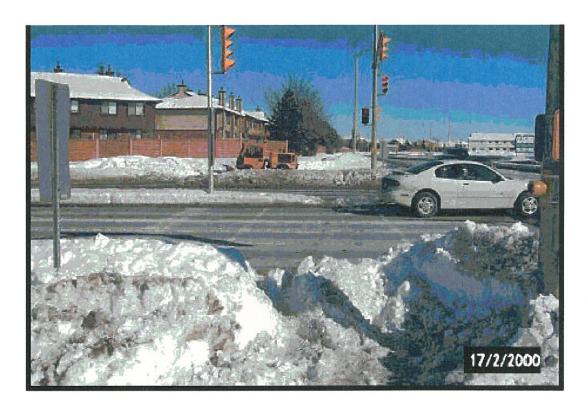
Walking Security Index Pilot Study





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Walking Security Index Pilot Study



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TABLE OF CONTENTS

A.	EXECUTIVE SUMMARY
В.	PILOT STUDY OBJECTIVES AND BACKGROUND
1.	Study Origin and Purpose
2.	Pilot Study Scope and Methodology
3.	Organization of the DBI Report
4.	Notes
C.	RESEARCH DESIGN
1.	Outline of the Research Problem and Process
2.	Representing Data, Scores and Rankings
	A. Number of Years of Data Coverage
	B. Accounting for Seasonality
	C. Peak Hours
	D. Minimizing Bias in Scores and Rankings
	E. Representativeness of Pilot Study Scores and Rankings
6.	Notes
D.	AVAILABILITY OF CITY OF OTTAWA BASE DATA FOR
	INDEX SCORE CALCULATIONS
1.	Review of Findings and Comments About Data Availability
2.	Availability of Intersection Volume and Design Index (IVDI) Data
3.	Availability of Quality of Intersection Condition Index (QICI) Data
4.	Availability of Driver Behaviour Index (DBI) Data
	A. Problems with City of Ottawa Data on Light-Related Incidents
	B. Problems with City of Ottawa Data on Fail-to-Yield Incidents
5.	Summary Findings About Data Availability
6.	Notes
E.	FIELDWORK FINDINGS AND COMMENTS ABOUT
	DATA AVAILABILITY
1.	Review of QICI and DBI Fieldwork Programs
2.	QICI Data from Fieldwork
3.	DBI Data from Fieldwork
4.	General Finding

5.	Notes
F.	CALCULATING INDEX SCORES
1.	Overview of Findings About Calculating Index Scores
2.	Calculating Intersection Volume and Design Index (IVDI) Scores
	A. Weighted Passenger Car Equivalent-Pedestrian Interaction Potential
	(WPCE-PIP) Index
	B. Intersection Pedestrian Challenge-Features (IPC-F) Index
	C. Intersection Volume and Design (IVD) Index
	D. Priority (P) Index
3.	Calculating QICI Scores
4.	Calculating DBI Scores
5.	Calculating IVDI, QICI and DBI Scores: General Finding
6.	Notes
G.	RANKING INDEX SCORES
1.	Overview of Findings About Ranking Index Scores
2.	Ranking IVDI Scores
3.	Ranking QICI Scores
4.	Ranking DBI Scores
5.	Ranking Index Scores: General Finding
6.	Notes
Н.	DEMONSTRATING DBI OPERATIONALITY
1.	Elements of Operationality
2.	Acquiring the Needed Data
3.	Organizing the Data for Index Calculations
4.	Calculating Index Scores
5.	Ranking Index Scores
6.	Notes
I. [DEMONSTRATING INDEX UTILITY
1.	Extending the Pilot Study Statement of Work

2.	Exam	ples of Utility-Oriented Pilot Study Results	90		
	A. P	eak Hour Intervals	90		
	B. S	easonal Patterns	91		
	C. Critical Failure				
	D. W	/eighted Variables	95		
	E. Ir	ndex Values as Research Aids and Decision Guides	95		
	F. In	clusion of Experts	97		
3.	Notes		98		
J.	CONC	CLUSION	101		
1.	Gene	ral Findings	101		
K.	REFE	RENCES	103		
L.	APPE	NDICES	106		
	Apper	ndix A. Terms of Reference, Walking Security Index Pilot Study	107		
	Apper	ndix B Acknowledgements	114		
	Apper	ndix C. Walking Security Index Publications	115		
		LIST OF FIGURES			
Fig	ure 1	Variable Evaluation Criteria Used to Design and Assess Walking			
		Security Index Research	15		
Fig	ure 2	Quality of Intersection Conditions (QIC) Index: Checklist of Core			
		Variables for Rating Intersection Design and Maintenance Features	36		
		LIST OF TABLES			
Tab	ole 1A	Questions Used to Set the Design Parameters for			
		Walking Security Index Tests of Operationality: IVDI	18		
Tab	le 1B	Questions Used to Set the Design Parameters for			
		Walking Security Index Tests of Operationality: DBI	19		
Tab	ole 1C	Questions Used to Set the Design Parameters for			
		Walking Security Index Tests of Operationality: QICI	20		
Ta	ble 2	Research Design Concerns, Problems, Issues, or Questions			
		Common to Two or Three Indexes	22		

rable 3	variables Used to Conduct the Inventory and Assessment of
	IVDI Data Holdings
Table 4	Variables Used to Conduct the Inventory and Assessment of
	QICI Data Holdings
Table 5	Variables Used to Conduct the Inventory and Assessment of
	DBI Data Holdings
Table 6	QICI Fieldwork Form Completed by a Community Association:
	Dalhousie Community Association
Table 7	DBI Field Report, WSI Pilot Study: King Edward and Rideau
Table 8	DBI Field Report, WSI Pilot Study: Bronson and Carling
Table 9	DBI Field Report, WSI Pilot Study: Bearbrook and Innes
Table 10	Values of Variables and Weighted Passenger Car Equivalent –
	Pedestrian Interaction Potential Index Scores, Pilot Study
	Intersections: Data and Calculations from ROC Counts Taken in
	1999, 1998, 1997 and 1995
Table 11	Values of Variables and Intersection Pedestrian Challenge –
	Features Index Scores, Pilot Study Intersections: Data and
	Calculations from ROC Counts Taken in 1999, 1998, 1997 and 1995
Table 12	Values of Variables and Intersection Volume and Design Index
	Scores, Pilot Study Intersections: Data and Calculations from ROC
	Counts Taken in 1999, 1998, 1997 and 1995
Table 13	Values of Variables and Priority Index Scores, Pilot Study
	Intersections: Data and Calculations from ROC Counts Taken in
	1999, 1998, 1997 and 1995
Table 14	Weighted Passenger Car Equivalent – Pedestrian Interaction
	Potential Index Scores and Priority Index Scores, Pilot Study
	Intersections: Data and Calculations from ROC Counts Taken in
	1999, 1998, 1997 and 1995
Table 15	Intersection Pedestrian Challenge – Features Index Scores, and
	Priority Index Scores, Pilot Study Intersections: Data and
	Calculations from ROC Counts in 1999, 1998, 1997 and 1995

Table 16	Intersection Volume and Design Index Scores, and Priority Index	58
	Scores, Pilot Study Intersections: Calculations from ROC Counts	
	Taken in 1999, 1998, 1997 and 1995	
Table 17	QICI Field Report, WSI Pilot Study: Carlingwood SC and Carling	60
Table 18	QICI Field Report, WSI Pilot Study: Hawthorne and Main	61
Table 19	Median QIC Index Scores, Winter 2000: AM, Noon and PM Peak	
	Hours	62
Table 20	Median QIC Index Scores, Fall 1999: AM, Noon and PM Peak	
	Hours	63
Table 21	Community Association Test of QICI Form B-4:	
	Carling and Fairlawn/Woodroffe	64
Table 22	Community Association Test of QICI Form B-4:	
	Parkdale and Wellington	65
Table 23	Community Association Test of QICI Form B-4:	
	Bronson and Somerset	66
Table 24	Community Association Test of QICI Form B-4:	
	Garland and Somerset	67
Table 25	Scores and Ratios for Intersections Evaluated by Community	
	Association Members Using QICI Form B-4	68
Table 26	DBI Field Report, WSI Pilot Study: Elgin and Laurier	71
Table 27	Field Counts of Aggressive Driving Incidents and Signal Phases, AM,	
	Noon and PM Peak Hours: Elgin and Laurier	72
Table 28	Aggressive Driving Incidents Per Signal Phase,	
	AM, Noon and PM Peak Hours: Elgin and Laurier	73
Table 29	Driver Behaviour Index Scores for Intersection Quadrants:	
	PM Peak Hour, Fall 2000	74
Table 30	Master List of Driver Behaviour Index Scores: Fall 2000	75
Table 31	Median IVDI Scores, All Pilot Study Intersections: PM Peak Hour	77
Table 32	Rankings Based on Median IVDI Scores, All Pilot Study	
	Intersections: PM Peak Hour	78

Table 33	Ranked Order of Pilot Study Intersections Based on Median Scores,	
	Intersection Volume and Design Index and Priority Index:	
	PM Peak Hour	79
Table 34	QICI Rankings Master List: AM, Noon, PM Peak Hours,	
	Winter 2000	81
Table 35	Scores and Ratios for Intersections Evaluated by Community	
	Association Members Using QICI Form B-4	82
Table 36	Master List of Driver Behaviour Index Rankings, Pilot Study	
	Intersection Quadrants: Fall 2000 (Partial Listing for	
	Illustrative Purposes)	84
Table 37	Key Parameters of Data Organization for the IVD, QIC and	
	DB Indexes	87

A. EXECUTIVE SUMMARY

Walking Security Index (WSI) research began in 1996, funded by the Region of Ottawa-Carleton. Based on the final project report (*Walking Security Index*) that was published in 1998, Regional Council in 1999 approved a pilot study to test the operationality of three macro indexes designed to measure pedestrians' security (safety, comfort, convenience) at signalized intersections. The three macro indexes are:

- Intersection Volume and Design Index (IVDI)*.
- Quality of Infrastructure Condition Index (QICI).
- Driver Behaviour Index (DBI).

The tests for operationality are complete, and are published in (six) reports – two for each index – previously submitted to the client. In addition, presentations on pilot study findings were made to the Transportation and Transit Committee, City of Ottawa, on November 7, 2001, and to the Police Services Board, City of Ottawa, on November 26, 2001. The materials used for the public presentations to city officials are included in the Minutes of the Transportation and Transit Committee meeting, and can be viewed at: http://www.city.ottawa.on.ca/calendar/ottawa/citycouncil/ttc/2001/11-07/minutes15.htm

In the next several pages the key initiatives and test results associated with each index – IVDI, QICI, DBI – are drawn from the respective pairs of pilot study reports. The Executive Summary is then concluded by comments on eight general findings – lessons learned, recommendations, concerns, etc. – that appear to be of critical importance to decisions and actions which affect index implementation and application.

Intersection Volume and Design Index (IVDI)

The formulation,

IVDI = (WPCE-PIP) • (IPC-F)

where,

-

^{*} This macro index was originally titled the Basic Walking Security Index (BWSI). The change in terminology was made in order to better represent a) the concepts imbedded in the index, and b) the variables used to operationalize the concepts.

IVDI = a composite index score ranking signalized intersections according to the likelihood that pedestrians' security expectations are matched by experiences,

WPCE-PIP = an index score representing the quantity of potential interactions between pedestrians and vehicles,

IPC-F = an index score that represents the magnitude of challenge to pedestrians' security caused by intersection design features,

was created to measure the combined effect of traffic volumes and intersection design features on pedestrians' safety, comfort, convenience.

The IVDI (BWSI) *Technical Supplement* contains more than 200 tables of index data, scores and rankings for the 33 pilot study intersections. Key findings from the analysis and synthesis of data tables, index scores and index rankings are summarized as follows.

- All data needed to calculate IVD index scores are specified, acquired and organized into data tables. As a result of being able to build the needed database, the <u>availability of data criterion</u> for assessing index operationality is satisfied.
- 2. All calculations needed to demonstrate operationality are performed, all index scores and rankings resulting from the calculations are transparent, and various ways of presenting index rankings for compare/contrast purposes are readily available via elementary design choices. As a result of being able to perform all calculation tasks with relative (technical) ease, the <u>degree of difficulty criterion</u> for assessing index operationality is satisfied.

3. All parts of the index implementation process are demonstrated to be operational, and the rankings of intersections can be directly used for interpretation, evaluation or other policy, plan and program purposes. In other words, the pilot study tests demonstrate that the IVDI is fully functional in every respect. As a result of demonstrating that the index is fully workable in a real-world setting, the pertinence criterion for assessing index utility is satisfied.

The general test conclusion is that the Intersection Volume and Design Index is fully operational, and that it effectively contributes to evaluating signalized intersections from the perspective of pedestrians' safety, comfort, convenience.

Quality of Intersection Condition Index (QICI)

The QICI test for operationality included developing and evaluating several alternative forms for making and recording field observations. The content and structure of the quadrant-based QICI form adopted for test purposes is shown on the next page.

The major comments about and findings from the QICI test for operationality are summarized as follows.

- 1. When the study was undertaken, the client's holdings of QICI data (operations, complaints) were sparse. That occurred because responsibility for a number of QICI variables rested with lower-tier municipalities. It is reasonable to anticipate that the transition to one-tier government in Ottawa-Carleton, and the integration of QICI-relevant files, will substantially increase the availability of QICI data needed for intersection rating purposes.
- The fieldwork form designed for observing and recording the condition of intersection design and maintenance features is found to satisfy the <u>data availability</u> and <u>degree</u> <u>of difficulty criteria</u>. As a result, the fieldwork form designed to assist in implementing the QIC Index is found to be operational.

Quality of Intersection Condition Index (QICI) Field Form

		Yes Condition Met No (Quadrant) NW NE SE	Condition Met			
ID #	Variable Names for Intersection Design and Maintenance Features					
			NW	NE	SE	SW
1	Sidewalk corner capacity					
2	Height of curbing					
3	Condition of curbing					
4	Sidewalk width capacity					
5	Sidewalk condition					
6	Crosswalk surface condition					
7	Median (refuge) capacity					
8	Median (refuge) condition					
9	Traffic calmer(s)					
10	Channel island (refuge) capacity					
11	Crosswalk capacity					
12	Crosswalk signed and painted					
13	Stop bar painted and signed					
14	Pedestrian signage					
15	Sight line obstruction					
16	Street furniture proximal to corner					
17	Ice/snow/slush removal				·	
18	Water drainage					
	Totals					
	Overall Score (YES – NO =):					

- 3. The task of producing index scores and rankings by applying the QIC Index is found to satisfy the <u>degree of difficulty criterion</u>. As a result, QIC Index operationality is demonstrated with regard to computing index scores and rankings.
- 4. Testing of the fieldwork form by community association members allowed for an important refinement to QICI methodology. That is, the ratio of actual scores and potential scores (actual scores ÷ potential scores) is found to be a definitive means of assessing intersections in regard to the condition of their design and maintenance features.

It is our summary finding, therefore, that the QIC Index satisfies the data availability and degree of difficulty tests of operationality. And, it is an associated finding that the actual score ÷ potential score ratio appears to have great merit for QICI ranking purposes.

Driver Behaviour Index (DBI)

Driver Behaviour Index =
$$\frac{ALI}{P} + \frac{RLI}{P} + \frac{FTYI}{P}$$

where,

 $\frac{ALI}{P}$ = amber-light incidents per phase,

 $\frac{RLI}{D}$ = red-light incidents per phase,

 $\frac{\text{FTYI}}{P}$ = fail-to-yield incidents per phase.

was created to serve the client's interest in combining light-related and fail-to-yield incidents of aggressive driving. The DBI formulation appears to be fully operational in both its structural and functional aspects.

As noted in reports and presentations to officials, at the present time the City of Ottawa does not have on file nor does it collect the data needed to implement the Driver Behaviour Index. However, in view of our ability to design and conduct a fieldwork program that generated all the data needed to test the DBI in the pilot study, it is our finding that the <u>data availability criterion</u> can be met, and that the <u>degree of difficulty</u> criterion is satisfied for data collection purposes.

Further, on the basis of knowledge gained from the research on IVDI and QICI components, and previous experience with the Region of Ottawa-Carleton and area municipalities on data-related matters over a number of years, we are unaware of any

technical, organizational or other reason that prevents the City of Ottawa from creating the database needed to implement and maintain the Driver Behaviour Index as a means of serving and promoting pedestrians' security at signalized intersections.

Finally, the process of producing scores and rankings by applying the Driver Behaviour Index is found to satisfy the <u>degree of difficulty criterion</u>. As a result, Driver Behaviour Index operationality is deemed to be demonstrated with regard to tasks involved in computing index scores and rankings.

It is our summary finding, therefore, that while the Driver Behaviour Index appears to be fully operational from a design perspective, a substantial amount of work remains to be done in developing and maintaining the database required to implement the DBI as part of a Walking Security Index program.

General Findings from the Pilot Study

Examination of the six pilot study background reports led to the derivation of eight general findings that are deemed critical to the effective implementation and application of the indexes*. Those findings were included in the (public) presentations made to City of Ottawa officials on November 7 and November 25 2001 in regard to the status of the WSI pilot study. The findings are stated here as recommendations, lessons learned, concerns, etc., and are discussed in detail in the main body of the report.

- A critical design study and pilot study feature was to elicit the views of three groups of experts – elected officials, professional staff, citizens – in the specification and prioritization of variables to be included in the index or indexes.
- 2. The concept of "critical failure" was introduced in the QICI phase as a means of identifying a quadrant or intersection at which conditions pose a clear and

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^{*} The search for general findings from the WSI Pilot Study project was initially undertaken to prepare the paper "Strategies for Designing IS/GIS Applications to Implement Walking Security Indexes", which was presented by B. Wellar at the URISA Annual Conference in Long Beach, CA, October 20-24, 2001.

immediate threat to pedestrians' safety, comfort, convenience. Upon completion of the pilot study it is our finding that such a concept appears equally pertinent to the Intersection Volume and Design Index, and the Driver Behaviour Index. Further, the concept of "critical failure" is put forward as an enlightened, overdue alternative to the "warrant" system, which is biased (by present definition) against giving due consideration to pedestrians' security.

- 3. It was our finding early in the project that for reasons of complexity and information loss due to aggregation, the "intersection" construct is too crude and too coarse for <u>insightful</u> investigations into the state of roadway infrastructure, or into the dynamic relationships among pedestrians, cyclists and vehicle operators.
- 4. There are <u>major</u> differences in scores and rankings as a function of when field observations and recordings occur. As a result, it is imperative that index implementation and application programs have due regard for <u>each</u> of the peak hour intervals (AM, noon, PM), and that data not be aggregated to a daily level, much less to weekly, monthly or yearly levels which increasingly remove pedestrian-relevant information from scores and rankings.
- 5. The time of peak hour volumes not only varies across the region (formerly, Region of Ottawa-Carleton, now, the City of Ottawa), but it is changing (fluctuating) with seeming rapidity due to spatial variations in congestion points, corporate start-ups and closures, the residential boom and slowdown, etc. It is advisable, therefore, that index scoring and ranking activities be designed to reflect the rapid-change feature of vehicle and pedestrian traffic patterns during the three peak hours, and for other hours according to need.
- 6. Ottawa is a favoured city in terms of usually having four distinct weather seasons, but it also has tourist, school and other "seasons". Since seasonality is pertinent to all the indexes Volume and Design, Quality of Intersection Condition, and Driver Behaviour it follows that seasonality must be explicitly

built into the text, tables and graphics used to support day-to-day operations, as well as into the decision function (elected officials, management) which makes the choices and allocates the resources that directly affect pedestrians' security during each season.

- 7. If a community has a problem with drivers who run reds, run ambers, or fail-to-yield (to pedestrians, cyclists, or to the rules of the road), perhaps compounded by a seeming need for increased enforcement, then a strategy for integrating ticket data, data from red-light camera images, and fieldwork data in multi-purpose IS/GIS applications is required in order to undertake effective and efficient corrective action(s). It is our finding that both the aberrant driver behaviour situation and proposed remedy are applicable to the City of Ottawa.
- 8. Citizens and community groups, both neighbourhood-oriented and otherwise, are eager to participate in the development and maintenance of index databases, and in the derivation and use of index scores and rankings. Further, they appear both prepared and able to make and record highly accurate observations on intersection or quadrant condition variables, and on driver behaviour variables. It is our impression that their active involvement in index implementation, application and evaluation programs would substantially strengthen both the operationality and the credibility of City of Ottawa initiatives involving the Intersection Volume and Design Index, the Quality of Intersection Condition Index, and the Driver Behaviour Index. And, conversely, the absence of their active involvement would weaken both the operationality and credibility aspects of City of Ottawa policies, programs, plans, projects or promises regarding pedestrians' safety, comfort, convenience at signalized intersections.

B. PILOT STUDY OBJECTIVES AND BACKGROUND

1. Study Origin and Purpose

The pilot study continues the Walking Security Index (WSI) project that had its origins in the (former) Region of Ottawa-Carleton=s (ROC) Transportation Environment Action Plan (TEAP). Background details in these regards are now available from the (new) City of Ottawa, which is the pilot study sponsor, and from project publications (1, 2, 3, 4, 5). More particularly, however, the pilot study origins reside in a proposal to conduct such a project (6), and the decisions in 1999 by Transportation Committee (7, 8, 9) and Regional Council (10) to fund the proposal.

The purpose of the pilot study is to examine Walking Security Index formulations as a means to evaluate signalized (regional road) intersections. That is, publication of *Walking Security Index* completed the conceptual phase of WSI research and development involving index design issues (5). The WSI project is now moving into the operational phase, and the task of the pilot study is to empirically Acheck out® the indexes prior to their formal adoption and implementation by the City of Ottawa.²

In the interests of making the report self-contained, pertinent elements of the terms of reference for the pilot study are presented in Appendix A.

2. Pilot Study Scope and Methodology

The pilot study involves empirically examining three Amacro@indexes:3

- 1. Intersection Volume and Design Index (IVDI)*.
- 2. Quality of Intersection Condition Index (QICI).
- 3. Driver Behaviour Index (DBI).

^{*} This macro index was originally titled the Basic Walking Security Index (BWSI). The change in terminology was made in order to better represent the concepts imbedded in the index, and the variables used to operationalize the concepts.

As illustrated by pilot study publications previously submitted to the client (11,12,13,14,15,16), the research design of the project involved an index-by-index approach in testing for operationality. Consequently, the scope of the reports for each index was argely confined to matters involving the respective pilot study components (IVDI, QICI, DBI), with only limited cross-reference to the other indexes.

The primary design reason for restricting the scope of study in that manner is explained by a combination of first, research complexity, and second, the amount of material involved in the index tests. That is, a large number of tables are required to present the data used for empirical analysis/synthesis involving <u>each</u> index, so adding still more tables of data for other indexes would create a logistically prohibitive situation. Worse, however, an excessive number of tables could create an incomprehensible body of cross-referenced tables and text, and thereby undermine the operationality tests.

As for methodological reasons to not separate the (macro) indexes C treat them as standalone research tasks C two fundamental concerns were identified. That is, care must be taken (via research design) to ensure that no errors of omission or commission occur which could compromise:

- a) operational testing of each index; or,
- b) examination of relationships between and among indexes.

