Ontario

Book 1C

Ontario Traffic Manual

July 2001

Introduction to the Ontario Traffic Manual

Appendix C - Positive Guidance Toolkit

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Table of Contents

List of Tables

List of Figures

Checklists

1. Introduction[1]

In late 1972, a narrow bridge accident in rural New Mexico took the lives of several Texas children and accompanying adults on a school outing. That tragedy was the genesis of the Positive Guidance program. The program was undertaken by the Federal Highway Administration (FHWA) to improve safety at hazardous locations. In testimony before the U.S. Congress, the Federal Highway Administrator, Norbert Tiemann stated, "If we cannot physically protect motorists, then we have an obligation to provide motorists with information to protect themselves." Positive Guidance was identified as the means by which that obligation would be met.

In 1977, FHWA published the first *Users Guide to Positive Guidance,* and began conducting training sessions in the United States. In 1986, Positive Guidance was brought to Canada for the first time, at a seminar at the University of Calgary. Seminars and workshops on Positive Guidance were held throughout Ontario under the sponsorship of the Ministry of Transportation (MTO) and by the Ontario Traffic Conference beginning in 1988. In the mid and late 1980s, there was a growing awareness within the MTO of the role of human factors or ergonomics in providing a safe, efficient driving environment for the broad range of Ontario motorists capabilities and limitations. Training sessions relating to understanding the needs of the growing elderly population, and projects related to the French Language Services Act were conducted by human factors professionals as consultants or under contract to MTO.

This appendix to the Ontario Traffic Manual documents both the principles upon which Positive Guidance is based and a simplified procedure by which engineers and technicians can identify and analyze driver problems at hazardous locations and black spots in order to provide appropriate safety-related information.

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2. Principles

Positive Guidance means giving drivers the information they need to avoid hazards, when and where they need it, in a form they can best use it. Since positive guidance can be achieved only through the understanding and integration of ergonomics (human factors) and highway engineering technologies, some basic human factors principles are included in Section 2 of this Appendix.

In terms of driver behaviour, optimum highway design is achieved where drivers know what to expect from the highway, where their attention is naturally attracted to the most important sources of information, and they have adequate time to respond to conditions and situations as they arise. To achieve this objective, it should be evident that all elements of highway planning, design, construction, maintenance and operations consider expectancy and primacy.

2.1 Definition and Concept

Any information carrier, including the highway, which helps or directs drivers in making speed and/or path decisions transmits guidance information. *Positive Guidance* is provided when that information is presented unequivocally, unambiguously and conspicuously enough to meet decision sight distance criteria and enhances the probability of drivers making appropriate speed and path decisions.

Control, Guidance and Navigation Levels of Performance

Control refers to task performance related to a driver's interaction with the vehicle. Vehicles are controlled in terms of speed, path and direction. Drivers exercise control through the steering wheel, accelerator and brake. Information about how well drivers perform at the control level comes from the vehicle and its displays as well as visual observation of changes in speed, path and direction. Drivers receive continual feedback through vehicle response to various control manipulations. Overt response to hazards is part of the control level of performance.

Guidance refers to task performance related to a driver's picking out and maintaining a safe speed and path. Control subtasks require action by the driver. Guidance requires decisions involving judgements, estimates and predictions. The driver should evaluate the immediate environment and translate changes in alignment, grade and traffic into control actions needed to stay in the appropriate lane at an appropriate speed for the prevailing conditions. Information at this level comes from the highway – its alignment and grade, geometric features, hazards, shoulders, etc.; from traffic – speed, relative position, gaps, headway, etc.; and traffic control devices – regulatory and warning signs, signals and markings.

Navigation refers to the activities involved in planning and executing a trip from origin to destination. Drivers generally evaluate route numbers and/or names, interchange or intersection designations, cardinal directions and landmarks. They make *guidance* level decisions at choice points, and ultimately translate those decisions into *control* actions. Off-line information sources include maps, verbal directions and prior experience. On-line information input comes from the full range of guide signs, verbal directions and landmarks. Depending on the rate of implementation of Intelligent Transportation Systems (ITS), map information might be increasingly presented on-line in the vehicle. This might create additional information processing concerns.

Task Complexity

Information and task performance associated with the three levels of performance, *control, guidance* and *navigation* form a hierarchy of complexity. At control, the lowest level, information processing and vehicle handling is relatively simple, and so completely over learned by experienced drivers, that it is performed almost without conscious thought. At the guidance and navigation levels, information handling is often increasingly complex and demanding, and drivers need more processing time to make decisions and respond to information inputs. This frequently occurs in urban locations, at intersections and interchanges and where there is heavy traffic demand. The nature and number of hazards and of the available information displays also affect task complexity. The scale of complexity increases from control through navigation.

Primacy

It should be evident that at any given location on the highway, some information is more important than other information. Primacy refers to the relative importance of each level of the driving task, and of the information associated with a particular activity within each level. Here too, there is a hierarchical scale. The major criterion upon which primacy is assessed is the consequence of driver performance error. Since loss of vehicle control is of the greatest immediate concern to the driver, and the results of which can be catastrophic, the control level is assigned the highest primacy. A guidance level failure also is assigned a high primacy in that errors in speed and path selection frequently result in accidents. In navigation, where errors usually result in delayed, lost or confused motorists, the lowest primacy is assigned. The scale of primacy decreases from control through navigation.

Primacy is a most important consideration when information competes for drivers' attention. If there is inadequate time to process all the information at one location, high primacy needs should be satisfied first and lower primacy needs should be deferred. Information should be so placed as to spread the information challenge at locations where critical driver actions are required.

Information Handling

While driving, drivers do many things simultaneously or nearly so. They monitor traffic, follow the road, stay in a lane, read signs, listen to the radio, and accelerate and decelerate their vehicles. At any given point in time, drivers might have several overlapping needs associated with each level of performance. To handle this array of needed and available information, drivers must search the environment for information sources, detect their presence, recognize their relevance and make decisions to perform control actions safely and efficiently. Thus, information should be available when and where needed, and in a form best suited for its intended purpose.

Drivers receive and handle information using a signal search, detection, recognition and use process. In the search and detection modes, drivers scan the environment and sample the information in short glances until a potentially needed source is detected. Once detected, the source is attended to either continuously or intermittently until recognized. Drivers then decide if the information is needed. If needed, it is processed and used to make speed, path and direction decisions and control actions. In situations where information competes for drivers' attention, unneeded and low primacy information is shed. Errors could occur when drivers process less important information and miss or shed more important information.

Relevant information that is not immediately used is stored in short-term memory. Information that is so stored is quickly forgotten (sometimes called load shedding) if not used or reinforced soon. When reinforced by repetition, information is moved to long-term memory for future use.

Perception-reaction Time (PRT)

PRT includes the components of information processing; detection, recognition, decision making plus action initiation. It varies not only from individual to individual, but also as a function of decision complexity, information content and driver expectancy. The more complex the decision, or the more information needed to make a decision, the longer the PRT. Clearly, long PRTs reduce the time available to load shed, attend to other information sources and to respond to other task requirements, increasing the probability of error. Although 2.5 seconds is the constant used for PRT in design and sight distance calculations, it is hardly a constant. Even for something as simple as brake reaction time, the literature shows substantial ranges in PRT (from less than one second to more than four seconds), with the range of responses to unexpected signals higher than the range of responses to expected signals. PRT at night will be longer than daytime for the same information content; quite a bit longer if the source of the information is neither illuminated nor reflectorized. Similarly, information detected in peripheral vision will also result in longer PRT.

2.2 Driver Expectancies and Surprises

The nature of the driving task and drivers' information handling characteristics emphasize the importance of expectancies. Reaction to an unexpected event takes longer than when the event is expected. Conversely, drivers are less likely to become confused or commit errors when their expectancies are reinforced. Because the key to safe, efficient driving task performance is rapid, error free information handling, what drivers expect and do not expect has a major influence on task performance, particularly under time pressures and high task loading.

Expectancy relates to a driver's readiness to respond to conditions, situations, events and information successfully. It influences the speed and accuracy of information processing, and is one of the more important driver related characteristics in the design and operation of highways. Configurations, geometric features, traffic operations and traffic control devices that meet or reinforce expectancies help drivers to respond quickly, efficiently and without error. The following section describes the expectancy principle with some Ontario examples.

Roadway Design

The interchange configuration on the outer lanes of westbound Highway 401 and Allen Road is a good example of an unusual design configuration that might contribute to driver expectancy problems. Because almost all exits are on the right, unfamiliar motorists expect to exit from the right lane of the freeway. Without conspicuous, specific advance notice, unfamiliar westbound motorists wanting to exit to Allen Road are likely to move to the right. Here, motorists will either miss their exit or perform an erratic late lane change to get to it. Even more unusual is the fact that it is a double expectancy violation – the left exiting movement is tangential to the approaching mainline roadway.

Freeway tangential exit ramps create expectancy problems for drivers. Interchange exits with this configuration are the scenes of many unintentional erratic manoeuvre and other errors. Drivers find themselves leaving the freeway by going straight ahead on the tangent while the freeway curves to the right or left. The tangential off movement is thus both an unexpected feature and one that creates perceptual problems whether the tangential exiting movement is at the beginning of the curve or within it.

Figure 1 – Allen Road Symbol Sign

tangential exiting movements have the effect of pulling motorists in the adjacent through lane off the mainline onto the exiting ramp, more drivers are affected, interactions in the traffic stream are more turbulent, and the potential for driver error is greater. Wherever left exits have been located, whether alone or in combination with another expectancy violation, like a lane drop or a tangential exiting movement, from Toronto to Vancouver, they have been recognized as sources of operational problems. Contributing to a driver orientation problem at this exit is an incompatibility between two signs in advance of the exiting movement. As shown in Figure 1, the first sign, mounted overhead is the symbol sign for the left exit. It shows the freeway going straight and the exiting movement curving to the left.

The following diagrammatic sign, shown in Figure 2 depicts the actual configuration – the freeway curving to the right and the left exiting movement going straight. It even shows the left lane is optional. Drivers might stay in that lane to exit or to continue on the Highway 401. Making the situation even more difficult is the fact that a downgrade and the ever present heavy Highway 401 traffic hides visibility of the actual configuration.

Figure 2 – Allen Road Diagrammatic Sign

In general, no traffic control device has yet been found that can adequately warn drivers about tangential exit ramps, Tangential exit ramps are best treated by so configuring the diverge area that the off movement does not appear as the continuation of the main roadway. If the diverge area could be relocated as little as 30 m up or downstream of the curve or the divergence angle is no longer tangent to the curve, so that drivers would be required to make a steering adjustment to exit, the desired effect could be achieved.

