period

Upon receipt of a Default Notice, if the Default is capable of being cured or remedied, the Defaulting Party must cure or remedy the Default within the Cure Period.

In addition to its obligations under Sub-Clause 21.1 [Notification and Cure Plans], if the Party not in Default has required the Defaulting Party to provide a Cure Plan, the Defaulting Party must:

(a) provide a Cure Plan within the time requested by the Defaulting Party;

(b) comply with the Cure Plan; and

(c) report to the Party not in Default on progress in relation to the Cure Plan at the times and in the manner specified by the Party not in Default.

The Defaulting Party may, by notice to the Defaulting Party, request an extension to a Cure Period. The Defaulting Party may only request such an extension once in relation to a particular Default. The notice must specify:

(a) the reason why the Defaulting Party is not able to cure or remedy the Default within the existing Cure Period,

(b) the additional time that the Defaulting Party requires to cure or remedy the Default and

(c) any other information that is relevant to the Party not in Default's assessment of the request.

The Defaulting Party may not give such a notice unless it has diligently sought to cure or remedy the relevant Default. The Party not in Default must not unreasonably withhold its consent to a request for such an extension of a Cure Period unless the Party not in Default believes, on reasonable grounds, that the extension of the Cure Period would have a material adverse effect on the provision of the Services or the use by the Party not in Default of the Facilities.

21.3 Failure to cure

If the Party not in Default has given a Default Notice to the Defaulting Party and:

(a) where the Default is capable of being cured or remedied, the Defaulting Party does not provide a Cure Plan acceptable to the Party not in Default within the time required in the Default Notice (if applicable);

(b) where the Default is capable of being cured or remedied, the Defaulting Party does not diligently pursue the Cure Plan (if applicable) or otherwise comply with its obligations under Sub-Clause 21.2 [Remedying the Default within the Applicable Cure Period];

(c) where the Default is capable of being cured or remedied, the Default is not cured or remedied within the Cure Period and, if applicable, in accordance with the Cure Plan; or

(d) the Default is not capable of being cured or remedied.

The Party not in Default may (without prejudice to any of its other rights with respect to the Default), exercise all or any of the following remedies:

(a) sue the Defaulting Party for compensation for the Default, and exercise all available legal and equitable remedies including without limitation suing for specific performance, injunctive relief or such other orders as the Party not in Default considers appropriate;

(b) terminate this Agreement.

21.4 Ways the Contract may be terminated

The Contract may be terminated by:

(a) The Employer for Convenience, in accordance with Sub-Clause 21.5 [Termination by the Employer for Convenience],

(b) The Employer for Cause, in accordance with Sub-Clause 21.6 [Termination by the Employer for Cause], or

(c) The Contractor for Cause, in accordance with Sub-Clause 21.7 [Termination by the Contractor for Cause].

21.5 Termination by the Employer for Convenience

The Employer shall be entitled to terminate the Contract, at any time for the Employer's convenience, by giving notice of such termination to the Contractor. The termination shall take effect 28 days after the later of the dates on which the Contractor receives this notice or the Employer returns the Performance Security.

The Employer shall not terminate the Contract under this Sub-Clause in order to arrange for the Services to be executed by another contractor or to avoid a termination of the Contract by the Contractor under Sub-Clause 21.7 [Termination by the Contractor for Cause].

After this termination, the Contractor shall proceed in accordance with Sub-Clause 21.12 [Actions on Termination] and shall be paid in accordance with Sub-Clause 21.8 [Payment on Termination by the Employer for Convenience].

21.6 Termination by the Employer for Cause

The Employer shall be entitled to terminate the Contract for cause, if the Contractor:

(a) in accordance with Sub-Clause 21.3 [Failure to Cure], is the Defaulting Party referred to in that Sub-Clause,

(b) fails to comply with Sub-Clause 16.3 [Performance Security],

(c) abandons the Services or otherwise plainly demonstrates the intention not to continue performance of his obligations under the Contract,

(d) without reasonable excuse fails to proceed with the Services,

(e) subcontracts the whole of the Services or assigns the Contract without the required agreement,

(f) becomes bankrupt or insolvent, goes into liquidation, has a receiving or administration order made against him, compounds with his creditors, or carries on business under a receiver, trustee or manager for the benefit of his creditors, or if any act is done or event occurs which (under applicable Laws) has a similar effect to any of these acts or events, or

(g) gives or offers to give (directly or indirectly) to any person any bribe, gift, gratuity, commission or other thing of value, as an inducement or reward:

  (i) for doing or forbearing to do any action in relation to the Contract, or

  (ii) for showing or forbearing to show favour or disfavour to any person in relation to the Contract,

  (iii) or if any of the Contractor's Personnel, agents or Subcontractors gives or offers to give (directly or indirectly) to any person any such inducement or reward as is described in this sub-paragraph (f). However, lawful inducements and rewards to Contractor's Personnel shall not entitle termination, or.

(h) in the judgment of the Employer, has engaged in Fraud and Corruption, as defined in paragrpah 2.2 a of the Appendix to the GCC, in competing for or in executing the Contract.

In any of these events or circumstances, the Employer may, upon giving 14 days' notice to the Contractor, terminate the Contract and expel the Contractor from the Facilities. However, in the case of sub-paragraph (e), (f) or (h), the Employer may by notice terminate the Contract immediately.

The Employer's election to terminate the Contract shall not prejudice any other rights of the Employer, under the Contract or otherwise.

21.7 Termination by the Contractor for Cause

The Contractor shall be entitled to terminate the Contract if:

(a) in accordance with Sub-Clause 21.3 [Failure to Cure], if the Contractor is the Defaulting Party referred to in that Sub-Clause,

(b) the Employer fails to pay any part of the Contractor's Remuneration within 56 days of it falling due

(c) the Employer substantially fails to perform his obligations under the Contract in such manner as to materially and adversely affect the ability of the Contractor to perform the Contract,

(d) the Employer fails to comply with Sub-Clause 3.1 [Assignment], or

(e) the Employer becomes bankrupt or insolvent, goes into liquidation, has a receiving or administration order made against him, compounds with his creditors, or carries on business under a receiver, trustee or manager for the benefit of his creditors, or if any act is done or event occurs which (under applicable Laws) has a similar effect to any of these acts or events.

