Developing a Framework for Analysing The Impacts of Urban Transportation:

A Research Summary

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Acknowledgements

This report is a summary of a Masters thesis titled, *Developing a framework for analysing the impacts of urban transportation*, compiled and written by:

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Any results not elaborated on in this report, can be found in the above titled thesis, along with additional reference information.

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Main Messages

- The current growth in private vehicular travel is not sustainable from either an environmental or a health perspective.

- Transportation impacts human health primarily through air and noise pollution, collisions, stress, and contribution to sedentary lifestyle.

- A new framework for recognizing the health and environmental issues associated with transportation projects is needed. The assessment framework developed in this report is a starting point for recognizing the full range of impacts that result from transportation projects.

- Traffic-related air pollution impacts on respiratory conditions in Edmonton are estimated to be over $4 million annually in direct health costs.

- Local stakeholder groups were divided over whether the Whitemud Drive widening would affect air quality. Community members believed the widening would increase air pollution, while scientific expert groups believed it would have no effect on air pollution.

- Land use and transportation planning are linked and individuals employed in these disciplines must work together to promote more sustainable cities.

- More funding should be allocated to municipal governments for their transportation infrastructure needs. Municipal government's dependence on property taxes contributes to the negative health effects of urban sprawl.

- Transportation planners, in consultation with community members, environmental, and health experts, are encouraged to adopt the assessment framework developed in this study as a tool for promoting healthy public policy.

Executive Summary

This report illustrates the impacts associated with transportation and implements them into an assessment framework that can be used to evaluate different transportation alternatives. The main health impacts resulting from urban transportation projects are air and noise pollution, injuries from collisions, contribution to physical fitness, and stress.

The assessment framework is derived from a mixture of approaches reviewed, borrowing most heavily from Multi-Criteria Analysis.

The assessment framework is applied to a local transportation issue of roadway widening in West Edmonton, by examining stakeholder perceptions, and estimating air pollution health effects.

Stakeholder involvement is crucial in understanding the differing viewpoints on transportation issues. Six different stakeholder groups provided input on the topic of roadway widening. The six stakeholder groups were two separate community groups, City councillors, environment and health professionals, and transportation planners. The groups were asked general questions about transportation's link to environment, economic and health issues and then more specifically about the Whitemud Drive widening in West Edmonton.

All stakeholder groups thought that noise pollution would increase due to the widening of Whitemud Drive. Aside from an increase in noise levels, the widening is not projected to have any significant effects according to the stakeholders.

The expert group (health, environment, and transportation planners) generally felt that roadway widening would help alleviate air pollution by reducing congestion and the start-stop driving that accompanies it. The community group (local citizens and City councillors) generally thought that an increased roadway would worsen air quality because of the extra traffic that would be induced by such a widening.

Air quality was an impact that was identified as a concern and this impact was examined in more detail. Edmonton's air quality has generally been improving over the last 10 years even though the amount of automobile

travel has increased. Estimates of the vehicle related respiratory effects were made. It was found that 685 respiratory emergency room visits, 72 hospital admissions, and 5 deaths occur from traffic related pollution in Edmonton each year. The direct health costs associated with these health effects is estimated to be over $4 million per year.

Transportation has many health, environmental, and economic impacts that must be accounted for in transportation planning. The assessment framework will assist in identifying those impacts that affect health, and more easily quantify these impacts if possible. Where it is possible, stakeholder opinion should be used.

Many variables outside of the health care system impact on people's health, including transportation. The assessment framework includes health impacts and its utilization should facilitate healthier transportation planning in the future and will help bring about healthier public policy.

Context

The growing number of people settling into urban areas underscores the importance of responsible urban planning. In 2001, 79% of Canadians lived in urban areas (Bradford, 2002). Along with the urban population growth comes the associated problem of traffic congestion on urban roadways. Urban planners are struggling with how to solve this congestion problem.

The main research questions addressed in this study are:

1) What are the social, health and ecosystem variables that urban transportation planners' should consider when deciding on transportation infrastructure projects?
2) Is it possible to quantify these impacts for a case study of a roadway widening project in Edmonton, Alberta?