There are rural two-lane road situations that function similarly to the freeway tangential exit ramp. Off-road features, such as a line of trees or railroad tracks that run parallel and adjacent to the highway create drivers' expectancy that the condition will continue. Another similar situation is that of a tangent roadway intersecting at the point of curve of a turning roadway, as shown in Figure 3 taken at the intersection of Provincial Highway 3, which is Main Street West and Regional Road 5, Killaly Street West on the west side of the City of Port Colborne.

Figure 3 – Tangential Roadway at Curve

Figure 4 shows the double exit lane drop sign at Bathurst Street on the outer lanes of Highway 401. At most freeway exits, and particularly on Highway 401, motorists must move into a deceleration lane or choose the adjacent optional lane to exit the facility. It is therefore an expectancy violation when a lane that had been a through lane exits the facility directly, leaving no option. Instead of having to change lanes to leave the freeway, motorists are required to change lanes to stay on the freeway. The black-on-yellow "EXIT/SORTIE" panel has the needed conspicuity when placed on the white-on-blue guide sign to gain drivers' attention. The uniform application of the panel at interchange lane drops serves to structure the appropriate expectancy. It is interesting to note that the distance between the gore at Bathurst Street and the gore at Allen Road is less than 300 m. It can be anticipated that unfamiliar motorists will have difficulty guiding themselves through the configuration of both these unusual interchange designs.

Figure 4 – Double Exit Lane Drop

A common freeway design feature with the potential for violating expectancies is a variant of the interchange lane drop – the split or bifurcation. Two kinds of split surprise drivers: first, any split where the off-route movement is to the left of the through route movement, as shown in Figure 5 taken eastbound on the QEW at the Highway 405 interchange; and second, the optional lane split, as shown in Figure 6 taken on westbound QEW at the Highway 403 interchange.

Figure 5 – Split with Off-route Movement to the Left

The optional lane split creates expectancy problems for many drivers. Because it is a lane drop, drivers in the exiting lane(s) are affected. Additionally, drivers in the optional lane do not expect to be faced with a lane choice by staying in lane. This situation could be described as a classical dilemma – the choice between equal alternatives. When drivers make a late choice, or worse – no choice, something undesirable usually happens, such as an erratic manoeuvre, a gore crossover, a fixed object struck in the gore, a truck jackknife, etc.

Any reduction in width of the road represents an expectancy violation and a hazard to drivers. Situations such as main line lane drops, work zones and narrow bridges are common sources of pavement width reduction. While all are expectancy violations, narrow bridges are particularly difficult because of the many configurations they take. Narrow bridges come in a variety of shapes and sizes, from those that are short box culverts to long bridges with trusses. Their narrowness ranges from loss of shoulder to narrowing of a lane width to a one-lane bridge that handles two-way traffic. Narrow bridges occur on curves (both horizontal and vertical), and in dips, making them hard to see. Thus, they are not only unexpected, they might be hard to detect, recognize and negotiate in the presence of oncoming traffic. Conspicuous advance warning is one key to providing safety.

Figure 6 – Optional Lane Split

Traffic Control Devices

Traffic control devices serve to structure expectancies about downstream features and operations. They also structure expectancies about information treatments at similar locations. The key to effective expectancy structuring is uniformity and standardization. Standard devices inconsistently applied create expectancy problems for drivers. If upstream curve warning signs underestimate maximum safe speed, drivers will expect similar underestimation for similar curves downstream. When a downstream curve is more realistically signed, drivers might be unprepared or unable to respond properly. Traffic control devices not only serve to structure expectancies, they tend to violate expectancies if misapplied, inconsistently applied, are absent when needed, present when unneeded, and/or ambiguous.

Traffic signals often violate expectancies. At many signalized intersections, motorists who are stopped for the red can see the signal display for the crossing roadway. This is particularly true at intersections where the roadways cross at something other than a 90 degree angle. From the stopped position, the lenses on the signal face for the crossing movement are frequently clearly visible. Invariably, a non-local driver at the head of the queue will move into the intersection when the crossroad signal changes from amber to red, expecting to get the green. But all too frequently their signal indication does not get the green. Lagging greens, protected turning movements, pedestrian phases, and even clearances intervals all surprise the unfamiliar motorist. Local drivers know the condition and stay put until the light changes to green. But visibility of the crossing movement signal induces inappropriate behaviour of those unfamiliar with the signal operation.

Another example of an unexpected traffic signal indication is the mid-block signal. In most instances, drivers do not expect a traffic signal anywhere but at an intersection. When a mid-block signal is used, they will not be prepared without conspicuous advance warning, and might not react in time or might rear end another vehicle stopped in the crosswalk.

Signs that provide information at the guidance level (regulatory and warning signs) as well as at the navigational level (guide signs) have the potential to structure and to violate driver expectancies. For example, drivers generally expect to be able to exceed the advisory speed safely when one is posted beneath a curve warning sign. These expectancies are, of course based on one's experience. Advisory speed warning plates in North America are usually conservative when it comes to a safe speed under most conditions.

There are locations where the warning message requires special emphasis. Curves where the advisory speed should be adhered to, even in dry weather, and unexpected situations beyond a curve or crest vertical that would surprise drivers are two examples where such special emphasis is justified, i.e., something that says, *"this time we really mean it."* Special display treatments such as Chevron Alignment Signs, oversize warning signs and flashing beacons are used to good effect at such locations. For the sake of continued credibility of these special emphasis devices, however, their use should be reserved for those locations where gaining drivers' attention is particularly important.

2.3 Key Considerations

The development of appropriate highway designs and traffic control devices that meet driver expectancies or that tell drivers what to expect is the primary way to aid performance and enhance safety and efficiency on all Ontario's highways. Attention should be given to assure consistent design from one segment of highway to another. When drivers get the information they expect from the highway and its information system, driver response tends to be rapid and error free. When drivers get what they do not expect or do not get what they do expect, longer response times, inappropriate responses, confusion and errors are the predictable result. Key considerations about expectancies include the following:

- Expectancies are associated with all levels of the driving task and all phases of the driving situation;
- Drivers experience problems and commit errors when they are surprised;
- Drivers anticipate upcoming situations and events that are common to the route they are driving;
- The more predictable the design, information displays or traffic operation, the less likely will be the chance for driver error;

- In the absence of information to the contrary, drivers assume they will have to react only to standard (expected) situations;
- The roadway, the information system and the environment upstream will structure expectancies of downstream conditions.

The objective in helping drivers overcome the effects of expectancy violation is to structure the appropriate expectation through advance warning. When it is not possible to give drivers what they expect, it is imperative to tell them what they should expect.

2.4 Failures at the Guidance Level

A guidance level failure occurs when the driver chooses an inappropriate speed or path. The failure translates to improper, inadequate or inappropriate control actions. This kind of failure does not imply driver fault. When an accident occurs because of wrong control action, it might be caused by certain inadequacies in relevant information available to the driver. Such inadequacies include too much information, too little information, ambiguity, conflicting information, the improper location of information, and information not visible under ambient conditions. *It is the function of Positive Guidance to enhance safe driver performance by providing appropriate, usable information that would reduce those failures that are not driver caused.*

Two limitations to Positive Guidance are important here. First, driver failures due to driver impairment are not necessarily amenable to correction by providing improved highway information. Drivers who are drunk, drugged or drowsy or whose normal performance is otherwise impaired have problems that are not usually solved by better signs and markings, although there are exceptions to this generality. Second, certain highway design features exceed driver response capabilities. Where the design complexity is such that drivers do not have enough time to make all the judgements required, no solution short of redesign will eliminate frequent accidents.

2.5 Information at the Guidance Level

At the guidance level of performance, drivers select and process information with the objective of picking out and maintaining a speed and path they consider to be safe, efficient and comfortable.

Roadway Environment

Drivers gather considerable information from the roadway itself. Drivers' ability to select an appropriate speed and path depends on their ability to see the road. Drivers should see the road directly in front, and see enough of that road at some distance ahead to predict its alignment, grade, width and several other factors with a high degree of accuracy.

Drivers' view of the road includes a view of the immediate environment including shoulder and any obstacles. This also includes sign supports, bridge piers, abutments, guide rails and median barriers. Information received from the roadway and its immediate environment is used continuously during performance at the guidance level.

Traffic Control Devices

Three kinds of devices directly affect guidance performance – pavement markings and delineators, regulatory and warning signs, and signals. Guide signs, associated with the navigation level, indirectly affect performance at the guidance level, and as such, are an important source, although lower in primacy.

Traffic

Maintenance of a safe speed and path in response to other vehicles in the traffic stream is a major activity at the guidance level. Information received from other vehicles should be processed by drivers at the same time as other information related to the driving task. Traffic information might be intermittent or continuous, but in either case, it should be integrated with other guidance information to assure adequacy of speed and path decisions.

2.6 Hazards at the Guidance Level

A hazard is any *object, condition* or *situation* that tends to produce an accident when drivers fail to respond successfully. *Object* hazards can, of course, be fixed or moving. *Condition* hazards refer to conditions of the major system elements: driver, vehicle or roadway environment. *Situation* hazards are combinations of conditions and objects, usually with a temporal feature, e.g., a wet pavement or a train approaching a highway – railroad grade crossing. It is well beyond the scope of positive guidance to deal with driver or vehicle condition hazards. Guidance level condition hazards are only those of the roadway environments.

Fixed Objects

This type of hazard is the most obvious since it includes those objects which are often lethal – bridge rails, piers and other bridge elements, non-breakaway sign supports, large trees, etc. In general, any object that is stationary and accessible is included. The fact that some objects are themselves protective devices, like guide rails and median barriers, does not mean they are hazard free.

Moving Objects

Anything that could move into a driver's path falls into this category. Driver assessment of what is hazardous is relatively simple for the fixed object hazard, but somewhat more complex for the moving object hazard. Further, the decision process involved in avoiding a moving object hazard is also more complex in that drivers are required to evaluate the speed and path of the moving object, make corrections in their own speed and path and re-evaluate. This iterative process is well within the capability of most drivers but can consume much mental processing time and capacity.

When seen, the object hazard is the simplest hazard to deal with. While the decision making process is complex under some situations, the identification of what is hazardous is usually rapid and error free. Unfortunately, perception of highway condition and situation hazards is neither simple nor without error.

Highway Conditions

The condition of the highway, its design features and its state of maintenance or repair, irrespective of any obstacles, contribute to consideration of the roadway environment as a hazard. Included are:

- Design features such as tangential off ramps or lane drops and other expectancy violations as mentioned above;

- Accessible roadway features that make it difficult to maintain or regain control of an errant vehicle such as pot holes, pavement edge drop off and curves with inadequate superelevation.