In the event the Bank suspends the loan or credit from which part or whole of the payments to the Contractor are being made, if the Contractor has not received the sums due to him within 7 days of the due date, the Contractor may, without prejudice to the Contractor's entitlement to financing charges under Sub-Clause 12.3 [Delayed Payment] take one of the following actions, namely (i) suspend work or reduce the rate of work, or (ii) terminate his employment under the Contract by giving notice to the Employer, with a copy to the Independent Expert, such termination to take effect 14 days after the giving of the notice.

In any of these events or circumstances, the Contractor may, upon giving 14 days' notice to the Employer, terminate the Contract. However, in the case of sub-paragraph (g), the Contractor may by notice terminate the Contract immediately.

The Contractor's election to terminate the Contract shall not prejudice any other rights of the Contractor, under the Contract or otherwise.

21.8 Payment on Termination by the Employer for Convenience

Upon termination of this Contract pursuant to Sub-Clause 21.5 [Termination by the Employer for Convenience] the Employer shall make the following payments to the Contractor:

(a) any portion of the Remuneration payable to the Contractor for Services satisfactorily performed or Performance Targets achieved prior to the Termination of the Contract;

(b) the Costs reasonably incurred by the Contractor in the removal of the Contractor's Equipment, Materials and Supplies from the Facilities and in the repatriation of the Contractor's Personnel and its Subcontractors' personnel;

(c) any amounts required to be paid by the Contractor to its Subcontractors in connection with the termination of any Subcontracts, including any reasonable cancellation charges;

(d) the reasonable Costs incurred by the Contractor in protecting and handing over the Facilities pursuant to Sub-Clause 21.12 [Actions on Termination]; and

(e) the reasonable Costs of satisfying all other obligations, commitments and claims that the Contractor may in good faith have undertaken with Third Parties in connection with the Contract and that are not otherwise covered by this Sub-Clause 21.8 [Payment on Termination by the Employer for Convenience].

The only payments to be made to the Contractor on termination by the Employer pursuant to Sub-Clause 21.5 [Termination by the Employer for Convenience] are those set out in this Sub-Clause 21.8. The Contractor shall not make any other claim for lost or foregone profits, revenues, consequential damages or any other costs, damages, expenses or losses of any kind as a result of or in connection with the termination of this Contract**.**

21.9 Payment on Termination by the Employer for Cause

Upon termination of this Contract pursuant to Sub-Clause 21.6 [Termination by the Employer for Cause], the Employer shall make the following payments to the Contractor:

(a) any portion of the Remuneration payable to the Contractor for Services satisfactorily performed or Performance Targets achieved prior to the Termination of the Contract and

(b) the reasonable Costs incurred by the Contractor in protecting and handing over the Facilities pursuant to Sub-Clause 21.12 [Actions on Termination].

The only payments to be made to the Contractor on termination by the Employer pursuant to Sub-Clause 21.6 [Termination by the Employer for Cause] are those set out in this Sub-Clause 21.9. The Contractor shall not make another claim for lost or foregone profits, revenues, consequential damages or any other costs, damages, expenses or losses of any kind as a result of or in connection with the termination of this Contract**.**

21.10 Payment on Termination by the Contractor for Cause

Upon termination of this Contract pursuant to Sub-Clause 21.7 [Termination by the Contractor for Cause] the Employer shall make the following payments to the Contractor:

(a) any portion of the Remuneration payable to the Contractor for Services satisfactorily performed or Performance Targets achieved prior to the Termination of the Contract;

(b) the Costs reasonably incurred by the Contractor in the removal of the Contractor's Equipment, Materials and Supplies from the Facilities and in the repatriation of the Contractor's Personnel and its Subcontractors' personnel;

(c) any amounts required to be paid by the Contractor to its Subcontractors in connection with the termination of any Subcontracts, including any reasonable cancellation charges;

(d) the reasonable Costs incurred by the Contractor in protecting and handing over the Facilities pursuant to Sub-Clause 21.12 [Actions on Termination];

(e) the reasonable Costs of satisfying all other obligations, commitments and claims that the Contractor may in good faith have undertaken with Third Parties in connection with the Contract and that are not otherwise covered by this Sub-Clause 21.10 [Payment on Termination by the Contractor for Cause]; and

(f) a payment in compensation for lost profits under the contract, which shall be either:

(i) the amount for Liquidated Damages on Termination by the Contractor for Cause **specified in the Contract Data**, or if no such amount is specified,

(ii) the amount of profit the Contractor would be expected to lose as a result of early termination of the contract. The Contractor shall submit an estimate of this amount.

The Employer shall either pay this amount, or submit it to dispute resolution under Sub-Clause 20.1 [Dispute Resolution].

The only payments to be made to the Contractor on termination by the Employer pursuant to Sub-Clause 21.7 [Termination by the Contractor for Cause] are those set out in this Sub-Clause 21.10. The Contractor shall not make another claim for lost or foregone profits, revenues, consequential damages or any other costs, damages, expenses or losses of any kind as a result of or in connection with the termination of this Contract**.**

21.11 Payment on Termination for Prolonged Force Majeure

Upon termination of this Contract pursuant to Sub-Clause 17.6 [Optional Termination, Payment and Release] the Employer shall make the following payments to the Contractor:

(a) any portion of the Remuneration payable to the Contractor for Services satisfactorily performed or Performance Targets achieved prior to the Termination of the Contract

(b) the Costs reasonably incurred by the Contractor in the removal of the Contractor's Equipment, Materials and Supplies from the Facilities and in the repatriation of the Contractor's Personnel and its Subcontractors' personnel;

(c) any amounts required to be paid by the Contractor to its Subcontractors in connection with the termination of any Subcontracts, including any reasonable cancellation charges;

(d) the reasonable Costs incurred by the Contractor in protecting and handing over the Facilities pursuant to Sub-Clause 21.12 [Actions on Termination].