With regard to concern a), no communications have been received from the client (City of Ottawa) about errors of omission or commission in the test for index operationality. As a result, it is taken as given that our research involving the individual indexes is complete, and that our attention can now turn to concern b), that is, relationships between and among indexes.

The scope of the final report (17) therefore extends across the three macro indexes. However, and as indicated above, we do not re-visit the details of either the *Technical Supplements* (11, 13, 15) or the associated *Commentary Reports* (12, 14, 16). Rather,

our interest here is in identifying and discussing the pilot study <u>findings</u> which appear most pertinent to the City of Ottawa's objective of effectively implementing and maintaining a Walking Security Index program.

The same overriding principle applies to methodology. That is, details about the research methods, techniques and operations used to conduct the respective index tests are not re-visited, as that documentation already exists (11, 12, 13, 14, 15, 16). Instead, we limit our discussion to affirming that the methodology behind the selection of findings was similar to that for variable selection (5), and that it included presentations/publications (18, 19) in open technical/professional situations, as well as public presentations given at the request of the client.⁴

3. Organization of the Final Report

The research design of the project included using a similar format to organize the commentary report written for each (IVDI, QICI, DBI) component of the pilot study. That was done in order to support examination of relationships between and among indexes, and to facilitate preparation of the final, overview report.

Based on the Table of Contents in each of the three commentary reports (12, 14, 16), the final report is therefore organized as follows:

Part A: Executive Summary

Part B: Pilot Study Objectives and Background

Part C: Research Design

Part D: Availability of City of Ottawa Data for Index Implementation

Part E: Fieldwork Findings About Index Data Availability

Part F: Calculating Index Scores

Part G: Ranking Index Scores

Part H: Demonstration of Index Operationality

At the conclusion of Part H, the formal, contractual obligations of the Walking Security Index pilot study are satisfied. In the interests of completeness, however, this report is extended to include Part I: Strategic Considerations. Our intent here is to make known to the client (and other interested readers) several matters that emerged over the course of the pilot study which appear to have significant implications for index implementation, maintenance and effectiveness. The report is then completed by the Conclusion (Part J), References (Part K), and Appendices (Part L).

As a closing note about report organization, we repeat a statement made in all pilot study reports. That is, the final report builds directly on the findings and recommendations presented in *Walking Security Index*, as this Awork in progresse moves from concepts to operations.⁵ Those findings and recommendations are a published part of the WSI project, so we do not revisit them in this report unless they are needed to assist in substantiating a pilot study initiative, finding or recommendation.

4. Notes

- 1. The Walking Security Index (WSI) design study (1996–1998) and pilot study (1999–2002) were funded by the Region of Ottawa-Carleton, which became the (new) City of Ottawa on January 1, 2001. In the interests of accuracy, the study client is referred to as the Region for all matters preceding January 1, 2001, and the City of Ottawa for all matters which arise after that date.
- 2. As stated in the pilot study terms of reference (6,10), and as made clear by the background documentation (3, 5, 6, 7), the three macro indexes are at quite different levels of development. In particular, the Intersection Volume and Design Index (IVDI), which was initially called the Basic Walking Security Index (BWSI), is shown in the first pilot study report to be ready for immediate implementation in an operational sense (11,12). The QIC Index, by comparison, appears to be in need of one or more rounds of operational refinement (13,15), and the DB Index is still early in the design phase (15, 16, 18, 19, 20). The reminder is therefore given that <u>stages</u> are attached to our use of the term "implementation" when it is applied to all three macro indexes. And, consequently, the stage of development C pilot study, pretest, trial run C defines the kind or kinds of activity which the literature suggests be undertaken in order for one or

all of the indexes to achieve full operational status (5, 11, 13, 16, 18, 19, 20, 21, 22, 23, 24, 25, 26, 27, 28).

- 3. These are termed macro indexes since two of them (IVDI, DBI) are comprised of two or more indexes (which, since they are now part of a composite are properly termed sub-indexes), and the QIC Index combines intersection feature and maintenance variables. In the interests of easier reading, the term index is generally used in the text. However, if there is a need to make a distinction, then the prefixes are attached.
- 4. Pilot study overview presentations were made to the Transportation and Transit Committee on November 7, 2001, and to the Police Services Board on November 26, 2001 (29). The "Foreword" and "Executive Summary" of each pair of pilot study reports are published in Agenda 15, Transportation and Transit Committee, City of Ottawa, Wednesday, November 7, 2001, and the materials used in the presentations can be read online at:

http://www.city.ottawa.on.ca/calendar/ottawa/citycouncil/ttc/2001/11-07/minutes15.htm

5. The term "work in progress" has been used on various occasions (8, 9, 10) to describe the state of Walking Security Index research (as project findings and recommendations move through the conceptual and operational phases towards partial or full implementation). It appears that the characterization is due in part to research originality, and in part to the relative recency of the Region's (City's) policy, plan, and program interests in pedestrians' security (safety, comfort, convenience) (30, 31, 32).

C. RESEARCH DESIGN

1. Outline of the Research Problem and Process

Three primary research tasks are involved in each component of the pilot study:

- 1. Designing tables for presenting index data, scores and rankings;
- 2. Acquiring the needed data and calculating the associated index scores;
- 3. Interpreting index scores and rankings.

These are referred to as <u>primary research tasks</u> because failure to achieve any one of them means, by definition, that an index fails the test of operationality. That is, to rephrase the research problem and process, if the data needed to implement an index cannot be specified, or cannot be acquired, or the results from combining data (into scores) cannot be interpreted, then the index cannot be made operational and, hence, could not be implemented as a means to serve and promote pedestrians= safety, comfort, convenience (5, 6, 7, 8, 9, 10).

In the remainder of this section two of the key design principles of the pilot study are briefly reviewed, and the reasons for design differences between the DBI component and the IVDI and QICI components are recalled. With those generic and contextual comments in place, Section 2 presents an overview of the research design used to undertake the tests of operationality for the three indexes.

First, all pilot study reports including this one are limited to an amount of detail necessary to ensure that the research is methodologically sound. That is, our contractual obligation to the client is to empirically ascertain whether the indexes can be made operational. Our task is not to produce a "how to@ manual on the topic of moving an index from concept to operation. Hence, the discussion about scores and ranks is therefore shaped accordingly, with emphasis on the results and findings from applying the indexes in operational settings.

Second, *Walking Security Index* (5) specifies and explains the criteria used for variable evaluation, which means that the criteria also have a direct bearing on the content of index formulations <u>and</u> representations. The associated consequence, from a research design perspective, is that the criteria (used to evaluate variables) <u>must be directly applicable</u> in whole or in part to decisions affecting the representation of index data, scores and rankings.²

The five variable evaluation criteria – three general and two particular – are presented in Figure 1.

Figure 1. Variable Evaluation Criteria Used to Design and Assess
Walking Security Index Research

General	<u>Particular</u>
Support	Enforceability
Pertinence	Data Availability
Degree of Difficulty	

Source: After Wellar (5).

Among the five evaluation criteria, <u>degree of difficulty</u> and <u>data availability</u> directly affect achieving the primary research tasks identified above. We therefore use those criteria when investigating the operationality of all indexes. The <u>pertinence</u>, <u>support</u>, and <u>enforceability</u> criteria are not applicable to the operationality tests, but they do bear on the effectiveness of index implementation, maintenance and use. As a result, they are included in the discussion of "Strategic Considerations" in Part I.

And, as a final point of context, the research design process for the DBI component differed considerably from those developed for the IVDI and QICI components. That occurred because the City of Ottawa did not provide data that could be used for DBI formulation or testing purposes, or as a basis for assessing fieldwork procedures. And, as a further point of comment in that respect, documentation of the research problems

investigated in the DBI component was made more complicated, and extended, because changes in the research process for the DBI component emerged as a result of the <u>major</u> change to the data availability situation. In the interests of completeness and self-containment, therefore, we are obliged to recall some of those differences and changes in the final report. However, we do not pursue the matter in detail, since it has already been thoroughly examined in the two DBI reports (15, 16).

2. Representing Data, Scores, and Rankings

A central, given circumstance of the pilot study is that we are dealing with 33 intersections that are named in the contract (6,10), and are listed in Appendix A. From a research design perspective, therefore, statistical or inferential representativeness of intersections is not a consideration at this time. Rather, our research design interest is limited to deciding how to best represent the data, scores and rankings that characterize the specified intersections.

Insofar as deciding how to best represent data, scores and rankings, there are several methodological matters to resolve. In the first instance, a decision is required about how to best <u>physically</u> present large quantities of data, index score calculations, and index rankings for 33 intersections. And the companion, very practical concern involves the cost of producing and publishing project reports, whether in hardcopy or electronic medium.

Based on prior WSI experience, which includes numerous publications and public events (meetings, interviews, workshops, open houses), it is clear that tables are an appropriate means of physically presenting index data, scores and rankings. Indeed, due to the large quantity of variables and numbers imbedded in the index calculations, it is necessary that tables be one of the means used to illustrate how the reality of intersections has been transformed to data.

As for other means of physically presenting intersection data, such as by images (photographs, films), they could make a useful contribution to both process and

products. Indeed, graphics were the primary means of communication for recent WSI pilot study presentations at conferences (18, 19), and to City of Ottawa officials.³ However, for reasons of cost and the presence of dozens of necessary tables, we are severely limited in the amount of use that can be made of sophisticated visualization procedures to test for and demonstrate index operationality and utility.

Consequently, the *Technical Supplements* (11, 13, 15), the *Commentary Reports* (12, 14, 16), and the final WSI pilot study report emphasize tabular representations. However, in recognition of their demonstrated utility (28), image-type graphics are referred to or recommended for topics, situations, events, etc., that are more effectively described or explained by a video or series of photographs, than by a table of data.

The second methodological matter involving representativeness is far more complicated, in that it involves research choices which directly affect the robustness of index data, scores and rankings. That is, choices need to be made about:

- 1) What research is to be done to test for operationality?
- 2) How that research is to be done?

The decision situation can be summarized as follows.

If correct or appropriate research decisions are made, then the expected result will be index data scores and rankings which satisfy the validity, reliability, consistency, reproducibility, self-containment, and other criteria associated with robustness. That being the case, then a science-based claim can be (legitimately) made that operationality is demonstrated at the pilot study level, and the implementation process has in place a sound, methodological basis upon which to proceed.

Conversely, if incorrect or inappropriate research decisions are made, such as not having due regard for similarities and differences in vehicle and pedestrian volumes, intersection characteristics, weather conditions, and travel patterns as a function of both time and space, then the expected result will be index data, scores and rankings which are incomplete and inaccurate to say the least. As a result, it could not be (legitimately) claimed that index operationality had been tested, much less demonstrated.

The approach taken in this project towards attaining and maintaining research robustness was to raise and respond to a series of research design questions. Since the questions are fundamental to the research process, and establish the threshold of robustness attained for each index, they are combined in Tables 1A, 1B and 1C for ease of reference and comparison purposes.

As an initial, qualifying comment about the contents of Tables 1A, 1B and 1C, it is emphasized that no claim about sufficiency is made in the component reports (11, 12, 13, 14, 15, 16), nor in this report. That is, there may be other questions that could be raised in order to increase the level of research robustness. However, that is more a matter for a curiosity-driven research project, and is not a consideration here.

Table 1A. Questions Used to Set the Design Parameters for Walking Security Index Tests of Operationality: IVDI

Intersection Volume and Design Index (IVDI)

- **1.** How many indexes need to be used?
- **2.** For how many years are counts needed?
- **3.** Why and how does the pilot study account for seasonality?
- **4.** How many peak hours are needed to achieve robustness?
- **5.** How can bias in scores and rankings be minimized?
- **6.** How representative are the pilot study scores and rankings of the universe of signalized intersections in Ottawa- Carleton?

Source: (12, pp. 13-14)

Table 1B. Questions Used to Set the Design Parameters for Walking Security Index Tests of Operationality: DBI

Driver Behaviour Index (DBI)

- 1. What are the bases or rules for deciding when an aggressive driving incident B Arunning the red@, Arunning the amber@, Afailing to yield@B has occured?
- **2.** What is the appropriate time frame for collecting and presenting data on the incidence of aggressive driving at signalized intersections?
- **3.** What is the appropriate spatial term of reference for collecting and organizing data (field observations, red-light camera recordings, police records) on aggressive driver behaviour (running the red, running the amber, failing to yield)?
- **4.** For how many years are data needed from fieldwork, red-light camera films or digital files, police records, traffic count program files, citizen complaint files, other sources?
- 5. Why and how does this pilot study account for seasonality?
- **6.** How many peak hours of data (from fieldwork, police records, red-light cameras, etc.) are needed?
- **7.** How representative are the pilot study observations, scores and rankings of actual driver behaviour situations at:
 - a) the 33 pilot study intersections?
 - **b)** the universe of signalized intersections in Ottawa?

Source: (16, pp. 12-13)

Table 1C. Questions Used to Set the Design Parameters for Walking Security Index Tests of Operationality: QICI

Quality of Intersection Condition Index (QICI)

- 1. What are the bases or rules for deciding whether a condition is met?
- **2.** How are scores scaled or categorized to reflect differences in the degree to which conditions are met?
- **3.** For how many years are counts needed?
- **4.** Why and how does the pilot study account for seasonality?
- **5.** How many peak hours are needed to achieve robustness?
- **6.** How can bias in scores and rankings be minimized?
- **7.** How representative are the pilot study scores and rankings of the universe of signalized intersections in Ottawa-Carleton?

Source: (14, pp. 12)

Specifically, our contractual obligation to the City of Ottawa in the pilot study is to demonstrate operationality. It appears fair to say that the elements considered and questions raised are more than adequate to dispel concerns about robustness. Indeed, in the absence of arguments to the contrary from the client (City of Ottawa), that is deemed to be the case.⁴

Second, it is of course Apossible@ to demonstrate operationality without addressing the kinds of methodological questions listed in Table 1A, 1B and 1C. However, the absence of Agood@ answers to such hard questions is likely to compromise the level of utility that can legitimately be assigned to any of the indexes. Therefore, in the interests of meeting the standards of both operationality and utility, the questions were responded to in detail in the respective Commentary Reports (12, 14, 16).

Third, our interest here is not in each of the questions associated with each index, but with the <u>questions that are common to two or three of the indexes</u>. That is, we need to know whether the answers to common questions are the same σ not, which in turn

contributes to our knowledge about the relationship(s) between and among index variables, formulations, data, scores and rankings.

In the remainder of this section we synthesize the decisions made in the *Commentary Reports* (12, 14, 16) about the research questions contained in Tables 1A, 1B and 1C.

As shown, Table 2 presents the research design concerns, problems or issues that are common to two or three indexes. We briefly review the decisions made in responding to these questions (12, 14, 16), with emphasis on identifying any differences, contradictions, discrepancies, etc. that could compromise pilot study findings about the operationality of each or all of the indexes.

A. Number of Years of Data Coverage

While data series that extend over several years could yield more robust index data scores and rankings, and thereby increase WSI utility, the tests for operationality do not require multi-year counts for any of the indexes.

B. Accounting for Seasonality

In all indexes there are variables whose values change as a function of the season (Spring, Summer, Fall, Winter) in which observations are made. As a result, a rigorous test of index robustness and utility includes acquiring data (from files, fieldwork, etc.) for each season. However, all tests of operationality can be performed with a combination of data for the Winter season and for one other season, preferably Fall or Spring.

C. Peak Hours

Three peak hour intervals B AM, noon, PM B are used in the tests of operationality for each index. Due to the fact that pedestrians use intersections during the three peak hours, and because there are variations in the intensity of use, types of users, etc., for each of the three intervals, peak hour considerations apply to operationality tests for all indexes.

Table 2. Research Design Concerns, Problems, Issues, or Questions Common to Two or Three Indexes

Research Concern, Issue, Problem		Index*	
	IVD	QIC	DB
Number of years of data coverage	X	X	X
2. Accounting for seasonality	X	X	X
3. Number of peak hours of data required	X	X	X
4. Minimizing bias in scores and rankings	X	X	X
5. Respresentativeness of pilot study intersection	X	X	X
scores and rankings			

^{*}IVD = Intersection Volume and Design Index, QIC = Quality of Intersection Condition Index, and DBI = Driver Behaviour Index.

D. Minimizing Bias in Scores and Rankings

In cases where there are multiple values associated with index variables, scores or rankings, bias is introduced by using a value which is not representative of the set from which the value is taken. To minimize bias in the IVDI and QICI components of the pilot study, median values are used in the derivation and presentation of index scores and rankings. The same principle is applicable to the DBI component.⁵

Further, the principle of not aggregating data either temporally (from hours to days, days to weeks, days to years, etc.), or spatially (from quadrants to intersections) is applicable to all indexes in order to minimize information loss and maximize information gain over the course of the pilot study.⁶

E. Representativeness of Pilot Study Scores and Rankings

The same 33 intersections are used in each pilot study component, so scores and rankings for those intersections are fully comparable between and among indexes by peak hour, season of year, location (Downtown Zone, Inner Surburban Zone, Outer Surburban Zone), day of week, or any other grouping which is permitted by the

available data. The design caution that scores and rankings for pilot study intersections are not directly applicable to other specific intersections, nor to the network of signalized intersections, applies to all indexes.

Based on the contents of A, B, C, D and E above, it appears that there are no fundamental contradictions, incompatibilities, incongruities, etc., on research design matters which are common to two or three indexes. The associated finding, therefore, is that the robustness of data, scores and rankings for each index in particular, and all indexes in general, is not compromised by the research design decisions behind the tests for operationality.

3. Notes

- 1. By way of a brief explanation, each of these tasks can be assigned a yes/no, go/stop, or similar binary classification that deals with being able to do or not do an operational activity. A secondary or tertiary research task might involve, for example, ascertaining how well tables represent data, whether a spatial graphic might be more effective, or whether different displays or measures are needed to make the scores and rankings more transparent.
- 2. The underlined term <u>must</u> applies due to the emphasis throughout the WSI project on the derived aspect of concepts, formulations, variables, etc., and the associated interdependence between those constructs and the criteria selected to evaluate variables.
- 3. The graphics (figures and images) used in Powerpoint presentations to City of Ottawa officials can be viewed at:

http://www.city.ottawa.on.ca/calendar/ottawa/citycouncil/ttc/2001/11-07/minutes15.htm

4. The pilot study reports were submitted to the client in August 2000 (11, 12), October 2000 (13), November 2000 (14), June 2001 (15), and October 2001 (16), respectively.

It appears fair to say that ample time was made available for the client to review the materials, and to raise any concerns about the research design.

- 5. In the absence of City of Ottawa data on DBI variables, the use of median values for calculation or presentation purposes is not a research design concern in practice. However, it is a major design concern in principle; that is, the consistency aspect of robustness requires that the same procedure be used for deriving or presenting index scores and values.
- 6. The disaggregation principle is discussed in detail in the QICI reports (13, 14). Our design decision to emphasize disaggregation as a key information and policy/plan matter appears to be validated by recent newspaper reports on the Baseline Rd./Merivale Rd. intersection (33, 34). As reported in the articles, the intersection is treated as an entity (e.g., A...98 collisions at the intersection...@), with no reference to any of the quadrants. However, the schematic A...showing ways to fix dangerous intersections@, is based on arrows pointing to modifications that are quadrant-oriented.

D. AVAILABILITY OF CITY OF OTTAWA DATA FOR INDEX SCORE CALCULATIONS

1. Review of Findings and Comments About Data Availability

The data availability situation of the client (Region of Ottawa-Carleton/City of Ottawa) is documented in the *Technical Supplement* for each pilot study component (11, 13, 15), and is discussed in the *Commentary Reports* (12, 14, 16), which critique the supplements. The purpose of Part D is to summarize pilot study findings, and to briefly comment on the availability of City of Ottawa data for calculating IVDI, QICI and DBI scores and, ultimately, for maintaining a Walking Security Index program.

2. Availability of Intersection Volume and Design Index (IVDI) Data

Part C of the *Technical Supplement* (11) contains 132 tables showing the availability of IVDI data for the AM, noon and PM peak hours for pilot study intersections. The variables used to conduct the inventory and assessment of IVDI data holdings are listed in Table 3.

Table 3. Variables Used to Conduct the Inventory and Assessment of IVDI Data Holdings

ID	Variable Name	
V1	Number of passenger car equivalents per hour	
V2	Number of pedestrians per hour	
V3	Number of lanes	
V4	Number of turn lanes by type	
V5	Intersection geometry	
V6	Intersection slope	
V7	Direction(s) of traffic flow	
V8	Number of channels adjacent to intersection	

As demonstrated by the background reports (11, 13), the City of Ottawa creates or has the capacity to create all the data needed to operationalize the Intersection Volume and Design Index for the full network of signalized intersections.

3. Availability of Quality of Intersection Condition Index (QICI) Data

Implementation of the QIC Index involves using operations data and complaints data, which are described as follows (13, p. D-1)¹:

- A. "Operations-based data are created or generated as part of traffic counts, police incident reports, road/sidewalk repair reports, snow removal/sanding/salting reports, ambulance incident reports, OC Transpo driver/supervisor reports, or other day-to-day activities of ROC [now City of Ottawa] departments/units which involve recording data on conditions at signalized intersections".
- B. "Complaints-based data are created or generated by citizens, professional staff and elected officials who contact the Region of Ottawa-Carleton [now City of Ottawa] by telephone, fax, e-mail, visits to offices, etc., to express concerns about intersection conditions."

The variables used to conduct the inventory and assessment of QICI data holdings are listed in Table 4.

As discussed in the background reports (13, 14), responsibility for the data on QICI variables previously rested in part with the former Region of Ottawa-Carleton, and in part with the 12 lower-tier municipal governments comprising the regional municipality. The data availability situation prevailing at the time of QICI component research may be summarized as follows.

 Responsibility for some entities represented by QICI variables rested with the Region of Ottawa-Carleton, and the responsibility for some entities was within the purview of one or more of the municipal governments;

Table 4. Variables Used to Conduct the Inventory and Assessment of QICI Data Holdings

ID	Variable Name
1	Sidewalk corner capacity
2	Height of curbing
3	Condition of curbing
4	Sidewalk width capacity
5	Sidewalk condition
6	Crosswalk surface condition
7	Median (refuge) capacity
8	Median (refuge) condition
9	Traffic calmer(s)
10	Channel island (refuge)
11	Crosswalk capacity
12	Crosswalk signed and painted
13	Stop bar painted and signed
14	Pedestrian signage
15	No sight line obstruction
16	Street furniture proximal to corner
17	Ice/snow/slush removal
18	Water drainage

Source: (13, p. D-3)

- 2. Among them, agencies in the two levels of government collected or could have generated data for all QICI variables;
- 3. QICI-pertinent data were held as separate databases, files, etc. by agencies in the regional government and the municipal governments, and "tapping into" a common database incorporating all QICI variables was not possible.

Since the data needed to test for operationality were not accessible, their existence notwithstanding, the data availability criterion was not satisfied. However, and as noted and emphasized in the background reports (13,14), this situation would be rectified in large part if the City of Ottawa integrated its holdings of QICI-related data.

4. Availability of Driver Behaviour Index (DBI) Data

Implementation of the Driver Behaviour Index involves data on light-running and fail-to-yield driving incidents. The two types of DBI incidents, which are characterized as "aggressive driving" (5), are represented as variables in Table 5.