All of these features create perceptual problems and expectancy violations for drivers. Without positive guidance, they could be expected to induce driver error. Any location where the condition of the highway or its immediate environment needs to be interpreted as a cause for extra caution or a cause to modify speed or path significantly should be considered as a highway condition hazard.

Situations

This hazard category includes combinations of conditions with or without objects, and might include a temporary condition such as rain. A situation hazard could include conditions that taken individually might be of only moderate concern, but that in combination are treacherous. Combining such elements as rain, a polished surface, a vehicle with bald tires and a curve with not quite enough superelevation leads to the kind of situation hazard that is responsible for many skidding and single vehicle run-off-the-road type accidents.

Highway-railroad grade crossings are good examples of the difference between highway condition and situation hazards. Many crossings have several hazards associated with them. Elevated tracks, crossings at angles other than 90 degrees, and rough crossings are all conditions that warrant extra driver caution. When they all exist at the same crossing, the problem is much more serious for drivers. It is the approach of a train, however infrequent, coming from the acute angle that takes the crossing to another level of hazard.

Strategic Improvements

Looking at the range of hazards, it is possible to define the obligation of the Province of Ontario to motorists on its highways. First, if possible, practicable, and within the financial and programmatic ability of the Ministry, the hazard should be eliminated. If that cannot be done, and there are many valid reasons for that to be the case, then the hazard should be made inaccessible or forgiving (move it, screen it or make it breakaway). If that cannot be done, and again there are many valid reasons for that to be the case, particularly with design features, motorists should be given enough information to avoid the hazard. It is that information that provides positive guidance. Short of closing the roadway to traffic, there are no other alternatives.

2.7 Drivers Avoiding Hazards

Successful performance by drivers is dependent upon their ability to detect a hazard, recognize it or the threat it poses, decide on an appropriate speed and path, and act on that decision. The principles of Positive Guidance would require that drivers be given all the information needed to maximize the selection of appropriate speeds and paths.

Detecting the Hazard

Hazards range in detectability from very easy (seeing a fixed object in the road) to very difficult (seeing a three inch pavement edge drop off at night). How seeable a hazard is depends on many factors including the interaction between its visibility, its conspicuity or target value, and the number of competing information sources. Also included are the driver’s scanning behaviour, visual acuity, prior knowledge and expectancy. This interaction defines how detectability of a hazard could be enhanced. In the case of a fixed object, making it more visible makes it more detectable. With objects and highway conditions, reducing the number of information sources competing for drivers’ attention gives drivers more time to detect the hazard. In the case of any hazard, increasing driver expectancy of seeing the hazard will improve its detectability. Here signing and marking play an important role in the hazard detection task.

Recognizing the Hazard

Hazard recognition is a simple name for a complex mental process. Once something has been seen, the driver should decide what it is. Because recognition follows detection in time, the driver is closer to the hazard and could see it better (or more of it), and get more information from it. That information is compared with the driver's store of prior knowledge. Prior driving experience becomes increasingly important in recognizing highway condition and situation type hazards, although some of the knowledge can be gained through driver training. Some knowledge is too situation specific to be taught in driver education, and in those cases hazards are recognized through personal experience or flagged with a device (usually a warning sign) or not recognized.

The use of warning signs, and to some extent regulatory signs, carries an implicit warning to the traffic practitioner who employs them. These signs prepare motorists to detect and recognize hazards. When the hazard is present, the value of the warning is reinforced. However, when the hazard is not there or not apparent to drivers, the credibility of the warning or regulation is reduced. A typical example is work zone signing including reduced speed warning with no work or workers in sight.

Deciding What to Do

After the hazard is recognized, drivers need to determine if modification of speed and path is necessary, and if so, define alternative courses of action. If more than one course of action is considered, drivers evaluate the probability of success as well as the ease and comfort of implementation. Here, too, experience plays a big role. We all tend to repeat past behaviour that has been successful. Finally, drivers select the speed and path they consider to be the most appropriate for the situation. These decisions are frequently made under great time pressure. Here, it can be seen that those who are inexperienced and those whose information processing abilities have deteriorated through advanced age or impairment are at a disadvantage.

Doing It

Helping motorists to select the appropriate speed and path is as far as the Positive Guidance process can go. Vehicle control to implement the decisions is entirely in the hands of the driver. After taking an action, the driver evaluates its adequacy, applies a speed or path correction if required, and continues the process until the hazard no longer poses a threat or a higher primacy need interferes. There is a great deal of information handling in this process, some at the guidance level, much at the control level.

2.8 Planning, Design and Construction

Although the Positive Guidance procedures contained in Sections 3 onward are designed to be used by traffic operations personnel, the concept and principles, as defined above, are equally important in the planning, design and construction phases of project development. Traffic control devices are usually considered the principal means of communicating with motorists. However, ***the highway itself conveys more information to its users than any other single source!***

Planners and designers whose job it is to determine what the highway will look like, therefore, play a key role in the development of highway related information. In fact, any activity, whose output conveys information related to the driving task to highway users, is an activity that has potential for providing positive guidance, whether or not information giving is its primary intent. For example, although the principal purpose of the placement of guide rail is the physical protection of motorists from fixed object hazards and the redirection of errant vehicles, there is no question that its placement and appearance give motorists important guidance information. The information imparted is positive guidance when it assists highway users in making correct speed and path decisions to avoid hazards. Here, it is no more or less an example of positive guidance than a line of reflectorized barrels delineating the temporary edge of travel lane in a work zone.

The alignment and profile relationships of any highway are crucial to the formulation of accurate driver expectancy. Together, and in combination with other features such as superelevation, signs, markings and roadside grading, they provide the positive guidance drivers need to conduct the task safely and efficiently. It is essential, therefore, that all the elements act in concert. For example, an urban or suburban facility should not be planned or designed to give the impression of a higher type facility than the posted speed limit would warrant. The ambiguity created by an apparent high type facility and relatively low speed limit violates driver expectancy, creates credibility problems and invites speeds higher than can safely be accommodated.

3. Procedures

There are two phases to the procedures described in this section of Appendix C, project planning and data collection, and data analysis. Project planning and data collection ranges in magnitude from small, informal studies to large, labour intensive studies with precise data gathering requirements. At its simplest level, collecting historical data is just a matter of gathering office records pertaining to the site to be studied. Other data are collected on site through detailed inspection and a review of operations. Both historical data and site inspection and review data are discussed in this section. However, if the project is to undergo a full scale effectiveness evaluation, a formal data collection plan and procedure becomes a part of the project. Although it is considered essential to conduct an appropriate effectiveness evaluation of the project if its results are to be applied elsewhere, formal data collection procedures and statistical treatments are not discussed here. See ITE's *Manual on Traffic Engineering Studies* for detailed discussions on the conduct of effectiveness evaluations.

The second phase analyzes the data. The analytic procedure consists of the following eight steps:

(1) Identifying the Hazards;

(2) Determining Land Use and Hazardous Avoidance Manoeuvres;

(3) Specifying Information Handling Zones;

(4) Rating Hazard Visibility;

(5) Determining Expectancy Violations;

(6) Analyzing Information Loads;

(7) Identifying Information Needs;

(8) Evaluating the Current Information System.

It should be noted that the analytic procedure itself does not extend to the ninth step, the development of improvements or a traffic control plan for the site under study. The value of this procedure is seen in the detailed site and needs analyses, which when combined with the principles contained in Section 2 allow the full range of engineering judgement to be applied to the problem.

A Positive Guidance project is usually initiated when a location with information system problems has been identified and selected for further review:

- Road Safety Audit, routine surveillance, design reviews, corridor or formal operations reviews identify locations with information system deficiencies.

- Accident analyses identify high accident locations and locations with high accident potential, e.g., narrow bridges and railroad grade crossings. Further investigation indicates that there might be deficiencies in the information system or restrictions in sight distance.

- Delay, congestion, or indications of driver directional confusion such as erratic manoeuvre and lost motorists identify locations where driver navigational uncertainty might contribute to throughput or traffic operations problems.

- Citizen complaints or feedback from police or maintenance personnel identify locations with information system deficiencies or driver confusion.

3.1 Project Planning and Data Collection

This phase of the project houses the data collection plan, an office review, and a site survey and operations review.

Data collection requirements vary from project to project. All projects require available historic data as well as data from the site survey and operations review. Additional performance data might be needed for diagnostic purposes, depending on data gaps identified by the historical review. Effectiveness data are required when statistical evaluations are performed. Although this type of evaluation is optional, it should be performed whenever possible. It determines whether, and to what extent, the site's problems have been reduced or eliminated and also provides input to the road authority's database.

There are three data collection strategies and assessments used to implement the Positive Guidance procedure:

(1) Historic data collection and review;

(2) Informal field data collection and review;

(3) Performance data collection and analysis.

Data Collection and Office Review

The historic data review uses existing accident, complaint, and engineering data to specify what safety and operational problems have occurred, where they have occurred, and when (time of day, day of week, time of year) they have occurred. The review could also serve to identify target groups of drivers (e.g., older drivers, truck drivers) or vehicles (e.g., trucks, motorcycles) experiencing difficulties. Finally, the historic data review can help identify conditions under which problems are occurring (e.g., weather, lighting).

The office review task should assemble existing site information, generate an initial condition diagram, develop a collision diagram/accident summary, and produce a list of “things to look for and at” for use in the site survey and operations review. Information developed during this activity is used to define the site in terms of land use, road type, and geometry. This information is also used to develop or verify the condition diagram, and to provide a framework for subsequent activities. In defining the project site, the following elements are identified:

- Land use (rural, urban or suburban);
- Road type and number of lanes (e.g., four lane divided arterial);
- Geometric Characteristics, including alignment, grade, at-grade crossings, changes in cross section, interchanges, intersections, off-road features, structures, turns, and other special characteristics.

These elements form the basis of the initial condition diagram which includes all the relevant sources of information and their location.

Assembly of Existing Site Information

Applicable existing site information and data should be assembled and reviewed. This activity applies only to existing data and does not require any data collection effort. This informal review provides insights about the site’s characteristics, operations, and problems, and can also identify requisite data to be collected in subsequent phases.

Initial Condition Diagram

Information from suitable plans or aerial photos and a traffic control device inventory, if available, should be used to develop an initial condition diagram. As the procedure is applied, this diagram will be used to locate traffic control devices and other pertinent features such as hazards, furniture, and terrain.

Collision Diagram/Accident Summary

Suitable accident summaries and/or collision diagrams should be obtained or generated, if at all feasible, during the office review. A review of this information helps to identify and describe problems and aids in data collection in later activities.