The assessment framework developed in this study outlines the major impacts that transportation has, on the environment, society, and human health. Some of these adverse health impacts include air pollution health effects, injuries and death from motor vehicle collisions, noise effects, contributions to a sedentary lifestyle, and stress (Dora, 1999; Granados, 1998; McCarthy, 1999; Morton, 2001; Richter & Reingold, 2002, Transport and Health Study Group, 1991).

The quantification of transportation's adverse health impacts has been performed by many authors (Greene & Jones, 1997; Litman, 1999; Spadaro, 2001). While these efforts have been noble, there is still a place for the qualitative aspect of determining the impact from transportation, and the assessment framework includes qualitative perceptions from major stakeholders.

Implications

The assessment framework should increase the awareness of the general public, about the potential impacts associated with urban transportation, and this should allow planners to more comprehensively plan for transportation infrastructure.

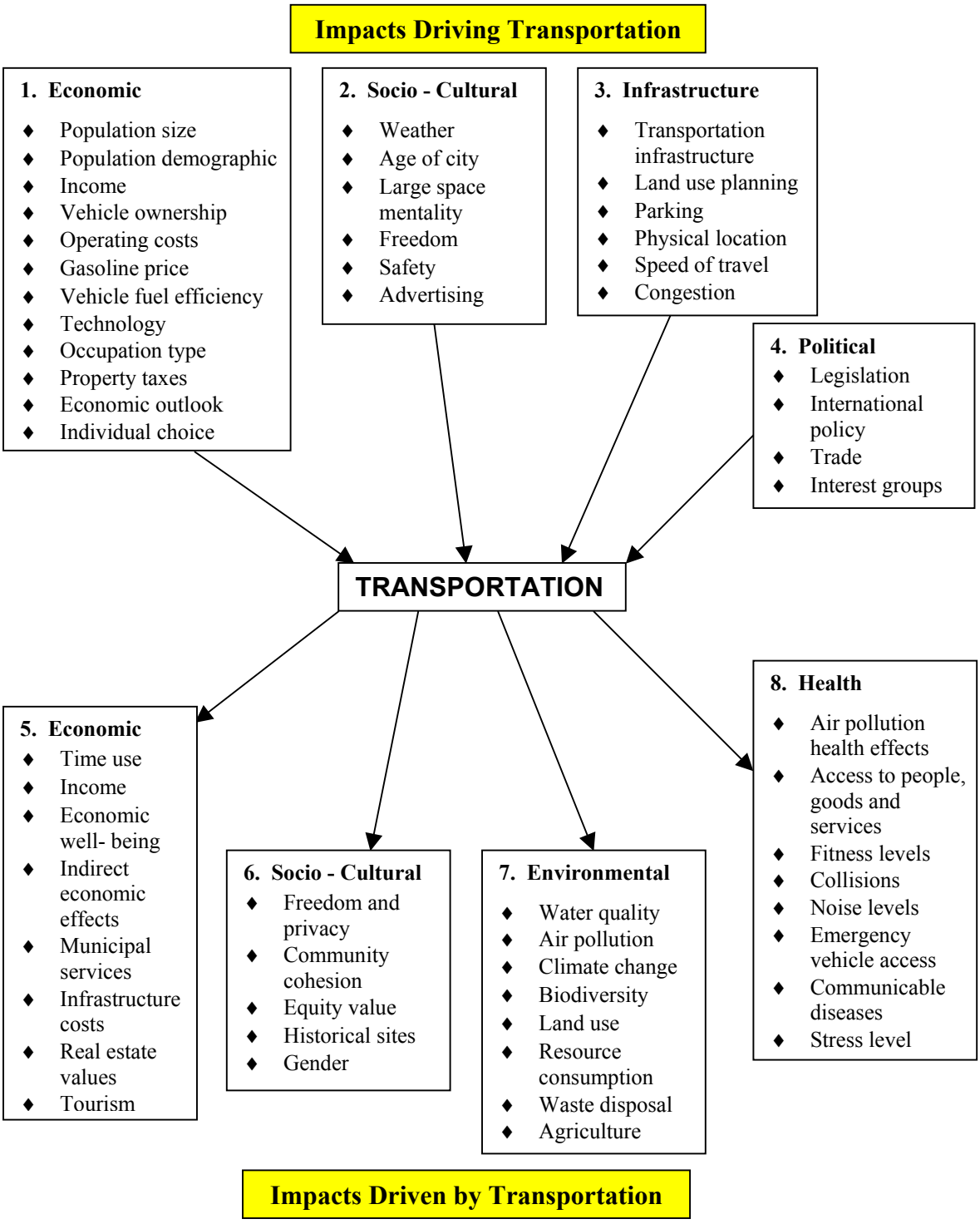
Approach

1) Literature Review

A) Impacts

To appreciate the complexities involved in making transportation decisions, it is necessary to determine the full scope of how transportation impacts on society. Figure 1 is a diagram that identifies all of the potential factors (or pressures), that impact on transportation (top half of Figure 1, numbered 1-4), and the impact that transportation has on society (bottom half of Figure 1, numbered 5-8). Not all impacts have been derived from the published literature, with some being an original contribution by the author. Note that the impact diagram is not an exhaustive list. The reader is referred to other publications that incorporate different lists of impacts (OECD, 1997; European Commission, 1996). Readers are referred to sources cited in Appendix 4 to obtain further information about each impact included in Figure 1, and about how transportation impacts on society in general.

Figure 1 Impact Diagram



B) Frameworks

To fully integrate health, environmental, and economic concerns into transport planning, a framework is needed. In reviewing the literature on frameworks, many approaches have potential relevance. The following is a brief review of these frameworks.

i) Integrated Assessment Framework

This approach seeks to integrate social, economic, health and environmental issues using both scientific and stakeholder knowledge (Martens & Rotmans, 1999). Though useful in framing complex questions logically for decision-making and research purposes, little has been done outside of global climate change.

ii) Health Impact Assessment (HIA)