The review of the City's holdings of DBI data included examination of the contents and the accessibility of survey databases, operations databases, red-light camera image files, and any other "medium" in which the client holds DBI-pertinent data². The general finding from the review is that "the City of Ottawa does not currently have the data which are needed to implement the DBI" (16, p.36).

In the next several pages some of the key findings and comments on the DBI "data availability problem" are presented. The first purpose of the materials is to reemphasize the causes of the data availability problem, so that directions are provided should remedial actions be taken by the client to deal with the problem. And, the second purpose is to provide a context to discuss the DBI data fieldwork program that was designed and undertaken in order to generate the empirical data required to test for DB Index operationality.

A. Problems with City of Ottawa Data on Light-Related Incidents

Elements of the data availability problem involving light-running behaviour are presented in Part F of the *Technical Supplement* (15), and Part D of the *Commentary Report* (16). Statements from both documents are included in this discussion of the data availability problem, but the reader is referred to the original texts (15, 16) for the details, comments, and references behind the materials which follow in this section.

Table 5. Variables Used to Conduct the Inventory and Assessment of DBI Data Holdings

ID	Variable Name (for Aggressive Driving Events)*
V1	For left turns and straights, vehicles cross the stop bar after the red shows;
V2	For right turns on red, vehicles do not come to a full rest before the stop bar;
V3	For left turns and straights, vehicles cross the stop bar after the amber shows;
V4	For right turns on amber, vehicles cross the stop bar after the amber shows;
V5	Vehicles block crosswalk when pedestrian signal in walk mode;
V6	Vehicles unable to clear intersection before start of pedestrian signal;
V7	Vehicles enter crosswalk when pedestrians in lane or about to enter lane;
V8	Vehicles accelerate to "beat" pedestrians to crosswalk;
V9	Vehicles fail to slow to allow pedestrians to enter crosswalk;
V10	Vehicles cause pedestrians to stop or change direction to avoid collision in crosswalk;
V11	Vehicles cause pedestrians to delay entering crosswalk;
V12	Vehicles change lanes to cut in front of or behind pedestrians;
V13	Vehicles fail to stop before reaching the stop bar.

^{*} The variable names represent the light-running and fail-to-yield events that are specified and defined in the *Technical Supplement* (15) that was prepared for the DBI component. Readers are referred to the DBI technical report (15) and the *Commentary Report* (16) for details about the derivation of the aggressive driving events and, by association, the variable names.

Data on light-related incidents are created via traffic tickets, and by two red-light cameras which are rotated among eight intersections selected for the City of Ottawa's red-light camera project. The content and accessibility problems associated with these data are illustrated by the following comments which are taken from the DBI background reports (15, 16).

- 1. "First, data on light-running incidents are written on the tickets issued by officers to drivers who commit light-related <u>infractions</u>. These data on infractions are an element of aggressive driving as it is operationally defined in Part B. As a result of having issued tickets, therefore, the client does have data <u>on file</u> which pertain to ranking intersections in terms of the incidence of light-running infractions" (15, p. F-1).
- 2. "There is a fundamental difference of a definitional nature that prevents us from using ticket data in this study, however, and it is given in Section 2, Part B. That is, red-light runners as defined by the Highway Traffic Act are not the same as the red-light runners who we have defined to be aggressive drivers. In other words, the Act and the DBI are not measuring the same behaviour or activity. Consequently, we cannot directly use the ticket data created by officers as part of the database for computing DBI scores and ranks for intersections²" (15, p. F-1).
- 3. "Further, there is a methodological gap which precludes using ticket data in the current DBI study. That is, and as made clear in Section 2, Part B, drivers who are ticketed are a subset of the population of (light-running) aggressive drivers. However, we have no knowledge about, and could not locate literature on the relationship between ticketed drivers and drivers who enter an intersection on the red or amber but are not ticketed. Consequently, we are unable to reconcile ticket data with data obtained by observing the incidence of light-running as it is operationally defined in Section 2, Part B" (15, p. F-2).
- 4. "Moreover, there are a number of practical considerations, including those involving privacy and confidentiality concerns, that make gaining access to the ticket data a difficult if not unlikely prospect.³ The summary observation with regard to "ticket data" generated by Regional Police Services therefore, is that the data exist, but they cannot be directly incorporated into either the formulation or the testing (for operationality) of the Driver Behaviour Index" (15, p. F-2).

The four statements from the *Technical Supplement* (15) identify the causes of the data availability problem with regard to traffic ticket data. These definitional and operational reasons for not being able to use the City's ticket data for DBI test purposes have been summarized as follows.

- 5. "Due to definitional differences between the Highway Traffic Act and the WSI project, there is not a direct correspondence between red-light or amber-light runners and those vehicle operators termed "aggressive drivers" (16,44,45). As a result, the data generated by tickets do not match the data needed to implement the DBI as it is presently formulated." (16, p.36).
- 6. "Ticketed drivers are (only) a subset of all drivers who commit Highway Traffic Act infractions, but there appears to be no (City of Ottawa) knowledge about the proportion of violators who are "caught" by police officers during any of the three peak hours. As a result of not knowing anything about the relationship between drivers actually ticketed and drivers who warrant being ticketed for red and amber violations, we have no insight as to how to use the ticket data to calculate scores" (16, p. 37).

The reasons for not being able to use camera-generated data are also due to definitional and operational factors.

- 7. "...since the cameras are programmed to identify red-light <u>infractions</u>, the associated data cannot be directly used since they do not correspond with data generated by our more inclusive measure of aggressive driving incidence (Section 2, Part B). That is, the cameras "catch" only a subset of the red-light runners identified by the DBI definition" (15, p. F-2).
- 8. "In addition to differences in what is being measured, and how, it appears that the City's red-light camera project contains an "intent" feature that is not reconcilable with the pilot study's emphasis on observable time-space evidence. Figure 3 an excerpt from a newspaper notice illustrates our point in this regard. As indicated by the underline, our concern is with the word "deliberately". The DBI fieldwork program data are generated on the basis of a perceived fact: the vehicle did or did not cross the stop bar after the light turned amber or red. End of story. Fieldworkers do not ponder whether the driver acted deliberately, nor do they stop drivers and ask about their behaviour or motivation. Further, we do not have sophisticated technologies that can instantly assess the likelihood that a deliberate act occurred.

As a result, therefore, of using very different grounds for specifying whether a light-related incident has occurred, a major data compatibility problem appears to arise. That is, how do data on "intent" relate to data on observed events? We do not know, and were not able to obtain guidance from a review of several texts on methodologically-designed research (23,24,25,26,27,28,29)" (15, p. F-3).

- 9. "Further, two cameras are being used at eight intersections, of which three are among the 33 intersections included in the WSI pilot study. It would be necessary to undertake a separate study to ascertain whether and how data from the red-light camera project could be obtained and used to test the DBI for operationality at the three common intersections. And, a further study would need to be designed in order to relate findings about the three intersections to the other 30 pilot study intersections" (15, p. F-3).
- 10. "Finally, with regard to data on amber-light infractions, it is not the City's practice to issue camera-generated tickets for that offence. Further, based on several hundred hours of field observations during which many amber-light incidents occurred, officers do not appear to issue tickets for amber-light infractions as a matter of routine practice. As a result, no data on "running the amber" are available from the City of Ottawa" (15, p. F-3).

The following summary comments from the *Commentary Report* (16) re-emphasize the findings expressed above. And, in addition, they serve as a re-statement of our concerns that were expressed in the Public Services Board presentation on November 26, 2001.

- 11. "The red-light runners "caught" by the cameras at a location do not necessarily include all red-light runners as defined by the Highway Traffic Act. Further, we have no knowledge as to whether the City has any "inference-type approach" to bridge the gap between all those who run the red and (only) those identified by the cameras" (16, p. 37).
- 12. "The red-light runners identified by cameras are only a subset of the drivers who aggressively proceed through on a red, as defined by the DBI methodology. We have no methodologically-derived knowledge about the relationship between the numbers of vehicles caught on camera and the numbers of vehicles involved in aggressive driving (on-the-red) incidents" (16, p. 37).
- 13. "The City's camera system project incorporates an "intent" feature on the part of drivers, whereas the DBI methodology is based on observed actions. Due to our inability to incorporate "intentions" of drivers into field accounts of observed events, and serious doubts on our part about the City's ability to distinguish between intended and unintended acts (of running the red), unresolved questions of data compatibility arise" (16, p. 38).

- 14. "The cameras do not identify vehicle operators who commit an infraction on the amber-light indication, whereas the DBI approach (following the Highway Traffic Act) includes observing and recording amber-light incidents. By definition, then, it follows that there are going to be differences between City and DBI data on light-running drivers, and we have no knowledge as to how the differences could be methodologically reconciled. As a result, we have no terms of reference for creating camera data, or using camera data to extend DBI data obtained via fieldwork" (16, p. 38).
- 15. "Of the 33 pilot study intersections, three are among the eight intersections at which two cameras are installed on a rotational, pairwise basis as part of the City's red-light camera project. We have no knowledge about the methodology of the project, about the images or data generated for the three pilot study intersections, nor about their applicability or generalizability to other intersections or quadrants. Before DBI testing could properly use the camera data on red-light matters, the knowledge gaps indicated above would need to be bridged" (16, p. 38).

B. Problems with City of Ottawa Data on Fail-to-Yield Incidents

There are two elements to the data availability problem involving fail-to-yield incidents.

- 1. The City of Ottawa does not have a structured data collection and database development program for even one fail-to-yield variable, much less all nine variables listed in Table 5. As a result, it was not possible to test this element of the DBI for operationality for even one intersection in the region, much less all 33 pilot study intersections.
- 2. The data which do exist are of the "bits-and-pieces" variety. That is, fail-to-yield data have been created over the years by occasional traffic studies and, most likely, by ticketing practices or activities of police operations. However, the client was unable to provide data from those sources that would have permitted even an indicative test of index operationality.

5. Summary Findings About Data Availability

The summary findings in regard to the availability of WSI data at the City of Ottawa are as follows.

- 1. Data needed to operationalize the Intersection Volume and Design Index (IVDI) are available, and the data availability criterion of operationality is satisfied.
- 2. Data needed to operationalize the Quality of Intersection Condition Index (QICI) are not available, and this criterion of operationality is not satisfied.
- 3. Data needed to operationalize the Driver Behaviour Index are not available, and this criterion of operationality is not satisfied.

Since the lack of data from the City of Ottawa meant that the QICI and DBI formulations could not be tested using existing data, it was necessary to attempt to generate the needed data in a field survey program. In the next section (Part E), we present the results from the fieldwork programs that were designed and undertaken for the QICI and DBI components of the pilot study.

6. Notes

- 1. These characterizations of operations-based and complaints-based data include both structural and functional distinctions, and are based on reviews of various literatures (1, 2, 3, 4, 8, 35, 36, 37, 38, 39, 40, 41, 42, 43, 44) and professional/technical association documents (45, 46). The characterizations (definitions) are intended to be generic and indicative, and are not presented as representative of the position of the Region of Ottawa-Carleton/City of Ottawa. It appears, however, that while no formal documentation has been provided/obtained in this regard, the characterizations do not seem to be widely at odds with prior ROC or current City of Ottawa practices.
- 2. As part of the pilot study contract, the Region (client) made an in-kind contribution of staff, equipment, materials and data to the project. Among the responsibilities assigned to John Blatherwick, who was engaged by the Region to support the pilot study, was that of ascertaining whether the client (ROC/City of Ottawa) had or could obtain needed data, and then ensuring that all archival and current data provided by the client are consistent and compatible between and among the 33 pilot study intersections.

E. FIELDWORK FINDINGS AND COMMENTS ABOUT DATA AVAILABILITY

1. Review of QICI and DBI Fieldwork Programs

The design and execution of the QICI and DBI fieldwork programs are discussed in detail in the background documents (13, 14, 15, 16). In this report we overview the activities undertaken and the results achieved by the fieldwork program. As noted at the conclusion of Part D, the task of the program was to ascertain whether data not available at the City of Ottawa are available via empirical observation, that is, via fieldwork.

2. QICI Data from Fieldwork

As demonstrated by the data sheets used in the N series of tables (13, Part E), both student researchers and community association members were able to make observations on all the QICI variables for all pilot study intersections. Further, all student and community fieldworkers were able to use any of the forms, including the quadrant maps, that were designed for making and recording observations on the quality of condition(s) associated with the 18 QICI variables. The recording form that was found to be the easiest to use, and the most discriminating in terms of how to make and assign observations on conditions, is shown in Figure 2.

The following statements from the two QICI background documents (13, 14) report on our investigation, and point to the summary finding that QICI data can be generated without undue difficulty via a fieldwork program.

1. "The tables in the N series demonstrate that field ratings can be assigned for all the variables contained in the QIC Index form. In regard to <u>data availability</u>, therefore, the finding is that this criterion can be satisfied by means of site visits to the study intersections" (13, E-2).

Figure 2. Quality of Intersection Condition (QIC) Index: Checklist of Core Variables for Rating Intersection Design and Maintenance Features

'/M/D):/Time(mil):							
ection:							
	Condition Met						
		No (Quadrant)					
besign and maintenance reactives	Yes	NW	NE	SE	SW		
Sidewalk corner capacity							
Height of curbing							
Condition of curbing							
Sidewalk width capacity							
Sidewalk condition							
Crosswalk surface condition							
Median (refuge) capacity							
Median (refuge) condition							
Traffic calmer(s)							
Channel island (refuge) capacity							
Crosswalk capacity							
Crosswalk signed and painted							
Stop bar painted and signed							
Pedestrian signage							
No sight line obstruction							
Street furniture proximal to corner							
lce/snow/slush removal							
Water drainage							
Totals							
Overall Score (YES - NO =):							
gator:Si	gnature:_						
comments:							
	Variable Names for Intersection Design and Maintenance Features Sidewalk corner capacity Height of curbing Condition of curbing Sidewalk width capacity Sidewalk condition Crosswalk surface condition Median (refuge) capacity Median (refuge) condition Traffic calmer(s) Channel island (refuge) capacity Crosswalk capacity Crosswalk capacity Crosswalk signed and painted Stop bar painted and signed Pedestrian signage No sight line obstruction Street furniture proximal to corner Ice/snow/slush removal Water drainage Totals Overall Score (YES - NO =):	Variable Names for Intersection Design and Maintenance Features Sidewalk corner capacity Height of curbing Condition of curbing Sidewalk width capacity Sidewalk condition Crosswalk surface condition Median (refuge) capacity Median (refuge) condition Traffic calmer(s) Channel island (refuge) capacity Crosswalk capacity Crosswalk signed and painted Stop bar painted and signed Pedestrian signage No sight line obstruction Street furniture proximal to corner Ice/snow/slush removal Water drainage Totals Overall Score (YES - NO =):	Variable Names for Intersection Design and Maintenance Features Sidewalk corner capacity Height of curbing Condition of curbing Sidewalk width capacity Sidewalk condition Crosswalk surface condition Median (refuge) capacity Median (refuge) condition Traffic calmer(s) Channel island (refuge) capacity Crosswalk capacity Crosswalk signed and painted Stop bar painted and signed Pedestrian signage No sight line obstruction Street furniture proximal to corner Ice/snow/slush removal Water drainage Totals Overall Score (YES - NO =):	Variable Names for Intersection Design and Maintenance Features Sidewalk corner capacity Height of curbing Condition of curbing Sidewalk width capacity Sidewalk condition Crosswalk surface condition Median (refuge) capacity Median (refuge) condition Traffic calmer(s) Channel island (refuge) capacity Crosswalk capacity Crosswalk signed and painted Stop bar painted and signed Pedestrian signage No sight line obstruction Street furniture proximal to corner Ice/snow/slush removal Water drainage Totals Overall Score (YES - NO =):	Variable Names for Intersection Design and Maintenance Features Sidewalk corner capacity Height of curbing Condition of curbing Sidewalk width capacity Sidewalk condition Crosswalk surface condition Median (refuge) capacity Median (refuge) condition Traffic calmer(s) Channel island (refuge) capacity Crosswalk signed and painted Stop bar painted and signed Pedestrian signage No sight line obstruction Street furniture proximal to corner Ice/snow/slush removal Water drainage Totals Overall Score (YES - NO =):		

Revised: 00/10/19

Source: (13, p. B-11)

- "With regard to <u>degree of difficulty</u>, this criterion is met in large part. That is, the
 meaning of QICI variables came to be commonly understood by fieldworkers, the
 QICI form evolved so that it is readily administered in the field, and the quadrant
 procedure enables fieldworkers to deal with what might be termed 'chewable
 bites' of an intersection" (13, E-3).
- 3. "The one aspect of difficulty that has been experienced with some QICI variables involves what might be called "tough judgements" about a condition. By way of example, V18 can be regarded as a present-absent or yes-no variable if there is a 10-centimeter [deep] puddle across the corner, or no water at the corner. However, how do fieldworkers assess a puddle which is one centimeter deep and one metre wide?" (13, E-3)*.
- 4. "As a result of our emphasis on field form and quadrant map design, we did not generate empirical data for QICI score and ranking purposes. Rather, we confirmed that the forms and maps appear to lend themselves to a high order of operationality, and that both the form and map effectively contributed to meeting the data availability criterion. Further, the apparently easy adoption of the forms by community association members is taken to mean that the degree of difficulty criterion is met for the fieldwork instrument and, consequently, data collection for QICI purposes" (13, E-4/E-5).
- 5. "During the Winter 2000 season, a concerted effort was made to collect data on all intersections for all peak hours for all days of the week. Further, assistants attempted to undertake fieldwork in different kinds of weather situations in order to represent as many conditions as their schedules and project resources allowed. It is our opinion that the 2000 Winter season data fully satisfy the design parameters for representativeness. As a result, it is our further opinion that a substantive basis exists for calculating median index scores and the associated rankings (Part F) for Winter 2000" (13, E-5).

37

^{*} In the interests of clarity, the original comment is revised to illustrate the simpler aspects of condition evaluation.

- 6. "Finally, while the objective of representativeness of data is not yet met, the data collected during the Winter 2000 and in other seasons are adequate to demonstrate the calculation of ratings, index scores and rankings. As a result, and in the company of an explicit caution about data limitations, we are able to present "comparative" index scores..." (13, E-6).
- 7. "..., and in a related vein, there are a number of QICI variables that are time-sensitive, including V1, V4, V7, V10, V11, V16, V17 and V18. As a result, the absence of entries in some cells does not relate to a data availability problem. Rather, it is further confirmation of the explicit emphasis on the seasonality and peak hour interval factors that are discussed in detail in the Basic Walking Security Index reports (11, 12)" (14, p.28).
- 8. "As for the degree of difficulty criterion, problems in making and recording observations on QICI observations diminished with each modification of the fieldwork form. Our evidence in this regard is the overall increase in rating accuracy and consistency, as forms B-1, B-2, B-3 and B-4 were field-tested. And, the degree of difficulty involved in administering the final version, B-4, was reduced even further by using Traffic Signal Drawings (TSDs) to perform ratings on a quadrant-by-quadrant basis" (14, p.29).
- 9. "In regard to the criteria of data availability and the (associated) degree of difficulty, it therefore appears fair to say that both are met, operationally, by the contents of Tables N-34 to N-44" (14, p.29).
- 10. "As for the ratings produced, their robustness increases as the quality of data increases. In the case of QICI data, they became more accurate and consistent with each refinement of the field form. And, if the Principal Investigator's

impressions are correct, the data and ratings became more robust with each discussion and walkabout that was held with project assistants and, ultimately, the Woodpark, Hintonburg and Dalhousie Community Associations, respectively² (14, p.29).

Table 6 is included to illustrate how the QICI form in Figure 2 is used to record data on intersection design and maintenance features. A further review of WSI publications, including the *Proceedings of the 1996 Ottawa-Carleton Pedestrian Safety Conference* (4), strongly supports our contention that community groups throughout the City of Ottawa could effectively and efficiently apply the QICI forms as part of a Walking Security Index program.

3. DBI Data from Fieldwork

This task was a project within a project, that is, a pilot study within a pilot study, because there was little if anything found from the literature, or at the City of Ottawa, that could be used as a foundation to design or undertake the DBI fieldwork program. Since our intent here is to speak to the matter of data availability at the general-finding level, the reader is referred to the two background reports (15, 16) for details about the derivation and application of DBI fieldwork forms, including the quadrant maps. In the interests of providing context for the reader and self-containment of the report, three completed DBI field forms are included as Table 7, Table 8 and Table 9.

The following sections and statements from the DBI background documents (15, 16) report on our investigation, and point to the general finding that DBI data can be generated, without undue difficulty, via a fieldwork program.

 "Following from the BWSI and QICI components (1,2), the primary objective of the DBI fieldwork program is to test the DB Index for two aspects of operationality: data availability and degree of difficulty. And, as a secondary objective, the fieldwork could provide insights into the enforceability criterion (34), which is relevant to the matter of observing and recording aggressive driving

Table 6. QICI Fieldwork Form Completed by a Community Association: **Dalhousie Community Association**

Date(Y/M/D): 00 / 11 / 04	Time(mil):	11-45 SAT	Count#:
Intersection: BRONSON &	SOMERSET	•	TSD#:

			C	ondition	Met	
ID	Variable Names for Intersection			No (Q	uadrant)	
	Design and Maintenance Features		2047	1		
1	Sidowalk corner conceit:	Yes	NW	NE	SE	SW
2	Sidewalk corner capacity		×	1 1	×	<u> </u>
5	Height of curbing		X	×	×	1
3	Condition of curbing	2	×		×	1
4	Sidewalk width capacity	1	×	1	X	X
5	Sidewalk condition	3	1 1		×	1
6	Crosswalk surface condition	4	 	Ì		
7	Median (refuge) capacity		<u> </u>	 _		-
8	Median (refuge) condition		 _			
9	Traffic calmer(s)	0	×	×	×	×
10	Channel island (refuge) capacity					
11	Crosswalk capacity	2		×	×	
12	Crosswalk signed and painted	0	×	×	×	×
13 *	Stop bar painted and signed	0	×	×	×	×
14	Pedestrian signage	0	X	×	×	×
15 .	No sight line obstruction	2	X	1	×	
16	Street furniture proximal to corner	2	×	1	×	i
17	Ice/snow/slush removal	,		<u> </u>		<u> </u>
18	Water drainage				_	
	Totals	18	10	6	12	6
	Overall Score (YES - NO =):		34 =	-16/		

BRIAN GILLIAM / DOUG GABELMANN Investigator: PON SIGN / DAVID SEABORN Signature:

Key comments:

12,13,14 High Volume of Redistrians; further signs, painting required

NW -15 Garbage bins, Newspaper boxes obstructing corner

NW - 2 Too High for Wheel Chair

NE-11 Paint lines beside brick.

NEBE-11 Crosswalks too narrow

SE - 15 Poles, traffic box conject corner corner copacities in adequate for pedestrian volumes

NO room for SNOW

Revised: 00/10/19

SW - 13 STOP BOX SHOULD BE MOVED BOCK.