List of Things to Look For and At

A site specific list of things that should be looked for or inspected during the conduct of the site survey and operations review should be developed. The list might include: specific accident locations, places where accidents cluster, traffic control device locations, hazards and hazard locations, sight distance/sight distance restrictions, sign blockage, horizontal and vertical alignment, driver confusion sources (geometry and information), speeds, erratic manoeuvre, encroachments, conflicts, pavement/shoulder width and condition, environmental conditions, and potential data collection locations.

Project File

A project file should be started at the beginning of the Positive Guidance project to document and summarize all aspects of the effort. Throughout the project, each activity should be documented in a timely manner to assure that the file is accurate and up to date. This will aid in developing improvements and writing a project report, when applicable.

Site Survey and Operations Review

These are the first data collection activities at the site. Using an appropriate informal field data collection technique as listed below, a drive through is conducted in order to:

- Experience the problems an unfamiliar motorist might encounter;

- Perform an expectancy violation review;

- Observe the manner in which drivers manoeuvre through the site. Take notes and pictures.

Informal Field Data Collection

A drive-through and an operations review are usually performed, and additional informal field reviews are often conducted in the course of the problem description activity.

- **Drive-through**
  Beginning upstream and ending downstream of a problem location, all paths and directions of the site are driven, and a “driver’s-eye” view of hazards and highway information sources is obtained. Notes of what is seen are prepared, photographs of important features are taken, and the condition diagram is completed during this review.

- **Commentary Drive-through**
  The commentary drive-through is a similar, more structured field review, where an audio or video with sound is made to provide a running verbal commentary of what is seen at the site. Such things as extremes in the site’s geometry, unusual manoeuvres, hazards, and deficiencies in the information system are “flagged” for further analysis. When an audio recording is used, it should be supplemented with site photos.

- **Walk-through**
  A walk-through is a supplementary effort, where the site is surveyed on foot to note accident debris, guide rail dents, skid marks, and other features or problem indicators that might not be apparent from a vehicle.

- **Site Survey**
  During a site survey, information from the historical data review is used to identify what problems the site is experiencing and specifically where they are occurring. The site is visited, its physical characteristics surveyed, and operations at the problem location observed from an unobtrusive vantage. The purpose of this activity is to watch traffic in order to gain insights about speeds, paths, and directions.

- **Operations Review**
  The operations review is more structured than the site survey in several respects. The site is observed at the times that most problems seem to be occurring, e.g., peak periods or at night. Additionally, a small sample of performance data (e.g., speed, erratic manoeuvre, traffic conflicts) is collected to obtain an indication of problems such as excessive speed and directional uncertainty (e.g., more than 3% of the sample commit erratic manoeuvre at an interchange). Locations for performance data collection are also identified.

Performance Data Collection

Performance data are usually collected to fill in data gaps, to aid in problem diagnosis, and/or when an effectiveness evaluation is applicable. A data collection plan should always be developed, including traffic volume collection used to determine exposure. When an evaluation is applicable, performance data to be collected for measures of effectiveness should be identified and defined. Volume III of the MOE’s U.S. FHWA’s Series on Positive Guidance, *Planning and Field Data Collection* and ITE’s *Manual of Traffic Engineering Studies* provide details on all aspects of performance data collection.

- **Data Collection Plan**
  The plan should account for:

  - representative conditions to replicate the times;
  - locations, and circumstances of problem occurrence;
  - unobtrusive vantages to assure that the traffic stream is unaware of the data collection;
  - appropriate data collection methods that are suitable for the needs of the project;
  - sufficient data for diagnosis and evaluation;
  - details of field crews, equipment, procedures, and schedules.

- **Applicable Data to Collect**
  Table 1 tabulates traffic performance measures that are usually collected as Measures of Effectiveness (MOE) for a range of site characteristics. Performance data needs are also determined by an assessment of what information is needed for diagnostic purposes. Generally, speed and volume data are considered baseline, and are not included in the table. In addition, applicable data to collect are also determined by the needs of a particular study. For example, the document *Traffic Conflicts Techniques for Safety and Operations* specifies the kinds of data required for a traffic conflicts study.

Table 1 – Traffic Performance Measures

Site Characteristics	Measures of Effectiveness
Alignment, Horizontal	Brake Applications
	Braking, Severe (at curve)
	Encroachments
	Lateral Placement
	Run-off-road
Alignment, Vertical	Brake Applications
	Time-headway (downgrade)
	Volume
Construction/Maintenance Zone	Brake Applications
	Delay
	Encroachments
	Last Minute Lane Changes
	Lateral Placement
Cross-section Change (Shoulder/Lane Width)	Brake Applications
	Lateral Placement
Interchange Diverge/Exit Gore	Brake Applications
	Backing (freeway ramp or mainline)
	Driving Slowly
	Erratic Manoeuvre (gore weave, last minute lane change)
	Point of Entry into Exit Lane

Table 1 – Traffic Performance Measures (cont'd)

Site Characteristics	Measures of Effectiveness
Interchange – Tangent/Split/Left Exit/Lane Drop	Brake Applications
	Backing
	Erratic Manoeuvre (gore weave, last minute lane change)
	Lateral Placement
	Traffic Conflicts
Intersection – Signalized	Brake Applications
	Braking, Severe
	Delay (percent stopping)
	Time Through Intersection
	Traffic Conflicts
	Travel Time
	Turning Movements
Lane Drop – Mainline	Braking, Severe (at taper end)
	Encroachments, Shoulder
	Erratic Manoeuvre (last minute, into dropped lane)
	Gap (merge) Availability
	Lateral Placement
	Run-off-road
Mainline Section/Tangent/Winding	Lane Changes
	Vehicle Classification
Merge/Weaving Section	Brake Applications
	Delay
	Distribution (of merges)
	Traffic Conflicts

Table 1 – Traffic Performance Measures (cont'd)

Site Characteristics	Measures of Effectiveness
Narrow Bridge	Encroachments (centreline)
	Lateral Placement
	Traffic Conflicts
Passing/No-passing Zone	Passes/Aborted Passes, Type
	Passes/Aborted Passes, Number
	Passing Time (distance)
	Traffic Conflicts
Pedestrian/School Crossing	Compliance (guard, signs, signals)
	Delay
	Traffic Conflicts (pedestrians)
Railroad – Highway Grade Crossing	Compliance with Traffic Control
	Head Turning Movements
	Speed, Spot
	Stop Profile
	Volume (vehicles, trains)
Stop Approach	Brake Applications
	Compliance
	Encroachments (stop line)
	Speed Profile and Volume

3.2 Applying the Positive Guidance Procedure

The Positive Guidance procedure provides a step-by-step assessment of a driver's task negotiating a problem location, thereby identifying driver-related problems caused by deficiencies in the site's information system.

Most of the activities are augmented by a checklist that can be filled out in the field or completed in the office after reviewing, documenting, and photographing field conditions and operations. Checklists are discretionary tools, and are recommended for use at visually complex and high accident locations. The information generated by the checklists is used to focus and help formulate activity outputs and products. There may be projects where, at the discretion of the user, some activities could be combined or eliminated.

Identifying the Hazards

Information for identifying hazards is obtained from historical data, and from notes, comments, slides, photographs, and videos taken during the drive-through. Hazard-related information is usually gathered after the initial drive-through has been conducted and problem definition findings developed, since the products of these activities provide insights on the site's hazards and hazard clusters. Checklist 1 serves as a framework for hazard identification and threat assessment.

Identification of Hazards and Inefficiencies

Hazards and hazard clusters are identified and their threat or threat potential determined by historical data analysis, field observation, and engineering judgement. For example, individual accident reports help identify fixed and moving objects involved in collisions and provide information regarding conditions contributing to problems. Accident plots point to specific problem locations and are useful for identifying hazard clusters. Drive-through and operations reviews verify accident and complaint files and also enable an identification to be made of obvious hazards such as trees and traffic, and less obvious ones such as short signal phases, culverts, and potholes. Photographs and slides provide views of hazards that may be missed during field review.

- **Fixed Objects**
  Fixed objects are generally the most readily identifiable type of hazard. Their threat is

Table 2 – Fixed Object Hazards

Barriers	Fences	Retaining Walls
Bridge Abutments	Guide Rails	Sign Posts
Bridge Rails	Guide Rail Ends	Trees, Shrubs
Bridge Rail Ends	Inlets	Tree Stumps
Bridge Piers	Light Poles	Utility Poles
Culverts	Mailboxes	Walls
Curbs	Parked Vehicles	

determined by their size, location, accessibility, proximity, forgiveness, and collision-consequence. Table 2 lists common fixed object hazards.

- **Moving Objects**
  Most moving object hazards, shown in Table 3, are associated with traffic. Vehicles potentially in conflict, such as cross-traffic, turning traffic, merging traffic, encroaching vehicles, etc. pose the greatest threats. In many locations, other moving hazards such as pedestrians, bicyclists, trains, and animals are significant. A finer-grained identification of moving object hazards, e.g., out-of-province trucks, young children, older pedestrians, tour buses, is also useful. Threat is assessed on the moving hazard's actions as well as its size and speed, e.g., a truck's last minute lane change, a pedestrian crossing mid-block, etc. Because moving hazards are transitory, and may rarely occur in low-volume situations, they can be difficult to capture during a drive-through. In these cases, their identification and threat assessment would be based on historic data and engineering judgement. At intersections, a traffic conflicts study is often used to identify accident potential.

- **Highway Conditions**
  Highway and traffic condition hazards are often difficult to identify because: they may not be readily apparent, e.g., a queue of traffic stopped beyond a crest vertical curve; they may be transitory in nature, e.g., potholes, maintenance operations; or they may not be associated with accidents, even though their accident potential is high, e.g., a narrow bridge, a railroad grade crossing. However, an experienced reviewer can generally spot condition hazards in the course of a drive-through. It is noted that many of the sources of expectancy violation, considered in subsequent activities, are actually condition hazards. Table 4 shows common condition hazards.

- **Situation Hazards**
  Situation hazards are usually the most difficult to identify and assess because they consist of fixed and/or movable objects in combination with condition hazards and may only occur under adverse environmental conditions. In many cases, the individual hazards are not a problem without fog, rain, snow, ice, blowing sand, smoke, darkness, etc. For example, overpasses are generally not hazardous until they freeze. Since situation hazards are transitory and often seasonal, it might not be possible to observe the site when it is hazardous. This requires a reliance on historical data, experience, and engineering judgement for situation hazard identification.

