



iRAP Survey Manual

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Because every life counts.

ABOUT IRAP

The International Road Assessment Programme (iRAP) is a registered charity dedicated to saving lives by eliminating high risk roads throughout the world. Like many life-saving charities working in the public health arena, we use a robust, evidence-based approach to prevent unnecessary deaths and suffering.

iRAP works in partnership with governments, road authorities, mobility clubs, development banks, NGOs and research organisations to:

- inspect high-risk roads and develop Star Ratings, Risk Maps and Safer Roads Investment Plans
- provide training, technology and support that will build and sustain national, regional and local capability
- track road safety performance so that funding agencies can assess the benefits of their investments.

The programme is the umbrella organisation for EuroRAP, AusRAP, ChinaRAP, KiwiRAP, USRAP, IndiaRAP, BrazilRAP and SARAP. Road Assessment Programmes (RAP) are now active in more than 100 countries throughout Europe, Asia Pacific, the Americas and Africa.



iRAP is financially supported by the FIA Foundation for the Automobile and Society. Projects receive support from the Global Road Safety Facility, mobility clubs, regional development banks and donors. Our partners, charities, the motor industry and institutions such as the European Commission also support RAPs in the developed world and encourage the transfer of research and technology to iRAP. In addition, many individuals donate their time and expertise to support iRAP.

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You can also subscribe to 'WrapUp', the iRAP e-newsletter, by [signing up](#) on the website homepage.

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1 INTRODUCTION

iRAP was established to help tackle the devastating social and economic cost of road crashes. Without intervention, the annual number of road deaths worldwide is projected to increase to some 2.4 million by 2030. The majority of these will occur in low-income and middle-income countries, which already suffer nine out of ten of the world's road deaths. Almost half of those killed will be vulnerable road users – motorcyclists, bicyclists and pedestrians.

Large as the problem is, making roads safe is by no means an insurmountable challenge. The requisite research, technology and expertise to save lives already exists. Road safety engineering makes a direct contribution to the reduction of road death and injury. Well-designed intersections, safe roadsides and appropriate road cross-sections can significantly decrease the risk of motorised vehicle crashes occurring and the severity of crashes that do occur. Sidewalks, pedestrian crossings and bicycle paths can substantially cut the risk that pedestrians and bicyclists will be killed or injured by avoiding the need for them to mix with motorised vehicles. Motorcycle lanes can minimise the risk of death and injury for motorcyclists.

By building on the work of Road Assessment Programmes (RAP) in high-income countries (EuroRAP, AusRAP, USRAP and KiwiRAP) and with the expertise of leading road safety research organisations worldwide, including ARRB Group (Australia), TRL (United Kingdom), MRI Global (United States) and MIROS (Malaysia), iRAP has developed four globally-consistent protocols to assess and improve the safety of roads.

The iRAP Protocols

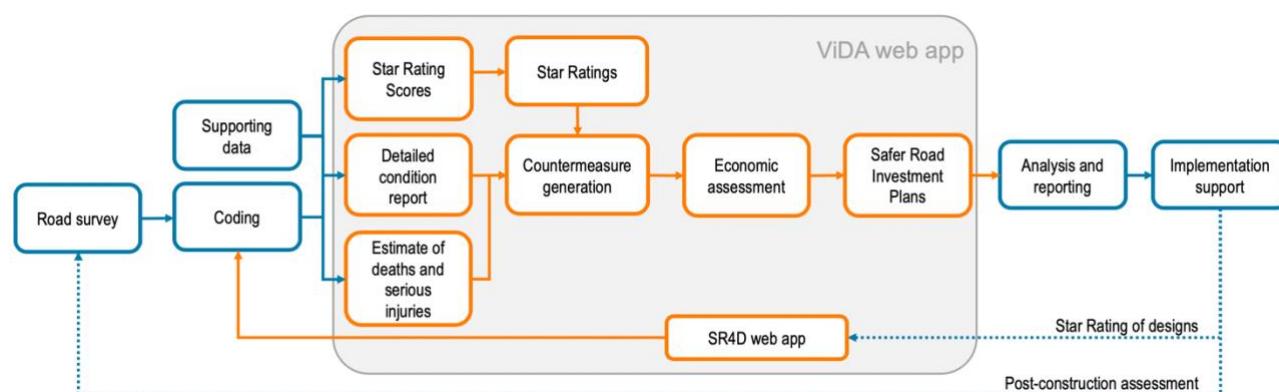
1. **Risk maps** use detailed crash data to illustrate the actual number of deaths and injuries on a road network.
2. **Star Ratings** provide a simple and objective measure of the level of safety provided by a road's design.
3. **Safer Roads Investment Plans (SRIP)** draw on approximately 90 proven road improvement options to generate affordable and economically sound infrastructure options for saving lives.
4. **Performance Tracking** enables the use of Star Ratings and Risk Maps to track road safety performance and establish policy positions.