Source: (13, p. E-48)

Table 7. DBI Field Report, WSI Pilot Study: King Edward and Rideau WALKING SECURITY INDEX PILOT STUDY DRIVER BEHAVIOUR INDEX (DBI) COMPONENT

Intersection: ()	22) King Edu	ward + R	deau Date: 2	911/10
Peak Hour: Al	VI; Noor	n; PM	Time: 3:30 -4:	30_
Quadrant		ggressive E	Priving Incidents K.C.	
Details	Ran Amber	Ran Red	Failed to Yield to Ped M.	
ζω	++++++++ +++ +++++++++++++++++++++++++	++++ 1 11\	M+-4H+ +++ 1(1	## ## ## ## ## ## !!!
	(9	3	3 3
5Ē	### ### ### ### ######################	HHH HHT		
	Θ	(10)	31)	<u>ক্তি</u>
Key Comments				
Fieldworker(s):		216R		
(Print Name)	MARK MUL	LINS		

41

Source: (15, p. H-28)

Table 8. DBI Field Report, WSI Pilot Study: Bronson and Carling

WALKING SECURITY INDEX PILOT STUDY DRIVER BEHAVIOUR INDEX (DBI) COMPONENT

Intersection:	(0)	1 Bransa	no Carlin	P Date: 30/11/00
Peak Hour:	AM_	; Noon _	; PM	Time: <u>430~530</u>

Quadrant	ρ.	# of		
Details	Ran Amber	Ran Red	Failed to Yield to Ped	Phases
SE	144 144 1111		HHT HHT HHT HHT	HT HT HT 1111
	(A)	0	35	29)
5W	HH HH HH	#######	IM ATT ATT ATT ATT ATT ATT ATT ATT ATT AT	14 Ht 14 Ht 14 III
	HT HT 111			

Key Comments:

Fieldworker(s): Erin Rankin lan Nash

Source: (15, p. H-12)

ey Comments:
- (amera d untersection
- many failed to yields on ort hand turns in SW
- left in SW quadrant, same time as pedestrian
walk in NW quadrant: this is conflicting

Table 9. DBI Field Report, WSI Pilot Study: Bearbrook and Innes

WALKING SECURITY INDEX PILOT STUDY DRIVER BEHAVIOUR INDEX (DBI) COMPONENT

Intersection:	(4)_	Imes	and	Bearbrook	•	Date:16 / 11/00
Peak Hour:	AM	; Noon	<u>_×_</u> ;	PM	Time:	12:00-13:00

Quadrant	Α	# of		
Details	Ran Amber	Ran Red	Failed to Yield to Ped り	Phases
		HH HH	JHT I	W W W
				W W W
				WWW
NW	2	(10)	(b)	HT HT HT
				u# (5)
	WH I	HT JH		W W W
		HH HH 11		M W M
O. 4				HH HH HH
SW	6			HH HH
		(F)		
				(\mathcal{A})
Key Comments	-			

-3 5chools nearby
- "Community Sofety Zone" sign
- many school buses
- signal's for "wark" / "no warking" are not always automatic
- "school ahead" sign posted but people ignore them... seem

Source: (15, p. H-10)

incidents which constitute by-law and/or Highway Traffic Act violations" (15, p.G-1).

- 2. "The original research design anticipated that we might be able to achieve at least three counts per quadrant for each peak interval for a total of 1125 counts. That level of data development included data on a number of intersections that would be made available from the client, with the field data to complement or supplement those holdings as appropriate. As discussed in Part F, however, the City's averred contribution of data did not come to pass. And, further, the pilot study proposal/contract did not contain a "Plan B", whereby funding and field personnel could be accessed on an as-needed basis to launch a relatively massive, crash exercise in DBI data collection" (15, p. G-2).
- 3. "It was our reasoning that if accurate data on aggressive driving incidents can be obtained without undue difficulty for the busiest quadrants, then they can be obtained for the (less) busy quadrants. And, that being the case, both the data availability and degree of difficulty criteria are satisfied, and operationality in those regards is demonstrated" (15, p. G-2).
- 4. "A fieldwork design objective was to achieve spatial and temporal representativeness of quadrants covered (NW,NE,SW,SE). From a spatial perspective, this meant allocating intersections to the Downtown, Inner Suburban Area, or Outer Suburban Area, and then assigning fieldworkers to those geographic areas on a busiest-first basis" (15, p. G-2).
- 5. "With regard to the temporal aspect, several design considerations contributed to approach selection. First, the decision took into account the nature of vehicular and pedestrian traffic flows/volumes, speeds, and directions for the AM, noon and PM peak hours. And, second, special regard was given to intersections and quadrants that involve crossings by elementary and secondary school children for one, two or three peak hours" (15, p.G-3).

- 6. "In addition, however, it appeared clear that in some cases a three-person team might be needed due to the high volumes of traffic (vehicles and pedestrians), the large size and high-order complexity of intersection design and traffic movement, and the high frequency of aggressive driving incidents. Alternatively, indications were that for some intersections one person could produce valid data while observing one, two, three or even four quadrants for any of the peak hours" (15, p.G-3-4).
- 7. "...Following from the findings of the previous pilot study reports (1,2,4,5), the research design stipulates that the data base be fully disaggregated which is demonstrated by the key parameters of fieldwork form design:
 - A. "Separate data forms completed for each visit to each intersection.
 - B. Explicit regard for each of the quadrants (approaches and exits), (NW,NE, SE, SW) which comprise pilot study intersections.
 - C. Explicit regard for each of the daily peak hour intervals (AM, noon, PM), and for sub-intervals in the peak hour (e.g., 0730-0830, 0800-0900, or 0830-0930 for the AM interval) in order to test the index form in conjunction with school, retail, work, sport, entertainment, or other activities that may be specific to particular intersection quadrants, or for spatial, temporal or other reasons.
 - D. Explicit regard for <u>each</u> of the five work/school days (M/Tu/W/Th/F).
 - E. Explicit regard for <u>each</u> of the seasons (Fall, Winter, Spring, Summer) during which data are collected" (15, p. H-1).
- 8. "The tables in the Q series demonstrate that field ratings can be assigned for all the variables contained in the DB Index form. In regard to <u>data availability</u>, therefore, the finding is that this criterion can be satisfied by means of site visits to the study intersections" (15, p.H-2).

- 9. "With regard to <u>degree of difficulty</u>, this criterion is met in large part. That is, the meaning of DBI variables came to be commonly understood by fieldworkers, the DBI form evolved so that it is readily administered in the field, and the quadrant procedure enables fieldworkers to deal with an intersection on an approach-by-approach lane and exit-by-exit lane basis. Further, relatively few problems were expressed in regard to observing and deciding whether light-running incidents occur" (15, p.H-3).
- 10. "As for the fail-to-yield incidents, it appears that they are generally susceptible to highly accurate observations. However, observing difficulties arise at what might be called "the margins", such as when it is not obvious (due to a sight line obstruction) that a conflict occurred or was about to occur, or that a vehicle has been smoothly slowed or accelerated for several seconds as part of an aggressive driving action" (15, p. H-2).
- 11. "Emphasis throughout the fieldwork program was to select the most or more difficult approaches as the preferred means to test for data availability and degree of difficulty. Then, time permitting, DBI data on other approaches would be or could be collected for hypothesis-testing or related research purposes" (15, p. H-4).
- 12. "The summary finding, therefore, is that feld data can be collected for the full range of approaches, and that the data can be (justifiably) used to calculate an initial set of DBI scores and ranks which are approach-and lane-specific" (15, p.H-4).
- 13. "In regard to the matter of data availability, the following interpretive comments about the fieldwork data and Tables Q-1 to Q-33 appear pertinent. First, fieldworkers are able to make and record observations on all DBI variables, so there are no variables for which data are unavailable for technical reasons.

Second, and in a related vein, all DBI variables are seemingly time-sensitive, in that there appear to be hourly and seasonal variations in the volume and frequency of incidents and, hence, in the observing and recording tasks of fieldworkers. This finding is further confirmation of the explicit emphasis that was put on the seasonality and peak hour interval factors in the Basic Walking Security Index reports (11, 12), and the Quality of Intersection Condition reports (13, 14).

As for the degree of difficulty criterion, problems in making and recording observations on DBI variables diminished with each modification of the fieldwork form. Our evidence in this regard is the feedback from project assistants who spoke of an overall increase in rating accuracy and consistency as forms were field tested. Further, the degree of difficulty involved in administering the final DBI form was reduced from the outset by using modified Traffic Signal Drawings (TSDs) to perform ratings on a quadrant-by-quadrant basis (recall Section 1C in Part C, above)" (16, p.42).

4. General Finding

The materials presented in Section 2 and Section 3 demonstrate that the data needed to operationalize the Quality of Intersection Condition Index and the Driver Behaviour Index can be obtained via a fieldwork program.

5. Notes

1. The observation about the DBI fieldwork task being a "pilot study within a pilot study" is consistent with the discussion in previous WSI publications about defining and relating pilot studies, pretests and trial runs as research project design-evaluation tools. In addition to WSI publications (5, 11, 12, 13, 14, 15, 16, 18, 19), the interested reader is referred to publications by Ackoff and others (20, 21, 22, 23, 24, 25, 26, 27) which make important methodological contributions to elaborating the pilot study-pretest-trial run connection.

F. CALCULATING INDEX SCORES

1. Overview of Findings About Calculating Index Scores

The purpose of Part F is to provide an overview of our experience in applying the three indexes to calculate scores from City of Ottawa data and pilot study fieldwork data. We therefore use a <u>selection</u> of tables to illustrate the application of the indexes, and the reader is referred to the respective pilot study reports (11, 12, 13, 14, 15, 16) for comprehensive, self-contained discussions about the whys and hows of calculating scores for the three indexes.

2. Calculating Intersection Volume and Design Index (IVDI) Scores

Part C of the IVDI *Technical Supplement* (11) contains 132 tables showing the scores for the four indexes associated with this component of the pilot study:

A Series: Weighted Passenger Car Equivalent-Pedestrian

Interaction Potential Index

B Series: Intersection Pedestrian Challenge-Features Index

C Series: Intersection Volume and Design Index

(Formerly, Basic Walking Security Index)

D Series: Priority Index

In the interests of completeness, the formulations used to calculate the IVDI scores are presented below. The reader is referred to the original sources (5, and references in 5) for discussion of their derivation.

The formulations to be tested for operationality were initially published in *Walking Security Index* (5). The materials which follow are taken from the *Technical Supplement*, however, since that report tied together all the IVDI (BWSI) materials used for operationality-testing purposes (11, pp. B-1, B-2, B-3).

A. Weighted Passenger Car Equivalent-Pedestrian Interaction Potential (WPCE-PIP) Index

The formulation of this index is

WPCE-PIP =
$$V_1 \cdot V_2$$

where,

 $V_1 =$ number of passenger car equivalents²/hour

 $V_2 =$ number of pedestrians/hour

B. Intersection Pedestrian Challenge-Features (IPC-F) Index

The formulation of this index is

IPC-F =
$$V_3 \cdot V_4 \cdot V_5 \cdot V_6 \cdot V_7 \cdot V_8$$

where,

IPC-F = intersection score on the challenge to pedestrians' security that is caused by intersection features

 V_3 = number of lanes rating

 V_4 = number of turn lanes by type rating

 V_5 = intersection geometry rating

 V_6 = intersection slope rating

 V_7 = direction(s) of traffic flow rating

V₈ = number of channels adjacent to intersection rating

C. Intersection Volume and Design (IVD) Index

This index combines the Weighted Passenger Car Equivalent-Pedestrian Interaction Potential Index and the Intersection Pedestrian Challenge-Features Index. The formulation of this index is

IVDI = (WPCE-PIP) • (IPC-F)
=
$$V_1 • V_2 • V_3 • V_4 • V_5 • V_6 • V_7 • V_8$$

where,

 V_1 = number of passenger car equivalents²/hour

 V_2 = number of pedestrians/hour

 V_3 = number of lanes rating

 V_4 = number of turn lanes by type rating

 V_5 = intersection geometry rating

 V_6 = intersection slope rating

 V_7 = direction(s) of traffic flow rating

 V_8 = number of channels adjacent to intersection rating

D. Priority (P) Index

The formulation of this index is

$$PI = V_1 \cdot V_2$$

where,

 V_1 = number of vehicles

 V_2 = number of pedestrians

Evidence of operationality is demonstrated in the *Technical Supplement* (11) through four sets of tables containing index scores for the 33 pilot study intersections. Tables 10, 11, 12, 13, 14, 15 and 16 are presented here to illustrate that the formulations are operational, that is, scores can be calculated from the index data provided by the City of Ottawa.

Upon re-examination of the *Technical Supplement* (11) and the *Commentary Report* (12), we believe that the prior comments on operationality for score calculating purposes continue to hold. They are therefore repeated in the final report.

"In regard to characteristics of the base data and index score tables, the following interpretive remarks appear pertinent to the matter of operationality. First, the tables clearly demonstrate regard for time series

considerations (years of counts), variations by time of day (AM, noon, PM), and variations in the timing of the peak hour for vehicular and pedestrian traffic. And, by the same token, the tabular format and the availability of data demonstrate the flexibility available to (future) researchers who might wish to explore variations in vehicular and pedestrian traffic volume patterns by year, season, peak time of day, and peak hour.

Second, it appears fair to say that all the tables in this section are highly transparent. That is, the values or variables are numerically stated, and two numbers are multiplied to yield a product. Indeed, and in view of the straightforwardness of the tables in the A, B, C, D series, this appears to be one of those cases where the data do, in fact, 'speak for themselves'." (12,p.21-22).

The general finding, therefore, is that operationality is demonstrated, and the degree of difficulty criterion is satisfied.

In concluding this section, it is noted that the quadrant-intersection relationship was not examined during the IVDI/BWSI phase of the pilot study. That examination did not occur because the relationship had not been explicitly identified as a research problem, question, or issue to be pursued as part of the operationality test.

It is our impression, however, that the distinction between intersection and quadrant could be operationalized, perhaps to great advantage, with little to no impact on the task or difficulty of calculating IVDI scores. Indeed, such a procedure could have two advantages in particular in regard to enhancing IVDI operationality:

First, using quadrants instead of intersections could make situations seem simpler, and easier to compare and contrast, if three or four smaller numbers (scores) replace a larger number.

Table 10.

Values of Variables and Weighted Passenger Car Equivalent – Pedestrian Interaction Potential Index Scores, Pilot Study Intersections: Data and Calculations from ROC Counts Taken in 1999, 1998, 1997 and 1995

Year	Peak	Date and		WPCE-PIP Varial	bles and Values*	WPCE - PIP
		of Count ,		V ₁ = # of Passenger Car Equivalents Per Hour	V_2 = # of Pedestrians Per Hour	Index Score
1999	AM	Thursday, July 15	07:30-08:30	936	19	16,645,824
	AM		08:00-09:00	942	19	16,859,916
	AM		08:30-09:30	854	43	31,360,588
1998	AM	Thursday, July 9	07:30-08:30	1015	19	19,574,275
	AM		08:00-09:00	976	32	30,482,432
	AM		08:30-09:30	858	57	41,961,348
1999	Noon	Thursday, July 15	11:30-12:30	1000	63	63,000,000
	Noon		12:00-13:00	1068	54	61,593,696
	Noon		12:30-13:30	1084	63	74,028,528
1998	Noon	Thursday, July 9	11:30-12:30	999	87	86,826,087
	Noon		12:00-13:00	1022	64	66,846,976
	Noon		12:30-13:30	994	59	58,294,124
1999	PM	Thursday, July 15	15:30-16:30	1228	62	93,495,008
	PM		16:00-17:00	1292	64	106,832,896
	PM		16:30-17:30	1351	61	111,337,261
1998	PM	Thursday, July 9	15:30-16:30	1192	71	100,881,344
	PM		16:00-17:00	1323	65	113,771,385
	PM		16:30-17:30	1449	81	170,067,681

* Passenger Car Equivalents (PCE) per hour: automobile = 1.0 PCE; heavy vehicle = 1.7 PCE; bus = 1.7 PCE

Source: (11, p. C-6)

Table 11.

Values of Variables and Intersection Pedestrian Challenge – Features Index Scores, Pilot Study Intersections:

Data and Calculations from ROC Counts Taken in 1999, 1998, 1997 and 1995

Year	Peak			IPC -	- F Variabl	les and Va	lues*		IPC -F
		Date of Count	V ₃	V ₄	V ₅	V ₆	V ₇	V ₈	Index Score
1999	AM	Thursday, July 15	2.0	3.0	1.5	1.0	2.0	1.0	18.0
	AM								
	AM								
1998	AM	Thursday, July 9	2.0	3.0	1.5	1.0	2.0	1.0	18.0
	AM								
	AM								
1999	Noon	Thursday, July 15							
	Noon								
	Noon								
1998	Noon	Thursday, July 9							
	Noon								
	Noon								
1999	PM	Thursday, July 15							
	PM								
	PM								
1998	PM	Thursday, July 9							
	PM								
	PM								

^{*} V_3 = number of lanes; V_4 = number of turn lanes by type; V_5 = intersection geometry; V_6 = intersection slope; V_7 = direction of traffic flow; V_8 = number of channels adjacent to intersection

Source: (11, p. C-39) (Reminder: This index was initially referred to as the Basic Walking Security Index)

Table 12.

Values of Variables and Intersection Volume and Design Index Scores, Pilot Study Intersections:

Data and Calculations from ROC Counts Taken in 1999, 1998, 1997 and 1995

Year		Date and Tir			BWSI \	/ariable	es and \	/alues*			BWSI	
	Pea k	of Count	V ₁	V ₂	V ₃	V ₄	V ₅	V ₆	V ₇	V ₈	Index Score	
1999	AM	Thursday, July 15	07:30-08:30	936	19	2.0	3.0	1.5	1.0	2.0	1.0	299,624,832
	AM		08:00-09:00	942	19							303,478,480
	AM		08:30-09:30	854	43							564,490,584
1998	AM	Thursday, July 9	07:30-08:30	1015	19	2.0	3.0	1.5	1.0	2.0	1.0	352,336,950
	AM		08:00-09:00	976	32							548,683,776
	AM		08:30-09:30	858	57							755,304,264
1999	Noon	Thursday, July 15	11:30-12:30	1000	63	2.0	3.0	1.5	1.0	2.0	1.0	1,134,000,000
	Noon		12:00-13:00	1068	54							1,108,686,528
	Noon		12:30-13:30	1084	63							1,332,513,504
1998	Noon	Thursday, July 9	11:30-12:30	999	87	2.0	3.0	1.5	1.0	2.0	1.0	1,562,869,566
	Noon		12:00-13:00	1022	64							1,203,245,568
	Noon		12:30-13:30	994	59							1,049,294,232
1999	PM	Thursday, July 15	15:30-16:30	1228	62	2.0	3.0	1.5	1.0	2.0	1.0	1,682,910,144
	PM		16:00-17:00	1292	64							1,922,992,128
	PM		16:30-17:30	1351	61							2,004,070,690
1998	PM	Thursday, July 9	15:30-16:30	1192	71	2.0	3.0	1.5	1.0	2.0	1.0	1,815,864,192
	PM		16:00-17:00	1323	65							2,047,884,930
	PM		16:30-17:30	1449	81							3,061,218,258

 *V_1 = passenger car equvalents² per hour; V_2 = number of peds per hour; V_3 = number of lanes; V_4 = number of turn lanes by type; V_5 = intersection geometry; V_6 = intersection slope; V_7 = direction of traffic flow; V_8 = number of channels adjacent to intersection Source: (11, p. C-72) (Reminder: This index was initially referred to as the Basic Walking Security Index)

Table 13.

Values of Variables and Priority Index Scores, Pilot Study Intersections:

Data and Calculations from ROC Counts Taken in 1999, 1998, 1997 and 1995

Year	Peak	Date an		PI Variable	Priority Index Score	
				V ₁ = # of Vehicles Per Hour	V ₂ = # of Pedestrians Per Hour	
1999	AM	Thursday, July 15	07:30-08:30	914	19	17,366
	AM		08:00-09:00	917	19	17,423
	AM		08:30-09:30	836	43	35,948
1998	AM	Thursday, July 9	07:30-08:30	972	19	18,468
	AM		08:00-09:00	936	32	29,952
	AM		08:30-09:30	824	57	46,968
1999	Noon	Thursday, July 15	11:30-12:30	980	63	61,740
	Noon		12:00-13:00	1044	54	56,376
	Noon		12:30-13:30	1057	63	66,591
1998	Noon	Thursday, July 9	11:30-12:30	975	87	84,825
	Noon		12:00-13:00	1000	64	64,000
	Noon		12:30-13:30	960	59	56,640
1999	PM	Thursday, July 15	15:30-16:30	1203	62	74,586
	PM		16:00-17:00	1273	64	81,472
	PM		16:30-17:30	1331	61	81,191
1998	PM	Thursday, July 9	15:30-16:30	1162	71	82,502
	PM		16:00-17:00	1300	65	84,500
	PM		16:30-17:30	1431	81	115,911

* V_1 =vehicles per hour; V_2 = number of pedestrians per hour

Source: (11, p. C-105)

Table 14.

Weighted Passenger Car Equivalent - Pedestrian Interaction Potential Index Scores and Priority Index Scores, Pilot Study Intersections: Data and Calculations from ROC Counts Taken in 1999, 1998, 1997 and 1995

Year	Peak	Date and Time	of Count	WPCE - PIP Index Score	Priority Index Score
1999	AM	Thursday, July 15	07:30-08:30	16,645,824	17,366
	AM		08:00-09:00	16,859,916	17,423
	AM		08:30-09:30	31,360,588	35,948
1998	AM	Thursday, July 9	07:30-08:30	19,574,275	18,468
	AM		08:00-09:00	30,482,432	29,952
	AM		08:30-09:30	41,961,348	46,968
1999	Noon	Thursday, July 15	11:30-12:30	63,000,000	61,740
	Noon		12:00-13:00	61,593,696	56,376
	Noon		12:30-13:30	74,028,528	66,591
1998	Noon	Thursday, July 9	11:30-12:30	86,826,087	84,825
	Noon		12:00-13:00	66,846,976	64,000
	Noon		12:30-13:30	58,294,124	56,640
1999	РМ	Thursday, July 15	15:30-16:30	93,495,008	74,586
	РМ		16:00-17:00	106,832,896	81,472
	ΡM		16:30-17:30	111,337,261	81,191
1998	РМ	Thursday, July 9	15:30-16:30	100,881,344	82,502
	ΡM		16:00-17:00	113,771,385	84,500
	ΡM		16:30-17:30	170,067,681	115,911

Source: (11, p. D-5)

56

Table 15.
Intersection Pedestrian Challenge – Features Index Scores, and Priority Index Scores, Pilot Study Intersections: Data and Calculations from ROC Counts Taken in 1999, 1998, 1997 and 1995

Year	Peak	Date and Time of Count		IPC - F Index Score	Priority Index Score
1999	AM	Thursday, July 15	07:30-08:30	18.0	17,366
	AM		08:00-09:00		17,423
	AM		08:30-09:30		35,948
1998	AM	Thursday, July 9	07:30-08:30	18.0	18,468
	AM		08:00-09:00		29,952
	AM		08:30-09:30		46,968
1999	Noon	Thursday, July 15	11:30-12:30	18.0	61,740
	Noon		12:00-13:00		56,376
	Noon		12:30-13:30		66,591
1998	Noon	Thursday, July 9	11:30-12:30	18.0	84,825
	Noon		12:00-13:00		64,000
	Noon		12:30-13:30		56,640
1999	РМ	Thursday, July 15	15:30-16:30	18.0	74,586
	РМ		16:00-17:00		81,472
	РМ		16:30-17:30		81,191
1998	РМ	Thursday, July 9	15:30-16:30	18.0	82,502
	РМ		16:00-17:00		84,500
	РМ		16:30-17:30		115,911

Source: (11, p. D-38)

Table 16.
Intersection Volume and Design Index Scores, and
Priority Index Scores, Pilot Study Intersections:
Calculations from ROC Counts Taken in 1999, 1998, 1997 and 1995

Year	Peak	Date and Time of	of Count	BWSI Score	P I Score
1999	AM	Thursday, July 15	07:30-08:30	299,624,832	17,366
	AM		08:00-09:00	303,478,480	17,423
	AM		08:30-09:30	564,490,584	35,948
1998	AM	Thursday, July 9	07:30-08:30	352,336,950	18,468
	AM		08:00-09:00	548,683,776	29,952
	AM		08:30-09:30	755,304,264	46,968
1999	Noon	Thursday, July 15	11:30-12:30	1,134,000,000	61,740
	Noon		12:00-13:00	1,108,686,528	56,376
	Noon		12:30-13:30	1,332,513,504	66,591
1998	Noon	Thursday, July 9	11:30-12:30	1,562,869,566	84,825
	Noon		12:00-13:00	1,203,245,568	64,000
	Noon		12:30-13:30	1,049,294,232	56,640
1999	PM	Thursday, July 15	15:30-16:30	1,682,910,144	74,586
	РМ		16:00-17:00	1,922,992,128	81,472
	РМ		16:30-17:30	2,004,070,690	81,191
1998	РМ	Thursday, July 9	15:30-16:30	1,815,864,192	82,502
	РМ		16:00-17:00	2,047,884,930	84,500
	РМ		16:30-17:30	3,061,218,258	115,911

(Reminder: This index was initially named the Basic Walking Security Index, which accounts for the BWSI heading in column 5)

Source: (11, p. D-71)

Second, the procedure of using quadrant(s) instead of intersection(s) could make things appear clearer, and easier to comprehend, since a quadrant-by-quadrant approach involves less complexity and more transparency than occurs in analysis/synthesis studies done at the intersection level.