(e) the reasonable Costs of satisfying all other obligations, commitments and claims that the Contractor may in good faith have undertaken with Third Parties in connection with the Contract and that are not otherwise covered by this Sub-Clause 21.11 [Payment on Termination for Prolonged Force Majeure].

21.12 Actions on Termination

In all cases of Termination, the Contractor shall promptly:

(a) cease all further work, except for such work as the Employer may specify in the notice of termination for the sole purpose of protecting the Facilities, or handing the over for safe and uninterrupted operation by the Employer or another party, including co-operating with the Employer in such manner as the Employer reasonably requires to ensure that the Services provided by the Contractor can be provided by another service provider or by the Employer itself.

(b) leave the Facilities

(c) deliver to the Employer all records related to the Contract and Services

(d) deliver all documents, know-how, information technology software and other intellectual property required for the provision of the Services and management of the Utility which were required to be left with the Employer or Utility at the Termination of the Contract under Clauses 6 [Know-How Transfer and Training] and 15 [Intellectual and Industrial Property Rights].

Section IX -Particular Conditions of Contract

The following Particular Conditions shall supplement the GCC. Whenever there is a conflict, the provisions herein shall prevail over those in the GCC.

Part A - Contract Data

Conditions	Sub-Clause	Data
Employer's name and address	1.1.2(f) & 1.3 (b)	DULT
Utility's Name	1.1.2(p)	DULT
Electronic transmission systems	1.3(a)	
Governing Law	1.4	Laws of India
Ruling language	1.4	English
Language for communications	1.4	English
Additional Conditions of Effectiveness	2.1(f)	
Period of Contract	2.3	[60] months
Employer's Representative	3.3	Name and Position from DULT. Name and Position from BTP
Contractor's responsibility for the acts or defaults of its Subcontractors	3.5	*[insert any statements different from the requirements established under Sub-Clause 3.5 (a) – (d)]*
Compliance with Laws	3.8	*[insert any statements different from the*

		requirements established under Sub-Clause 3.8]
Maximum amount of payment reductions for Quarterly Billing Value	7.1	10% of each Quarterly Billing Value
Categories of staff that must be hired locally if and to the extent that a sufficient number of appropriately qualified staff is locally available	8.6	
Employers intention to publish Performance Targets	15.4	The Employer _____*[insert "has" or "does not have"]* the right and intention to: (a) publish the Performance Targets and the progress against those Performance Targets in appropriate mass circulation media in the Country.
Maximum total liability of the Contractor to the Employer	16.1	*[Select one of the two options below as appropriate]* The product of_____*[insert a multiplier less or greater than one]* times the Contractor Remuneration, *or* _____*[insert amount of the maximum total liability]*
Performance Security	16.3	The performance security will be in the form of a performance bond*[insert either one of "demand guarantee" or "performance bond"]* in the amount(s) of *[10]* percent of the Contractor Remuneration and in the same currency(ies) of the Contractor Remuneration.
Periods for required submissions by the relevant insuring Party to the other Party	16.4	Period (calculated from the Commencement Date) for submission of: (a) evidence that the insurances described in Clause 16 have been effected: _____*[insert period of time]*, and (b) copies of the policies for the insurances as required by Schedule M:_____*[insert period of*

		time]
List of Employer-proposed potential Independent Experts	20.1.2	
Date by which the Employer shall respond to Contractor's counterproposal (if any)	20.1.2	
Appointing entity or official in case of disagreement between the Parties	20.1.2	
Currency for payment of the Independent Expert	20.1.3	
International Arbitration Institution	20.1.4 (a) (i)	
Amount of Liquidated Damages on Termination by the Employer for Convenience	21.8 (f) (i)	
Amount of Liquidated Damages on Termination by the Contractor for Cause	21.10 (f)(i)	

Part B - Specific Provisions

Sub-Clause 1.1.2
Parties and Persons

The followings are deleted.

(a) "Bank" means the financing institution (if any) named in the Contract Data.

(b) "Borrower" means the person (if any) named as the borrower in the Contract Data.

Replace the entire (o) "Third Party" with the following.

(o) "Third Party" means a person or an entity other than a Party, the Utility, the Utility Board or the Government.

Sub-Clause 1.1.4
Money and Payments

The followings are deleted.

(a) "Contractor's Account" means paid for the by the Contractor, as defined in Sub-Clause 12.5.1.

(h) "Utility's Account" means paid for the by the Utility, as defined in Sub-Clause 12.6.1.

Replace (c) "Contractor's Remuneration" with the following:

(b) "Contractor's Remuneration" means the price defined in Clause 12.1 [Contractor's Remuneration] and Schedule G (G.1 to G.9), and includes adjustments in accordance with the Contract.

The followings are added.

(i) "Liquidated Damages on Termination by the Employer for Convenience" means the amount specified in the Contract Data pursuant to Sub-Clause 21.8(f)(i) to be payable in the event of Termination by the Employer for Convenience pursuant to Sub-Clauses 21.5 and 21.8.

(j) "Quarterly Billing Value" means the amount of quarterly payment excluding payment reductions.

Sub-Clause 1.1.6 Fraud and Corruption

The following is deleted.

(a) The Bank requires compliance with the Bank's Anti-Corruption Guidelines and its prevailing sanctions policies and procedures as set forth in the WBG's Sanctions Framework, as set forth in Appendix to the GCC.

Sub-Clause 1.1.7 Other Definitions

The following is deleted.

(h) "Delegation of Management Authority" means the delegation to the Contractor of authority to manage the Facilities and the Utility which is granted under Clause 11 [Delegation of Management Authority to the Contractor].