This approach uses a combination of procedures to determine how a policy, either inside or outside the health sector, impacts on population health (Scott-Samuel, 1998). HIA is enjoying increasing popularity in both regional and national policy-making (Mindell, Hansell, Morrison, Douglas, & Joffe, 2001) and is linked to healthy public policy (Health Canada, 1997). Healthy public policy is the explicit concern for health and equity in all areas of policy (WHO, 1988), and HIA is a key method for determining how healthy a public policy is. Up to this point in time, environmental, economic and socio-cultural aspects have not been recognized adequately in HIA.

iii) Environmental Impact Assessment (EIA)

EIA is a process to determine the environmental effects of a project to help developers form their judgement about whether the project should go ahead (as cited in British Medical Association, 1998). A weakness of EIAs is that they are narrowly focused at the project level and do not allow for alternative options to be considered at the policy level.

iv) Strategic Environmental Assessment (SEA)

This approach was first developed in 1969 for environmental issues in California, but has more recently come into favour especially with transportation issues in the 1990s. SEA is similar to EIA with one important difference. EIAs are performed at the project level whereas SEA is conducted at the level of policy, plans, and

programmes where costs and benefits of various alternatives can be compared (ECMT, 1998). There remains a need for health considerations to be more prominent in SEAs.

v) Ecosystem Approach to Human Health (Ecohealth)

The Ecohealth approach is a method of research that examines how ecosystems affects human health. An ecosystem is defined as the interaction between living and non-living entities in any system (Forget & Lebel, 2001), and can include a pond, a rural farmyard, or an entire urban area. The Ecohealth approach has features that make it appealing for urban transportation problems because they influence the environment and subsequently human health.

vi) Cost-Benefit Analysis (CBA)

This approach was first proposed as a technique to assist in public policy decision making in 1844 and is considered the gold standard of economic evaluation (Clemmer & Haddix, 1996). It quantifies the costs and benefits of an intervention into monetary terms in order to allow comparisons for each intervention. A weaknesses of CBA is that impacts that are not quantifiable (e.g. environmental, health) are either excluded from the analysis (as cited in Hau, 1994), or given reduced attention compared to time travel savings.

vii) Multi-Criteria Analysis (MCA)

This is an assessment where effects given a monetary value, as well as those using subjective criteria, are provided to decision-makers and analysts for comparison (ECMT, 2001; OECD, 1997b). The benefit of MCA is that it includes those impacts commonly excluded from CBA. MCA is a synthesis of environmental, economic, and social assessments combined into one overall assessment. Overall, the MCA is an ideal method for considering all relevant impacts related to transportation infrastructure.