This manual relates to Protocols 2 and 4. The *iRAP Survey Manual* is one of a number of specifications and guides provided for completing projects, accreditation and results analysis shown below.

- Project Planning Manual (includes the Standard Terms of Reference)
- Inspection System Accreditation Specification
- **iRAP Survey Manual**
- iRAP Coding Manual
- iRAP Star Rating and Investment Plan Manual
- Upload File Specification
- ViDA User Guide
- Star Rating for Designs User Guide (for users of the SR4D web app)

The figure below illustrates the process used to undertake Star Ratings and Safer Roads Investment Plans, which can be used as part of a systematic, proactive approach to road infrastructure risk assessment and renewal based on research about where severe crashes are likely to occur and how they can be prevented.

The iRAP Star Rating and Safer Roads Investment Plan process



1.1 What is an iRAP survey?

The primary purpose of an iRAP survey is to collect geo-referenced images of roads which can be used for road attribute coding. Collection of samples of traffic flows, pedestrian flows, bicyclist flows and speeds on the roads is also typically performed during a survey. This manual provides guidance on the survey process and standard deliverables. Adherence to this guidance will help ensure that:

- Data collected can be used in subsequent coding activities and to produce Star Ratings and Safer Roads Investment Plans (SRIP).
- Poor quality or erroneous data is quickly identified so it can be rectified.
- Data is collected in a repeatable way in future Star Rating and SRIP assessments.

1.2 Training and accreditation

iRAP activities require specialist skills and knowledge. iRAP strongly recommends training for people preparing to undertake an iRAP project. Information about the training courses available can be found on the iRAP website, at <https://www.irap.org/training>.

iRAP also manages an accredited supplier scheme. There are two categories of iRAP accreditation:

1. Activity accreditation. Suppliers that hold activity accreditation have completed training and successfully completed a test and have demonstrated experience. They have also signed the *iRAP Accredited Supplier Code of Conduct*. Activity accreditation is renewed annually based on demonstrated experience and may include refresher training and consideration of client feedback.
2. Inspection system accreditation, which relates to equipment and software used to perform surveys and coding. Inspection systems that are accredited have met the requirements described in the [iRAP Inspection System Accreditation Specification](#), and their manufacturers have signed the *iRAP Accredited Supplier Code of Conduct*. Inspection system accreditation is renewed every three years and may include retesting of the system and consideration of client feedback.

It is beneficial that accredited suppliers and an accredited inspection system are used in iRAP assessments, though it is not mandatory. Information about accreditation can be found on the iRAP website, at <https://www.irap.org/accreditation>.

If it is decided that accredited suppliers and/or an accredited inspection system will be used in a survey project, the following information on the team members and inspection system should be included in terms of references (TORs) and contracts.

Survey team members

Name	Email address	Role(s) in project	iRAP accreditation number	iRAP accredited since date	iRAP accreditation renewal due date