Sub-Clause 2.3 Duration

The following is added at the end of Sub-Clause 2.3:

During the Period of Contract, the Parties shall make a yearly review and a required adjustment and/or necessary amendment of the Conditions of Contract as the need arises. If the Parties cannot agree on the adjustment and/or the amendment, either Party may refer the issue for determination through the procedure under Sub-Clause 20.1 [Dispute Resolution].

Sub-Clause 3.3 Employer's Representative

Replace the entire Sub-Clause 3.3 (a) with the following:

(a) The Employer shall name its representative before the Effective Date stated in the Contract Data.

Sub-Clause 3.10 Inspections and Audit by the Bank

This Sub-Clause is deleted entirely.

Sub-Clause 5.2 Contractor not to benefit from commissions, discounts, etc.

Replace the entire Sub-Clause 5.2 (b) with the following:

(b) Furthermore, if the Contractor, as part of its obligations under the Contract, has the responsibility of advising the Employer on the

procurement of goods, works or services, the Contractor shall comply with applicable procurement regulations, and shall at all times exercise such responsibility in the best interest of the Employer. Any discounts or commissions obtained by the Contractor in the exercise of such procurement responsibility shall be for the account of the Employer.

Clause 7
Performance Targets

Replace the entire Clause 7 with the following:

The Contractor shall carry out the Services complying with Schedule D: Performance Targets defined in the Schedules of Services Requirements.

7.1 Non-compliance with the Performance Targets

If, for reasons attributable to the Contractor, the Performance Targets are not attained, payment reductions to the Contractor due to the failure to meet the Performance Targets shall be made in accordance with the Schedule D and Schedule G.

However, the amount of payment reductions for each Quarterly Billing Value under this Sub-Clause shall not exceed the maximum amount of payment reductions for each Quarterly Billing Value (if any) stated in the Contract Data.

Sub-Clause 8.1
Provision of Contractor's Personnel

Replace the second paragraph with the following:

All costs of providing the Staff are to be at the cost of the Contractor, unless otherwise specified in Schedule E.

Sub-Clause 8.2
Substitution of Contractor's Key Staff Member or Key

Replace the entire Sub-Clause 8.2 (b) (ii) with the following:

(ii) Require the Proposed Substitute Key Staff Member

Subcontractor	or Proposed Substitute Key Subcontractor to attend an interview with the Employer in the Country. Any costs incurred in the Proposed Substitute Key staff Member or Proposed Substitute Key Subcontractor attending the interview will be at the cost of the Contractor.
Sub-Clause 9.1 Responsibility to Manage Utility Capital Works and Finance	This Sub-Clause is deleted entirely.
Sub-Clause 9.2 Responsibilities for Specified Capital Works	Replace the second paragraph with the following: The cost of Specified Capital Works will be at the cost of the Utility, unless otherwise specified in Schedule F.
Sub-Clause 9.4 Procurement Rules	The following is deleted. (a) This Contract was awarded competitively to the satisfaction of the Bank, and Replace the entire Sub-Clause 9.4 (b) with the following: (b) The thing being procured is at the cost of the Contractor.
Sub-Clause 11 Delegation of Management Authority to the Contractor	This Clause is deleted entirely.
Sub-Clause 12.1 Contractor's Remuneration	Replace the sentence: "**Payment to be made without penalty or deduction** The Remuneration shall be paid in full without penalty or deduction unless otherwise provided in Schedule G, or this Contract." with the following sentence: **"Payment reductions**

	Failure to meet the Performance Targets will result in payment reductions for default and not as a penalty, in accordance with the Schedule D and Schedule G.”
Sub-Clause 12.5 Contractors Costs and Account	This Sub-Clause is deleted entirely.
Sub-Clause 12.6 Utility Financial Issues	This Sub-Clause is deleted entirely.
Sub-Clause 13.8 Employer’s Financial Arrangements	The following second paragraph is deleted. “In addition, if the Bank has notified to the Borrower that the Bank has suspended disbursements under its loan, which finances in whole or in part the execution of the Services, the Employer shall give notice of such suspension to the Contractor with detailed particulars, including the date of such notification, with a copy to the Independent Expert, within 7 days of the Borrower having received the suspension notification from the Bank. If alternative funds will be available in appropriate currencies to the Employer to continue making payments to the Contractor beyond a date 60 days after the date of Bank notification of the suspension, the Employer shall provide reasonable evidence in such notice of the extent to which such funds will be available.”
Sub-Clause 15.4 Confidentiality and Publication Obligations of the Employer	The following is deleted. (a) Publish the Contract in its entirety in the World Bank Private Participation in Infrastructure Database, and such other media as it deems appropriate, and
Sub-Clause 16.1 Limitation of Liability	Replace the entire Sub-Clause 16.1 with the following: Neither Party shall be liable to the other Party for loss of

use of any Services, loss of profit, loss of any contract or for any indirect or consequential loss or damage which may be suffered by the other Party in connection with the Contract, whether in contract, tort or otherwise, other than as specifically provided in Sub-Clause 7.1 [Non-compliance with the Performance Targets]; Sub-Clause 15.1 [Intellectual Property and Copyright]; Sub-Clause 16.2 [Indemnities]; Sub-Clause 16.7 [Consequences of Employer's Risks]; Sub-Clause 21.8 [Payment on Termination by the Employer for Convenience];Sub-Clause 21.9 [Payment on Termination by the Employer for Cause]; andSub-Clause 21.10 [Payment on Termination by the Contractor for Cause].

The total liability of the Contractor to the Employer, under or in connection with the Contract, whether in contract, tort or otherwise, shall not exceed the sum stated in the Contract Data, or (if such multiplier or other sum is not so stated), the Contractor Base Remuneration.

This Sub-Clause shall not limit liability in any case of fraud, deliberate default, gross negligence, or reckless misconduct by the defaulting Party.

