# Tauranga Transport Operations Centre

## TTOC-06: – Traffic Signals Modelling Guidelines

### Document History and Status

| | Revision | Date | Prepared By | Authorised By | Description |
|---|---|---|---|---|---|
| TTOC–06<br>Traffic Signals Modelling Guidelines | Final | August 2017 | Haydn Wardley | Haydn Wardley | Final |
| | | | | | |

**Disclaimer**

The concepts and information contained in these above documents and their subsequent amendments or replacements are the property of the participants of the Tauranga Transport Operations Centre (TTOC). No use of copying of these documents in whole or in part is allowed without the written permission of Tauranga Transport Operations Centre.

Every attempt was made to ensure that the information in these documents was correct at the time of publication. Any errors should be reported as soon as possible so that corrections can be issued. Comments and suggestions for future editions are welcome and periodical reviews are undertaken on a regular basis. Users of these documents must ascertain themselves that they obtain the latest versions as valid references.

## Table of Contents

# 1. Introduction

The Tauranga Transport Operations Centre (TTOC) is responsible for all traffic signals operations in the Bay of Plenty region from installation through to maintenance.

This document is designed to assist all interested parties to understand the TTOC functions and the standards that have been adopted to ensure a consistent approach is maintained when designing and installing traffic signals and associated equipment.

## 1.1 Purpose

This guideline is specifically designed to provide guidance without being prescriptive or limiting the modeller building the model. A proportion of the content of the document is designed to make the model scope, building, submission, review and approval as transparent as possible for all parties without inhibiting the practitioner in the technical construction of the model.

## 1.2 Who Should Use This Document?

Modellers, on behalf of consultants and contractors, should use this document and project managers (we refer to as "**applicant"** in this document) involved in the design, installation and maintenance of traffic signals on behalf of Road Controlling Authorities (RCA) in the Bay of Plenty.

The TTOC has prepared this document to assist practitioners when designing traffic signal installations. Although this document has technical and specialist content for modellers it must read in conjunction document TTOC-02 Requirements for Traffic Signal Design. The applicants should also refer to TTOC-00 Standard Traffic Signal Documents Index.

# 2. Glossary of Terms

| | |
|---|---|
| **AS / NZ** | Australian Standard / New Zealand Standard |
| Active Traffic Management System (**ATMS**) | Technology that provides information to road users by means of Variable Message Signage. |
| **Controller** | The equipment (including the housing) that switches power to signal lanterns and controls the duration and sequence of signal displays as defined by the controller personality. |
| Controller Information Sheets (**CIS**) | A hard copy of the information used to make a Controller Personality that is contained within the PROM. |
| Controller Personality | The unique program stored in the PROM, which configures the controller to the specific operational design of the intersection. |
| **CCTV** | Closed Circuit Television. |
| **DP** Number | Distribution Point for telecommunications. |
| **FSL** | From Stop Line, measurement used for distance from start of detector loop. |
| **IDC** | Infrastructure Development Code |
| **ICP** Number | Installation Connection Point Number (for electricity power meter). |
| Intelligent Transport Systems (**ITS**) | Refers to various systems like SCATS, CCTV, VMS and ATMS systems that provide and add information and communications technology to transport infrastructure. |
| **JUMA, JUSP** | Joint Use Mast Arm, Joint Use Service Pole |
| **KJB** | Kerbside Junction Box to access services, for example, detector loop feeders. |
| **NZTA** | New Zealand Transport Agency. |
| **NGEN** | Software product developed by RMS to produce .SFT and .M68 files. |
| **PCMCIA** Card | A computer card containing the controller personality information housed in the TSC / AS 2578 compliant controller. |
| **PROM** | A computer chip containing the controller personality information housed in the TSC3 compliant controller. In this document PROM refers to either a PROM, a PCMCIA card or similar software storage device. |
| Road Asset and Maintenance Management (**RAMM**) | An Internet accessible system that stores the Traffic Signal assets. RAMM also records the activity of the Maintenance Contractors by the logging of faults as Dispatches and their completion by the Contractors. Contractors' claims are generated from the RAMM system each month end. |
| **RCA** | Road Controlling Authority. |
| Roads and Marine Services (**RMS**) of New South Wales (**NSW**) | The Authority accepted by Council as the basis for the TTOC standards and for product approval. RMS also develop and own SCATS traffic signal software and other products related to SCATS and their output files. |
| **SAT** | Site Acceptance Test, commissioning checklist. |
| **.SFT / .M68** | File formats for traffic signal software (TRAFF) |