3. Calculating QICI Scores

The N and O series of tables in the *Technical Supplement* (13) demonstrate that when the data are available, QICI scores, including median scores, can be readily calculated. Two fieldwork tables from the N series and two scores tables from the O series are reproduced as Tables 17, 18, 19, and 20 to illustrate the use made of fieldwork data recorded by project assistants (13, 14).

In addition to calculating scores from data collected by project assistants, scores were also calculated using data collected by community association members. Tables 21, 22, 23, and 24 illustrate how field data were recorded, and scores were calculated for quadrants and intersections using a quadrant-based field form.

Table 25 is included to show how actual and potential scores can be combined to compute an actual ÷ potential, or actual/potential ratio. The value of this ratio is that it puts all the intersections on the same footing, since the potential rating is used in all cases to compute the index scores. As a result, intersections are compared on an "apples to apples" basis, and the scores are not distorted due to non-condition variations, such as differences in number of quadrants, or the presence/absence of a school or traffic calming measures that may be particular to selected intersections.

Table 17. QICI Field Report, WSI Pilot Study: Carlingwood SC and Carling WALKING SECURITY INDEX: PILOT STUDY

Quality of Intersection Condition (QIC) Index: Checklist of Core Variables for Assessing Intersection Construction and Maintenance.

Date(Y/M/D): 60 / 61 / (33	Time(mil):_ 845
		SC/Fairlawn TSD#: 5690 Count#:
	1100 3.04 1110	

	Variable Names for Intersection	Condition Met?					
ID	Construction or Maintenance Features	Yes				No	
		(+1)	(+,5)	(0)	(5)	(-1)	
1	Sidewalk corner capacity					V	
2	Height of curbing						
3	Condition of curbing						
4	Sidewalk width					V	
5	Sidewalk condition					V	
6	Crosswalk surface condition					~	
7	Median (refuge) capacity					·-	
8	Median (refuge) condition						
9	Traffic calmer(s)			V			
10	Channel refuge island capacity	V					
11	Crosswalk capacity	1					
12	Crosswalk signed and painted	/					
13	Stop bar painted and signed	Y					
14	Pedestrian signage	1					
15	No sight line obstruction	/					
16	Street furniture proximal to corner			~			
17	lce/snow/slush removal					ν	
18	Water drainage					iv	
	Totals =	6		\$		-10	
	Overall Assessment = (Yes - No) =	-4.0					

18	vvater drainage		İ	l	Ĺ	i i
	Totals =	6		¢		-10
	Overall Assessment = (Yes - No) =	-4.0				
Invest	ligator (print): Meghawlson	Sign	ature:	Meh	11/s	5
Key	Comments:					
├ ── S	Source: (13, p. E-17)					

Table 18. QICI Field Report, WSI Pilot Study: Hawthorne and Main Quality of Intersection Condition (QIC) Index: Checklist of Core Variables for Assessing Intersection Construction and Maintenance.

able Names for Intersection instruction or Maintenance Features Sidewalk corner capacity Height of curbing Condition of curbing Sidewalk width Sidewalk condition Crosswalk surface condition	Yes (+1)	(+,5) ×	(0) -/	(5) ×	(-1
Sidewalk corner capacity Height of curbing Condition of curbing Sidewalk width Sidewalk condition	(+1)		r		(-1
Height of curbing Condition of curbing Sidewalk width Sidewalk condition				Ø	
Condition of curbing Sidewalk width Sidewalk condition		_	×	X	
Sidewalk width Sidewalk condition		~	X		
Sidewalk condition		V	-		
12.1000 (2.1000 (2.1000 (1.100		~			
Crosswalk surface condition		1.2	X		
		X	,	-	
Median (refuge) capacity	-		NA	~~	_
Median (refuge) condition			NA		_
Traffic calmer(s)			NA		_
hannel refuge island capacity	_		MA		_
Crosswalk capacity	X				
Crosswalk signed and painted			X		
Stop bar painted and signed		7			
Pedestrian signage	, , ,	1			
No sight line obstruction					×
	4				DIVE-
ice/snow/slush removal				X	
Water drainage				X	
Totals =	2	2	D	-15	-1
Overall Assessment = (Yes - No) =	1.5			0	
	crosswalk capacity Crosswalk signed and painted Stop bar painted and signed Pedestrian signage No sight line obstruction reet furniture proximal to corner Ice/snow/slush removal Water drainage Totals = Overall Assessment = (Yes - No) =	Crosswalk capacity Crosswalk signed and painted Stop bar painted and signed Pedestrian signage No sight line obstruction reet furniture proximal to corner Ice/snow/slush removal Water drainage Totals = 2 Overall Assessment = (Yes - No) = 1/1.5	channel refuge island capacity Crosswalk capacity Crosswalk signed and painted Stop bar painted and signed Pedestrian signage No sight line obstruction reet furniture proximal to corner Ice/snow/slush removal Water drainage Totals = 2 Overall Assessment = (Yes - No) = 1.5	channel refuge island capacity Crosswalk capacity Crosswalk signed and painted Stop bar painted and signed Pedestrian signage No sight line obstruction reet furniture proximal to corner Ice/snow/slush removal Water drainage Totals = 2 2 9	channel refuge island capacity Crosswalk capacity Crosswalk signed and painted Stop bar painted and signed Pedestrian signage No sight line obstruction reet furniture proximal to corner Ice/snow/slush removal Water drainage Totals = 2 2 8 -1 5 Overall Assessment = (Yes - No) = 1.5

Table 19. Median QIC Index Scores, Winter 2000: AM, Noon and PM Peak Hours

ID	Intersection	Winter, 2000		
		AM	Noon	PM
1	Albert and O'Connor	6.5	5.5	1.5
2	Bank and Queen	7.0	7.0	3.0
3	Baseline and Greenbank	3.5	0.5	3.75
4	Bearbrook and Innes	7.25	4.25	5.0
5	Broadview and Carling	3.75	3.0	0.25
6	Bronson and Carling	1.5	1.25	0
7	Carling and Edgeworth	-2.5	-3.75	-1.5
8	Carling and Fairlawn (Woodroffe N)	-1.0	-3.0	-1.25
9	Carling and Woodroffe South	6.25	4.25	4.0
10	Carling and Iroquois	0	-1.0	1.0
11	Carlingwood SC and Carling	-1.75	-3.0	-1.0
12	Carlingwood SC and Woodroffe	6.0	5.75	5.75
13	Churchill and Richmond	-2.0	-2.0	-2.0
14	Cleary and Richmond	-0.75	-1.25	-1.25
15	Clegg and Main	4.5	5.5	5.5
16	Elgin and Laurier	8.0	7.5	3.0
17	Evelyn and Main	5.5	7.5	8.0
18	Hawthorne and Main	1.5	0	1.5
19	Hazel and Main	3.75	5.0	4.75
20	Hazeldean and Carbrooke	0.75	-0.5	0.75
21	Jeanne D'Arc Blvd and Orleans Blvd	-1.25	-2.25	-2.5
22	King Edward and Rideau	3.5	7.0	4.0
23	Kirkwood and Merivale	-3.75	-3.75	-3.5
24	Lees and Main	1.0	1.0	0
25	Lenester and Woodroffe	1.0	0.5	1.75
26	Main and Oblate	4.0	4.0	4.0
27	Main and Riverdale	4.5	5.0	5.0
28	Merivale and Meadowlands	-3.25	-4.5	-3.50
29	Montreal Rd and St. Laurent Blvd	1.0	0	6.0
30	New Orchard and Richmond	3.75	3.5	5.5
31	Richmond and Woodroffe	1.25	1.0	2.75
32	Saville and Woodroffe	3.0	2.25	2.5
33	Woodroffe at Algonquin College	-4.75	-6.0	-4.5

Source: (13, p. F-6)

Table 20. Median QIC Index Scores, Fall 1999: AM, Noon and PM Peak Hours

I D	Intersection	Fall, 1999		
		АМ	Noon	PM
1	Albert and O'Connor	4.5		
2	Bank and Queen	4.5		
3	Baseline and Greenbank	6.5		
4	Bearbrook and Innes	9.0		7.0
5	Broadview and Carling		2.0	
6	Bronson and Carling		2.25	
7	Carling and Edgeworth		6.25	8.5
8	Carling and Fairlawn (Woodroffe N)		0.75	0.0
9	Carling and Woodroffe South		8.0	9.0
10	Carling and Iroquois		7.0	4.5
11	Carlingwood SC and Carling		5.0	
12	Carlingwood SC and Woodroffe		0.5	
13	Churchill and Richmond		-4.0	
14	Cleary and Richmond		3.5	7.5
15	Clegg and Main			4.75
16	Elgin and Laurier	4.0		
17	Evelyn and Main			5.5
18	Hawthorne and Main			6.5
19	Hazel and Main	11.0		3.0
20	Hazeldean and Carbrooke	11.0	5.5	8.0
21	Jeanne D'Arc Blvd and Orleans Blvd	5.5		3.5
22	King Edward and Rideau	2.0		2.0
23	Kirkwood and Merivale		4.5	
24	Lees and Main			4.0
25	Lenester and Woodroffe		6.5	1.5
26	Main and Oblate			0.75
27	Main and Riverdale			2.25
28	Merivale and Meadowlands	-2.25		
29	Montreal Rd and St. Laurent Blvd			1.0
30	New Orchard and Richmond		6.5	5.5
31	Richmond and Woodroffe		3.0	7.0
32	Saville and Woodroffe		5.75	8.75
33	Woodroffe at Algonquin College		-3.0	

Source: (13, p. F-5)

Table 21. Community Association Test of QICI Form B-4:
Carling and Fairlawn/Woodroffe

Date(Y/M/D): 00/ 10/27	Time(mil):/ 6 _ 4 5	Count#:
Intersection: Oarlung	Karman	TSD#:

			Col	ndition N	Net	
ID	Variable Names for Intersection			No (Qu	adrant)	
	Design and Maintenance Features	Yes	NW	NE	SE	SW
1	Sidewalk corner capacity	VVVV				
2	Height of curbing	Y .	×		X	X
3	Condition of curbing	VVV				
4	Sidewalk width capacity	VVVV				
5	Sidewalk condition	V/VV				
6	Crosswalk surface condition	//	×σ	XO		
7	Median (refuge) capacity			ΧĹ) —	Xª
8	Median (refuge) condition	VV				
9	Traffic calmer(s)		X	Χ	λ	×
10	Channel island (refuge) capacity			X		
11	Crosswalk capacity -	VVV				
12	 Crosswalk signed and painted 	VVV				
13	Stop bar painted and signed	VYVV				
14	Pedestrian signage					
15	No sight line obstruction	VVV				
16	Street furniture proximal to corner	VVVV				
17	lce/snow/slush removal					
18	Water drainage				·X	
	Totals		7 .	4	3	
	Overall Score (YES - NO =):	27				

Investigator: La Wivges Signature: La Weiges	
E Fast to small. The cust on the median refuge is	

Source: (13, p. E-49)

Table 22. Community Association Test of QICI Form B-4: Parkdale and Wellington

Date(Y/M/D):2004 10 130	Time(mil): 5:15-5:45pm	Count#: 1
Intersection: PARKDALE	•	TSD#:

			Co	ndition	Met	
ID	Variable Names for Intersection		No (Quadrant)			
1	Design and Maintenance Features	l				
		Yes	NW	NE	SE	SW
1	Sidewalk corner capacity	/	×	×	X	
2	Height of curbing	-	X	X		X
3	Condition of curbing	レレレ				X
4	Sidewalk width capacity	سنس	X	X		
5	Sidewalk condition	VVV	X			
6	Crosswalk surface condition	レレ	X		l	X
7	Median (refuge) capacity	_			<u></u>	
8	Median (refuge) condition	_	-			
9	Traffic calmer(s)		X	X	X	X
10	Channel island (refuge) capacity				-	
11	Crosswalk capacity ¹	LV	X			X
12 *	Crosswalk signed and painted	VVV				
13	Stop bar painted and signed	vv				
14	Pedestrian signage	ノレレン				
15	No sight line obstruction	V	X	X	×	
16	Street furniture proximal to comer	V	X	X	X	
17	Ice/snow/slush removal	_	_			
18	Water drainage					
	Totals	28	10	6	4	5
	Overall Score (YES - NO =):	28	- 25	=(3))	

		THE PERSON OF TH		
Investigator:	KRISTA APSE, HC	A_Signature:_	KAppe	

Key	comments	5:

. NW \$SW CROSSWALKS & SIDEWALKS ARE NOT WIDE ENOUGH TO ACCOMODATE PED TRAFFIC

Source: (13, p. E-56)

Table 23. Community Association Test of QICI Form B-4: **Bronson and Somerset**

Date(Y/M/D): 00 / 11 / 04	Time(mil):1	11-45 SAT	Count#:
Intersection: BRONSON &	SOMERSET	•	TSD#:

		Condition Met No (Quadrant)				
ID	Variable Names for Intersection					
	Design and Maintenance Features					
		Yes	NW	NE	SE	SW
1	Sidewalk corner capacity	l	· X	1	×	×
2	Height of curbing	1	×	×	×	1
3	Condition of curbing	2	×	1	×	1
4	Sidewalk width capacity	1	×	1	X	×
5	Sidewalk condition	3	1	1	×	1
6	Crosswalk surface condition	4	1	1	1	١
7	Median (refuge) capacity	1	_	_		
8	Median (refuge) condition	1	_	_		-
9	Traffic calmer(s)	0	×	×	×	×
10	Channel island (refuge) capacity	,	-	_		_
11	Crosswalk capacity	2	1	Х	×	1
12	Crosswalk signed and painted	0	×	×	×	×
13 *	Stop bar painted and signed	0	×	×	×	×
14	Pedestrian signage	0	X	×	×	×
15 .	No sight line obstruction	2	X	1	×	1
16	Street furniture proximal to corner	2	×	1	Х	1
17	Ice/snow/slush removal	Ī	1	1	_	-
18	Water drainage	_	_	_	-	_
	12	6				
	Overall Score (YES - NO =):	18-	· 34 =	-16/		

BRIAN GILLIAM / DOUG GABELMANN Investigator: RON SIGNATURE SIGNATURE:

Key comments:

12,13,14 High Volume of Pedestrians; further signs, painting required

NW-15 Garbage bins, Newspaper boxes obstructing corner

NW - 2 Too High for Wheel Chair

NE-11 Paint lines boside brick.

NESE-11 Crosswalks too narrow

SE - 15 Pules, traffic box conjest corner Corner copacities inadequate for padostrian volumes
NO room for SNOW

Revised: 00/10/19

STOP BOX SHOULD BE HOVED BOCK. 5W - 13

Source: (13, p. E-48)

Table 24. Community Association Test of QICI Form B-4:
Garland and Somerset

Date(Y/M/D):	80 / 91 / 01	Time(mil): 15:30 - 14:15	Count#:
Intersection:_	Garland	Somerset	1 Wellington	TSD#:

			Co	ndition I			
ID	Variable Names for Intersection	No (Quadrant)					
1	Design and Maintenance Features			·			
į		Yes	NW	NE	SE	vs	W(2)
1	Sidewalk corner capacity	15)	V	~	~	10	V
2	Height of curbing	235	X	V	X	V	X
3	Condition of curbing	3	X		/	1	X
4	Sidewalk width capacity	5	V	V	<u>/</u>	1	1
5	Sidewalk condition	4	V	XY O	/	1	1
6	Crosswalk surface condition	4	/	XY O		1	/
7	Median (refuge) capacity					1	
8	Median (refuge) condition				1-		
9	Traffic calmer(s)			bump-out		1	
10	Channel island (refuge) capacity	-				<u> </u>	<u> </u>
11	Crosswalk capacity	5	V	~	V	1	1
12	 Crosswalk signed and painted 		V	15	~	1 4	1
13	Stop bar painted and signed	ŋ	NA	V	/	1	NA
14	Pedestrian signage		NA	NA	NA	NA	NA
15	No sight line obstruction	4	V	V	/	×	1
16	Street furniture proximal to corner	ሃ	/	/	~	1~	1
17	Ice/snow/slush removal					<u> </u>	<u> </u>
18	Water drainage					<u> </u>	<u> </u>
	Totals	46	12	2		11	2
	Overall Score (YES - NO =):	4 (, -8	= 38			

Investigator:_	hinda	Hoad	Signature:	Ginda Hoad
_				

Key comments:

NE sidewalk extension heaving, one long crack in intersection

Garland, both enw sides (NW & part of NE) - Aldewalls curb too

high on one side of cross walk ie curb slope does not match

the cross walk

Source: (13, p. E-52)

Table 25. Scores and Ratios for Intersections Evaluated by Community Association Members Using QICI Form B-4.*

Intersection	Sc	Ratio	
intersection	Actual (A)	Potential (P)	A, P
Booth and Gladstone	46	53	.87
Booth and Somerset	22	48	.46
Bronson and Carling	26	54	.48
Bronson and Somerset	18	52	.35
Carling and Fairlawn/Woodroffe	32	44	.73
Carling and Woodroffe S.	30	39	.76
Garland and Somerset	44	52	.85
Holland and Tyndall	34	52	.65
Parkdale and Wellington	28	53	.53
Richmond Rd and Woodroffe	29	40	.73
Saville Row and Woodroffe	31	43	.72

^{*} The entries in this table are based on fieldwork done by members of the Dalhousie, Hintonburg, and Woodpark Community Associations. Tables 21 to 24 present some of the evaluations undertaken by association members.

Findings in regard to using the QIC Index forms to calculate scores are summarized as follows.

- The procedures for calculating QICI scores involve elementary arithmetic, so the degree of difficulty criterion is satisfied from a computational perspective. It is our impression that attaching weights to QICI variables would cause only a slight increase in technical difficulty.
- 2. Use of a quadrant-based form to assess construction and maintenance features appears to increase the validity of scores, and especially when the fieldworkers' range of experience is expanded by multiple site visits involving different locations, days of week, peak hours, and weather conditions.

^{**} The median score is used for intersections that received multiple evaluations.

The general finding, therefore, is that operationality of the QIC index is demonstrated with regard to calculating index scores.

4. Calculating DBI Scores

Part J of the *Technical Supplement* (15) provides a detailed description of the procedure for tabulating Driver Behaviour Index scores. In addition, it contains the sections "Demonstration of Operationality", and "Interpretive Comments on the T Series [Driver Behaviour Index Scores for Intersection Quadrants] of Tables", in which tabulations are discussed. Part E and Part F of the *Commentary Report* (16) add more explanative comments about the principles and procedures behind calculating DBI scores.

The purpose behind those detailed discussions in both background papers was to make them as self-contained as the project schedule and resources allowed. A matter of particular concern was to guard against the misuse of either the formulation, which was at the <u>initial specification</u> phase, or the scores, which were <u>initial approximations</u> of the incidence of aggressive driving behaviour at pilot study intersections.¹

It is again emphasized that, due to the <u>formative</u> nature of DBI research, the background reports should be consulted for details, and especially with regard to the *caveats* and limitations that we attach to the scores.

At an overview level, it appears that three statements about findings are sufficient to establish the operationality of DBI scoring procedures. The statements are supported by sets of tables which are presented on consecutive pages at end of the section. It is our impression that this approach may assist the reader in better appreciating the research process behind a numeric exercise.

First, and using examples from the R, S and T series of tables from the *Technical Supplement* (15) for illustrative purposes, Tables 26 to 30 show the progression from field counts, to incidents per phase, to scores. Since the derivation of scores involves elementary arithmetic, the degree of difficulty criterion is satisfied.

Second, and having regard for the disaggregation principle outlined in the QICI reports (13, 14), the test of DBI operationality included calculating index scores for each quadrant (rather than intersection) on a peak hour (rather than daily) basis. As demonstrated by the R, S and T series of tables (15), and illustrated by the examples of Tables 26 to 30, quadrant scores are calculated. Hence, the disaggregation test of operationality is satisfied.

Third, and again having regard for the disaggregation, the test of DBI operationality included calculating DBI scores based on the frequency of incidents per phase. As shown by the original tables and Tables 26 to 30, the temporal disaggregation test is also satisfied.

The summary finding, therefore, is that the procedure for calculating DBI scores is demonstrated to be fully operational.

5. Calculating IVDI, QICI and DBI Scores: General Finding

We have not identified any contradictions, inconsistencies or incompatibilities between or among the procedures for calculating scores. And, we have not had any perceived or real concern in that regard brought to our attention by the client or other party. As a result, it is the general finding that the scoring procedures for each and all macro indexes have been demonstrated to be operational.

6. Notes

1. As stated in a number of project reports and papers (1, 3, 5, 6, 7, 8, 9, 15, 16, 18, 19, 29, 38), the Driver Behaviour Index research is in the early stages of conceptualization, design and development. And, as also stated in the WSI publications (1, 3, 5, 15, 16, 18, 19, 29, 38), it would be inappropriate to present or to treat the initial DBI formulation and scores as more than preliminary and exploratory approximations of the best formulation and data. Those cautions and advisements notwithstanding, however, we remain concerned that the contents of this report could be used without proper referencing to the background reports (15, 16). The purpose of the additional comments in the text of the final report (17) is to make our concerns about misuse of the DBI formulation and data explicit and emphatic.