Clause 18
Suspension of Services

The following title of Sub-Clause should be added at the beginning of Clause 18:

18.1 Contractor's Entitlement to Suspend the Services

Sub-Clause 18.1.1
Suspension for non-payment

Replace the entire Sub-Clause 18.1.1 (c) with the following:

(c) commits a substantial breach of the Contract; and

Sub-Clause 18.1.2
Suspension in the event

This Sub-Clause is deleted entirely.

of loan suspension

Sub-Clause 18.2 Employer's Entitlement to Suspend the Services and Delegated Management Authority	Replace the entire Sub-Clause 18.2 with the following: **18.2 Employer's Entitlement to Suspend the Services** The Employer may suspend the Services, if this is necessary in the public interest, by notice to the Contractor. Such notice shall specify the effective date of the suspension, the reasons for the suspension, and the date on which the suspension will end. If the Employer suspends the Services in accordance with this Sub-Clause 18.2, the Contractor shall then cease to perform its obligations under the Contract. However, the Contractor shall still be entitled to the Contractor Remuneration under the Contract. If the suspension continues for more than 90 days, the Contractor may, by notice to the Employer, treat the suspension as Termination by the Employer for Convenience.
Sub-Clause 21.7 Termination by the Contractor for Cause	The following second paragraph is deleted. "In the event the Bank suspends the loan or credit from which part or whole of the payments to the Contractor are being made, if the Contractor has not received the sums due to him within 7 days of the due date, the Contractor may, without prejudice to the Contractor's entitlement to financing charges under Sub-Clause 12.3 [Delayed Payment] take one of the following actions, namely (i) suspend work or reduce the rate of work, or (ii) terminate his employment under the Contract by giving notice to the Employer, with a copy to the Independent Expert, such termination to take effect 14 days after the giving of the notice."
Clause 21.8 Payment on Termination	Add the following after (e).

by the Employer for Convenience

(f) a payment in compensation for lost profits under the contract, which shall be either:

(i) the amount for Liquidated Damages on Termination by the Employer for Convenience **specified in the Contract Data**, or if no such amount is specified,

(ii) the amount of profit the Contractor would be expected to lose as a result of early termination of the contract. The Contractor shall submit an estimate of this amount. The Employer shall either pay this amount, or submit it to dispute resolution under Sub-Clause 20.1 [Dispute Resolution].

Section VII - Schedules of Services Requirements

[This Section includes the various schedules that comprise the contract specific Management Services requirements, completed by the Employer as appropriate.]

Schedule A: Recitals and Objectives

A.1 Recitals

To mitigate traffic congestion and normalize traffic flow through effective utilization of road infrastructure are becoming more important. Intelligent Transport System (hereinafter referred to as "ITS") is an important non-structural measure, whereby information technology is applied in the field of road transportation, and there are high expectations from the development of ITS in the Bengaluru Metropolitan Area.

For the purpose of above, the Government of Republic of India has received a grant from Japan International Cooperation Agency (hereinafter to as “JICA”) toward the cost of the Project for Implementation of Advanced Traffic Information and Management System in Core Bengaluru (hereinafter referred to as “the Project”).

The Project implements Traffic Information System and Signal System (hereinafter referred to as “System”) and Bengaluru Traffic Information Centre (hereinafter referred to as “BTIC”) is newly developed under Directorate of Urban Land Transport (hereinafter referred to as “DULT”) and VMS system and Signal System is implemented for existing Traffic Management Centre (hereinafter referred to as “TMC”) under Bengaluru Traffic Police (hereinafter referred to as “BTP”).

As the System installed by the Project are mainly consist of Japanese high technology, the Service for operation and maintenance of the System (hereinafter referred to as “the Service”) for continuous and effective operation and technical transfer to local party is required.

A.2 Objectives

The purpose of the Service is to keep the System in operation in the manner originally intended, that is to collect traffic status data, process and analyse the data into useful information, disseminate the information to road users, or to

moderate traffic congestion and to prolong the life of the System.

Schedule B: Services

Table 1: Services

Services	**Pre-Conditions**
▪ The Services is composed of; i) Operation, ii) Primary Response, iii) Emergency Response, iv) Periodic Inspection and Preventive Maintenance v) Local Training and Seminar, vi) Annual Evaluation and Adjustment of the System. ▪ Details of the Services are explained in "Operation and Maintenance Service Specifications"	

Schedule C: Know-how Transfer and Training

C.1 Know-how and systems to be transferred

-Basic and advanced O&M technology to staff of Employer

-ITS technology to ITS related parties

C.2 Software, systems, and manuals to be left at the end of the contract

-Operation Manual

-Preventive Maintenance Plan

-Emergency Response Plan

C.3 Training program required

-Basic course of O&M technology

-Advanced course of O&M technology

-On sight training

-Seminar

Detail are explained in “Operation and Maintenance Service Specifications”

Schedule D: Performance Targets

Performance Targets of the system consists of “Response time and Resolution time”
and “Availability”.

1. Performance Target of Response time and Resolution time

Response and Resolution Time in case of incidents, the Contractor shall perform less than the indicated time period in the table below.

Severity of Incidents	Contents	Response time	Resolution time	
			System Failures	Facility Incident at Site
Critical	Incidents which have high possibility of immediately impairing road user’s safety.	1 Hour	12 Hours	24 Hours
Major	Incidents which may impair road user’s safety.	1 Hour	24 Hours	
Minor	Failures of control system that does not have any possibility to impair	2 Hours	36 Hours	

	road users' safety			

2. Performance Target of Availability

Availability of the System is evaluated quarterly and its Performance Target of availability is 99%.

The formula of calculation of availability is shown as follows;

$$Availability = (1 - \frac{Downtime - PermissiveDowntime}{Totaltime - PermissiveDowntime}) * 100$$

Downtime (hours):"Total time" during the System are not available.