Table 3 – Moving Object Hazards

Animals	Deer	Recreational Vehicles
Automobiles	Encroachers	School Children
Bicylces	Golf Carts	Livestock on Road
Construction/Maintenance Vehicles	Oncoming Vehicles	Trains at Crossing
Construction/Maintenance Workers	Pedestrians	Trucks

Table 4 – Highway and Traffic Condition Hazards

Animal Crossing	Drawbridge	Maintenance Zone
Berm	Falling Rock Zone	Narrow Bridge
Bifurcation/Split	Fire Station	Narrow Lane/Shoulder
Bump/Speed Bump	Grade	No-passing/Passing Zone
Bus Stop	Height Restriction	One-lane Bridge
Closed Lane(s)	Hump Back Crossing	Pedestrian Crossing
Circles/Squares	Intersection	Pothole/Worn Pavement
Construction Zone	– Multi-legged	Queues
Contraflow Lane	– Offset	Rail-grade Crossing
Crest Vertical Curve	– Skewed	Sag Vertical Curve
Cross Section Change	– Tee	School Zone
Curve, Horizontal	– Uncontrolled	Superelevation Problem
– Compound	Interchange	Truck Restriction
– Reverse	– Tangent	Underpass/Overpass
– Vertical	– Multilane	Unpaved/Gravel Road
Cut/Fill Slope	Inadequate Merge	Unpaved Shoulder
Dip	Lane Drop/Interchange	Unmarked Lane/Road
Dirt Road	Lane Drop/Mainline	Weight Restriction
Ditch	Left Exit/Entrance	Weaving Section
Dirt Road	Low Water Crossing	Winding Road

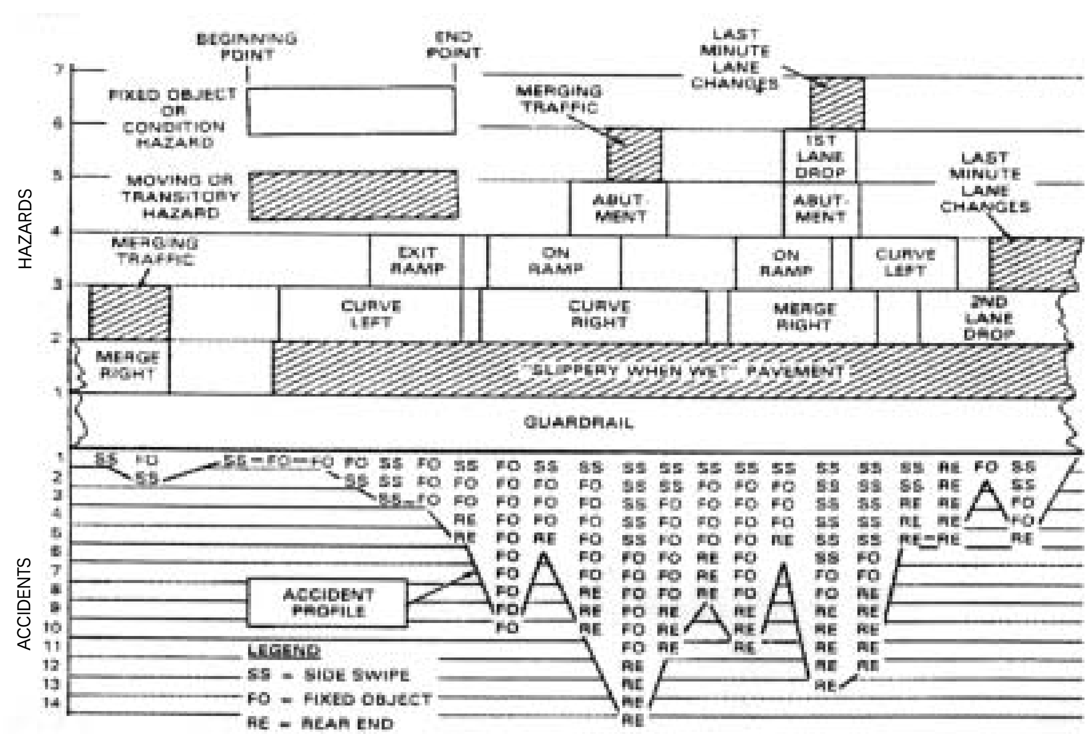
- **Inefficient Operations**
  Although hazard identification emphasizes safety-related hazards, it also addresses navigation problem sources that can result in inefficient traffic operations. It does not, however, address throughput problem sources (incidents, excess demand, insufficient capacity).

Inefficiencies are caused by and result in lost or confused drivers, less than optimum routing, wasted fuel, path confusion, and excess delay and travel time. Navigation problems are generally associated with choice points, i.e., intersections and interchanges. Problems can be caused by deficiencies in advanced guide signs, inadequate forward sight distance, poor choice point information, or path confusion at the choice point. Inefficient operations caused by navigation deficiencies are identified from complaint files, drive-through, and observing erratic manoeuvre, brake applications, slow driving, and tire marks on the pavement approaching or at the choice point.

Determination of Significant Hazard Clusters

Often, several hazards occur in such close proximity that they affect drivers as if they were one hazard. In this case, they are considered to be a hazard cluster. Constructing a hazard profile is an optional effort undertaken to identify or verify the existence of suspected clusters. The profile is generated by positioning all hazards in a given location along the X axis of a graph calibrated in distance units. When hazards overlap, they are plotted as hazard levels, along the positive Y axis. Accidents associated with a hazard are plotted on the negative Y axis, calibrated in accident frequency. The resultant profile of hazards plotted against accidents provides a graphic display of clusters (See Figure 7). However, it must be emphasized that there are often problems inherent in locating accidents from accident reports. Therefore, the profile should serve primarily as an indicator of a cluster's existence, and secondarily as an indicator of its location.

Figure 7 – Hazard Profile



Checklist 1 – Hazard Identification

Fixed Object (Accessible and Unprotected):

❏ Tree	❏ Utility Pole	❏ Parked Vehicle
❏ Sign Post	❏ Guide Rail End	❏ Bridge Abutment
❏ Curb	❏ Barrier	❏ Wall

❏ Other ____________________

Moving Object (Accessible and Unprotected):

❏ Cross Traffic	❏ Turning Traffic	❏ Merging Traffic
❏ Slow Moving/Stopped Traffic	❏ Trucks, Buses, etc.	❏ Railroad Trains
❏ Pedestrians	❏ Bicycles	❏ Animals

❏ Other ____________________

Highway Condition (Conditions Requiring Significant Speed/Path Modification):

❏ Inadequate superelevation	❏ Sharp Horizontal Curve	❏ Steep Grade
❏ Deficient Sight Distance	❏ Lane Width Reduction	❏ Mainline Lane Drop
❏ Inadequate Shoulder	❏ Inadequate Recovery Area	❏ Pothole
❏ Poor Drainage	❏ Worn Pavement	❏ Accessible Ditch
❏ Inadequate Diverge	❏ Optional Lane	❏ Short Weave
❏ Sharp Off-ramp Angle	❏ Tight Radius Loop Ramp	❏ Left-on Ramp
❏ Contraflow Lane	❏ Uncontrolled Intersection	❏ Narrow Bridge
❏ One-lane Bridge	❏ Draw Bridge	❏ Low Clearance
❏ Weight Restriction	❏ Work Zone	❏ School Crossing
❏ Railroad Crossing	❏ Pedestrian Crossing	❏ No-passing Zone
❏ Falling Rock Zone		

❏ Other ____________________

Checklist 1 – Hazard Identification (cont'd)

Situation (Combination of Objects, Conditions,and/or Environmental Effects):

- ❏ Icy Pavement
- ❏ Snow Covered Pavement
- ❏ Slippery Pavement
- ❏ Fog Area
- ❏ AM/PM Sun in Drivers' Eyes
- ❏ Standing Water
- ❏ Headlight Glare
- ❏ Object or Condition Beyond Crest Vertical
- ❏ Train in Unprotected Crossing
- ❏ Other ______________________________

Inefficiency (Feature that Leads to Directional Problems):

- ❏ Tangential Off Ramp
- ❏ Left Exit
- ❏ Exit Lane Drop
- ❏ Optional Lane Split
- ❏ Congested Intersection
- ❏ Detour
- ❏ T- or Y-Intersection
- ❏ Offset Intersection
- ❏ Circle or Roundabout
- ❏ Other ______________________________

Significant Hazards

List significant hazards and hazard clusters from preceding categories.

Fixed Objects: ______________________________

____

Moving Objects: ______________________________

____

Highway Conditions: ______________________________

____

Situations: ______________________________

____

Inefficiencies: ______________________________

____

Assessing Hazard Visibility

This part of the procedure is used in conjunction with Checklist 2 to determine whether hazard and hazard cluster visibility is adequate for a problem location's driving task requirements. When visibility is found to be inadequate, the assessment also provides criteria for the placement of advance warning information.

The objective of this activity is to assess each hazard and hazard cluster to determine if it can be detected, recognized, and its threat potential assessed in sufficient time for drivers to respond safely and efficiently. This assessment is made using land use, hazard avoidance manoeuvre, and speed to determine decision and stopping sight distance.

Determining Land Use and Hazard Avoidance Manoeuvre

A determination is made of the site's land use, which serves as a surrogate for visual clutter. Land use is categorized as rural (low clutter), suburban (moderate clutter), or urban (high clutter). Following this determination, a judgement is made as to whether the appropriate hazard avoidance manoeuvre is a stop or a change in speed, path or direction. For example, approaching an occupied railroad grade crossing, the appropriate manoeuvre would be to stop. On the other hand, the appropriate manoeuvre at a freeway exit or lane drop could be a path and directional change.

Specify Applicable Sight Distance Case

The land use/hazard avoidance manoeuvre determination is used to specify the applicable sight distance case from Table 5.

Table 5 – Sight Distance Case

Case	Land Use	Avoidance Manoeuvre
A	Rural	Stop
B	Suburban/Urban	Stop
C	Rural	Speed/Path/Direction
D	Suburban	Speed/Path/Direction
E	Urban	Speed/Path/Direction

Determine Approach Speed

In order to specify stopping and decision sight distances, the 85th percentile approach speed to the hazard or hazard cluster is determined and rounded to the higher 5 km/h increment.

The 85th percentile speed can be determined from a cumulative frequency distribution of spot speeds from a representative sample collected for the project, or from existing data, if available.

The 85th percentile speed can be calculated from existing mean speed **(M)** and standard deviation **(SD)** data using the formula:

85th Percentile Speed = M + [1.1 x SD]

If no data exist or can be collected, the 85th percentile speed may be estimated from the traffic stream, using the posted speed as a guide.