Table 26. DBI Field Report, WSI Pilot Study: Elgin and Laurier

FIELD SHEET WALKING SECURITY INDEX PILOT STUDY DRIVER BEHAVIOUR INDEX (DBI) COMPONENT

Intersection:	(14	LAURIER	VELGIN ST	•	Date: 11 108100
Peak Hour:	AM.	; Noon	; PM <u>×</u>	Time: <u>3</u>	35-4:35pm

Quadrant		Aggressive Driving Incidents				
Details	Ran Amber	Ran Red	Failed to Yield to Ped	Phases		
	1111-1111-1111	1111	HH HH HH HH	+++ +++		
	1111 1111 1111		 	HH +H+ +H+		
	1111 +111		HH HH HH HH III	1111 +111		
SE						
<u> </u>						
		(2)	AU	(a)		
	(3)	(5)	(4)			
	1111-1111 1111	\	++++ +++ 1111	1111-1111-1111		
	HH-HH IIII			1111-1111		
				1111 +111		
SW						
),,,						
	(FR)	(D)	Ŕ	(43)		

Key Comments:

THE COLUMN "FALLED TO YIELD TO PED" INCLUDES ALL FAILED

TO YIELD, NOT ONLY FAILING TO YIELD TO PEDESTRIANS.

OF PHASES IS DEFINED AS EVERY TIME THE LIGHT TURNED

GREEN IN THAT PARTICULAR QUADRANT.

Fieldworker(s): T. MANURYK AND M. LEACH

Source: (15, p. H-22)

Table 27. Field Counts of Aggressive Driving Incidents and Signal Phases, AM, Noon and PM Peak Hours*: Elgin and Laurier

Pe	ak Hour: AM	Quadrant	# of Incidents			# of Phases
Date	Time	Quadrant	Reds	Ambers	Yields	i ilases
00/11/09	08:15 – 09:15	NW	6	36	36	42
00/11/09	08:15 - 09:15	SW	14	7	20	42

Peak Hour: Noon		Noon		# of Incidents			
Date	Time	Quadrant	Reds	Phases			
00/11/01	11:51 – 12:51	NW	8	38	60	45	
00/11/01	11:51 – 12:51	NE	34	34 85 40			
00/11/09	12:30 – 13:00*	NW	20	5	18	64	
00/11/09	12:30 – 13:00*	SW	7	36	39	72	

Pe	ak Hour: PM	Quadrant	# of Incidents			# of Phases
Date	Time	Quadrant	Reds	Ambers	Yields	i ilases
00/11/08	15:35 – 16:35	SE	5	41	74	40
00/11/08	15:35 – 16:35	SW	1	29	19	40
00/11/09	16:10 – 16:40*	NW	6	33	35	60
00/11/09	16:15 – 16:45*	SW	14	6	12	61

^{*}The duration of counts is generally 60 minutes, any exceptions are noted. Source: (15, p. I-19)

Table 28. Aggressive Driving Incidents Per Signal Phase, AM, Noon and PM Peak Hours*: Elgin and Laurier

Pe	ak Hour: AM	Quadrant	# of Incidents			# of Phases	
Date	Time	Quadrant	Reds Ambers Yields			Filases	
00/11/09	08:15 – 09:15	NW	.14	.86	.86	1.85	
00/11/09	08:15 - 09:15	SW	.33	.17	.48	.98	

Peak Hour: Noon		Quadrant	#	# of Phases			
Date	Time	Quadrant	Reds	Reds Ambers Yields			
00/11/01	11:51 – 12:51	NW	.18	.84	1.33	2.35	
00/11/01	11:51 – 12:51	NE	.81	.81 1.89 .89			
00/11/09	12:30 – 13:00*	NW	.37	.08	.28	.73	
00/11/09	12:30 – 13:00*	SW	.10	.50	.54	1.14	

Pe	ak Hour: PM	Quadrant	# of Incidents			# of Phases
Date	Time	Quadrant	Reds	Ambers	Yields	i ilases
00/11/08	15 :35 - 16 :35	SE	.13	1.02	1.85	3.00
00/11/08	15 :35 - 16 :35	SW	.02	.73	.47	1.22
00/11/09	16:10 - 16:40*	NW	.10	.55	.58	1.23
00/11/09	16:10 - 16:40*	SW	.23	.10	.20	.53

^{*}The duration of counts is generally 60 minutes, any exceptions are noted. Source: (15, p. I-52)

Table 29. Driver Behaviour Index Scores for Intersection Quadrants: PM Peak Hour, Fall 2000

			Quac	Irant	
ID	Intersection Name	NW	NE	SW	SE
1	Albert and O'Connor	3.08	0.99	-	-
2	Bank and Queen	0.26	0.75	1.28	0.28
3	Baseline and Greenbank	2.62	3.00	-	-
4	Bearbrook and Innes	-	-	-	-
5	Broadview and Carling	0.34	-	-	-
6	Bronson and Carling	1.12	-	2.12	1.99
7	Carling and Edgeworth	-	-	-	-
8	Carling and Woodroffe North	-	-	•	-
9	Carling and Woodroffe South	-	0.84	0.79	-
10	Carling and Iroquois	-	-	-	-
11	Carlingwood SC and Carling	-	0.22	0.15	0.47
12	Carlingwood SC and Woodroffe	-	0.64	-	0.39
13	Churchill and Richmond	0.23	0.11	0.11	0.08
14	Cleary and Richmond	0.25	0.12	0.04	0.10
15	Clegg and Main	1.84	0.55	-	-
16	Elgin and Laurier	1.23	-	0.89	3.00
17	Evelyn and Main	1.27	1.32	-	-
18	Hawthorne and Main	-	-	-	1.39
19	Hazel and Main	-	-	•	-
20	Hazeldean and Carbrooke	-	-	-	-
21	Jeanne D'Arc Blvd and Orleans Blvd	-	-	3.77	2.50
22	King Edward and Rideau	4.39	4.32	3.06	4.50
23	Kirkwood and Merivale	0.25	-	0.14	-
24	Lees and Main	1.84	1.77	-	1.75
25	Lenester and Woodroffe	-	0.64	-	0.45
26	Main and Oblate	-	-	-	-
27	Main and Riverdale	0.29	-	0.15	0.34
28	Merivale and Meadowlands	0.59	2.16	1.92	3.53
29	Montreal Rd and St. Laurent Blvd	-	-	1.70	1.40
30	New Orchard and Richmond	-	-	-	-
31	Richmond and Woodroffe	0.98	3.43	-	-
32	Saville and Woodroffe	-	0.13	-	-
33	Woodroffe at Algonquin College	2.51	3.79	2.60	0.00

Source: (15, p. J-10)

Table 30. Master List of Driver Behaviour Index Scores: Fall 2000 (Partial Listing for Illustrative Purposes)

		(Quad	lrant		P	eak Ho	ur	
ID	Intersection name	NW	NE	SE	SW	AM	Noon	PM	Score*
21	Jeanne D'Arc Blvd and Orleans Blvd		٧			٧			5.31
22	King Edward and Rideau	٧				٧			5.24
22	King Edward and Rideau			٧				٧	4.50
22	King Edward and Rideau	٧						٧	4.39
22	King Edward and Rideau		٧					٧	4.32
33	Woodroffe at Algonquin College		٧					٧	3.79
21	Jeanne D'Arc Blvd and Orleans Blvd				٧			٧	3.77
16	Elgin and Laurier		٧				٧		3.59
28	Merivale and Meadowlands				٧			٧	3.53
28	Merivale and Meadowlands			٧			٧		3.52
31	Richmond and Woodroffe		٧					٧	3.43
6	Bronson and Carling				٧	٧			3.30
22	King Edward and Rideau			٧			>		3.09
1	Albert and O'Connor	٧						٧	3.08
22	King Edward and Rideau				٧			٧	3.06
3	Baseline and Greenbank		٧					٧	3.00
16	Elgin and Laurier			٧				٧	3.00
18	Hawthorne and Main				٧	٧			2.73
18	Hawthorne and Main	٧				٧			2.72
33	Woodroffe at Algonquin College		٧				٧		2.68
22	King Edward and Rideau		٧			٧			2.67
3	Baseline and Greenbank	٧						٧	2.62
33	Woodroffe at Algonquin College			٧				٧	2.60
1	Albert and O'Connor	٧					٧		2.58
6	Bronson and Carling			٧		٧			2.55
22	King Edward and Rideau		٧				٧		2.55
33	Woodroffe at Algonquin College	٧						٧	2.51
21	Jeanne D'Arc Blvd and Orleans Blvd	-		٧				٧	2.50
31	Richmond and Woodroffe		٧			٧			2.50
17	Evelyn and Main		٧			٧			2.48
22	King Edward and Rideau				٧	٧			2.45
22	King Edward and Rideau	٧					٧		2.44
28	Merivale and Meadowlands	٧					V		2.39

^{*} The higher the score the greater the incidence of aggressive driving behaviour running amber, running red, failing to yield).

Source: (15. p. J-11)

G. RANKING INDEX SCORES

1. Overview of Findings About Ranking Index Scores

The assignment of rankings is the last step in the test of index operationality. In Part G the pilot study findings for each ranking procedure are summarized, and the procedures are then discussed in terms of any incompatibilities, contradictions, inconsistencies or other shortcomings that could affect implementation.

2. Ranking IVDI Scores

Tables in the H, I and J series in the BWSI/IVDI *Technical Supplement* (11) demonstrate that it is a technically straightforward task to assign ranks to scores: the higher or lower the score, the higher or lower the rank.

In the case of the IVDI, we recommend using median scores and median ranks. This approach makes the best use of existing City of Ottawa data, because the median (as opposed to the mean, mode or single observation) generates the most robust measure of the relative position of <u>intersections</u> in regard to their volume and design characteristics (12). Following from a comment made in Part E, it is our expectation that more and better information could be derived from data which are quadrant-based. However, since the client currently uses the intersection construct to structure and organize its data holdings, we refer to intersections when testing for IVDI operationality.

As shown by Tables 31, 32, 33 and 34 which are illustrative of tables in the H, I and J series, IVDI rankings can be assigned to the macro index as well as to the sub-indexes (WPCE-PIP and IPC-F) that are combined to create this macro index. Further, by assigning ranks using the City of Ottawa's Priority Index (PI), four indexes are available for conducting analysis and evaluations of the volume and design characteristics of intersections.

It is our summary finding, therefore, that operationality is demonstrated in regard to the procedure used to rank Intersection Volume and Design Index scores.

Table 31. Median IVDI Scores, All Pilot Study Intersections: PM Peak Hour*

Intersection Name	WPCE - PIP Score	IPC - F Score	BWSI Score	P I Score
Albert and O'Connor	3,695,045,741	2.0	7,390,091,681	2,109,066
Bank and Queen	5,646,707,325	6.0	33,880,243,950	3,652,245
Baseline and Greenbank	1,351,748,633	40.5	49,774,381,882	331,060
Bearbrook and Innes	109,085,079	18.0	1,963,531,409	81,987
Broadview and Carling	964,177,345	27.0	26,032,788,329	303,161
Bronson and Carling	1,445,765,760	31.5	45,541,621,440	354,960
Carling and Edgeworth	331,482,056	11.3	3,623,271,351	150,261
Carling and Fairlawn (Woodroffe N)	1,463,838,642	30.0	46,527,325,740	399,428
Carling and Woodroffe South	195,327,492	36.9	7,257,584,455	65,493
Carling and Iroquois	196,814,912	67.5	13,248,803,982	79,334
Carlingwood SC and Carling	330,039,432	27.5	9,076,084,380	150,552
Carlingwood SC and Woodroffe	69,766,079	3.9	274,180,689	35,323
Churchill and Richmond	910,320,704	11.3	10,241,107,920	379,004
Cleary and Richmond	60,466,176	2.6	158,723,712	45,972
Clegg and Main	74,802,565	4.5	336,611,542	35,695
Elgin and Laurier	22,312,950,327	26.3	585,714,946,083	5,715,909
Evelyn and Main	142,581,708	2.8	399,228,782	61,317
Hawthorne and Main	297,200,233	3.5	1,066,722,048	135,037
Hazel and Main	261,229,445	2.6	608,713,499	124,993
Hazeldean and Carbrooke	232,613,648	49.2	9,776,420,808	80,637
Jeanne D'Arc Blvd and Orleans Blvd	313,923,411	108.0	33,903,729,388	124,287
King Edward and Rideau	12,411,708,004	28.1	349,141,496,152	3,061,105
Kirkwood and Merivale	233,284,248	23.0	5,365,537,716	94,234
Lees and Main	392,628,168	5.9	2,316,506,191	177,822
Lenester and Woodroffe	299,273,216	3.0	897,819,648	112,860
Main and Oblate	182,056,264	3.0	546,168,792	81,738
Main and Riverdale	25,949,359	8.86	229,911,316	12,848
Merivale and Meadowlands	1,145,271,391	54.0	61,844,655,087	240,325
Montreal Rd and St. Laurent Blvd	1,820,210,834	26.3	47,780,928,143	499,328
New Orchard and Richmond	81,204,768	4.1	332,939,549	48,104
Richmond and Woodroffe	572,766,063	39.4	23,778,785,843	221,248
Saville and Woodroffe	62,580,869	3.3	205,265,250	41,470
Woodroffe at Algonquin College	930,931,840	37.5	34,909,944,000	323,352

^{*} The PM peak hour varies among intersections. See the A, B, C and D series of tables for details.

(Reminder: This index was originally named the Basic Walking Security Index, which accounts for the BWSI heading in column 4). Source (11, p. E-5)

Table 32. Rankings Based on Median IVDI Scores, All Pilot Study Intersections: PM Peak Hour*

Intersection Name	WPCE - PIP Rank	IPC - F Rank	BWSI Rank	P I Rank
Albert and O'Connor	4	33	17	4
Bank and Queen	3	21	10	2
Baseline and Greenbank	8	5	4	9
Bearbrook and Innes	27	17	22	22
Broadview and Carling	10	13	11	11
Bronson and Carling	7	9	7	8
Carling and Edgeworth	15	19	20	16
Carling and Fairlawn (Woodroffe N)	6	10	6	6
Carling and Woodroffe South	24	8	18	26
Carling and Iroquois	23	2	13	25
Carlingwood SC and Carling	16	12	16	15
Carlingwood SC and Woodroffe	30	25	30	32
Churchill and Richmond	12	18	14	7
Cleary and Richmond	32	31	33	29
Clegg and Main	29	23	28	31
Elgin and Laurier	1	15	1	1
Evelyn and Main	26	30	27	27
Hawthorne and Main	19	26	23	17
Hazel and Main	20	32	25	18
Hazeldean and Carbrooke	22	4	15	24
Jeanne D'Arc Blvd and Orleans Blvd	17	1	9	19
King Edward and Rideau	2	11	2	3
Kirkwood and Merivale	21	16	19	21
Lees and Main	14	22	21	14
Lenester and Woodroffe	18	29	24	20
Main and Oblate	25	28	26	23
Main and Riverdale	33	20	31	33
Merivale and Meadowlands	9	3	3	12
Montreal Rd and St. Laurent Blvd	5	14	5	5
New Orchard and Richmond	28	24	29	28
Richmond and Woodroffe	13	6	12	13
Saville and Woodroffe	31	27	32	30
Woodroffe at Algonquin College	11	7	8	10

^{*}The PM peak hour varies among intersections. See the A, B, C and D series of tables for details.

(Reminder: This index was originally named the Basic Walking Security Index, which accounts for the BWSI heading in column 4).

Source: (11, p. E-8)

Table 33. Ranked Order of Pilot Study Intersections Based on Median Scores, Intersection Volume and Design Index and Priority Index: PM Peak Hour*

BWSI Score	BWSI Rank	Intersection Name	P I Rank	P I Score
585,714,946,083	1	Elgin and Laurier	1	5,715,909
349,141,496,152	2	King Edward and Rideau	3	3,061,105
61,844,655,087	3	Merivale and Meadowlands	12	240,325
49,774,381,882	4	Baseline and Greenbank	9	331,060
47,780,928,143	5	Montreal Rd and St. Laurent Blvd	5	499,328
46,527,325,740	6	Carling and Fairlawn (Woodroffe N)	6	399,428
45,541,621,440	7	Bronson and Carling	8	354,960
34,909,944,000	8	Woodroffe at Algonquin College	10	323,352
33,903,729,388	9	Jeanne D'Arc Blvd and Orleans Blvd	19	124,287
33,880,243,950	10	Bank and Queen	2	3,652,245
26,032,788,329	11	Broadview and Carling	11	303,161
23,778,785,843	12	Richmond and Woodroffe	13	221,248
13,248,803,982	13	Carling and Iroquois	25	79,334
10,241,107,920	14	Churchill and Richmond	7	379,004
9,776,420,808	15	Hazeldean and Carbrooke/Irwin Gate	24	80,637
9,076,084,380	16	Carlingwood SC and Carling	15	150,552
7,390,091,681	17	Albert and O'Connor	4	2,109,066
7,257,584,455	18	Carling and Woodroffe South	26	65,493
5,365,537,716	19	Kirkwood and Merivale	21	94,234
3,623,271,351	20	Carling and Edgeworth	16	150,261
2,316,506,191	21	Lees and Main	14	177,822
1,963,531,409	22	Bearbrook and Innes	22	81,987
1,066,722,048	23	Hawthorne and Main	17	135,037
897,819,648	24	Lenester and Woodroffe	20	112,860
608,713,499	25	Hazel and Main	18	124,993
546,168,792	26	Main and Oblate	23	81,738
399,228,782	27	Evelyn and Main	27	61,317
336,611,542	28	Clegg and Main	31	35,695
332,939,549	29	New Orchard and Richmond	28	48,104
274,180,689	30	Carlingwood SC and Woodroffe	32	35,323
229,911,316	31	Main and Riverdale	33	12,848
205,265,250	32	Saville and Woodroffe	30	41,470
158,723,712	33	Cleary and Richmond	29	45,972

^{*}The PM peak hour varies among intersections. See the A, B, C and D series of tables for details.

(Reminder: This index was originally named the Basic Walking Security Index, which accounts for the BWSI heading in columns 1 and 2).

Source: (11, p. E-11)

3. Ranking QICI Scores

The tables in the P series in the QICI *Technical Supplement* (13) demonstrate that it is a technically straightforward task to assign ranks to the QICI scores for pilot study intersections. And, as can be seen from inspection of Table P-5 in the *Supplement*, it is a similarly easy task to assign ranks to the ratios calculated from the actual and potential scores created from the fieldwork undertaken by community associations.

For illustrative purposes, Table 34 is included to demonstrate the assignment of ranks to scores derived from fieldwork by project assistants. And, Table 35 is included to demonstrate the assignment of ranks to the ratios calculated from the actual ÷ potential scores generated by community association inspections of intersection construction and maintenance features.

Further, with regard to the principle of disaggregation (13, 14, 15, 16), we could not identify any technical or other problem that affects implementation. That is, regardless of whether intersections or quadrants are used as the spatial reference, the assignment of ranks to scores is an elementary arithmetic operation. And, if the "grunt work" is performed by computers, the effort involved in ordering the ranks and assigning scores entails minimal difficulty.¹

A comment about using quadrants as the spatial reference for QICI implementation is appropriate at this point. That is, ranks based on quadrant scores point directly to the most problematic areas of intersections, whereas ranks based on intersection scores could mask that important information. Therefore, and especially since the quadrant-based ranks are directly available from the scoring process, that information should be explicitly factored into the QICI implementation program.

The summary finding is that operationality of the QICI ranking procedure is demonstrated.

Table 34. QICI Rankings Master List: AM, Noon, PM Peak Hours, Winter 2000

ID	Intersection		Rankings* Winter 2000	
		AM	Noon	PM
1	Albert and O'Connor	4	6	18
2	Bank and Queen	2	3	13
3	Baseline and Greenbank	10	16	12
4	Bearbrook and Innes	2	10	6
5	Broadview and Carling	11	14	22
6	Bronson and Carling	17	16	23
7	Carling and Edgeworth	30	29	28
8	Carling and Fairlawn (Woodroffe N)	27	27	26
9	Carling and Woodroffe South	5	10	9
10	Carling and Iroquois	24	23	20
11	Carlingwood SC and Carling	28	27	25
12	Carlingwood SC and Woodroffe	6	5	3
13	Churchill and Richmond	29	25	29
14	Cleary and Richmond	26	24	26
15	Clegg and Main	8	7	4
16	Elgin and Laurier	1	1	13
17	Evelyn and Main	7	1	1
18	Hawthorne and Main	17	33	18
19	Hazel and Main	8	9	8
20	Hazeldean and Carbrooke	23	22	21
21	Jeanne D'Arc Blvd and Orleans Blvd	24	26	30
22	King Edward and Rideau	16	4	9
23	Kirkwood and Merivale	32	29	31
24	Lees and Main	21	18	23
25	Lenester and Woodroffe	21	20	17
26	Main and Oblate	14	12	9
27	Main and Riverdale	11	8	6
28	Merivale and Meadowlands	31	31	31
29	Montreal Rd and St. Laurent Blvd	20	21	2
30	New Orchard and Richmond	11	13	5
31	Richmond and Woodroffe	19	18	15
32	Saville and Woodroffe	15	15	16
33	Woodroffe at Algonquin College	33	32	33

^{*} In the P series of tables (11), the lower the number of the ranking the better the condition of an intersection relative to other intersections. Relatively speaking, then, Albert and O'Connor (ID #1) ranked 4th, 6th and 18th and Churchill and Richmond (ID # 13) ranked 29th, 25th and 29th for the AM, noon and PM peak hours, respectively.

Source: (13, p. G-6)

Table 35. Scores and Ratios for Intersections Evaluated by Community Association

Members Using QICI Form B-4*

	So	core**	Ratio	
Intersection	Actual	Potential	A, P	Rank***
	(A)	(P)	3	
Booth and Gladstone	46	53	.87	1
Booth and Somerset	22	48	.46	10
Bronson and Carling	26	54	.48	9
Bronson and Somerset	18	52	.35	11
Carling and Fairlawn/Woodroffe	32	44	.73	4
Carling and Woodroffe S.	30	39	.76	3
Garland and Somerset	44	52	.85	2
Holland and Tyndall	34	52	.65	7
Parkdale and Wellington	28	53	.53	8
Richmond Rd and Woodroffe	29	40	.73	4
Saville, Row and Woodroffe	31	43	.72	6

^{*}The entries in this table are based on fieldwork done by members of the Dalhousie, Hintonburg, and Woodpark Community Associations. Tables N-34 to N-44 in the QICI *Technical Supplement* (13) present some of the evaluations undertaken by association members.

Source: Based on Table P-5 in the QICI *Commentary Report* (14), with the rank column added to the original for illustrative purposes.

^{**}The median score is used for intersections that received multiple evaluations.

^{***}Following from the * above, and the design of Tables N-34 to N-44 (13), the lower the number of the ranking the better the condition of an intersection relative to other intersections. As indicated, Booth and Gladstone and Garland and Somerset at .87 and .85, respectively, are rated highly (#1, #2); conversely, Bronson and Somerset at .35 and Bronson and Carling at .46 are rated 11 and 10, respectively, and are at the "bottom of the barrel" in this group.

4. Ranking DBI Scores

Tables in the U series in the DBI *Technical Supplement* (15) contain the rankings assigned to quadrant scores for the AM, noon and PM peak hours, Fall 2000. Table 36 illustrates the assignment of ranks to the 33 <u>quadrants</u> with the highest incidence of aggressive driving behaviour.