Table 1 displays the defining features of each of the frameworks reviewed.

The assessment framework developed for this study is presented next, and it is argued that it best suits the task of integrating health, environment and economics to address transportation planning.

Table 1 Framework Review Matrix

	Disciplines used to complete	Understandable	Policy relevant	Long-term and short-term impacts	Examination of all impacts	Feasible to conduct within one year	Reliable	Community participation included
IAF	Public Health, Climatology, Meteorology, Economics			✔	✔			
HIA	Epidemiology, Public Health, Engineering, Transportation	✔	✔			✔		✔
EIA	Environment, Transportation, Engineering	✔	✔	✔		✔	✔	
SEA	Environment, Economics, Transportation, Epidemiology, Public Health			✔	✔	✔		✔
Ecohealth. Approach	Environment, Public Health, Geography			✔	✔	✔		✔
Cost-Benefit Analysis	Economics, Transportation, Public Health	✔	✔	✔		✔	✔	
Multi-Criteria Analysis	Economics, Environment, Public Health, Engineering, Transportation, Epidemiology	✔	✔	✔	✔			✔

Note: IAF – Integrated Assessment Framework
HIA – Health Impact Assessment
EIA – Environmental Impact Assessment
SEA – Strategic Environmental Assessment

2) Assessment Framework

The assessment framework uses the impacts identified in Figure 1, and places them into a Multi Criteria Analysis framework. Table 2 is a pictorial representation of the assessment framework as well as lists the impacts and indicators that are affected by urban transportation.

It is important to note that many impacts can be included in an assessment framework and the decisions about what impacts to include will vary depending on local context. The impacts included in this assessment framework do not include all the impacts possible, but rather illustrates those that were thought to be significant based on the published literature, and stakeholder perception.

Categories Included

The four main categories in the IIAF are listed in the left-hand column:

(1)Health
(2)Environment
(3)Economic
(4)Socio-Cultural

Within each of these categories are impacts, that are derived from Figure 1. For instance, within the Health category, air quality, collisions, noise, fitness, stress levels, and community cohesion are listed as impacts. Subsequently, quantitative and quantitative indicators are listed for each impact. For example, in the collision impact, a quantitative indicator of the estimated number of collisions occurring in the network because of the project, and the cost of those injuries is listed. To supplement this, a qualitative indicator of the likely impact the project will have on collisions is also listed. Common data sources for both quantitative and qualitative indicators is also shown.

To assess the usefulness of the assessment framework, a case study of a roadway widening project in Edmonton is presented next. Community participation from various stakeholders is included to confirm the significance of the impacts included in the assessment framework and acts as a resource for qualitative indicators in the framework.

Table 2 Assessment Framework

Option Title:			**Cost of option:**	
Category	**Impact**	**Quantitative Indicator**	**Qualitative Indicator**	**Data Source**
Health	Air quality	♦ Est. no. of people experiencing respiratory degradation from alternative and cost ♦ Est. no. of air quality guidelines expected to be exceeded annually due to alternative		♦ Air monitoring stations ♦ Epidemiologist
	Collisions	Est. no. of collisions occurring in network and cost of injuries/fatalities resulting	Likely impact on collisions in the network	♦ Transport. Planning ♦ Police Dept.
	Noise	Est. no. of people exposed to noise above City guidelines and cost	Likely impact on noise levels	♦ Transport. Planning
	Fitness	No. of non-vehicular trips made	Likely impact on pedestrian and bicycling	♦ Transport Planning ♦ Stakeholders
	Stress levels		Likely impact on drivers stress levels	Stakeholders
	Community cohesion		Likely impact on community stress level and barrier effect	Stakeholders
Environment	Climate change	Est. cost based on CO2 emissions		Transport. Planning
	Biodiversity	♦ No. of road kills expected ♦ Amount of habitat land area loss	Potential effect on displacement of plants, animals in area	Environment Screening Review
	Water quality		♦ Potential for water contamination in area ♦ Risk of spills from hazardous goods	Environment Screening Review
Economic	Traffic volume	Daily average volume for network		Transport. Planning
	Journey times	Est. no. of minutes saved on journeys through network		Transport. Planning
	Real estate values		Likely impact on real estate values	Real Estate Board
Socio-Cultural	Gender		Likely differential impact on both genders	Transport. Planning Stakeholders
	Equity		Likely impact on public transit accessibility	Transport. Planning Stakeholders