Determine Stopping and Decision Sight Distance

Once the case and 85th percentile speed has been derived for significant hazards and hazard clusters, stopping and decision sight distances are obtained from Table 6. This table presents desirable decision sight distance and calculated stopping sight distance values for cases A through E and for a

Table 6 – Stopping and Decision Sight Distance Values

Speed (km/h)	Stopping Sight Distance (m)	Decision Sight Distance (m) by Case				
		A	B	C	D	E
50	65	67	152	137	152	190
60	85	105	221	183	221	251
70	110	128	259	205	243	282
80	135	152	297	228	275	312
90	160	178	358	277	320	358
100	185	207	396	305	350	389
110	215	275	465	335	396	442

range of approach speeds from 50 km/h to 110 km/h. (As discussed in the AASHTO Green Book and adapted for use in Ontario.)[2]

Specifying Information Handling Zones

Five information handling zones are used to assess a hazard/hazard cluster's visibility and to locate hazard-associated information. Hazard visibility is ultimately rated on what zone the driver is in when he/she can first detect it, recognize it as a hazard, and recognize its threat; and where in the zone this occurs.

- Advance Zone – The advance zone is upstream of the hazard, beyond the decision sight distance. At best, a hazard might be visible toward the downstream end of the zone. This zone is used to display low primacy and supplemental information and to structure expectancies.
- Approach Zone – The approach zone is upstream of the hazard, beginning at the start of its decision sight distance and ending at the start of its stopping sight distance. Optimum hazard visibility should occur at the end of the advance zone or at the beginning of the approach zone. When the hazard is not visible, advance hazard warning information should be located in this zone.
- Non-recovery Zone – The non-recovery zone is upstream of the hazard, beginning at the start of its stopping sight distance and ending at the hazard. The hazard's visibility is sub-optimum in this zone, particularly approaching the hazard. Speed and path information is displayed in this zone.

2 *A Policy on Geometric Design of Highways and Streets;* Washington, DC: American Association of State Highway and Transportation Officials, 1990, pp. 125 to 127.

- Hazard Zone – The hazard zone encompasses the hazard. Information in this zone enhances hazard visibility through lighting, clearing sight lines, painting, hazard markers, etc.

- Downstream Zone – The location beyond the hazard is its downstream zone. This zone is primarily used for route confirmation, "pull-through", and low primacy information.

Rating Hazard Visibility

Using the stopping and decision sight distance values, a hazard-specific information handling zone diagram is developed. A drive-through is conducted to determine where the hazard is first visible and recognizable. The distance from this point to the hazard is measured, noted on the checklist, positioned on the diagram, and used to assess the hazard's visibility. Generally, the further upstream the hazard is detectable and recognizable, the better is its visibility.

Visibility Rating Scale – A five-point scale is used to rate how well a hazard can be detected and recognized:

1 = Excellent Visibility (detectable and recognizable in the advance zone);

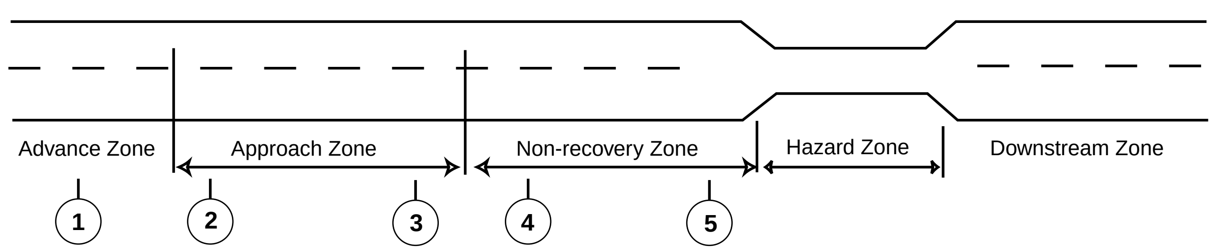
2 = Good Visibility (detectable and recognizable early in the approach zone);

3 = Fair Visibility (detectable and recognizable late in the approach zone);

4 = Poor Visibility (detectable and recognizable early in the non-recovery zone); and

5 = Very Poor Visibility (detectable and recognizable late in the non-recovery zone). If the hazard's visibility rating is poor, the assessment is used to position advance hazard warning information. The encircled numbers in Figure 8 shows the visibility rating scale relative to the information handling zones.

Figure 8 – Information Handling Zones



Checklist 2 – Hazard Visibility Assessment

Hazard Avoidance Manoeuvre

Assess each hazard or hazard cluster separately. Note significant hazards from Checklist 1. Start with hazard closest to reviewer and work downstream.

Determine Case from Tables 3 to 5.

Hazard(s) or Hazard Cluster(s)	Case				
a. ____________________________	A ❑	B ❑	C ❑	D ❑	E ❑
b. ____________________________	A ❑	B ❑	C ❑	D ❑	E ❑
c. ____________________________	A ❑	B ❑	C ❑	D ❑	E ❑
d. ____________________________	A ❑	B ❑	C ❑	D ❑	E ❑
e. ____________________________	A ❑	B ❑	C ❑	D ❑	E ❑

Specify posted, estimated or 85th percentile speed (km/h)

50 ❑ 60 ❑ 70 ❑ 80 ❑ 90 ❑ 100 ❑ 110 ❑

Determine Stopping and Decision Sight Distance for applicable speed and case from Tables 3 to 6.

	Sight Distance		
Hazard(s) or Hazard Cluster(s)	**Stopping**	**Decision**	**Visible**
a. ____________________________	__________	__________	__________
b. ____________________________	__________	__________	__________
c. ____________________________	__________	__________	__________
d. ____________________________	__________	__________	__________
e. ____________________________	__________	__________	__________

Checklist 2 – Hazard Visibility Assessment (cont'd)

Rate each hazard or hazard cluster in terms of its upstream visibility. 1 is the best, 5 is the worst.

Hazard(s) or Hazard Cluster(s)	Rating				
a. ______________________	1 ❏	2 ❏	3 ❏	4 ❏	5 ❏
b. ______________________	1 ❏	2 ❏	3 ❏	4 ❏	5 ❏
c. ______________________	1 ❏	2 ❏	3 ❏	4 ❏	5 ❏
d. ______________________	1 ❏	2 ❏	3 ❏	4 ❏	5 ❏
e. ______________________	1 ❏	2 ❏	3 ❏	4 ❏	5 ❏

Determining Expectancy Violations

The expectancy violation determination is designed to find out whether general, widely-held population expectancies are violated, and whether site-specific expectancies structured upstream of a problem location are violated downstream in the vicinity of the site being assessed. Data for this activity are collected from drive-through of the problem location and adjacent areas in all directions, often beginning at points considerably upstream of the site. In performing this step, each hazard should be assessed, and less obvious expectancy violation sources should be searched for. A key determination to make is whether drivers are being surprised by aspects of the site. Checklist 3 is used to help make these determinations.

The objectives of this activity are to obtain, through the performance of a general expectancy review, an overall impression of the area adjacent to the problem location, and to note potential sources of expectancies and expectancy violations; and to focus in on the area immediately upstream of the problem site to identify, through the performance of a detailed expectancy violation determination, sources of site-specific expectancies, and to determine whether these, and/or population expectancies have been violated downstream at the site.

General Expectancy Review

The general expectancy review is initiated well upstream of the problem location. Its purpose is to obtain a "feel" for areas that drivers will be passing through before negotiating the site. The general review should be accomplished from the perspective of a "stranger" who is unfamiliar with the area and road network. As much of the road that the problem is located on, upstream and downstream, and as much of the surrounding area as possible should be reviewed. If the problem site is in a low density rural location, the review should start several miles upstream, possibly where the road with the problem site junctions with a major primary route. If the problem site is in a high density urban location, the review should encompass as much of the adjacent street, arterial, and freeway network as possible, as well as several miles of the facility upstream of the problem. If the problem location is close to a jurisdictional boundary such as a provincial or district line, the general review should begin in the adjacent jurisdiction to note if changes occur across the boundary.

The general review is informal and can be performed in conjunction with drive-through from previous activities. However, it should be conducted when problems are occurring, such as during peaks, or at night. It is best to use pencil and paper or commentary driving to record observations, to take pictures of significant features, and to locate them relative to the problem site. The key in the general review is to identify changes and/or different or unusual practices that could affect expectancies.

Table 7 lists factors that should be considered in terms of changes from upstream to the site. This table could be brought to the field as an informal checklist. When general expectancy violations are found, they should be flagged for further assessment during the detailed expectancy violation review.

Table 7 – General Expectancy Review Factors

Factor	**Changes from Upstream to the Sight**
Abutting Land Use	Describe any changes.
Road Type, Surface, Cross-section	Describe any changes.
Terrain	Describe any changes.
Environment	Describe changes in ambient lighting.
Traffic	Describe changes in traffic volume, mix, operations.
Information	Describe changes in traffic control devices or other information displays. Are any aspects confusing, ambiguous or missing? Describe.

Checklist 3 – Expectancy Violation Determination

1. Are there unusual features or attributes that drivers find surprising?

- ❑ Intersections ____________________
- ❑ Interchanges ____________________
- ❑ Geometric Extremes ____________________
- ❑ Manoeuvre ____________________
- ❑ Cross Section Changes ____________________
- ❑ Roadway Environment Changes ____________________
- ❑ Regulatory Changes ____________________
- ❑ Off-line Restrictions ____________________
- ❑ Climatological ____________________
- ❑ Traffic Patterns/Vehicle Mixes ____________________
- ❑ Lighting ____________________
- ❑ Terrain Features ____________________
- ❑ Miscellaneous Features ____________________

2. Are there first-of-a-kind features?

3. Are there changes in the road that could surprise unfamiliar drivers?

- ❑ Land Use ____________________
- ❑ Road Type ____________________
- ❑ Road Surface ____________________
- ❑ Cross Section ____________________
- ❑ Operating Practices ____________________

4. Are there unexpected geometric inconsistencies?

5. Do any existing traffic control devices violate driver expectancy?

- ❑ Regulatory and Warning Signs ____________________
- ❑ Guide Signs ____________________
- ❑ Traffic Signals ____________________
- ❑ Markings/Delineation ____________________

Checklist 3 – Expectancy Violation Determination (cont'd)

❑ Work Zone Devices ______________________________

❑ Other ______________________________

6. Is any aspect of the route-following and direction-finding task surprising? Specify.

____

Expectancy Violation Visibilty

7. Rate each expectancy violation feature in terms of its upstream visibility. 1 is best, 5 is worst.

Expectancy Violation Feature	Rating				
a. ______________	1 ❑	2 ❑	3 ❑	4 ❑	5 ❑
b. ______________	1 ❑	2 ❑	3 ❑	4 ❑	5 ❑
c. ______________	1 ❑	2 ❑	3 ❑	4 ❑	5 ❑
d. ______________	1 ❑	2 ❑	3 ❑	4 ❑	5 ❑
e. ______________	1 ❑	2 ❑	3 ❑	4 ❑	5 ❑

Advance Warning

8. Is there advance warning of unexpected features? ❑ Yes ❑ No

9. If Yes, is it adequate? ❑ Yes ❑ No

10. Specify deficiencies: ______________________________

Overall Rating

11. Overall rating of site's expectancy violations.

❑ No Expectancy Violation Problem

❑ Minor Expectancy Violation Problem

❑ Major Expectancy Violation Problem

Detailed Expectancy Violation Determination

The difference between the general review and the detailed expectancy violation determination is that the detailed determination is more focussed, considers a much smaller area, and builds on the results of the general review. The detailed review usually starts at a convenient spot in the advance zone. It can be conducted in the field during a drive-through or in the office using suitable site photos, slides, or videos. In performing the review, the site-specific questions shown below, pertaining to expectancy violations and their sources, surprises, and first-of-a-kind features, such as those shown in Table 8, should be addressed. The adequacy of any advance warning and the visibility of expectancy violation sources are also rated.