Total time (hours): Total time of evaluation period (three(3)months;2,160 hours)

Permissive downtime (hours): The time period required for periodic inspection, preventative maintenance, repair works for damages caused by the third parties (e.g. traffic accidents, black out, surge caused by thunder storm, fire, failure of communication lines, vandalism, etc.) and works instructed by the Employer.

Schedule E: Contractor's Personnel

Key Personnel are shown below;

Detail are explained in "Operation and Maintenance Service Specifications"

1. Contractor's Representative

2. Operator

3. Call Operator

4. Chief Engineer for Periodic Inspection & Preventive Maintenance

5. Team Leader for on-site service

Schedule F: Specified Capital Works and Finance

Not Applicable

[Specify any Capital Works the Contractor is to manage, and its role.]

[Specify any Finance the Contractor is to procure, and its role. See Section VIII, General Conditions, Clause 9.]

[When the Contractor is to be responsible for sourcing, negotiating, and otherwise procuring finance for the Utility, these obligations need to be thoroughly spelled out.

Schedule G: Contractor's Remuneration

[See Section VIII, General Conditions, Sub-Clause 12.1.]

G.1 Contractor's Base Remuneration

Table 3: Base Remuneration

Period	Quarterly				
Amount Currency Units	Quarterly Billing Value				

[List Base Remuneration to be paid in each period or delete above and describe alternative basis for Base Remuneration payments, e.g., on basis of staff inputs times unit rates]

G.2 Contractor's Incentive Remuneration

Not Applicable

G.3 Contractor's Capital Works Remuneration

Not Applicable

[Insert remuneration for managing Capital Works. See Section VIII, General Conditions, Sub-Clause 9.2]

G.4 Contractor's Sourcing of Finance Remuneration

Not Applicable

G.5 Contractor's Other Remuneration

[Insert any other remuneration to be paid]

G.6 Payment Terms

1. Composition of Payment items

Payment items consist of Lump-sum portion and Unit Price portion.

1.1. Lump-sum Portion

- Operation
- Primary Response
- Emergency Response (including resolution cost for damaged facilities)
- Periodic Inspection and Preventive Maintenance including Update and Debugs of the Installed Software
- Local Training and Seminar
- Annual Evaluation and Adjustment of the System
- Minor modifications of the system software (e.g. Improvement of visibilities of system console, web site design of traffic condition information of internet system, etc.) within one (1) year after the completion of the Project according to bilateral negotiations to avoid impartial and excessive burden of the Contractor

1.2 Unit Price Portion

The Contractor can claim invoice of following items according to the unit price prescribed in the Contract

- Purchasing additional equipment/system and supporting facilities for upgrade

and expansion according to instructions of the Employer

- Purchasing new equipment and parts if retrieved defective/damaged equipment and parts is impossible to be repaired

2.3 Notes

- In case the Employer requests to upgrade software by adding new function, the price for the upgrading is subject to negotiation.

2. Payment Reduction

When the availability does not reach the target availability, the Employer can deduct calculated amount from Quarterly Billing Value. Following is the formula for calculation of the amount for payment reduction.

Payment Reduction = Lump sum portion of O&M payment*(Target availability (%) - Availability (%))/50

The maximum amount of Payment Reduction is 10% of the Quality Billing Value

G.7 Advance Payments

Amount of Advance Payment _____

[*Should generally be enough to cover Contractor's expected mobilization costs. See Technical Note, Section 4.8.3*]

[Insert here rules for repaying advance payment, for example by deductions from Base Remuneration payments. See Section VIII, General Conditions, Sub-Clause 12.2]

G.8 Rate for Delayed Payments

[Insert here – see Section VIII, General Conditions, Sub-Clause 12.3]

G.9 Adjustment of Remuneration

[Note: In order to adjust the remuneration for foreign and/or local inflation, a price adjustment provision should be included here if the contract has duration of more than 18 months or if the foreign or local inflation is expected to exceed 5% per annum. The adjustment should be made every 12 months after the date of the contract for remuneration in foreign currency and – except if there is very high inflation in the Employer's Country, in which case more frequent adjustments should be provided for – at the same intervals for remuneration in local currency. Remuneration in foreign currency should be adjusted by using the relevant index for salaries in the country of the respective foreign currency (which normally is the country of the Contractor) and remuneration in local currency by using the corresponding index for the Employer's Country. A sample provision is provided below for guidance:

Payments for remuneration made in accordance with Section VIII, General Conditions, Clause 12.1 in [*foreign and/or*] [*local*] currency shall be adjusted as follows:

(a) Remuneration paid in foreign currency pursuant to the rates set forth in Section G.1 of Schedule G shall be adjusted every 12 months (and, the first time, with effect for the remuneration earned in the 13th calendar month after the date of the Contract) by applying the following formula:

$$R_f = R_{fo} \times \frac{I_f}{I_{fo}} \qquad \{\text{or} \quad R_f = R_{fo} \times \left[\ 0.1 + 0.9 \frac{I_f}{I_{fo}}\ \right]\}$$

where R_f is the adjusted remuneration, R_{fo} is the remuneration payable on the basis of the rates set forth in Section G.1 of Schedule G for remuneration payable in foreign currency, I_f is the official index for salaries in the country of the foreign currency for the first month for which the adjustment is supposed to have effect, and I_{fo} is the official index for salaries in the country of the foreign currency for the month of the date of the Contract.