| | |
|---|---|
| Sydney Coordinated Adaptive Traffic System (**SCATS**) | A fully adaptive area wide control system for traffic signals that is linked to the traffic signal controllers running TRAFF software via telecommunication lines. |
| **TRAFF** | Traffic signal “base” software inside traffic controllers on site running the signals. |
| **TCC** | Tauranga City Council |
| Tauranga Transport Operations Centre (**TTOC**) | Organisation tasked with managing the traffic signals and the ITS systems for local roads and State Highways Bay of Plenty by monitoring SCATS and CCTV. |
| Vehicle Activated Sign (**VAS**) | VAS is a generic term for a type of road traffic sign that displays a message conditional upon the presence or speed of a road vehicle. |
| Variable Message Sign (**VMS**) | An electronic traffic sign often used to display a message or picture. The sign display is changeable and dynamic. |
| **Win Traff** | A software programme used to check the controller information by testing the software of the controller personality. |

# 3. Technical Criteria

The design of the traffic signals must be carried out in accordance with the standards and guidelines listed below and their revised / subsequent replacements:

- TTOC-00 Standard Traffic Signal Documents Index.
- TTOC-01 Requirements for Traffic Signal Works.
- TTOC-02 Requirements for Traffic Signal Design.
- TTOC-06 Traffic Signals Modelling Guidelines.
- AUSTROADS Traffic Management Guides.
- NZTA Pedestrian Planning and Design Guidelines.

## 3.1 Reference Material

Recommended documents to assist in the processes required are as follows:

- NSW Roads & Maritime Services, Traffic Modelling Guidelines.
- NSW Roads & Maritime Services, Traffic Signal Design.
- Australian Road Research Board (ARRB), Traffic Signals: Capacity and Timing Analysis.
- Signals National User Group (SNUG).

# 4. Modelling Report

The modelling report must show initiative and educated judgement rather than default parameter settings in modelling (e.g. analysis period profile in terms of peak hour factor, demand arriving at back of queue versus counts at stop-line on oversaturated approaches, adjustments to gap parameters, intergreen times, coordinated arrival types). The modelling report must also contain site observations including calculations.

Whichever traffic signal modelling software is used, the user should consult the SIDRA User Guide [i] or SIDRA software Help menus for any model-specific guidance on reconciling the signal timing input and outputs with average SCATS operation for the peak periods. To facilitate more realistic modelling of existing traffic signal site upgrades, SCATS history files of typical peak hour timings can be provided to modellers upon request to the TTOC (including signals in close proximity, refer Table 1).

Due to the nature of the models, traffic surveys must be undertaken at all intersections to be modelled. Other critical data collection includes signal operation, queue observation and saturation flow measurement (or estimation). Future traffic flows can be estimated using highway assignment models or by applying growth factors as appropriate. Highway assignment models should only be used to estimate traffic growth as they are generally too coarse to adequately produce detailed turn movements.

## 4.1 Modelling Outputs

The designer shall submit a detailed SIDRA report consisting (as a minimum):

- Introduction.
- Background.
- Traffic volumes including any adjustments made to modelled volumes noting in particular, the forecast years(s).
- Each Option should be modelled in Year 0 and Year 10. The land arrangement and phasing of each Option must be shown.
- Analysis Methodology (including details of calibration).
- Analysis Results Summary, including a table highlighting the following for each movement and the intersection as a whole:
    - Degree of Saturation (DoS) (maximum 0.90).
    - Average Delay (RMS NSW Method).
    - Level of Service (LoS).
    - 50% and 95% Back of Queue distance.
    - Fuel Consumption, Emissions and Cost (total and rate).
    - Flow Scale / Design Life Results based on a 10% increase in traffic volumes.
    - Pedestrian Movements.
- Discussion on all observations of the analysis results and outcomes.
- Conclusions and Recommendations (e.g. length of extensions to turn lanes, etc.).
- A table indicating the proposed cycle length, phase splits and offsets (if coordinated) that the model suggests be adopted by SCATS for the morning peak, and, afternoon peak.