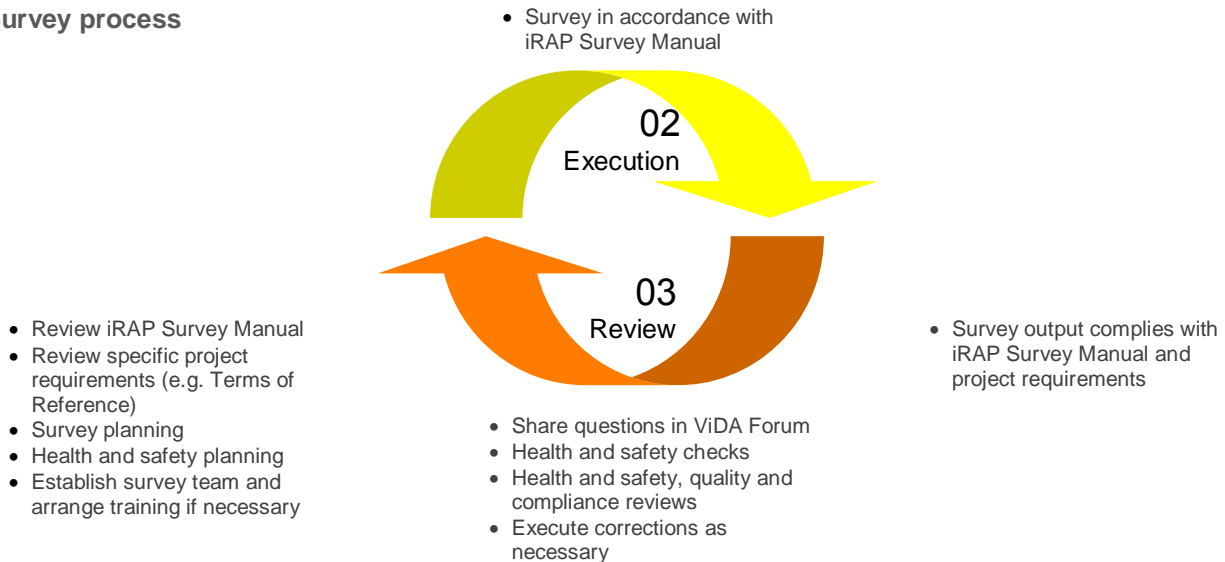
Inspection system

Inspection system name	Manufacturer	iRAP accreditation number	iRAP accredited since date	iRAP accreditation renewal due date

2 SURVEY PROCESS

An iRAP survey always involves the collection of geo-referenced images of roads which can be used for road attribute coding (see the [iRAP Coding Manual](#)) and typically involves collection of samples of traffic flows, pedestrian flows, bicyclist flows and speeds on the roads. The survey process and examples of survey activities are shown in the images below. The process is described in more detail in the following sections.

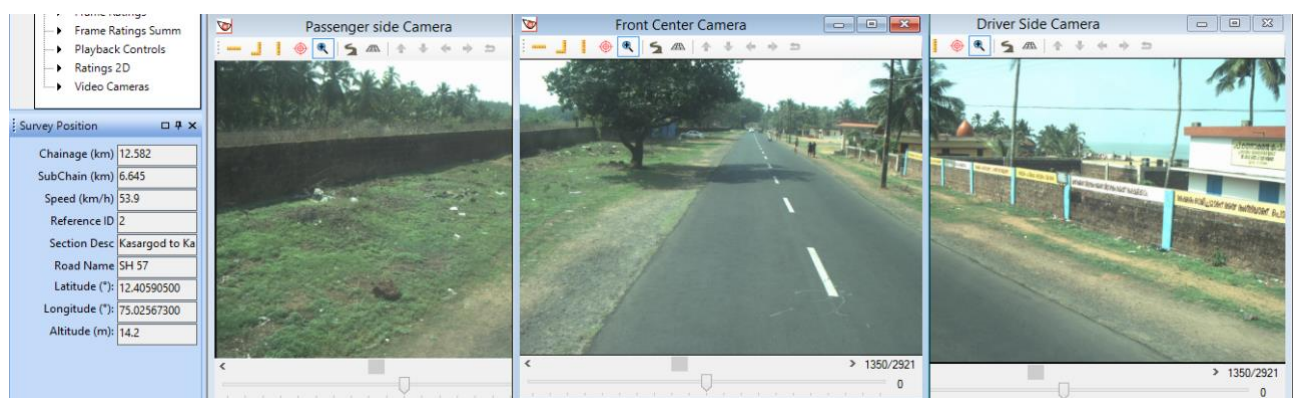
Survey process



An example of a survey vehicle (left) and a team performing speed data sampling (right)



An example of georeferenced survey images



2.1 Familiarisation with manual and project requirements

An iRAP survey project should begin with a clear understanding of the guidance in this manual and the specific requirements of the project, which are usually set out in a project plan or terms of reference. A substantial investment of time and resources can be consumed in a project, so it is desirable that all requirements are well understood by everyone involved in the survey. Survey data that does not comply with the guidelines in this document cannot be accepted.