(b) Remuneration paid in local currency pursuant to the rates set forth in Section G.1 of Schedule G shall be adjusted every *[insert number]* months (and, for the first time, with

G.9 Adjustment of Remuneration

effect for the remuneration earned in the *[insert number]*th calendar month after the date of the Contract) by applying the following formula:

$$R_l = R_{lo} \times \frac{I_l}{I_{lo}} \qquad \{\text{or} \qquad R_l = R_{lo} \times \left[\ 0.1 + 0.9 \frac{I_l}{I_{lo}}\ \right]\}$$

where R_l is the adjusted remuneration, R_{lo} is the remuneration payable on the basis of the rates set forth in Section G.1 of Schedule G for remuneration payable in local currency, I_l is the official index for salaries in the Employer's Country for the first month for which the adjustment is to have effect and, I_{lo} is the official index for salaries in the Employer's Country for the month of the date of the Contract.*]*

Schedule H: Procurement Rules

Not Applicable

[Insert in this Schedule any specific procurement rules the Contractor is to observe. See Section VIII, General Conditions, Sub-Clause 9.4]

H1. Procurement for Utility Operations

H2. Procurement for Services

H3. Procurement for Utility Capital Works

H4. Procurement for Specified Capital Works

Schedule I: Delegation of Management Authority

Not Applicable

(No delegation of Management Authority to the Contractor)

Table 4: Delegation of Management Authority

Delegations	**Limits**
Delegated power to manage Utility Personnel *[List here delegated powers if any]* Delegated power to commit Utility to expenditure *[List here delegated powers if any]* Delegated power to commit Utility to borrowing *[List here delegated powers if any]* Delegated power to enter contracts *[List here delegated powers if any]* Any other delegated power [List here delegated powers if any]	*[List here limits or controls on each delegated power]*

Schedule J: Financial Management of the Utility

Not Applicable

Schedule K: Reporting Requirements

[Insert reports either Party is to produce including contents, deadlines and formats. See Section VIII, General Conditions, Clauses 10 and 14.]

Schedule L: Utility Personnel Retrenchment

Not Applicable

Schedule M: Insurance Required

Table 5: Insurance Required

Risk	Insuring Party	Amount per occurrence	Minimum Total Limit	Detailed description of risk
Protection of Contractor's Personnel				
Professional Indemnity				
Public Liability				
Motor Vehicle				

Schedule M: Insurance Required (continued)

Periods for submission of insurance: (a) evidence of insurance. (b) relevant policies	*[Insert period for submission of evidence of insurance and policy.Period may be from 14 days to 28 days.]* _____days _____days
Maximum amount of deductibles for	*[Insert maximum amount of deductibles]*

insurance of the Employer's risks	

Schedule N: Extension and Subsequent Bidding

[See Section VIII, General Conditions, Sub-Clause 19.5]

Contract Agreement

THIS AGREEMENT made the _____ day of _____, _____, between _____of _____ (hereinafter "the Employer"), of the one part, and _____ of _____ (hereinafter "the Contractor"), of the other part:

WHEREAS the Employer desires that the Services known as _____ should be executed by the Contractor, and has accepted a Bid by the Contractor for the execution and completion of these Management Services and the remedying of any defects therein,

The Employer and the Contractor agree as follows:

1. In this Agreement words and expressions shall have the same meanings as are respectively assigned to them in the Contract documents referred to.

2. The following documents shall be deemed to form and be read and construed as part of this Agreement. This Agreement shall prevail over all other Contract documents.

(a) the addenda Nos. _____(if any)
(b) the Letter of Acceptance
(c) the Particular Conditions
(d) the General Conditions;
(e) the Schedules of Services Requirements,
(f) the Letter of Bid

3. In consideration of the payments to be made by the Employer to the Contractor as indicated in this Agreement, the Contractor hereby covenants with the Employer to execute the Services therein in conformity in all respects with the provisions of the Contract.

4. The Employer hereby covenants to pay the Contractor in consideration of the execution and completion of the Services, the Contractor Remuneration or such other sum as may become payable under the provisions of the Contract at the times and in the manner prescribed by the Contract.

IN WITNESS whereof the parties hereto have caused this Agreement to be executed in accordance with the laws of _____ on the day, month and year indicated above.

Signed by _____ (for the Employer)

Signed by _____ (for the Contractor)

From: DULT Mr.
To: BTP Mr.

Subject: Delegation of the Authority related to the Services for BTP

Based on the Authority vested in me as the Employer, I hereby notify you that I delegate the full authority related to the Services for BTP to you to act on my behalf for purposes of the Contract in all matters except in relation to the following clauses of the Conditions of Contract:

Clause 13.3	Payments by the Employer
Clause 18.	Suspension of Services
Clause 19.	Contract Variation, Extension and Rebidding
Clause 20.	Dispute Resolution
Clause 21.	Default and Termination

Except as above mentioned, you shall carry out such duties and have full authority to issue or receive such drawings, notices, instructions, approvals, certificates and to give such determinations, decisions, opinions and comments on behalf of the “Employer”, all as may be necessary under the Contract.

資料　7 - 6

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Statement of Work for System Monitoring

Two (2) kinds of items will be carried out as follows:

- Site Survey
- Evaluation of the System Introduction Effect

(1) Site Survey

The outline of the site surveys is shown in the table below.

Table 1 Outline of Site Survey

Survey Name		Survey Outline
1)	Travel Time /Delay Time Survey	Measuring travel time and delay time (stop time at junctions) on the target routes for introduction of Area Traffic Signal Control System
2)	Junction Traffic Volume Survey in Each Direction	Counting traffic volume of approaching roads at the key junctions (7 junctions)
3)	Passing Traffic Volume Survey	Counting passing traffic volume per unit of time during green indication at the key junctions (7 junctions)

1) Travel Time Survey

Travel Time Survey will be carried out to find out the journey speed, running speed and the type of delay, i.e. delays caused by (i) stopping time at signal and (ii) other factors, to evaluate the traffic flow. It will be carried out under the conditions as follows:

- Survey Route: 2 Corridors in Both Directions
- Survey Time: 16 hours from 06:00 to 22:00
- Survey Day:

  Two (2) Weekdays: Tuesday, Wednesday or Thursday

  These days shall not be school/college/government holidays.

  These days shall not be rainy day.