- Best Level of Service whilst fuel consumption and emission are not the highest rate compare to other level of services.
- The applicant must obtain all traffic data deemed necessary to complete the validation. An electronic copy of the software input and output files for all options, showing the phasing and time settings used in the evaluation, must be provided.
- For closely spaced signals, a decision needs to be made and justified on isolated versus coordinated system analysis. An initial isolated analysis should inform the design layout and phasing prior to a full coordinated system analysis, serving as a useful cross-check.

## 4.2 Modelling Inputs

The designer shall consider listed SIDRA input data when preparing a SIDRA report for traffic signals at grade and if required, as a network. The list below is a minimum requirement for outputs:

- Lane width.
- Grade.
- Median.
- Approach Cruise Speed.
- Vehicle Movements.
- HV%.
- Peak Flow Factor.
- Peak Flow Period.
- Signal Coordination.
- Phasing.

### 4.2.1 Signal Analysis Method[i]

*For intersections running under SCATS Coordinated or Master Isolated Control, use the Fixed-Time / Pretimed analysis option. Although SCATS is an adaptive control system, the Fixed-Time / Pretimed analysis method is recommended to emulate the SCATS control algorithms, especially due to the "equal degree of saturation method" used for determining green splits. SCATS green splits and cycle time may change cycle by cycle. The green splits and cycle time determined by SIDRA INTERSECTION should be considered to represent average timings under SCATS control for the analysis period. Use the Actuated analysis method for intersections operating under the traditional actuated control method. This control method uses maximum green and gap settings and does not implement an equal degree of saturation strategy for green splits.*

### 4.2.2 Intersection Dialogue

In the SIDRA intersection dialogue[i:]

*Area Type Factor parameter for Signals is used as a saturation flow adjustment factor. It applies to all lanes of the approach. HCM recommends 0.9 for CBD area type. This parameter could also be used as a simple saturation flow calibration parameter which can be specified per approach.*

*Area Type Factor affects the SCATS MF estimates as well.*

### 4.2.3 Geometry Dialogue

Geometry should closely resemble actual alignment and orientation of the intersection.

The following is required as a minimum in the Geometry Dialogue:

- Approach and exit lane data are to be as per the existing geometry for constructed intersections and/or for Construction Plans for approved intersections.
- If slip lanes or continuous lanes already exist then the appropriate selection is required.
- Values for extra bunching should be used if there are upstream signals in close proximity. Extra bunching should only be applied to sign-controlled and roundabout intersections.

Maximum values to be used to simulate the effects of extra bunching should be as shown in Table 1.

| Distance to upstream signals (m) | <100 | 100-200 | 200-400 | 400-600 | 600-800 | >800 |
|---|---|---|---|---|---|---|
| Extra bunching (%) | 25 | 20 | 15 | 10 | 5 | 0 |

**Table 1 - Maximum values for extra bunching**

The maximum basic saturation flow should be 1950 tcu[1]/hr (SIDRA Default). Any higher or lower values than default value should be supported by appropriate data. Saturation flow measurements[i] should be undertaken whenever possible on approaches that are heavily congested or forecasted to be heavily congested:

*The following method is recommended to calibrate the saturation flow in SIDRA INTERSECTION:*

i. *measure the lane saturation flow, s' (veh/h) using the HCM or ARR 123 method; this saturation flow will have effects of all road and traffic factors (heavy vehicles, turning vehicles, lane width, grade, and so on);*

ii. *compare the measured lane saturation flow, s' with the lane saturation flow estimated by SIDRA INTERSECTION, s (veh/h) given in the Lane Flow and Capacity Information table in the Detailed Output report; if they are significantly different (given that all road and traffic factors have been specified as input to SIDRA INTERSECTION correctly), calculate a calibration factor s' / s;*

iii. *adjust the basic saturation flow (tcu/h) to $s'_b = (s' / s)\, s_b$ where $s_b$ is the basic saturation flow (tcu/h) specified as input for estimating saturation flow s (veh/h);*

iv. *specify the adjusted basic saturation flow in the Lane Data tab of the Lane Geometry dialog and re-process SIDRA INTERSECTION to estimate saturation flow using the new basic saturation flow ($s'_b$); repeat the process if necessary.*