3A) Case Study Background

The City of Edmonton produced a Transportation Master Plan that identified the need to balance private automobile use with improved public transit, bicycling and pedestrian. The impetus for this plan was the forecasted population growth for metropolitan Edmonton, expected to increase by one third to 1.17 million in 2020 (City of Edmonton, 1998). In congruence with the population growth was the fact that the city was predicted to continue its decentralized pattern of expansion in the suburban areas of the city.

Whitemud Drive was selected as a key component of the transportation system, linking south and west Edmonton. While most of Whitemud Drive is six lanes of through traffic, there is a section between 122nd street and 149th street that provides only four lanes of through traffic, with congestion arising especially during the morning and evening peak hours. Therefore, the City of Edmonton planned to widen Whitemud Drive by one lane in each direction, including expanding the Quesnell Bridge to eight lanes from six lanes.

3B) Case Study Method

To adequately address the concerns of the citizens involved, an assessment framework has to include those impacts that the community, experts, and decision-makers feel are important. The information gathered from the case study (using a questionnaire, with ethics approval from the University of Alberta), was used to verify the impacts that were included in the assessment framework, and to include expert knowledge of one of the impacts; air pollution health effects.

Stakeholder input from six different groups was sought for this study to provide a balanced viewpoint on transportation in Edmonton and the Whitemud Drive widening in particular. Individuals within each group were asked to fill out a questionnaire about their perceptions of Whitemud Drive and the impact that the proposed widening would have.

3C) Case Study Results

The following are selected results from the questionnaire. The stakeholder groups and number of participants are shown in Table 3 in Appendix 1. Owing to time and resource considerations, these six groups and 36 individuals, were the only stakeholders contacted for this case study.

One question asked whether the participants felt that congestion on Whitemud Drive between 122nd street and 149th street was a problem. A majority of those asked said congestion was a problem (26 out of 36, or 72%). This response was expected, given answers in an earlier questionnaire where congestion and high traffic volume was most often listed as a problem on Whitemud Drive (Equus Consulting Group, 2001).

Another question asked if those respondents who said that congestion was a problem in the previous question, then what methods would they propose to reduce congestion on Whitemud Drive. Table 4 in Appendix 1 lists the four most common responses, with widening of Whitemud Drive being the most common.

One question asked if respondents had any concerns about how Whitemud Drive affects people's health if at all. Air pollution health effects were of most concern, followed by injuries from collisions and noise effects. The four most common responses to this question are displayed in Table 5 in Appendix 1.

Another question asked whether respondents thought city planners should consider the area of human health when they consider transportation options. The majority of respondents either agreed or strongly agreed with this statement (29 out of 36) as shown in Table 6 in Appendix 1.

4A) Air Quality Background

Transportation-related particulate matter comes from the incomplete combustion of fossil fuels, from tire contact with the road, brake lining strewn off vehicles when brakes are applied, and from the interaction of several other air pollutants (Colvile, Hutchinson, Mindell, & Warren, 2001). Particulate matter is seen as a useful indicator of several sources of outdoor air pollution primarily because of the complexity of this component owing to its air pollution mixture (Kunzli et al, 2000; Aunan, 1996).

Particulate matter has been well published in the literature concerning its association with human health effects, (Environment Canada & Health Canada, 1999; WHO, 2000). Relying on these and other studies, it was decided that particulate matter less than 2.5 microns in diameter ($PM_{2.5}$) would be the pollutant examined in this study. The limitation in this decision is that the interaction of a number of different air pollutants will not be examined, so that any health related effects calculated in this analysis would likely be underestimated.