The DBI scores can be represented as ranks for each type of aggressive driving incident (running red, running amber, failing to yield) or for the set of incident types, the ranks can be based on quadrants and/or intersections, the rankings can be spatially organized by location (downtown, inner suburban, outer suburban, city or region, and they can be peak hour-oriented (AM, noon, PM). It is therefore our finding that operationality is demonstrated with regard to assigning DBI ranks.

5. Ranking Index Scores: General Finding

We have not identified any inconsistencies or incompatibilities among the procedures for assigning ranks to scores. And, we have not had any concerns about the procedures brought to our attention. Indeed, even our use of the #1 ranking to represent both best and worst case intersections, and/or quadrants, did not prompt a response or inquiry. It is our perception that such was the case because of the realization that this is a pilot study, and that any decision about how to best utilize the rankings for operations and decision purposes will be made by the client in due course. It is our general finding, therefore, that operationality is demonstrated with regard to assigning ranks to scores obtained by application of the Intersection Volume and Design Index (IVDI), the Quality of Intersection Condition Index (QICI), and the Driver Behaviour Index (DBI).

6. Notes

1. Whether the ranking exercise deals with signalized intersections (33 in the pilot study, about 880 in the City's network) or quadrants (125 in the study, about 3500 in the network), the procedure is so simple – assign ranks to scores in order of magnitude – that it rates as a trivial computer operation regardless of the number of sites (intersections or quadrants) that are being ranked.

Table 36. Master List of Driver Behaviour Index Rankings, Pilot Study Intersection Quadrants: Fall 2000*
(Partial Listing for Illustrative Purposes)

			Quadrant			Peak Hour			
ID	Intersection name	NW	NE	SE	SW	AM	Noon	PM	Ranking
04	La saura D'Ava Dhad and Odasa								*
21	Jeanne D'Arc Blvd and Orleans			V		٧			1
22	King Edward and Rideau	V				V			2
22	King Edward and Rideau			V				V	3
22	King Edward and Rideau	V						V	4
22	King Edward and Rideau		V					V	5
33	Woodroffe at Algonquin College		V					V	6
21	Jeanne D'Arc Blvd and Orleans				V			V	7
16	Elgin and Laurier		V				V		8
28	Merivale and Meadowlands				V			V	9
28	Merivale and Meadowlands			V			٧		10
31	Richmond and Woodroffe		V					V	11
6	Bronson and Carling				V	٧			12
22	King Edward and Rideau			٧			٧		13
1	Albert and O'Connor	V						٧	14
22	King Edward and Rideau				٧			٧	15
3	Baseline and Greenbank		٧					٧	16
16	Elgin and Laurier			٧				٧	17
18	Hawthorne and Main				٧	٧			18
18	Hawthorne and Main	V				٧			19
33	Woodroffe at Algonquin College		٧				٧		20
22	King Edward and Rideau		٧			٧			21
3	Baseline and Greenbank	V						٧	22
33	Woodroffe at Algonquin College			٧				٧	23
1	Albert and O'Connor	٧					٧		24
6	Bronson and Carling			٧		٧			25
22	King Edward and Rideau		٧				٧		26
33	Woodroffe at Algonquin College	V						V	27
21	Jeanne D'Arc Blvd and Orleans			V				٧	28
31	Richmond and Woodroffe		V			٧			29
17	Evelyn and Main		V			٧			30
22	King Edward and Rideau				٧	٧			31
22	King Edward and Rideau	v					V		32
28	Merivale and Meadowlands	v					٧		33
' -			ı	<u> </u>				A 11 41	

^{*} Rank # 1 = quadrant with highest incidence of aggressive driving behaviour. All the marked quadrants experienced 2.39 or more aggressive driving incidents per phase.

Source: (15, p. K-6)

H. DEMONSTATING INDEX OPERATIONALITY

1. Elements of Operationality

The pilot study examination of index operationality involves three elements:

- Acquiring the needed study data from Region of Ottawa-Carleton/City of Ottawa archives and operations, and from fieldwork as necessary;
- Organizing the acquired data in tables in order to calculate index scores;
- Calculating scores and assigning rankings by applying the indexes to archival, operational and fieldwork data.

In the remainder of this section we overview the degree and extent to which each of the three elements is achieved. As previously discussed in the *Commentary Reports* (12, 14, 16), this review is very much a factual matter in that the numbers are either there, or they are not, and the operationality findings follow accordingly. That is, if the numbers are there as data, scores and rankings, then operationality is demonstrated; and, conversely, if the numbers are absent then operationality is not demonstrated.

2. Acquiring the Needed Data

In the case of the Intersection Volume and Design Index, all the data needed to test for operationality are available from the City of Ottawa. As for the Quality of Intersection Condition Index, the data availability criterion is not fully satisfied at present. However, any unmet data needs can be satisfied via fieldwork. And, while the City of Ottawa could not provide the data needed to test the Driver Behaviour Index for operationality, data on light-running and fail-to-yield incidents can be obtained via fieldwork.

The summary pilot study finding is that Walking Security Index data needed to operationalize the indexes are either available or can be obtained. The associated finding is that the degree of difficulty involved is well within the technical capability of the City of Ottawa. Finally, we did not encounter nor do we currently perceive any inconsistencies or incompatibilities between or among data acquisition practices involving the three indexes.

It is therefore concluded that index operationality is demonstrated in regard to acquiring needed data.

3. Organizing the Data for Index Calculations

Index score calculations are presented for each macro index, which demonstrates that the archival, operational and fieldwork data can be organized as databases to support such calculations. As a result, the data availability critierion is satisfied insofar as being able to create index databases is concerned.

The degree of difficulty criterion was also satisfied during the pilot study in that we were able to design the forms needed to record field observations, and to structure the databases in ways that enabled the computation of index scores.¹ As shown in Table 37, a number of parameters were included in the design decisions behind how to develop and organize the data for index calculation purposes.

It is our impression that the data development and organization tasks undertaken over the course of the WSI pilot study are similar to other database-related tasks performed by the City of Ottawa. We have no reason to believe that the City of Ottawa would have any technical difficulty building on, adopting or otherwise incorporating our approach to data development and organization in the City's' current or impending database programs.

It is therefore concluded that index operationality is demonstrated with regard to developing and organizing the body of data needed to support calculating scores for all indexes.

4. Calculating Index Scores

A primary concern with any scoring procedure is that of degree of difficulty. That is, if a procedure is seen to be unduly complicated, intricate, mentally taxing, etc., then for all practical purposes its operationality is compromised.

Table 37. Key Parameters of Data Organization for the IVD, QIC and DB Indexes

		Affected Index				
	Parameter	IVDI	QICI	DBI		
1	33 Intersections	V	V	٧		
2	Three daily peak traffic intervals	V	V	V		
3	A multiple-category rating system that takes into account different conditions at individual intersection quadrants		v			
4	Variables that are time-dependent or time-independent	v	v			
5	Variables that are time-dependent with frequency of incidents recorded at the phase (green, amber, red) level			v		
6	Variables that are not applicable in all cases due to intersection design differences		v			
7	A multiple-category data recording system that takes into account different types of aggressive driving behaviours			V		
8	Multiple-year counts	v	v	v		
9	Four indexes and associated variables	V		V		
10	Scores and rankings for four (macro- and sub-) indexes.	v		V		

Source: (12, p. 31; 14, p. 56; 16, p. 75)

In the case of all WSI macro indexes, the scoring procedure involves the elementary arithmetic operations of addition, subtraction, multiplication and division. And, in all cases, there is room to manoeuver in terms of incorporating weights or changing the mixes of variables used to produce scores by peak hour, season of year, etc., as well as by intersection and/or by quadrant.

Further, index scores have been successfully calculated by project assistants (undergraduate students), and by community association members. No feedback has been received to date from any participant to indicate that the calculating procedures are technically difficult for any index.

It is therefore concluded that operationality is demonstrated with regard to calculating index scores.

5. Ranking Index Scores

From a technical perspective, this is the most elementary and deterministic aspect of the WSI pilot study. That is, the scores obtained for intersections or quadrants are placed in order from lowest to highest, best to worst, least to most, etc., and then a rank is assigned to the score on the basis of its place *vis-à-vis* the other scores.

For each index assigning ranks to scores proved to be a straightforward, non-difficult task. And as for comparing or contrasting ranks or sets of ranks assigned to intersections or quadrants, we have not identified any inconsistencies or other flaws in how the rankings are generated. And, no flaws of that nature have been called to our attention by the client or other readers.

The summary conclusion, therefore, is that operationality of the rankings procedure is demonstrated individually and collectively for the three WSI macro indexes.

6. Notes

1. The data holdings of the former Region of Ottawa-Carleton and associated municipalities, now the City of Ottawa, include numerous paper and electronic data entries. However, we did not encounter any field forms, or database development protocols employed by the client, that were directly applicable to the pilot study task of generating the data needed to conduct the index operationality tests. The fact that some of the field forms and data tables underwent two or three iterations reveals that the final solution was not evident at the outset of the design task, and serves in part to justify the pilot study. Moreover, and very significantly in regard to index implementation, since the forms and tables were created with the resources available, the database development and organization task was proven "do-able", which means that the degree of difficulty criterion is satisfied.

I. DEMONSTRATING INDEX UTILITY

1. Extending the Pilot Study Statement of Work

The pilot study terms of reference do <u>not</u> include demonstrating the utility of an operational index. Rather, the utility of an index was deemed to exist in principle by the dient (formerly Region of Ottawa-Carleton, now City of Ottawa), and actual implementation hinges upon whether an index can be operationalized in practice. As a result of demonstrating that the indexes work, all contractual obligations of the WSI pilot study component are satisfied.

Beyond the matter of contractual obligations, however, there is the question,

"Would the public interest be served by a discussion of whether index utility is demonstrated by the WSI pilot study?

The catalyst for thinking about extending the pilot study into the utility domain was an invitation to report on the Walking Security Index pilot study at the 2001 Annual Conference, Transportation Research Board (TRB), in Washington, D.C. Discussions with organizers indicated that comments on the value (utility) of the WSI pilot study would be welcome at TRB 2001, so a brief section on utility was included in the author's conference presentation.¹

Therefore, in the interests of promoting more research in the field (including comparative studies in other cities), as well as giving credence to arguments and decisions to act on the test results, we present several utility-oriented findings from our analyses of what the pilot study research revealed.² It is our impression that these findings may persuade elected officials, professional staff and the citizens of Ottawa to have due regard for index scores and rankings when faced with two conflicting transportation situations:

- A. Seeking better ways to serve and promote pedestrians' security, that is, their safety, comfort, convenience; or,
- B. Considering so-called road or intersection "improvements" that serve the underlying objective of moving more cars.³

2. Examples of Utility-Oriented Pilot Study Results

Selected examples of findings containing information that may be useful to agencies responsible for pedestrian-related studies and programs were presented in two of the background reports (12, 14). Evidence to support the findings was provided in numerous tables, and associated analyses, throughout the *Technical Supplements* prepared for the Intersection Volume and Design Index and the Quality of Intersection Condition Index components of the field study (11, 13).

In this section of the *Walking Security Index Pilot Study*, selected utility-related comments from the IVDI and QICI reports are presented, along with several observations about the utility of an operational Driver Behaviour Index (DBI).

Our primary objective is to examine several of the utility arguments in terms of their applicability to all indexes, and to identify any inconsistencies among the utility findings for each index. A secondary objective is to raise several matters for consideration and action by the client, with the intent being to assist the City of Ottawa achieve its stated goal of serving and promoting the needs of pedestrians (30, 31, 32). It is emphasized that our effort here is limited to making suggestions, and does not include drafting an action plan or program for implementation purposes.

A. Peak Hour Intervals

For a number of intersections and quadrants, the scores and ranks vary <u>significantly</u> among peak hours (AM, noon, PM) for each index, and between or among indexes. This appears to be a very valuable piece of information to bear in mind when evaluating intersections, or when considering modifications. By way of brief comment to emphasize a point of concern, making a decision based on counts taken during just one of the peak hours could have serious, inadvertent consequences. It is our empirical experience, based on the pilot study tests, that <u>all</u> the peak hour intervals merit being included in IVDI, QICI and DBI calculations.

B. Seasonal Patterns

It is our finding that there are significant seasonal variations in index counts, scores and rankings for many pilot study intersections and quadrants.⁴ In order to achieve the highest information gain which the application of each index can yield, it is therefore necessary that count or other observation data for Ottawa accurately represent the seasonality factor.

As for the underline emphasis on <u>accurately</u>, it follows directly from the pilot study research (13, 14, 15, 16). That is, if the City's existing data files are weak, and the methodology behind its modeling tools is weak, then it is inappropriate to use so-called "seasonally-adjusted" data, scores or rankings as bases to make decisions affecting pedestrians' security.⁵ Rather, the alternative, appropriate, methodologically-sound strategy is to collect the data <u>during</u> the season(s) of interest, so that the empirical reality represented by the data is as close to the real thing as conditions permit.

C. Critical Failure

The phrase "intersection failure" is used in traffic engineering, and especially when road widenings are at issue, to describe a level of service (LoS) situation that is deemed unacceptable (45, 46).⁶ In brief, and as discussed in previous WSI reports (3,4,5,7), LoS "grades" of A, B, C, D, E, F *purportedly* reflect the level of <u>inconvenience</u> that vehicle operators experience because capacity constraints limit how quickly they can be processed through an intersection.⁷

The concept of *critical failure* arose during the QICI phase, and it was pursued into the DBI phase. As implied by the phrase, our concern went beyond what might be called annoying or irritating shortcomings, and involved matters that could take on life-threatening significance for pedestrians.

In the next several pages we overview aspects of the critical failure concept as it applies to the Quality of Intersection Condition Index and the Driver Behaviour Index. It is our expectation that this line of thought could be instructive for elected officials, professional staff and citizens in their discussions about when, where and how to proceed with actions that serve and promote pedestrians' security.

Critical Design/Maintenance Failures (QIC Index)

For this section we draw on materials presented in the *Walking Security Index* (5), and in the two QICI pilot study background reports (13, 14), and which were summarized in the *Commentary Report* as follows:

"During the fieldwork program to test the QIC Index, "intersection failures" that affect pedestrians' convenience, as well as their comfort and safety, have also been observed. It appears, however, that the mere inconvenience (of delay) suffered by drivers pales in comparison when arrayed against what pedestrians are obliged to endure as a result of intersection design or maintenance failures. The following observed situations illustrate the nature of this concern, and indicate why we refer to them as <u>critical</u> failures.

- Individuals in wheelchairs are confronted by snowbanks and 10- to 15-centimetre deep puddles of slush or water, bullnoses that extend across the crosswalk and are not level with the pavement, and traffic signal push buttons that cannot be reached (due to pole location) in both medians and sidewalk corners.
- Visually handicapped pedestrians are confronted by all of the above "failures", as well as cracked or broken roadway surfaces, potholes, storm sewer grates in or near crosswalks, and broken curbs and sidewalks.
- Children, seniors, and adults pushing carriages or strollers, struggle to climb snowbanks, keep their footing on ice patches, wade through piles of slush, and jump back because cars, trucks or buses have mounted a sidewalk corner or channel island curb in the vicinity of schools and seniors' residences.

And, in regard to additional design or maintenance failures affecting all pedestrians, these are among the <u>dangerous</u> conditions that have been observed:

 blocked sightlines caused by opaque bus shelter signs, advertising stands/refuse receptacles, snowbanks, overgrown trees and shrubs, and utility poles;⁷

- channels angled in such a way that when drivers are watching for oncoming vehicles they cannot see approaching pedestrians;
- school zone signs that are placed in such a way or location as to serve no useful purpose;
- worn-away stop bar and crosswalk paint markings; and,
- stop bars and crosswalks in such close proximity that vehicles regularly drive into or slide into the crosswalks.

For many of these features the adverse consequences for pedestrians go far beyond inconvenience, or loss of comfort. That is, the safety of pedestrians is compromised to the extent that bodily harm and even death can be the result of intersection design or maintenance failures.

The approach taken during the pilot study is for fieldworkers to note on the (field) forms the observed conditions which are adversely affecting pedestrians' safety, comfort, convenience. It is recommended that these notes be consulted in the event that the Region (or, the new City of Ottawa) undertakes a study to further investigate what we have termed <u>critical</u> design/maintenance failures. [A case in point in this regard is provided by Table 10, which contains remarks about drivers' lack of regard for school signs.]

The most immediate value of such a study, based on our experience, is that it would direct attention to intersection conditions that <u>must</u> be corrected in a responsible, timely manner in order for the Region to duly serve and promote pedestrians' security.

In other words, and re-emphasizing the value statement, the critical failures research could assist the Region to avoid legal or human rights actions, arising from a failure to meet expected standards or regulatory requirements involving the safety, comfort, convenience of pedestrians using signalized intersections.

Finally, and insofar as the QIC Index is concerned, such a study could lead to the creation of a re-formulated index that more accurately and precisely defines intersection condition scores and rankings. That done, it would then be reasonable to expect that the proponents of "improvements" to intersections for the purposes of moving vehicles would respond in kind. That is, they would explain how any "critical failure factors" in their level of service (LoS) or other vehicle-oriented models/indexes are defined and justified, and then the respective index outputs could logically be compared in a methodologically robust manner."(14, p. 63-64)

Those comments have been in print since November 2000. During the intervening 17 months we have accumulated numerous reports and communications which support applying the critical failure concept to QICI implementation. And, conversely, we have not located or received any materials which challenge or discount the idea of applying a critical failure criterion to intersection design and maintenance programs and features.

Critical Enforcement Failures (DBI)

The most prominent enforcement failure is simply that: **failure by police to enforce existing laws and by-laws** for both light-running and fail-to-yield incidents. The pilot study research demonstrated that the DBI consists of "enforceable" elements, and that application of the DBI could be directly used to monitor and analyze driver behaviour, and to design traffic, surveillance or other enforcement programs to deal with drivers who compromise pedestrians' security.

The critical failure consequence in this case, therefore, is that pedestrians' limbs and lives are at risk. More specifically, the longer the enforcement lags between aggressive driving incidents and police actions, the longer the length of time that pedestrians are exposed to drivers who do not have due regard for the laws, signals, symbols and signs that (are supposed to) govern drivers' behaviour when approaching, traversing and exiting a signalized intersection.

In addition to the conventional enforcement problem, however, several "subtle" forms of enforcement failure were identified. First, **window tinting** is frequently so dark that drivers cannot be confidently identified. Second, numerous license plates are obscured by snow, mud or a film of dirt, which means that rapid, accurate reading of a plate is impossible.

In both those cases – unseeable driver, obscured plate – a pedestrian is denied the opportunity to bring a complaint against a vehicle operator who commits a traffic violation, or is driving in an erratic manner. And, worse, the denied complaint could involve a pedestrian who had been harmed during the course of the event.

It was made clear during the DBI phase of the pilot study that lack of enforcement of traffic laws and by-laws in general, and in the vicinity of schools and seniors' facilities in particular, is widely regarded as a critical failure on the part of elected officials and the police establishment. The DB Index materials (15, 16) identify the dimensions of the enforcement failure, and several recent papers (18, 19, 28, 29) provide suggestions (strategic and tactical) on how to begin dealing with it in ways that best serve and promote the security of pedestrians, who are the most vulnerable intersection users.

D. Weighted Variables

The initial versions of WSI indexes treated all variables as equal. During the course of the investigations, however, and having regard for the accumulated evidence from the literature, fieldwork, surveys, etc., questions arose as to whether some of the variables should be regarded as more important than others. As demonstrated by the formulations, weights were introduced for some variables. And, suggestions were made to the client about the need to investigate the pros and cons of weighting additional variables in the IVDI, QICI and DBI formulations.

Since our task in the pilot study is to test the operationality of the indexes presented in Walking Security Index (5, 6, 7, 8, 9, 10), investigation of the variable weighting topic is not within the purview of the current contract. It appears to be evident from the pilot study research, however, that an in-depth inquiry into appropriate variable weights is needed in order to fully ascertain the utility of the three indexes.

E. Index Values as Research Aids and Decision Guides

Given that the index scores and ranks produced by the WSI project are apparently a "first" for the City of Ottawa, it is appropriate to be cautious in suggesting how they can be used as research aids and decision guides. In respect of that caution, therefore, it appears that a first principles approach is in order. That is, examination of the IVDI, QICI and DBI documents (11, 12, 13, 14, 15, 16), and this report, should focus onensuring that the following kinds of methodologically-based research activities are undertaken by the City of Ottawa in a timely, operations-oriented manner:

- Examine our literature review, research design and fieldwork documentation in order to confidently accept or reject our research methodology, and the associated index data, scores and rankings.
- 2. Use the IVDI materials in projects that involve evaluations of intersection volume and design characteristics, with particular emphasis on projects which seek to expand, enlarge or otherwise modify intersections in order to "process" more vehicles. Then, assess the IVDI instrument as a means for ascertaining how to best modify an intersection so that its "new" volume and design characteristics better serve and promote pedestrians' safety, comfort and convenience.
- 3. Use the QICI materials as a basis for seasonal and peak hour field inspections of signalized intersections. Then, assess the QICI instrument as a means of ascertaining how to modify design and/or maintenance features to better serve and promote pedestrians' safety, comfort and convenience at those intersections.
- 4. Use the DBI materials as a basis for seasonal, field-based studies of driver behaviour at signalized intersections. Then, assess the DBI instrument as a means for ascertaining the characteristics of aggressive driving behaviour events in Ottawa, for monitoring the levels and locations of aggressive driving behaviour, and for initiating and evaluating "remedial" programs designed to serve, promote and achieve pedestrians' safety, comfort and convenience at signalized intersections.

As a closing observation about using index values as research aids and decision guides, it is necessary to make explicit the reason for the bold underlining – **pedestrians' safety**, **comfort and convenience** – in each of points 2, 3 and 4.

In brief, and to repeat a concern identified in previous WSI reports (35, 36, 37, 38, 39), and demonstrated by the newspaper review in particular (28), the vast majority of transportation research has been and continues to be focused on vehicles and vehicle operators. By way of cases in point that drive home this concern, very little of the current debate and research

involving red-light cameras, or cell phones, makes reference to the interests of pedestrians. Rather, attention is given almost exclusively to the needs, wants, foibles, etc., of drivers, even though the drivers are going through the same intersections that are also used by **pedestrians!**

At the request of the Region of Ottawa-Carleton/City of Ottawa, the WSI project has largely turned that research situation on its head. That is, from the conceptual and design phases through to the tests for operationality, primacy has been assigned to **pedestrians' safety**, **comfort and convenience**.

Points 2, 3 and 4 contain advisements about how the City of Ottawa could conduct further research into index implementation. However, they also contain the **bold-underline reminder** that the subjects of research attention are the many, many thousands of pedestrians of all ages and abilities who use or want to use signalized intersections, and who want to do so safely, comfortably, and conveniently.

F. Inclusion of Experts

Three groups of experts – citizens, professional staff and elected officials – contributed to the selection and prioritizing of variables to be included in the indexes (4, 5, 9, 10, 37, 38, 39). Further, during the index formulation phase, they provided guidance on variable selection criteria and index design.⁹

In continuing their involvement in the project, members from the three groups of experts participated in the test of index operationality. These activities included assisting in developing field forms, undertaking field surveys, testing and rating field forms, collecting data, calculating and interpreting index scores and rankings, and providing general feedback on pilot study directions and findings.