*The calibration factor (s' / s) can be used for future design options if it is believed that it adjusts the SIDRA INTERSECTION default basic saturation flow for local driver behaviour adequately. This method is not recommended for short lanes, or for lanes with opposed (permitted) turns.*

[1] tcu = through car units

- *Saturation Speed*[i]:

*Saturation Speed is the steady speed value associated with queue discharge (saturation) flow rate. This parameter indicates that vehicles do not accelerate to the speed limit during queue discharge.*

*The Program option is selected by default and the data field is blocked. The Saturation Speed is estimated by the program in this case. To use an observed value to override the program calculations, select the Input option and enter the value in the data field. The program will use the value you specify. Select the Program option again for program to estimate the saturation speed (no need to delete the value in the data field).*

*The saturation speed can be observed easily while driving a car, e.g. when the car crosses the stop line after accelerating from the queued position at signals, while its position was more than about the fifth car in the queue.*

*In addition to estimating the driver response time, Saturation Speed is useful for determining parameters such as various SCATS parameters (occupancy and space time at saturation, DS, best loop length, etc), and parameters for microsimulation (average and maximum acceleration rate, acceleration time and distance during queue discharge).*

*Saturation Speed is determined by SIDRA INTERSECTION for each approach lane using the method described below. This parameter is applicable to all types of intersection. The Saturation Speed is subject to various constraints related to Approach Cruise Speed and the Negotiation Speed.*

*For* through movements *at signalised intersections, the saturation speed,* $v_s$ *is estimated from:*

$v_s = 0.75\ v_{ac}$

*where 0.75 is the saturation speed factor and* $v_{ac}$ *is the approach cruise speed.*

*If the queue discharge behaviour is influenced by existence of signals at a nearby downstream location, then the user can specify a lower value than the program estimate (say 10 per cent lower).*

*For* turning movements *at signalised intersections, Exit Negotiation Speed estimated by the program or specified by the user is used as the saturation speed.*

*For all movements at* roundabouts and sign-controlled intersections*, Exit Negotiation Speed estimated by the program or specified by the user is used as the saturation speed.*

*The following should be noted in relation to the Saturation Speed parameter in SIDRA INTERSECTION:*

- *Movement Classes: the Saturation Speed is not adjusted for Movement Classes.*
- *Queue Move-up Speed: The Saturation Speed is used as an upper limit in determining the queue move-up speed. In previous versions, the Approach Cruise Speed was used for this purpose.*

- *Negotiation Speeds:*
    - *For Through Movements at signalised intersections, the Approach Cruise Speed is used as the Approach and Exit Negotiation Speed,* $v_{an} = v_{en} = v_{ac}$ *for* unqueued *vehicles. This is relevant for* [*geometric delay*] *calculations.*
    - *User-specified Saturation Speed values that exceed the Exit Negotiation Speed are ignored. If a user-specified Saturation Speed is less than the Exit Negotiation Speed, then the Exit Negotiation Speed is reduced to match the Saturation Speed value,* $v_{en} = v_s$ *to ensure that there is no acceleration in the Exit Negotiation section.*

*The* Driver Characteristics *and* SCATS Parameters *tables in the Detailed Output report include the estimates of saturation speeds and other parameters derived using the Saturation Speed parameter, e.g. driver response times."*

Utilisation Ratio, Saturation Speed and Capacity Adjustment Data values should only be changed subject to appropriate intersection data being collected or provided. The Turning Movement Designation should be allocated as per the existing or proposed operation of the intersection.

For wider lane approaches the SIDRA Intersection model should show how the intersection is used rather than how it operates. A wide approach is where width of the lane allows two vehicles to stand next to each other at a Stop line or operate the road as two lane road even though the road is marked as one lane only.

For signalised intersections, the parameters for Buses Stopping, Parking Manoeuvres, Short Lane Green Constraints and free queue should only be inserted if the appropriate intersection data is available.

### 4.2.4 Volumes Dialogue

The following is required as a minimum in volumes dialogue.