2.2 Survey planning

Survey planning requires the preparation and maintenance of a survey plan. A plan will include the following topics:

1. Health and safety (see [2.3](#) for more details).
2. Project roads. A complete list of the roads to be surveyed including exact names and survey start and end points (such as GPS location, chainage, intersection or cross street names or landmarks).
3. Selection of vehicle, equipment and software. The survey system to be used should reflect a number of factors such as:
 - Length of road network: For short surveys of less than 100 km, it may be feasible to use an off-the-shelf video camera. For longer surveys where very large amounts of data is generated and needs to be managed, it may be desirable to select system that is tailor-made for road surveys, such as those that are iRAP accredited (see: <https://www.irap.org/accreditation>).
 - Type of roads: When surveying roads in cities, it is easy to lose a GPS signal because buildings can block the line of sight. More sophisticated inspection systems, such as differential GPS and distance measuring instruments (DMI), can help compensate for this.
 - How the survey data will be stored and shared: There are a number of off-the-shelf cameras compatible with Google Streetview, which provides a powerful platform for sharing survey data. For other camera types, planning will need to consider how data can be transferred and stored on hard drives or servers.
 - Inspection systems already in use: Many road agencies have well-established road data collection programs and systems. It is often desirable that iRAP survey data be collected in a format that is compatible with data collected in the past.
4. Vehicle, equipment and software setup and maintenance. This includes the set-up of cameras to capture images of requisite quality for coding, cleaning camera lenses, calibration of distance measuring instruments (DMI) and/or cameras (when on-screen length measurements are to be used). It also includes preparation of equipment to be used in flow and speed sampling and back-up equipment (hard drives). It is important the plan contains precise information as errors made in the calibration or set up of the hardware will result in poor quality or erroneous data that will affect the coding phase of the project.
5. Travel to the start of the survey. The distance from the overnight accommodation to the survey start location should be considered when planning each day's survey. If overlooked, the survey team will need to catch up this time during the day, which may impact the safety of the survey and the quality of the data collection.
6. Travel speed. iRAP surveys must be carried out at a safe speed. The survey vehicle should not exceed the legal speed limit.

7. Traffic congestion. It is possible that during the survey the vehicle may be slowed by traffic congestion, particularly in busy urban environments. The team should anticipate and allow for these delays, or plan to avoid peak hours, so that they are not rushing to make up lost time.
8. Time of day. If the survey is undertaken in low level light this can make the images hard to read, therefore requiring re-survey. Sun-glare can also lead to poor image quality.
9. Weather conditions. Adverse weather conditions such as snow, high winds and heavy rain can delay the survey and make progress slow. Avoid surveying during periods of prolonged bad weather and allow extra time to complete the survey as necessary.
10. Supporting data collection. Time should be allowed for traffic, pedestrian and bicyclist counts and speed sampling. The plan should include a complete list of locations where traffic, pedestrian and bicyclist flows and speed data samples will be collected.
11. Driving hours. For safety, regular breaks from driving should be made by the survey team.
12. Navigation. When a survey team is operating in an unfamiliar territory, allowance should be made for the possibility that they get lost.
13. Travelling to the overnight location. Care must be taken when driving to the overnight location at the end of the survey day as this is when the survey team are at their most fatigued. Also, poor light can make the driving task more demanding and can make it harder to find a predetermined destination.
14. Rest days. Time should be built into the schedule to allow the survey team to rest and recover.
15. Briefings and presentations. A survey team is often asked to give presentations on their work during the survey, for example at a district highway department office. Time should be allocated for these briefings.
16. Health and safety, quality and compliance reviews. Allocating time for these reviews is essential.

2.3 Health and safety

iRAP assessments are typically focussed on high-risk roads. Therefore, it is very important that everyone involved in the survey is informed of—and manage—all risks associated with the completion of the survey activities.