- Does the site contain features or attributes that drivers might find unusual or special? Describe.
- Are there first-of-a-kind features? What are they?
- Are any features or attributes surprising? Describe them.
- Are there changes in the site's characteristics? What are the changes?
- Are there changes in the site's operating practices? What are they?
- Are there forward visibility restrictions? Describe them.
- Is there advance warning? Is it adequate?

The output of this activity is used to identify what expectancy violations require restructuring, and what the sources of the violations are. It addresses whether sources upstream of the problem location might have to be changed.

Information Load Analysis

Data for this activity are developed from a drive-through, using Checklist 4 to assess load factors and rate load potential. The factors serve as surrogates for processing load, thereby eliminating the need to count information sources and gauge their information content. Factors are assessed qualitatively, based on whether a low, moderate, or high information load is imposed. The individual load factors and overall site ratings are derived using engineering judgement.

Table 8 – First-of-a-Kind Features

Unusual Intersections	Circles, Roundabouts, Offset, Skewed, Angle
Unusual Interchanges	Multiple, Left, Weaving Sections
Extremes in Geometry	Grades, Dips, Sags, Sharp Curves
Cross-section Changes	Lane Drops, Shoulder/Lane Reductions
Unusual Manoeuvre	Weaves, "Jug Handles"
Unusual Traffic	Long Queues, Traffic Conflicts
Miscellaneous	School Zones, Construction and Maintenance Zones, Pedestrian Crossings, Railroad Crossings, Mid-block Signals

The objectives of this activity are to analyse the site in terms of a number of information load factors and rate its overall load potential. The overall site load potential is based on the number of load factor ratings in each processing load category. If virtually all factors are low, the site would have a potential for "underload," if virtually all factors are high, the site would have a potential for "overload," and, if most factors are moderate, there should not be any load problems at the site. The information load analysis is comprised of the following:

Information Load Factors

- Land Use
- Access Control
- Volume
- Speed
- Task / Manoeuvre
- Number of Hazards
- Hazard Visibility
- Sight Distance
- Expectancy Violations
- Clutter
- Competition
- Complexity

Individual Factor Ratings

- Low
- Moderate
- High

Overall Site Ratings

- Probable Underload (all factors rated low)
- Possible Underload (most factors rated low)
- No Load Problems (most factors rated moderate)
- Possible Overload (most factors rated high)
- Probable Overload (all factors rated high)

Information Load

Driver performance is usually most consistent, reliable and predictable when there is a steady, moderate level of information to process. Since processing capability varies from driver to driver, it is not possible to specify with precision how many information sources or how much information content per source is too little or too much. It is also difficult to tell which or how many sources of information a driver is attending to, and the information content of an individual source. One or two sources is usually considered a low information load, and more than seven to nine sources is usually considered a high information load.

Rather than counting all information sources and quantifying each source's information content, in bits, the information load analysis uses a qualitative approach. It estimates the processing load imposed on the driver from a number of site-related factors and uses the aggregate of these estimates to determine the site's overall processing load. The individual factor and overall ratings are derived using engineering judgement, with the overall rating based on how most of the factors are rated:

- Low Load – If most or all factors are rated low, there is an underload possibility.
- Moderate Load – If most or all factors are rated moderate, there should be no load problems.
- High Load – If most or all factors are rated high, there is an overload possibility.

Checklist 4 – Information Load Analysis

1. Evaluate information processing load factors:

		Low	Moderate	High
a.	Land Use	❑ Rural	❑ Suburban	❑ Urban
b.	Access Control	❑ Full	❑ Partial	❑ None
c.	Traffic Volume	❑ Low	❑ Moderate	❑ High
d.	Operating Speed	❑ Low	❑ Moderate	❑ High
e.	Task Complexity	❑ Simple	❑ Moderate	❑ Complex
f.	Hazard(s)	❑ None	❑ One or Two	❑ Multiple
g.	Hazard Visibility	❑ Good	❑ Fair	❑ Poor
h.	Sight Distance	❑ Good	❑ Fair	❑ Poor
i.	Expectancy Violations	❑ None	❑ Minor	❑ Major
j.	Visual Clutter	❑ None	❑ Moderate	❑ High
k.	Competing Information	❑ None	❑ One or Two Sources	❑ Many
l.	Information Complexity	❑ Simple	❑ Moderate	❑ Complex

2. Rate overall information load:

❑ Very Low Information Load – Underload
(This condition is very unlikely except for flat, straight roadways in open farm country)

❑ Low Information Load – Possible Underload
(Look for incidence of single vehicle run off road accidents)

❑ Moderate Information Load

❑ High Information Load – Possible Overload
(Look for incidence of intersection accidents in suburban and urban areas)

❑ Very High Information Load – Overload
(This condition is likely to occur at or near major interchanges
on high volume urban freeways)

Specifying Information Needs

This activity uses Checklist 5 to specify information needs. Information needs are specified analytically. Inputs are obtained from determinations of the site's problems, its hazards and their visibility, expectancies and expectancy violations, and information load. Additional input comes from information about the laws, rules, regulations, and practices of the jurisdiction in which the problem site is located.

The objective of this activity is to identify site-specific information needed to negotiate the site safely and efficiently. The following needs are identified:

- Laws, Rules, Regulations, Practices
- Hazard Warning
  - Advance Warning / Hazard Identification
  - Safe Speed and Path
  - Speed and Path Changes
  - Hazard Visibility Enhancement
- Navigation / Route Guidance
  - Advance Guide Signs
  - Location
  - Direction
  - Destination
  - Route Confirmation / Turns
- Other Needs
  - Service
  - Landmarks
  - Traffic Generators

Table 9 shows information needs by information handling zones.

Table 9 – Standard Information Needs by Zones

Advance Zone	Approach Zone	Non-recovery Zone	Hazard Zone	Downstream Zone
Expectancy Needs	Advance Hazard Warning Needs	Speed and Path Implementation Needs	Hazard Detection Enhancement Needs	Low Primacy Needs
Low Primacy Needs	Speed and Path Selection Needs		Speed and Path Implementation Needs	

Checklist 5 – Information Needs Specification

Are there traffic laws and regulations information needs? ❑ Yes ❑ No

❑ Right of Way ______________________ ❑ Speed ______________________

❑ Parking ______________________ ❑ Pedestrian ______________________

❑ Other ____

Are there hazards/expectancy violations warning information needs? ❑ Yes ❑ No

❑ Alignment Change ______________ ❑ Intersection ______________

❑ Traffic Control Devices ______________ ❑ Converging Lanes ______________

❑ Road Narrows ______________ ❑ Changes in Design ______________

❑ Grades ______________ ❑ Surface Condition ______________

❑ Railroad Crossings ______________ ❑ Entrances/Crossings ______________

❑ Other ____

Is hazard visibility poor? Are expectancies violated? Is sight distance restricted? ❑ Yes ❑ No

Advance hazard/expectancy violation warning information needs: ______________________

Is a safe speed and/or path apparent? ❑ Yes ❑ No

Safe Speed Needs ______________________ Safe Path Needs ______________________

Is speed or path change information needed? ❑ Yes ❑ No

Speed/Path Change Information Needs: ______________________________

Is hazard/expectancy violation detection enhancement needed? ❑ Yes ❑ No

Detection enhancement needs: ______________________________

Is route guidance information needed? ❑ Yes ❑ No

❑ Route Marking ______________________ ❑ Intersection/Interchange ______________

❑ Destinations ______________________ ❑ Services ______________________

Is advance information needed? ❑ Yes ❑ No

Specify other information needs, if any: ______________________________

Evaluating the Current Information System

The final diagnostic activity, the current information system evaluation, uses Checklist 6 as an aid. The current information system is evaluated in terms of 12 rating factors, using information from the previous activities as input, and engineering judgement to make individual and overall information system evaluations.

The objective of this activity is to evaluate the suitability of the overall existing information system and each of its elements (traffic control devices, informal information carriers, sight lines, etc.) in fulfilling information needs and overcoming problems identified by all activities in the Positive Guidance procedure. This determination is needed during the improvement development phase to insure that effective elements of the current information system are retained, and unsatisfactory ones improved.

Questions associated with the following current information system's rating factors should be answered:

Presence

Are there traffic control devices or other information displays in place that satisfy each identified information need? If not, what needs are not satisfied?

Location

If needed information carriers are in place, are they properly located (visible when needed and where required)? What are the nature of deficiencies (e.g., too close, too much offset, etc.)?

OTM Compliance

Are standard devices used in accordance with the OTM? What nonstandard devices are used?

Expectancy Violations

Do expectancy violations exist? Are they caused by the site's information displays? Are violated expectancies adequately restructured by current displays? If they exist and are not adequately restructured, what are the source(s) of each violation?

Superfluous Displays

What displays are superfluous, and how can they be dealt with? Are there too many displays? Are any information sources in place of either a very low primacy or unnecessary? Can they be spread or eliminated?

Field of View

Is current information located within a driver's field of view? Is blockage possible? If deficiencies exist, what are they?

Target Value

Are devices conspicuous enough (day and night) to gain a driver's attention, particularly when there is visual clutter? Are special attention-gaining techniques (e.g., oversized signs, beacons, etc.) needed? What can be done?

Content

Is the information content of a display very high? Can it be reduced or simplified? How can content be reduced?