- Vehicle volumes are to be based on the most current data collected through an intersection survey / count. Turning Movement Demands are required, which in all cases can be collected by counting arrivals at the back of queue. If a lane or approach is over-saturated (i.e. Cycle failure), then departure counts at the stop-line (presence detectors) only represent capacity, which are likely to be less than the true demand, which the new signal design should accommodate. Thus, stop-line or detector counts are only acceptable if that movement is not over-saturated.

- SIDRA default Peak Flow Factor of 95% is acceptable. Analysis of intersection data collected may impact the Peak Flow Factor used. Supporting documentation is required to justify the factor used other than the default Peak Flow Factor of 95%.

- The appropriate Growth Rate parameter should be used in consultation with the TTOC if completing a design life analysis on the intersection.

- Growth rates used for future volume estimation and/or the justification of the methods used to determine future volumes should be included in the final report.

Unit time for volumes and peak flow period should reflect data of the intersection counts where the:

- Maximum unit time for volumes is 60 minutes (unit used is dependent on actual flow data and any variation should be discussed with the TTOC and documented).
- Maximum peak flow period is 30 minutes.
- Peak Flow Factor (volume dialogue box) should be carefully assessed to replicate actual Peak Period.

### 4.2.5 Path and Movement Data Dialogue

The Approach Cruise Speed and Exit Cruise Speed for existing intersections should reflect the present intersection conditions. The Approach Travel Distance should be changed to reflect the existing and/or proposed operation of the intersection. The Negotiation Speed and Negotiation Distance can be changed manually to indicate the physical parameters for intersections that have unusual geometry features. Justification should be given for the values used for the intersections of unusual nature. All other items in this dialogue should be the SIDRA default values.

In the Movement Data input dialogue some of the data items may not be available depending on the intersection type and the characteristics of the movement. The default values in the Movement Data Dialogue box should be used unless evidence is provided indicating a different set of values are appropriate. Data in the Pedestrian Effects section can be manually inserted with the appropriate justification provided.

### 4.2.6 Lane Data Dialogue[i]

*In the Lane Data input dialogue, you can specify a lane utilisation ratio which is less than 100 per cent in order to allow for lane underutilisation observed in the field. The resulting lane flows estimated by SIDRA INTERSECTION can be compared with the observed lane flows and the lane utilisation ratio can be modified for the estimated lane flows to match the observed values. Where available, SCATS lane flow information is useful for this purpose. The sensitivity analysis facility (the Demand & Sensitivity input dialogue) allows for testing varied values of user-specified lane utilisation ratios.*

### 4.2.7 Gap-Acceptance Dialogue

Default values should be adjusted under different geometric arrangements. Therefore, gap-acceptance parameters applicable to particular intersection geometry and flow conditions should be selected by using good judgement and taking into account the local driver characteristics.

Appropriate judgement is required while selecting the critical gap and follow-up headway values to suit the circumstances considering grades, sight distance conditions, opposing movement speeds, number of lanes, and one-way or two-way conditions. Any changes to these values should be justified.

### 4.2.8 Pedestrians Dialogue

The volume of pedestrians and Peak Flow Factor can be altered to suit the intersection counts obtained. The growth rate used under Pedestrian Data should be justified and explained. Data for Crossing Distance, Approach Travel Distance, and Downstream Distance can be changed to reflect the geometry of the existing intersection if this data is available. Default values should be used for all other parameters in this dialogue.

SIDRA default for Pedestrian Walking Speed (Average) in the Pedestrian Data dialogue box is 1.3m/sec. A value of 1.5 m/sec should be used for pedestrian modelling.

Where partial pedestrian protection is proposed the calculation shall be measured ¾ across the full width of crossing.

### 4.2.9 Phasing and Timings Dialogue

The phasing and timing on signalised intersections can be altered to determine the most appropriate solution. However, when modelling the existing intersection, the phasing and timing should be representative of current Phasing and Timing of that intersection. Intersection surveys should be undertaken if the necessary data is not available. Default yellow time of four seconds and red time of two seconds should be used if the measured data is not available.

The maximum cycle time to be used is 120 seconds, consult with the TTOC for advice. Cycle time is generally controlled by the SCATS master subsystem. Therefore the cycle time for all intersections linked with the master subsystem should use the same cycle time.