A health and safety plan should take into account the following issues:

- Operational working hours: How many hours will be worked by the survey each day, including travel to and from survey start and end points.
- Road travel: Safety and security issues on the selected routes and what to do in the case of a break down, crash or security threat.
- Inspections and data collection: Vehicle operation protocols, safety equipment (hi-vis vests for road side inspections), safety instructions for selecting and stopping at road side locations.
- Vehicle safety details: Seat-belts for all passengers, air-bags and safe mounting of equipment.
- Traffic and personnel management during flow and speed data sampling: Supervision and safety training, personnel communications, length of time, rendezvous points (if required), emergency and incident protocols.
- Country specific requirements: Immunisations, letters of authority and security arrangements.
- Office conditions: Safe and healthy workspace for data management and quality control.
- Arrangements for regular check-ins with home office: Regular reporting intervals, protocols for alerting home office of any issues that threaten the safety or security of the survey team.

- Insurance and procedures in the event of an incident.

The following is provided as an example only. Survey teams should prepare a plan of their own that reflects the specific project activities and circumstances.

Example health and safety plan

Project Name:				Date:	
Project Description:					
Personnel Details:					
Name	Position	Email	Phone	Emergency contact (name and number)	
Health insurance:					
Provider	Member number	Phone	Notes		
Equipment and vehicle description:					
Item	Description				
Key project contacts:					
Name	Position	Email	Phone	Notes	
Notes:					
Author name and signature:				Date:	
Supervisor name and signature:				Date:	

Example Risk Assessment

Risk assessment matrix	Common/ repeating occurrence	Known to occur	Could occur	Not likely to occur	Very unlikely to occur
Fatality or permanent disability	High	High	High	Medium-high	Medium-high
Lost time injury or illness	High	High	Medium-high	Medium-high	Medium
Medical treatment	High	High	Medium-high	Medium	Low
First aid treatment	High	Medium-high	Medium	Low	Low
Incident report only	Medium-high	Medium-high	Medium	Low	Low

No.	Job Sequence	Potential Hazard	Probability	Consequence	Risk Rank	Required Hazard Control
1	Road survey	Crash due to fatigue	Known to occur	Fatality or permanent disability	High	The driver shall stop in a safe location and take a break every 2 hours.
2	Manual pedestrian flow counts	Struck by vehicle	Known to occur	Fatality or permanent disability	High	People taking flow counts will wear high visibility vests and shall stand in a location as far a practical from moving traffic.
3	Road survey	Crash due to speeding	Could occur	Fatality or permanent disability	High	The driver shall always comply with official speed limits and drive at speeds that respect safety of themselves and others.
4	Etc...					

2.4 Survey team

The survey team should include (noting that one person may play multiple roles):

1. A supervisor who oversees the survey and is able to represent the project and present basic information at stakeholder briefings.
2. One or more professional drivers or personnel trained to operate the survey vehicle.
3. Technical staff capable of completing activities in this manual.

The following should also be considered:

1. During a survey, the team may be required to conduct demonstrations of data collection during stakeholder briefings.
2. All team personnel should have necessary travel documentation and approvals.
3. The team should be suitably attired to participate in stakeholder briefings and demonstrations as required.
4. Team members should be responsible for, and act in accordance with, the health and safety plan and ensure all safety and security issues are adequately addressed.
5. Additional stakeholder personnel may participate in the survey at their request. This may include, for example, a local navigator from the local road agency to ensure all road referencing details align to authority practices. Other stakeholders may participate in the survey from a training and awareness-raising perspective. The survey team should ensure that any additional personnel comply with the health and safety plan, including using seat belts inside the survey vehicle at all times and wearing hi-vis vests during roadside inspections and supporting data collection.

2.5 Survey vehicle

A range of technologies and systems may be used to collect georeferenced images of the road. Systems that are iRAP accredited are listed on the iRAP website (<http://www.irap.org>). In most cases, a survey system is attached to a car or van, though it is feasible that surveys are performed using trucks, motorcycles and bicycles. The following are standard requirements for a vehicle used in a survey:

1. The survey vehicle should be in a safe, well-maintained condition and comply with the Health and Safety Plan.
2. The survey vehicle should meet all licence, registration and insurance requirements (e.g. width, height, signage) for operation in the survey jurisdiction.
3. The survey vehicle should be clean and presentable (suitable for media, steering committee, stakeholder and promotional activities).
4. High quality logos of the stakeholder organisations can be placed on the survey vehicle for the duration of the survey.
5. The survey vehicle should have sufficient space for the survey team as well as provide for additional stakeholder personnel and their luggage who may participate in parts of the activities.
6. The vehicle should be available for viewing and inspection during events such as a commencement mission or official project launch.