4B) Air Quality in Edmonton

A prior study had been done in the Edmonton area measuring air quality. Over a 10 year period, $PM_{2.5}$ concentration has decreased by 4.7% per year in the Edmonton area (Cheng, Sandhu, Angle, & Myrick, 1998) and the mean $PM_{2.5}$ level in 1995 was 11.2 $\mu g/m^3$. Approximately 60% of fine particulate matter in Edmonton is from transportation and road dust (Cheng et al., 1998), which is consistent with one finding (ECMT, 1990), though higher than another (Environment Canada & Health Canada, 1999).

For this study, air quality monitoring measurements were taken from Alberta Environment's permanent station in Northwest Edmonton. Air quality measurements near Whitemud Drive were not available at the time of writing the thesis, even though they were promised from Alberta Environment earlier in 2002.

4C) Health Costs Associated with Traffic in Edmonton

There are health related costs in the City of Edmonton related to traffic pollution, as displayed in Table 7 in Appendix 2. The table illustrates that traffic is directly responsible for 5 respiratory related deaths, 72 hospital admissions, and 685 emergency room visits.

Table 8 in Appendix 2 displays four different transportation scenarios for the Whitemud Corridor. The widening of Whitemud Drive primarily for the use of private automobiles is expected to generate more traffic per day than the other scenarios of status quo, widening for designated bus lanes, and reduction in lanes. This extra traffic contributes to increased adverse respiratory health effects for the citizens of Edmonton. It is for this reason, that the City of Edmonton should adopt a more healthy public policy of promoting alternatives to private automobiles, such as bicycles and bus lanes.

The final summary table using the quantitative and qualitative indicators for selected impacts related to the widening of Whitemud Drive is presented in Appendix 3. For the qualitative indicators, aside from moderate increases expected in noise and economic benefits to the city, no changes in the impacts listed are expected from the widening of Whitemud Drive according to the stakeholders involved.

More detailed analysis is needed to complete the assessment framework for the case of widening Whitemud Drive. Only a completely tested assessment framework is useful for decision-makers when deciding on transportation options. Therefore, drawing inferences from Appendix 3 would be premature.

Additional Resources

Readers are referred to Appendix 4 which details supplemental information on urban transportation and its effects.

Further Research

Traffic-related air pollution is estimated to have a $4 million cost for the health care system annually in Edmonton. This figure is likely underestimated because only particulate matter was analysed, not all of the health effects from particulate matter were considered, and indirect costs were not

included. Further studies are needed to estimate traffic's impact on cardiac conditions, cancer, noise related effects, stress levels, and the impact on physical activity.

The variation in stakeholder opinion found in the case study, suggests that more communication is needed between these groups. Transportation planning should then be more aware of community concerns, and of the public health impact associated with transportation infrastructure.

The questionnaire should be used on a larger sample size so that the results can be applied outside of the study group. This would serve to increase the reliability of the questionnaire.

More detailed studies should be conducted that measure indoor air pollution levels in homes and schools surrounding busy roadways like Whitemud Drive. This would provide a better picture of how much air pollution people are exposed to indoors, where people spend the majority of their time.

More collaboration is needed among the various government organizations. The case study of Whitemud Drive is the first issue, to the researcher's knowledge, that transportation, environment, and health organizations have collaborated. The assessment framework may be one mechanism to encourage these various agencies to work together to estimate the combined impacts associated with transportation options.

The provision of more roadways is not seen as an environmentally sustainable option because of the induced traffic that results (Goodwin, 1996; Noland, 2001; SACTRA, 1994), although some still debate this fact (Dowling & Colman, 1998). More studies performed in Canada should be done to link the precise association between roadways and the increased traffic that it generates. This should help to resolve the differences that occur in this debate.

The assessment framework should prove useful for transportation planning in the future, especially because it includes public health~~.~~ concerns. Healthy public policy should be a goal of any municipality, and the assessment framework is a tool that could help to achieve this goal.

References

Alberta Health (2001). *Health costing in Alberta: 2001 annual report*. Retrieved April 5, 2002 from www.health.gov.ab.ca/public/document/health_costing_2001.pdf.