- Slip Lanes without detectors[i]:

*Slip/bypass lane movements should be treated as Undetected under the SCATS control system where turning vehicles using slip/bypass lanes do not cross over stop-line detectors. This is not appropriate in control systems where turning vehicles using slip/bypass lanes cross over advanced detector loops, or with controllers using fixed-time signal plans where the plans are designed to accommodate all turning vehicles.*

- Detection Zone length[i]:

*Effective Detection Zone Length can be specified at all signalised intersections regardless of whether the Analysis Method is specified as; Fixed Time/Pre-timed or Actuated. This is particularly relevant to modelling of intersections running under the SCATS system.*

## 4.3 SCATS Standard Traffic Signal Phasing Diagrams

The TTOC has standard phasing arrangements in one of the following forms:

- Conventional phases.
- Conventional phases with turning leading, trailing or repeat right turn phases.
- Diamond phase.
- Split phases.

These phase arrangements should be used in intersection modelling. Refer to Table 2 for examples of phasing arrangements.

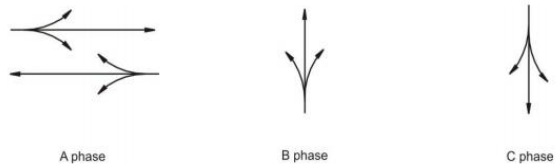
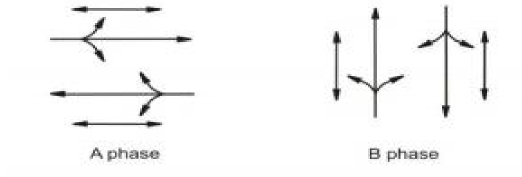
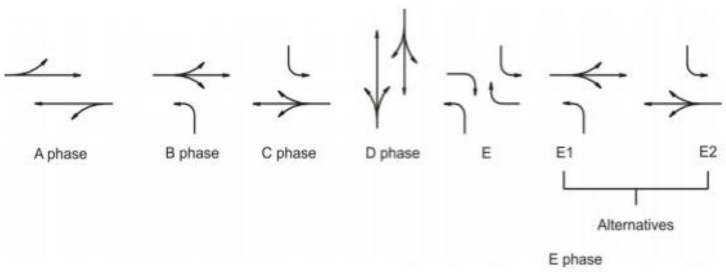
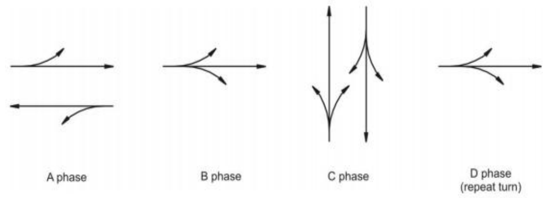
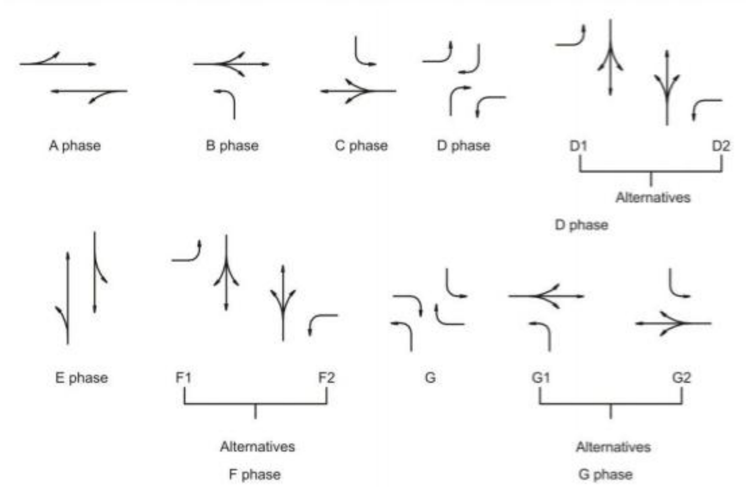
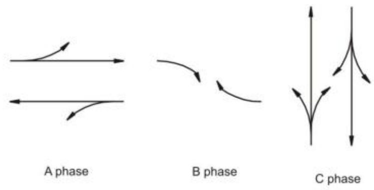
| | |
|---|---|
|   Split approach phasing |   Two phase design |
|   Single diamond overlap phasing |   Repeat right turn phasing |
|   Double diamond overlap phasing |   Diamond turn phasing |

**Table 2 - Examples of phasing arrangements**

## 4.4 Calibration

The calibration process should be based on various traffic surveys and site observations. All changes required in order to calibrate the model should be fully documented with an explanation and justification of the change. SIDRA User Guidelines should be referred to for possible calibration methods.