  These days shall not be under the situation of major incident that may disrupt usual traffic flow.
- Required Data:
  - ✓ Route Length
  - ✓ Travel Time, Journey Speed and Running Speed for both total route length and between junctions
  - ✓ Details in Delay: Location, time and causes of delay for both delays caused by stopping time at the signals and other factors
- Survey Locations:
  - ✓ Route 1 indicated on the attached map
  - ✓ Route 2 indicated on the attached map

2) Junction Traffic Volume Survey in Each Direction

Junction Traffic Volume Survey in Each Direction will be carried out under the conditions as follows;

- Survey Location: 7 junctions shown on the attached map
- Survey Time: 16 hours from 6:00 to 22:00
- Survey Day:

  Two (2) Weekdays: Tuesday, Wednesday or Thursday

  These days shall not be school/college/government holidays.

  These days shall not be rainy day.

  These days shall not be under the situation of major incident that may disrupt usual traffic flow.
- Traffic volume shall be counted at 15-minute intervals.
- Traffic volume shall be classified into the following vehicle classes:
  - ✓ Two-wheeler
  - ✓ Auto-rickshaw
  - ✓ Car/Jeep/Van
  - ✓ Bus
  - ✓ Light Commercial Vehicle / Heavy Commercial Vehicle
  - ✓ Containers
  - ✓ Emergency Vehicle (e.g. Ambulance, Fire Trucks)
  - ✓ Other Special Vehicle (e.g. Military Vehicles)
- All turning movements including grade separated movements (for both legal and illegal) at each junction shall be counted as follows:
  - ✓ Left movement
  - ✓ Right movement
  - ✓ Through movement
  - ✓ U-turn movement
- Wasted and Dead Green Time Measurement

  The following shall be observed and recorded for each signal phase of all directions:
  - ✓ Wasted Green Time: If there is no vehicle passing through the junction during green signal indication due to absence of traffic, it shall be recorded with time as Wasted Green Time.
  - ✓ Dead Green Time: If there is an occasion that the vehicles cannot move forward at the junction during green signal indication because the traffic got blocked due to congestion ahead, it shall be recorded with time as Dead Green Time.

3) Passing Traffic Volume Survey

- Survey Location: All approach roads at 7 junctions shown on the attached map
- Survey Time: 16 hours from 6:00 to 22:00
- Survey Day:

  Two (2) Weekdays: Tuesday, Wednesday or Thursday

  These days shall not be school/college/government holidays.

  These days shall not be rainy day.

  These days shall not be under the situation of major incident that may disrupt usual traffic flow.
- The vehicles under the following conditions shall be counted;

  ✓ The vehicles which pass stop line at the junction during green signal indication

  ✓ Only the vehicles which go straight shall be counted.

  (The vehicles which turn right, turn left and make U-turn shall not be counted.)
- Only the number of the vehicle shall be counted regardless of vehicle type

  But all types of vehicle e.g. two-wheelers, auto-rickshaws, buses, trucks, passenger vehicles, etc. shall be included in the counted number if the above-mentioned conditions are met.
- The above vehicle count shall be made for the duration of green signal indication of the first one cycle every half an hour

  Example

  06:00 To count vehicle during green signal indication of the first one cycle which starts at 06:00

  06:30 Same as above

  07:00 Same as above

  07:30 Same as above

  If the green signal indication is already given at the time of the above each measurement time, the next cycle shall be adopted for the vehicle counting.
- The total number of passing vehicle every 10 seconds during the green signal indication shall be reported.
- The above count shall be made until termination of the green signal indication.
- The above count shall be made at all approach roads of each intersection.
- The result shall also be indicated by approach road of each intersection, accordingly.

(2) Evaluation of the System Introduction Effect

1) Short-term Index for Evaluation of the System Introduction Effect

The short-term indexes for evaluation of the system introduction effect are shown in the table-2 and table-3.

Table 2 Queue Length and Average Travel Speed - Base Line Value

Index	Base Line Value (Measured Value in 2016)
Queue Length (Peak Hour: 9:00-10:00)	Total of the longest queue length among all approaching roads at each junction (*1): 844.8 m
	Total of the longest queue length of all approaching roads at each junction (*1): 1576.9 m
Average Travel Speed (*2) (Peak Hour: 9:00-10:00)	13 km/h

(*1) For 7 key junctions among 29 junctions (*2) Major arterial roads in the central area of the city

Table 3 Wasted Green Time at Key Junctions - Base Line Value

	Junction Name	Operating Hours of Traffic Signal Per Day (Minutes)	Base Line Value of Wasted Green Time Per Day (*1)	
			Minutes	Percentage
01	Queens Statue Junction	930	281	30%
02	Cauvery Arts and Craft Junction	960	179	19%
03	Trinity Circle Junction	960	329	34%
04	Kamraj and Cubbon Road Junction	870	127	15%
05	Opera Road Junction	930	144	15%
06	Vellera Road Junction	240 (*2)	81	34%
07	Vivekananda/Bhaskaran Junction	900	510	57%

(*1) Measured value in 2017 (*2) The survey time at this junction was limited to the above indicated duration.

2) Evaluation Methods

The items shown in Table 4 will be verified to confirm whether the base line values of the short-term indexes in Table 2 and 3 are improved as the system introduction effect.

Table 4 Evaluation Items by Confirmation Purpose

Confirmation Purpose	Evaluation Item	Data Source
Improvement of Average Travel Speed	Travel Time/Delay Time	(Site Survey)
Reduction of Wasted Green Time	Passing Traffic Volume	(Site Survey)

Improvement of Queue Length	Queue Length (*1)	O&M Contractor (*2)

(*1) Key Junctions (7 junctions) in each direction (*2) Data to be acquired from system log

(3) Deliverables

- Materials to be Submitted:

  The result shall be prepared in the form of report using graphs and tables. The raw and processed data of the above three surveys shall also be provided. These deliverables shall be submitted both in soft copy (CD) and hard copy formats.

- Submission:

  The deliverables shall be submitted to the Employer.

  They will be shared with the Contractor through the Employer to utilize the system adjustment.

= End of Documents =