Checklist 6 — Current Information System Evaluation

1. Are any information needs unsatisfied? ❑ Yes ❑ No
   If Yes, Specify: ______________________________
2. Are all information sources properly located? ❑ Yes ❑ No
   If No, Specify: ______________________________
3. Do all traffic control devices comply with the OTM? ❑ Yes ❑ No
   If No, Specify: ______________________________
4. Do any information sources violate driver expectancy? ❑ Yes ❑ No
   If Yes, Specify: ______________________________
5. Are there locations of likely information overload? ❑ Yes ❑ No
   If Yes, can some devices be moved or eliminated? ❑ Yes ❑ No
   If Yes, Specify: ______________________________
6. Are all information sources visible from all driver eye positions? ❑ Yes ❑ No
   If No, Specify:
7. Are any information sources too inconspicuous to be seen? ❑ Yes ❑ No
   If Yes, can special emphasis techniques be used? ______________________________
   If Yes, Specify: ______________________________
8. Do any signs contain too much information to be read completely? ❑ Yes ❑ No
   If Yes, Specify: ______________________________
   Recommend improvement: ______________________________
9. Are any signs inaccurate, confusing, ambiguous or unreadable? ❑ Yes ❑ No
   If Yes, Specify: ______________________________

Accuracy

Is the displayed information accurate? Current? Credible? What inadequacies exist?

Understandability

Is the information displayed understandable to unfamiliar drivers? If not, why?

Ambiguity

Is the displayed information potentially ambiguous? Can it create confusion for unfamiliar drivers? What makes it ambiguous?

Legibility

Is the information legible at the road's operating speed to drivers with 20/40 vision? Is there sufficient contrast? Can it be read and acted on? What makes it illegible?

Developing Improvements

There is no formula procedure for improvement development except as province wide design and traffic control device policies dictate. This is due primarily to the broad range and diversity of problems that occur, their site-specific nature, and the wide spectrum of potential solutions.

As a beginning step in this phase, if there are unsatisfied information needs identified in Checklist 6, it is appropriate to make a comprehensive list of all current standard traffic control devices that address each specific need. However, it is important to recognize that some needs are not addressed by traffic control devices, and solutions to some problems might not involve and/or might go beyond improving the site's information system with traffic control devices. For example, positive guidance can be achieved through reconstruction to remove hazards. Positive guidance can also be achieved by:

- Enhancing a hazard's sight distance;
- Removing structures, foliage and berm;
- Painting curbs;
- Lighting crossings, crosswalks, interchanges, and freeways; and
- Altering a site's traffic operations through one-way streets, commercial vehicle restrictions, and signal timing changes.

However, in many cases, Positive Guidance improvements will involve optimizing the site's information system through traffic control devices.

After the Positive Guidance procedure has been completed, potential devices, techniques, and strategies that could be used to improve the site's safety and operating efficiency should be identified and assessed, and an improved information system that fulfills all information needs should be developed. Consideration should be given to selecting devices that the procedure has identified as needed, and by applying the following selection factors.

Historical Effectiveness

MTO and other jurisdictions within the Province use a repertoire of techniques, devices, and strategies that have proven to be effective in past applications. It is generally proper to use these practices in similar applications. All jurisdictions within the Province should therefore use appropriate solutions with demonstrated historical effectiveness when applicable.

Human Factors Considerations

Section 2 of this Appendix C contains human factors considerations that should be addressed in device selection. These include basic concepts about the driver and the driving task, and sight distance criteria.

Target Populations

When the procedure identifies the existence of significant target populations (e.g., older drivers, non-english speaking drivers, truckers, motorcyclists, pedestrians), devices should be designed or selected that take their special needs or attributes into account to the maximum extent possible.

OTM Effectiveness Criteria

The combined books of this *Ontario Traffic Manual* comprise the Provincial standard governing the design and deployment of traffic control devices. Keep in mind five basic traffic control device selection criteria:

- Fulfill a need;
- Command attention;
- Convey a clear simple meaning;
- Command the respect of road users;
- Give adequate time for a proper response.

Standardization

Standard traffic control devices, specified in the OTM and consistently applied across the province, reduce ambiguity, and assure universal understanding. On the other hand, non-standard devices and applications might result in confusion, since their meaning might not be readily apparent, particularly to unfamiliar drivers. Standardization also facilitates the “self-learning” of new devices and applications, since drivers will always be able to link situations with device applications, thereby learning their meaning.

It is recognized that there are applications for which no standard device exists, and that nonstandard devices might be necessary. For example, there is no standard sign to alert drivers of upcoming grooved or milled pavement in a construction zone. In these instances, if a non-standard or experimental device is developed, the device should be pretested to assure that it is readily understood, adheres to OTM requirements, and employs sound human factors display criteria. Use of non-standard devices should be kept to a minimum, and when used, their effectiveness should be evaluated.

Engineering/Economic Considerations

Engineering and economic considerations that affect device selection and improvement design include costs, available funding, implementation time frame, feasibility, device availability, installation requirements, reliability, maintenance factors, service life, climate, etc. Many of these considerations cannot be assessed until devices have been selected and display techniques identified. It might be necessary to perform highway engineering economy and trade-off studies to finalize site improvements.

Information Display Techniques

It is beyond the scope of this Appendix C to discuss the range of standard and nonstandard traffic control devices and display techniques available to improve the site’s information system. Standard devices specified in the OTM include fixed and variable signing, marking and delineation, signalization, curbs, islands, gates, barricades, etc. Display techniques include verbal messages, symbols, shape and colour codes, flashing warning lights, painted markings, raised reflectorized pavement markers, gates, lights, repetition and redundancy, overhead sign installations, oversized displays, etc. There are also numerous nonstandard and state-of-the-art devices and techniques such as real-time variable message signs, Highway Advisory Radio, and in-vehicle information and navigation systems.

4. Case Studies

4.1 Introduction

This section illustrates the application of the Positive Guidance procedures to supplement the systematic safety review engineering studies and give additional insights into drivers' problems such as expectancy violations, and information handling. The following materials contains neither the detail of a full case study nor full Positive Guidance procedures, however, a comprehensive discussion of a case study is provided in the Training Package associated with the OTM Book 1, Appendix C.

The training package includes a case study of an urban intersection in the Region of Niagara, with an intention to introduce the methodology of conducting a safety review applying the Positive Guidance Procedures. The purpose of the safety review is to identify any operational deficiencies affecting traffic and pedestrians safety, develop and evaluate potential mitigating measures to reduce collision risk. The study includes a safety-oriented benefit-cost analysis to demonstrate the value of the feasible countermeasures.

4.2 General Procedures

The Positive Guidance principles and systematic procedures were followed to review the historic data, conduct the office reviews, and site surveys. The data of roadway geometry, traffic volumes, collision history and traffic conflict characteristics were reviewed accompanied by completing Checklist during the site investigation to generate and evaluate improvement options. The undertaken steps are summarized as follows:

Diagnosis of Deficiencies

(1) Data Collection and Office Review:
Intersection turning movement, collision history, geometric features, access points to adjacent land use developments, traffic control devices, signs, etc.

(2) Site Investigations:
Site survey, complete checklists for hazard identification, hazard visibility assessment, expectancy violation, information load analysis, information needs specification, and current information system evaluation, traffic conflict observations, and spot speed survey, etc.

Development of Countermeasures

(1) Development of potential countermeasures based on the identified deficiencies, understanding of the driving behaviour, and feasible solutions.

(2) Estimation of expected safety benefits based on Accident Modification Factors (AMF), previous experiences, research work, etc. It should be noted that the current calibrated AMFs are not very definitive to estimate the expected reduction of the collisions, however, they are used to predict ranges of safety benefits associated with the implementation of specific countermeasures. On-going and future research work can provide better estimates to substitute the current ones.

Recommendations and Conclusion

Evaluation of recommended countermeasures and improvements is based on the benefit-cost analysis. Costs are based on the cost of improvements and benefits are expected savings in collisions.

4.3 Urban Intersection Case Study

Site Location

This is a case study of an urban intersection in the Region of Niagara. The intersection is located in the south east section of the City of Niagara Falls, providing access to major nodes of attraction such as Casino Niagara, the Falls, Museums, and Maple Leaf Village. The Region identified this intersection as a deficient intersection which had high motor vehicle collision risk and safety concerns, and extensive land use activities.

The purpose of the study is to conduct a review of traffic conditions and collision characteristics to identify any operational deficiencies affecting traffic and pedestrians safety, and to develop and evaluate potential mitigating measures to reduce collision risk. The study includes a safety-oriented benefit-cost analysis to demonstrate the value of the feasible countermeasures.

The Positive Guidance principles and systematic procedures were followed to review the historic data, conduct the office review, and site surveys. The data of geometry, traffic volumes, collision history and traffic conflict characteristics were reviewed accompanied by checklists for hazard identification, hazard visibility assessment, expectancy violation, information load analysis, information needs specification, and current information system evaluation. The undertaken steps are summarized as follows:

(1) The geometric review included the inspection of the road cross section characteristics, land use, parking restrictions, horizontal and vertical alignments, and intersection traffic control devices at the intersection.

(2) Intersection turning movement data were collected and the intersection capacity was evaluated using the Highway Capacity Software, where a level of service is assigned to the intersection legs (varying from A to F). Levels of Service A and B indicate generally good conditions with minimum traffic delays. Levels of Service C and D indicate average conditions with acceptable delays. Levels of Service E and F indicate poor conditions with long delays and potentially significantly queuing.

(3) Summaries and original police records of motor vehicle collisions reported in the three years from 1994 to 1996, were provided by the Region. Collisions were segregated into 12 types, using the information available in the police report and the police officer sketches. These types are categorized as crossing, left-turn opposing, left-turn crossing, rear-end, weaving, sideswipe, cyclists, pedestrian, fixed objects, right-turn, and head-on.

(4) A review of collision characteristics was conducted including temporal and spatial distributions, collision types, and collision severity. Contributing causes to the motor vehicle collisions were reviewed and trends were established.

(5) Site investigations were conducted by drive-through, and walk-through. A traffic conflict survey was conducted by field observations of 32-person hours of traffic operation at the intersection. The purpose of this survey was to gain further insight into the collision risk. Also, spot speed survey was performed near the intersection (30 m to 40 m from the intersection) to find out any evidence of speeding at this location.

(6) Findings and results were analysed, safety-related problems were identified at the intersection and mitigation strategies were developed.

More details of summaries of the collected data, conducted analysis, completed checklists, traffic conflict analysis, and speed surveys, recommended countermeasures, and a safety oriented benefit-cost analysis to demonstrate the value of the feasible counter-measures, are included in the training package case study.

Enquiries regarding the purchase and distribution of this manual should be directed to:

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