In order to properly identify the effects of future network and/or demand changes on the existing operation of signalised intersections, the timings obtained from a calibrated model of existing conditions (based on observed signal times) should be compared with those obtained from the SIDRA optimised timings. In this way differences can be compared and an explanation provided as to why they may exist.

This comparison is useful in identifying:

- Incorrect model assumptions in respect of traffic behaviour (saturation flows, delays due to pedestrians, queue storage space etc.).
- Incorrect model assumptions in respect of signal operation assumptions (i.e. alternative phase calls, phase skipping, offset, cycle times, minimum greens, clearance times etc.).
- Incorrect SCATS setup.

In addition to the above, many model software packages have specific SCATS input/import and output/export features. The Help instructions regarding SCATS compatibility should be consulted and guidelines followed, to the extent possible. Specifically, SIDRA has a SCATS Parameters Table available in the Detailed Output report[i]:

*It provides the user with estimates of the Maximum Flow (MF) and the associated Headway at maximum Flow (HW), Occupancy Time at maximum Flow (KP) and Space Time parameters reported by the SCATS traffic signal control system.*

*SCATS parameter estimates can be used together with lane flow rates reported by SCATS for the purpose of calibrating SIDRA INTERSECTION against measured conditions. The* basic saturation flow *parameter can be adjusted so as to match the measures SCATS MF parameter.*

*The SCATS on-line feedback system determines the MF parameter using a complex set of filtering rules using traffic data collected cycle by cycle during the day. On the other hand, the SIDRA INTERSECTION estimate of the MF parameter is based on average conditions and derived on the basis of various assumptions regarding the factors that influence this parameter.*

*Therefore, a one to one correspondence should not be expected between a SCATS-reported MF value and the corresponding SIDRA INTERSECTION estimate. However, a comparison of the SCATS-reported value of MF and associated parameters and the SIDRA INTERSECTION estimates can be of valuable help when saturation flow rates from field surveys are not available.*

*The SIDRA INTERSECTION sensitivity analysis facility (Demand & Sensitivity dialog) can be used to vary the basic saturation flow parameter so as to match the SCATS-reported MF parameters.*

## 4.5 Outputs

As outlined in the Introduction, the designer shall submit a detailed SIDRA report consisting (as a minimum) of the following:

- Introduction.
- Background.
- Traffic volumes including any adjustments made to modelled volumes noticing in particular the forecast years(s).
- Each Option should be modeled in Year 0 and Year 10. The land arrangement and phasing of each Option must be shown.
- Analysis Methodology (including details of calibration).

- Analysis Results Summary, including a table highlighting the following for each movement and, the intersection as a whole:
  - Degree of Saturation (DoS) (maximum 0.90).
  - Average Delay (RMS NSW Method).
  - Level of Service (LoS).
  - 50% and 95% Back of Queue distance.
  - Fuel Consumption, Emissions and Cost (total and rate).
  - Flow Scale / Design Life Results based on a 10% increase in traffic volumes.
  - Pedestrian movements.
- Discussion on all observations of the analysis results and outcomes.
- Conclusions and Recommendations (e.g. length of extensions to turn lanes, etc.).
- A table indicating the proposed cycle length, phase splits and offsets (if coordinated) that the model suggests to be adopted by SCATS for the morning peak, and, afternoon peak (include SCATS Parameters Table from Detailed Output report).
- Best Level of Service whilst Fuel Consumption and Emission are not the highest rate compare to other level of services.
- The applicant must report all traffic data deemed necessary to complete the validation in an appendix. An electronic copy of the software input and output files for all options, showing the phasing and time settings used in the evaluation, must also be provided.
- For closely spaced signals, a decision needs to be made and justified on isolated versus coordinated system analysis. An initial isolated analysis should inform the design layout and phasing prior to a full coordinated system analysis, serving as a useful cross-check.

---

[i] SIDRA *Intersection 7.0 User Guide*