Moreover, community association members demonstrated that they could make a very significant contribution to implementation and maintenance of a Walking Security Index program. At the risk of overstating the case, it appears fair to say that inclusion of the three

groups of experts throughout the project attests to both the operationality and the utility of the indexes.

While other examples of utility might be useful, our intent was to extend the pilot study test results in an indicative manner. For the purposes of this report, it appears that the examples and explanations presented above are sufficient to demonstrate the utility of implementing the IVD, QIC and DB Indexes to assist in evaluating signalized intersections from the perspective of **pedestrians' security**.

3. Notes

- 1. A paper titled "Walking Security Index (WSI) Overview: Goals, Indexes and Pilot Study Status" was presented by B. Wellar at a panel session on *Walkability Indicators and Evaluation Models*, 2001 Meetings, Transportation Research Board, January 7-12, Washington, DC.
- 2. There are various ways of describing pilot study or experimental design utility, and they are elaborated in detail in numerous research texts. In our experience the discussion by Ackoff (20) is among the most enlightening, with a number of other texts (21, 22, 23, 24, 25, 26, 27) providing additional insights into defining, measuring and evaluating the utility of pilot studies and experimental designs. Interested readers are referred to the 2001 *Applied Geography Conference Proceedings* for a discussion of the pilot study as a step in the process of implementing a transportation innovation (18).
- 3. The term "improvements" is critically discussed in WSI project reports (eg., 2, 3, 4, 5, 11, 12, 18, 19, 28, 36, 38) and in a letter to the editor, *Ottawa Citizen* July 5, 2000. As suggested, the index scores and rankings could be used to assess the incidence of benefits and costs arising from any purported "improvements", and especially when the term is used in conjunction with a car-serving initiative. And, conversely, the scores and rankings could be used to provide guidance on how to better serve **pedestrians**= security (safety, comfort, convenience) when intersection changes are being examined.

- 4. We do not have a comprehensive, longtitudinal, empirical database on which to base this statement. However, it is our impression from discussions with project assistants, community association members, numerous neighbours and area residents, reviews of newspaper articles (28), and 30 years of walking, cycling, busing and driving on the streets of Ottawa-Carleton, that the finding is highly accurate.
- 5. The lesson learned from all the pilot study components, however, is that there is <u>no</u> good reason for the City of Ottawa to employ either shoddy data or shoddy methods when making decisions that affect pedestrians' security. And, similarly, <u>no</u> good reason has been found to delay the process of implementing the IVD, QIC and DB Indexes as decision-support tools. Under any of those circumstances shoddy data, shoddy methods, unjustifiable delay –, the term "inappropriate" which is used in the text could be construed as overly diplomatic, and perhaps even misleading. As a result, a blunter statement of concern is in order. That is, irresponsible and reckless are more accurate descriptors if avoidable harm is done to a pedestrian, or a claim of liability is made against the Corporation for reasons involving shoddy data, shoddy methods, or failure to implement and use a tested index.
- 6. Attempting to conjure or invoke the spectre of "intersection failure" is a popular tactic at transportation, planning or other committee meetings, and especially at Ontario Municipal Board (OMB) hearings, when proponents of road widenings (to move cars) attempt to attach an almost apocalyptic air to the thought of vehicle operators enduring delays due to "congestion". In the case of Ottawa, however, with its priorities on walking, cycling and transit (30, 31, 32), it appears that the "intersection failure" concept actually has merit for performance measurement purposes, and all the moreso if used in conjunction with the IVDI, QICI and DBI formulations (29, 35, 36, 38).
- 7. A theme that was vigorously pursued at the 2001 Transportation Research Board Meetings is that of level of service (LoS) <u>as it pertains to pedestrians</u>. The Principal Investigator attended the Meetings and discussed the concept of LoS within the context of the Walking Security Index project in general, and the pilot study in particular. Feedback

suggests a general sense that the time is long overdue to ensure <u>actual regard for</u> pedestrians' time while they wait for the signal to change at an intersection.

8. After site visits to several intersections, the Principal Investigator sent an e-mail communication (00/09/17) to Councillor Diane Holmes, Chair, Transportation Committee, Region of Ottawa-Carleton, to express his concern that the advertising stands/garbage receptacles placed at intersections could endanger pedestrians by distracting drivers and/or blocking sight lines. As a case in point, the stand/receptacle at the southeast corner of Lenester Ave./Woodroffe Ave. was brought to the attention of Regional Councillor Wendy Byrne. This stand/receptacle was situated on Woodroffe Ave., less than two metres from the roadway curb, and only a metre from the sidewalk corner used by children attending D. Roy Kennedy Elementary School and other schools in the SE quadrant. The stand/receptacle directly faced oncoming vehicular traffic, and could easily "hide" four or five children, even from the eyes of attentive drivers. And, to compound the sight line problem, driver visibility on this regional road was compromised by other opaque advertisements on an OC Transpo bus shelter located proximal to the advertising stand/garbage receptacle.

The complaint/warning caused that particular stand/receptacle to be re-located several metres further back, away from the curb. However, the basic question remains: How was municipal permission gained in the first instance to allow an installation that posed such a clear and obvious danger to all pedestrians, and especially to children?

9. This is a client-driven as opposed to a curiosity-driven research project (28). Given that circumstance, it was good research design to seek to involve the three groups of experts in specifying the evaluation criteria, and in making the connections between ideal and practical research design considerations. However, it was good fortune that interested members from each group made the needed contributions to the design and test phases of the WSI project. Of particular value, with each group contributing to the theme, was the explicit and implicit reminder to "keep it simple" (18, 19, 28).

J. CONCLUSION

1. General Findings

This report and the associated background reports (11, 12, 13, 14, 15, 16) present the results of a pilot study which tests the operationality of the Intersection Volume and Design Index (IVDI), the Quality of Intersection Condition Index (QICI), and the Driver Behaviour Index (DBI).

The first and most fundamental finding is that we were able to rigorously test the indexes for operationality. That is, we were able to ascertain whether:

- 1. The data needed for implementation are available or obtainable;
- 2. The (needed) data can be organized into databases to support calculating index scores;
- 3. Index scores can be calculated, and index ranks can be assigned to intersections and/or quadrants.

As demonstrated by the background documents, each element (1, 2, 3) of the testing procedure was achieved for each index.

Second, it is our finding that all the procedures and formulations "work", that is, the indexes are or can be made operational. Towards that end we identified the data that need to be acquired, suggested how they can be acquired and organized, and demonstrated in numerous tables and figures how index scores can be calculated and ranks assigned to intersections and/or quadrants.

Third, all the design and testing documentation was published and put into the open literature. Publication media included journals, conference proceedings, association newsletters, newspapers, minutes of meetings, and web pages at various sites. The pilot study reports, articles, contracts, etc., were available for examination by the client, citizens, researchers, and other interested parties. In the absence of evidence to the contrary, we have no reason to believe that the published findings in the pilot study are not as claimed.

Fourth, we made numerous public presentations on the WSI pilot study that included speaking to citizens, community organizations, academics, elected officials and professional staff. And, we also engaged in numerous media events (interviews, articles, letters) at the neighbourhood, local, regional, provincial and national scales. Again in the absence of evidence to the contrary, the public presentations on the pilot study are deemed to have received a supportive reception from our three groups of experts, that is, citizens, elected officials and professional staff.

It is therefore our summary finding that the examination of Walking Security Index operationality has tested positive for the Intersection Volume and Design Index (IVDI), the Quality of Intersection Condition Index (QICI), and the Driver Behaviour Index (DBI).



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L. APPENDICES

Appendix A. Terms of Reference, Walking Security Index Pilot Study

Appendix B. Acknowledgements

Appendix C. Walking Security Index Publications

APPENDIX A. TERMS OF REFERENCE FOR THE WALKING SECURITY INDEX PILOT STUDY

The materials in Appendix A are from the contract between the Region of Ottawa-Carleton (now the City of Ottawa) and the University of Ottawa. In the interests of direct relevancy, we include only those parts of the statement of work which pertain to the design and contents of this report and the associated background documentation from the pilot study (11, 12, 13, 14, 15, 16).

Readers who wish to see the entire contract are directed to the project sponsor, the Region of Ottawa-Carleton/City of Ottawa. In addition, readers may wish to examine several publicly-available documents which refer to the terms of reference and the pilot study contract. These materials are cited in the References (8,9,10), and/or are included in the list of WSI publications which is presented in Appendix C, and which may be viewed at:

http://aix1.uottawa.ca/~wellarb

or

http://www.uottawa.ca/academic/arts/geographie/personnel/pfbwellar.htm

Statement of Work: Walking Security Index Pilot Study

Selected Sections

1. Background

Published documents and public meetings which provide context for the pilot study project include the following:

- A. Walking Security Index. Final Report of the Walking Security Index Project. July 1998.
- B. Verbal presentation on *Walking Security Index* by B. Wellar to Transportation Committee. 18 November 1998.
- C. Departmental recommendations (report) on Walking Security Index.RMOC File No. 50 20-98-0101. 07 December 1998.
- D. Departmental recommendation (report) on Walking Security Index.RMOC File No. 50 20-99-0101. 31 March 1999.
- E. Presentation and discussion of the Departmental recommendation (report) on Walking Security Index at Transportation Committee. 21 April 1999. Details in regard to participants, commentaries, submissions, motions, etc. are contained in the Transportation Committee Minute of the meeting on 21 April 1999.
- F. Disposition of Committee Report to Council, 28 April 1999. Transportation Committee Report No. 34, 2 *Walking Security Index*, and Motion No. 85, No. 86, No. 87.

[Note: This is intended to be an <u>indicative</u> listing, which is sufficient for the context purpose noted above. Readers seeking information about additional materials held by the client should contact the City of Ottawa directly. For details about additional background documents published by the Principle Investigator, the reader is referred to Appendix C, Walking Security Index Publications.]

A total of ten indexes have been formulated, and adoption in principle of several indexes is recommended in the Departmental report. However, it is further recommended by the designer of the indexes (B. Wellar) and the Transportation Department that the indexes be "tested" via pilot studies before being implemented. The role of the pilot study, therefore, is to move the Walking Security Index into the operational phase as a tool for evaluating Regional intersections.

2. Indexes to be Used in the Pilot Study

- A. Basic Walking Security Index (BWSI).
- B. Quality of Infrastructure Condition Index (QICI).

These indexes are recommended for pilot study attention in the Departmental Recommendations.

3. Indexes to be Refined in the Pilot Study

A. Driver Behaviour Index (DBI).

Recommendations 4 and 5 of the Departmental Recommendations propose variations to the Aggressive Driving Indexes contained in *Walking Security Index*. This part of the pilot study proposes to examine staff recommendations, and to re-examine WSI findings with the goal being to create a consensus index – herein termed the Driver Behaviour Index (DBI) – that better measures driver behaviour as an intersection evaluation component.

4. Regional Intersections to be Evaluated

Field testing of WSI formulations occurs in three different kinds of regional road "environments".

A. Woodroffe Avenue Transportation Study Intersections (11)

Richmond Rd. and New Orchard Ave.

Woodroffe Ave.

Cleary Ave.

<u>Carling Ave.</u> and <u>Edgeworth Ave.</u>

Woodroffe Ave. S.

Woodroffe Ave. N/Fairlawn Ave. Carlingwood SC/Fairlawn SC

Iroquois Rd.

Woodroffe Ave. and Lenester Ave./Georgina Dr.

Carlingwood SC

Saville Row.

B. Main Street Transportation Study Intersections (7)

Main St. and Hawthorne Ave.

Lees Ave.
Evelyn Ave.
Oblate St.
Hazel St.

Clegg St.

Riverdale Ave.

C. Proposed Comparative Study Intersections (15)

- 1. Bearbrook and Innes
- 2. Broadview and Carling
- 3. Hazeldean and Carbrooke/Irwin Gate
- 4. Bronson and Carling
- Montreal Rd and St Laurent Blvd
- 6. Merivale and Meadowlands
- 7. Kirkwood and Merivale
- 8. King Edward and Rideau
- 9. Baseline and Greenbank
- 10. Bank and Queen
- 11. Albert and O'Connor
- 12. Elgin and Laurier
- 13. Churchill and Richmond
- 14. Woodroffe at Algonquin College
- 15. Jeanne D'Arc Blvd and Orleans Blvd

There are more than 800 signalized, regional road intersections in Ottawa-Carleton. Based on prior WSI Project studies, communications with electeds, professionals and community groups, re-examination of traffic data provided by RMOC, and comments by RMOC staff and area residents on *Walking Security Index*, the proposed intersections appear to provide a reasonable basis for examining the use of the selected indexes for evaluation purposes in a pilot study.

5. Support/In Kind Requirements Involving RMOC

The proposed pilot study would need the same database and related support that is provided to the consultants undertaking the Woodroffe Avenue and Main Street studies.

The point of concern is that such support would be reeded if the client/Regional Council requested a compare/contrast study involving application of the BWS Index in those locations.

And, in order to robustly examine the subject indexes (BWS, QIC, DB) via the pilot study approach, additional in-house assistance is required. The following are among the study tasks/needs to be met by RMOC:

- intersection assessments to be undertaken by a person (employed by RMOC) with access to RMOC vehicle, and familiarity with video equipment, manual and electronic denominator boards, automatic traffic recorders, and creation of reports from downloaded ATR data;
- data and document retrieval/analysis (of RMOC files) in order to satisfy baseline data requirements and other pilot study data/information demands involving RMOC data/document holdings;
- access is needed to a person (employed by RMOC) with a working knowledge of the RMOC data processing/information resources system, in both the paper and electronic modes;
- assistance will be needed to help supervise/coordinate fieldwork done during the pilot study. In particular, supervisors of students hired for the Region's count program may not have the time to become involved in WSI pilot study activities. However, in order to maximize the benefits from all the fieldwork, close liaison between the fieldwork supervisors/coordinators is essential.

6. Schedule

The following is a point-form outline of the key elements of the schedule.

- A. Fieldwork to extend over one calendar year to reflect seasonal changes (weather, work, vacation, school, shopping, etc.) in trip-making conditions and behaviours;
- B. Fieldwork to coincide as necessary (for research robustness purposes) with the Woodroffe Avenue and Main Street Transportation Studies;
- C. Final report to be submitted within 16 months of project start date. For the Woodroffe Avenue and Main Street studies, supplementary reports on WSI pilot study findings are to be submitted on an "as-needed" basis.

APPENDIX B. ACKNOWLEDGEMENTS

The author gratefully acknowledges the Region of Ottawa-Carleton/City of Ottawa for funding the Walking Security Index pilot study, and the University of Ottawa for administering the project. In addition, the editorial assistance of Marjorie Wellar, the proof-reading assistance of Jessica Julius, Honours Program in Geography, University of Ottawa and the research assistance of Mark TeKamp, Honours Program in Geography, University of Ottawa, in the preparation of *Walking Security Index Pilot Study* are gratefully acknowledged. Project assistants and community association members who undertook fieldwork activities for the IVDI, QICI and DBI components of the pilot study are acknowledged in the respective *Technical Supplements* (11, 13, 15) and in journal or proceedings publications. The Principal Investigator, Barry Wellar, is solely responsible for the contents of this document.

APPENDIX C. WSI PUBLICATIONS

1. Walking Security Index Publications

Publications from the design and pilot study phases of the Walking Security Index project are listed in the attachment. In addition, information is also provided about WSI-related reports which have been published in journals and conference proceedings. For further details about WSI-based publications or comments on the WSI project, including those published in journals, conference proceedings, newspapers, texts, and internet sites, the reader is referred to the Principal Investigator's web page: http://aix1.uottawa.ca/~wellarb

2. Walking Security Index Pilot Study Publications

Information about the availability of paper or electronic versions of pilot study reports (main texts and technical supplements) may be obtained from Ms. Daphne Hope, Traffic and Parking Operations, City of Ottawa, 2 Constellation Cres., 6th Floor, Nepean, ON K26 5J9. Ms. Hope can also be contacted as follows: (tel.) 613-580-2400 x 13225; (fax) 613-244-5410; (e-mail) Daphne.Hope@city.ottawa.on.ca

3. Open Literature Reports

Additional reports on the WSI project are published in conference abstracts and proceedings. Interested readers are invited to examine the sources cited for access to conference presentations.

Walking Security Index (WSI) Publications

In 1994, with the financial support of the Region of Ottawa-Carleton, Dr. Barry Wellar, Department of Geography, University of Ottawa, established an applied transportation research program with a focus on pedestrians. A central element of the Walking Security Index is the preparation and distribution of publications —technical reports, journal articles, conference proceedings and papers, etc. — which inform elected officials, professional staff and



citizens about research objectives, methodology, and findings. Publications from the design phase of the WSI project include the following documents.

Design and Pre-Testing of a Survey Instrument to Measure Pedestrian Levels of Safety and Comfort: A Case Study of the Channelized Cut-Off from Laurier Avenue East to Nicholas Street South, Ottawa, Ontario. Barry Wellar, July 1995. 95 pages.

Walking Security Index Project: Literature Search, Outreach and Research Design Activities. Interim Report 1. Barry Wellar, April 1996. 75 pages.

Perspectives on Pedestrian Safety. Conference Proceedings. Barry Wellar, editor, August 1996. 143 pages.

Findings from a Field Re-Survey of the Laurier and Nicholas Cut-Off Channel (E-S), and Implications for the Walking Security Index. Interim Report 2. Barry Wellar and Ingrid Froelich, December 1996. 69 pages.

Capability of IS/GIS-Based Intersection Applications to Implement the Walking Security Index (WSI): A Preliminary Status and Prospect Assessment. Barry Wellar, April 1997. 31 pages.

Safety, Comfort, and Convenience as Principal Components of the Walking Security Index: Initial Specification. Barry Wellar, June 1997. 71 pages.

Walking Security Index Variables: Initial Specification. Barry Wellar, November 1997. 57 pages.

Walking Security Index. Final Report, Walking Security Index Project. Barry Wellar, July 1998. 191 pages.

Newspapers as a Source of Fact and Opinion on Pedestrians' Safety, Comfort, Convenience: A Keyword-Based Literature Search and Review. Barry Wellar, January 2000, 214 pages.

Questions about the availability and cost of reports from the design phase of the WSI project, or about the content of any WSI design report, should be directed to the Principal Investigator:

Dr. Barry Wellar, Professor,

University of Ottawa, Department of Geography, Tel: 613-562-5800 x1065

Ottawa, ON K1N 6N5 Fax: 613-562-5145

Canada e-mail: wellarb@uottawa.ca

Walking Security Index Pilot Study Publications

In September 1999, the Region of Ottawa-Carleton (now the City of Ottawa) funded a pilot study to test three 'macro indexes' for operationality. As of April 2002, seven WSI pilot study reports have been completed. They are titled as follows:

- 1. Walking Security Index Pilot Study:
 Basic Walking Security Index Component.
- 2. Walking Security Index Pilot Study: Basic Walking Security Index Component Technical Supplement.
- 3. Walking Security Index Pilot Study: Quality of Intersection Condition Component.
- 4. Walking Security Index Pilot Study: Quality of Intersection Condition Component –Technical Supplement.
- 5. Walking Security Index Pilot Study: Driver Behaviour Index Component.
- 6. Walking Security Index Pilot Study: Driver Behaviour Index Component Technical Supplement
- 7. Walking Security Index Pilot Study





Responsibility for providing access to or distributing pilot study reports —electronically or in hardcopy — rests with the project client, that is, the City of Ottawa. Details about the procedures for gaining access to or obtaining these reports may be obtained from:

Daphne Hope
Traffic and Parking Operations,
City of Ottawa,
2 Constellation Cres., 6th Floor,
Nepean, ON K26 5J9

e-mail: Daphne.Hope@city.ottawa.on.ca

Tel: 613-580-2400 x 13225



The reader may also wish to visit the City of Ottawa website at www.city.ottawa.on.ca for information about Walking Security Index publications and related materials, including Committee and Council reports and minutes.

The presentation, "Overview of the Walking Security Index Pilot Study", made to the Transportation and Transit Committee on November 7th, 2001 can be read online at: http://www.city.ottawa.on.ca/calendar/ottawa/citycouncil/ttc/2001/11-07/minutes15.htm



Open Literature Reports

- 1. "Pedestrian Perspectives on Intersection Performance: A Case Study Report on Channelization", Barry Wellar, in *1996 URISA Proceedings*, pp. 181-201.
- "Integrating Intersection Feature and Performance Data Using the Walking Security Index Model", Barry Wellar and Jason Soroko, in 1997 URISA Proceedings (CD-ROM).
- 3. "Combining Client-Driven and Curiosity-Driven Research in Graduate Programs in Geography: Some Lessons Learned and Suggestions for Making Connections", Barry Wellar, in *1998 Papers and Proceedings of the Applied Geography Conferences*, pp. 213-220.
- 4. "Strategies Behind Using Client-Driven Research on the Walking Security Index (WSI) to Connect Ontology, Epistemology and Praxis in Undergraduate Courses", Barry Wellar, in *1998 Papers and Proceedings of the Applied Geography Conferences*, pp. 161-169.
- 5. "Walking Security Index Project", Barry Wellar, in *Abstracts, 1998 Conference of the Association of American Geographers.*
- 6. "The Walking Security Index (WSI) as a Means of Harmonizing Transportation and Community Goals", Barry Wellar and Grant Malinsky, in 1998 Proceedings of the Annual Conference of the Transportation Association of Canada.
- 7. "Moving Research from Concepts to Operations: Comments on Contract Negotiations for the Walking Security Index (WSI) Pilot Study", Barry Wellar, in 1999 Papers and Proceedings of the Applied Geography Conferences, pp. 11-19.
- 8. "Field Tests of the Driver Behaviour Index (DBI) Survey Forms: Initial Findings from an Applied Geography Project Involving Selected Regional Intersections in Ottawa-Carleton", Barry Wellar and Catherine Vandermuelen, in **2000 Papers** and Proceedings of the Applied Geography Conferences, pp. 206-214.
- 9. "Spatial Factors Affecting Implementation of the Walking Security Index (WSI): Initial Pilot Study Findings", Barry Wellar, in *Abstracts, 2000 Conference of the Association of American Geographers.*
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- 12. "Strategies for Designing Applications to Implement Walking Security Indexes", Barry Wellar, in **2001 URISA Proceedings** (CD-ROM).
- 13. "Overview of the Walking Security Index Pilot Study", Barry Wellar, in Transportation and Transit Committee Minutes, 07 November 2001, City of Ottawa. May be viewed at: http://www.city.ottawa.on.ca/calendar/ottawa/citycouncil/ttc/2001/11-07/minutes15.htm
- 14. "Implications of the Walking Security Index (WSI) Pilot Study for Urban Transportation Programs", Barry Wellar, in **Abstracts**, **2002 Conference of the Association of American Geographers**.
- 15. "Lessons Learned from the Walking Security Index (WSI) Project on How to Achieve Street-Smart Urban Transportation Improvements", Barry Wellar, in Proceedings, 2002 Conference of the Canadian Institute of Planners. Vancouver, BC, May 26-29, 2002. May be viewed at: http://www.cip-icu.ca/English/conference/proceedings/02proc15.pdf