2.6 Survey images

The minimum requirements for images collected during a survey are:

1. Resolution of 1280 x 960 pixels.
2. 140-degree field of view (centred on the travel lane). This may be accomplished with either a single camera or with multiple cameras with overlapping fields of view.
3. For still images, captured at fixed intervals of no greater than 20 metres.
4. Geo-referenced with the following data recorded for each image:
 - a. Unique image number
 - b. Road name
 - c. Road section
 - d. Distance along the road
 - e. Section length
 - f. Date
 - g. Time
 - h. Latitude and longitude.
5. Recorded with latitude and longitude data in WGS84 projection and decimal degrees units. Latitude and longitude data are recorded with a minimum accuracy of $< \pm 10$ metres for at least 90% of images and must not 'drop-out' for any more than 500 metres at a time.
6. Road and roadsides are clearly visible. Images should not be compromised by factors such as sun glare, rapid changes in shade/sun, poor lighting, dirty camera lenses, fog and blurring.
7. Forward space within the images is kept clear of vehicles as much as possible to ensure the required attributes can be viewed and assessed. This may require an escort for congested urban areas.

8. Recorded for a minimum of 500 metres before the official start point and 500 metres after the official end point of each section of road. Road sections should be segmented in accordance with advice from the relevant road authority.
9. Collected for all divided carriageway road lengths (surveyed in both directions) regardless of length. The definition of a divided carriageway road for the purposes of this project is all road sections where the median type is classified as code 1-7, 12, 15 as listed in [iRAP Coding Manual](#).

2.7 Daily survey records

Each day's survey activities should be recorded. The records should include the date, start and end locations, total length surveyed, the name of the road or corridor being surveyed, the file name, and any other details, such as landmarks or if the day's survey is a repeat of a previous days to address quality issues and so on.

Daily survey records are valuable for tracing data issues and understanding where errors may have been made. As part of this, it is useful to check that road names and sections are labelled correctly in the data, and that the correct roads have been surveyed.

Example of a daily survey record

Survey Log		Job Number:		048_iRAP_EARIV		
Region:	East Riviera					
Vehicle Reg #	HVT298					
File Name	Survey Date	Start Location	End Location	Total length	Survey Corridor	Comments
Springfield to Georgetown 01	30/04/2018	Eastern Freeway interchange	Goldfields Road	26km	A86	
Springfield to Georgetown 02	30/04/2018	Goldfields Road	M2 interchange	8.9km	A86	
Georgetown to Newport 01	30/04/2018	Georgetown Airstrip	Quarry Road intersection	16.7km	A86	Resurvey of 4.2 km of Springfield to Georgetown section between Georgetown airstrip and M2 Interchange.
Georgetown to Newport 02	30/04/2018	Quarry Road intersection	Newport Railway Station	22km	A86	
TOTAL				73.6km		
Team members	1. Marcus Smith	All surveys are imported into processing toolkit				YES
	2. Gillian Walter	Video files check for image quality (camera focus/ zoom)				YES
		All surveys processed for roughness, rutting, texture and geometry				YES
		All data copied from vehicle hard drive to portable hard drive				YES

2.8 Flow and speed sample process

Flow and speed data is required for a Star Rating and SRIP analysis. Samples of these data are typically collected during the survey. However, in circumstances where reliable traffic flow, pedestrian flow, bicyclist flow

and speed data are already available, collection of these data may be excluded from the survey. If this data is not required, this should be clearly stated in the project plan or terms of reference.

The minimum requirements for flow and speed data are as follows:

1. The sample locations should be representative of the network including, for example, rural, urban, schools, straight, curved, flat and sloping sections of road.
2. The number of sites at which data is collected must be sufficient to describe the general flow and speed characteristics various types of sections of the road network. Unless otherwise specified, the number of locations should be at least:
 - a. 3 for surveys less than 100km in length
 - b. 10 for surveys for less than 2,500km in length
 - c. 20 for surveys less than 10,000km in length
 - d. 40 for surveys greater than 100,000km in length.
3. Sample periods should be a minimum of 1 hour. Sampling should not be conducted on days of abnormal traffic periods, such as national, local and school holidays. Special attention should be given to schools. Data collection periods should overlap with school start and finish times.
4. The following descriptive information should be collected for each location:
 - a. Site number
 - b. Road name
 - c. Road section
 - d. Area type (urban/rural)
 - e. Location description (e.g. rural, urban, school, straight, curved, flat and sloping)
 - f. Latitude
 - g. Longitude
 - h. Date
 - i. Start time
 - j. End time
 - k. Posted speed limit(s)
 - l. Number of traffic lanes in each direction.
5. All motorised vehicles passing each location during the sample period should be counted. Where the road is divided, numbers of vehicles should be reported separately for each travel direction.
6. All pedestrians walking along and across the road during the sample period should be counted and recorded separately. Numbers of people walking along the road should be reported separately by travel direction.
7. All bicycles, including conventional bicycles and e-bikes, passing the location during the sample period should be counted. Numbers of bicycles should be reported separately by travel direction.
8. Speed data should be recorded as follows:
 - a. Locate vehicles, personnel, and equipment in a concealed location that does not attract the attention of drivers or affect their speeds. Ideally, drivers should not know their speeds are being measured as they approach the speed measurement location.

- b. Measure speeds of at least 100 motor vehicles at each location and record the speeds. Do not record speeds for bicycles or other non-motorized vehicles. At sites with very low vehicle volumes, the collection of speed data may be ended after 1 hour, even if 100 vehicles have not yet been measured.
- c. Measure speeds only for vehicles that are not being delayed by another vehicle or impeded by traffic at intersections, property access points or other temporal factors.
- d. Record speeds separately for cars, trucks and motorcycles.
- e. Select the vehicle to measure in an unbiased way, so that the vehicles selected are representative of the vehicle stream.
- f. At most sites, measure speeds for vehicles travelling in only one direction of travel. The direction of travel for which vehicle speeds are measured should be recorded on the form as northbound, southbound, eastbound, or westbound. At sites with very low vehicle volumes, speeds of vehicles may be measured for both directions of travel so that it will take less time to get speed data for 100 vehicles.

2.9 Quality and compliance reviews

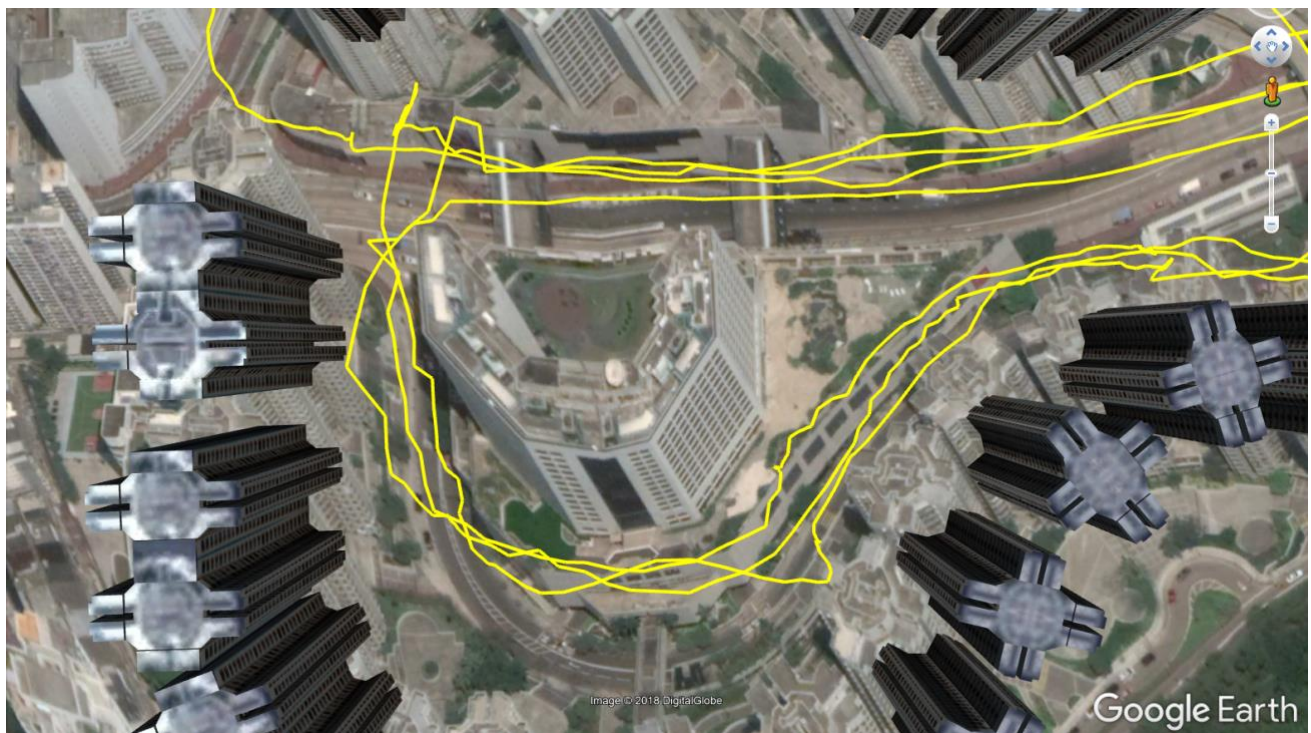
It is good practice to perform quality and compliance reviews on a daily basis. If problems are found and corrected early, then subsequent complications can be minimised and/or the need for re-surveys can be avoided. These reviews involve checking that each of the guidelines described in this manual have been complied with and should particularly include:

1. Checks of compliance with the health and safety plan and recording any issues that have occurred and responses.
2. Checks that the specific requirements of the project (i.e. the project's terms of reference) have been complied with.
3. Completion of a daily survey record (see 2.7).
4. Reviewing images to ensure that they comply with the minimum requirements. It useful to plot the survey points on a map to check GPS and distance measurement accuracy (see example below).
5. Reviewing flow and speed sample data to ensure that they comply with the minimum requirements.
6. Checking the condition of hardware, such as checking that cameras are free of dirt and insects, and that all the components are secure.
7. Making a daily back-up of the survey data to avoid the need for costly resurveys to capture lost data.

Example of good quality GPS data collected during a survey



Example of poor quality GPS data collected during a survey (in this case the GPS was affected by the presence of tall buildings)



Example of a good quality survey image



Example of a poor quality survey image (sun glare)



3 STANDARD DELIVERABLES

Standard deliverables for an iRAP survey are:

1. An **inception report** including details on the following:
 - a. Survey plan
 - b. Health and safety plan
 - c. Survey team
 - d. Survey vehicle
 - e. Survey images
 - f. Daily survey records
 - g. Flow and speed sampling, and
 - h. Quality and compliance reviews.
2. **Licensed copies of any specialised software** used for viewing georeferenced images and data.
3. **Short weekly reports** summarising:
 - a. Progress (measured in terms of km completed)
 - b. A summary of key activities completed
 - c. Health, quality and compliance review processes completed
 - d. Health, quality and compliance issues that have been identified and rectifications made
 - e. Photos of activities
 - f. Planned activities for the next 2 weeks
 - g. Any issues that may affect performance of the survey, and
 - h. Samples of survey data for the road sections where surveys are complete.
4. An **electronic copy of all geo-referenced images** upon completion of the survey.
5. An **electronic copy of traffic flow, pedestrian flow, bicyclist flow and traffic speed data** and corresponding descriptive information for each sample location in Microsoft Excel format (where collection of this data is required in the project).
6. A **final report** describing activities undertaken, key data and results and any issues that those who will use the data need to take into consideration.

It is suggested that final acceptance of road survey data is withheld until a review by the road coding team is completed. This review may reveal previously unidentified issues with the survey that may require correction or update.

Document version

Version	Update
June 2011	iRAP model version 3 compatible specification, <i>Road Survey and Coding Specification</i> , created.
May 2013	Appendix A updated to reflect May update to the upload specification.
April 2014	Revisions made to reflect creation of the Standard iRAP Term of Reference document. Adjustments made to section describing supplier staff. Appendix A removed and replaced with a link to an online list of road attributes.
May 2019	<i>iRAP Survey Manual Version 4.0</i> released as part of a full update to iRAP specifications, user guides and manuals. The new <i>iRAP Survey Manual</i> combines information from previous versions of the <i>Road Survey and Coding Specification</i> , <i>Quality Assurance Guide</i> and <i>Supporting Data Template</i> . The new <i>iRAP Survey Manual</i> now includes requirements for the collection of speed and flow data as part of the survey process (if data is not currently available).