Applications Management Consulting Ltd. (1995). *Household travel survey: Project report.* Edmonton, AB: Author.

Aunan, K. (1996). Exposure-response functions for health effects of air pollutants based on epidemiological findings. *Risk Analysis, 16*(5), 693-709.

Bradford, N. (2002). *Why cities matter: Policy research perspectives for Canada: CPRN Discussion Paper No. F/23.* Retrieved June 22, 2002 from http://www.cprn.org/cprn.html.

British Medical Association. (1998). *Health and environmental impact assessment: An integrated approach.* London: Earthscan Publications, Ltd.

Capital Health Authority. (2000). *How healthy are we? Health status in the Capital Health region: a technical report 2000*. Edmonton: Author.

Carrothers, T.J., Graham J.D., & Evans, J. (1999). Valuing the health effects of air pollution. *Risk in Perspective, 7*(5), 1-6.

Cheng, L., Sandhu, H.S., Angle, R.P., & Myrick, R.H. (1998). Characteristics of inhalable particulate matter in Alberta cities. *Atmospheric Environment, 32*(22), 3835-3844.

City of Edmonton. (1998). *Transportation Masterplan.* Edmonton: Author.

Clemmer, B. & Haddix, A.C. (1996). Cost-Benefit Analysis. In A.C. Haddix, S.M. Teutsch, P.A. Shaffer, D.O. Dunet (Eds.), *Prevention Effectiveness* (pp.85-102). New York: Oxford University Press.

Colvile, R.N., Hutchinson, E.J., Mindell, J.S., & Warren, R.F. (2001). The transport sector as a source of air pollution. *Atmospheric Environment, 35,* 1537-1565.

Dora, C. (1999). A different route to health: Implications of transport policies. *British Medical Journal, 318*, 1686-1689.

Dowling, R.G. & Colman, S.B. (1998). Effects of increased highway capacity: Results of a household travel behaviour survey. *Transportation Research Circular, 481,* 21-32.

Environment Canada & Health Canada. (1999). *Priority substances list assessment report: Respirable particulate matter less than or equal to 10 microns.* Retrieved

January 24, 2002, from http://www.ec.gc.ca/substances/ese/eng/psap/final/reports/PM-10_fin_e.pdf

Equus Consulting Group. (2001). *Whitemud drive/Terwillegar drive facility planning study. Appendix B public consultation.* Edmonton: Stantec Consulting.

European Commission. (1996). *Transport Research: EURET: Cost benefit and multi-criteria analysis for new road construction* (Concerted Action 1.1 VII-2). Brussels: Commission of the European Communities, Directorate-General for Energy and Transport. (http://www.cordis.lu/transport/src/public2.htm)

European Conference of Ministers of Transport [ECMT]. (1990). *Transport policy and the environment: ECMT ministerial session*. Paris: OECD

ECMT (1998). *Strategic environmental assessment in the transport sector.* Paris: OECD.

ECMT. (2001). *Assessing the benefits of transport.* Paris: OECD

Forget, G., & Lebel J. (2001). An ecosystem approach to human health. *International Journal of Occupational and Environmental Health, 7*(Suppl 2), S3-S36.

Goodwin, P.B. (1996). Empirical evidence on induced traffic: A review and synthesis. *Transportation, 23,* 35-54.

Granados, J.A.T. (1998). Reducing automobile traffic: an urgent policy for health promotion. *Pan American Journal of Public Health, 3*(4), 227-240.

Greene, D.L., & Jones, D.W. (1997). The full costs and benefits of transportation: Conceptual and theoretical issues. In D.L. Greene, D.W. Jones, and M.A. Delucchi (Eds.), *The full costs and benefits of transportation: Contributions to theory, method and measurement.* (pp. 1-26). Berlin: Springer.

Hau, T.D. (1994). [Review of the book *Fast wheels slow traffic: Urban transport choices*]. *Journal of Economic Literature, 32*(2), 743-745.

Health Canada (1997). *Health promotion in Canada: A case study.* Retrieved August 13, 2002, from http://www.hc-sc.gc.ca/hppb/healthpromotiondevelopment/pube/hprpte.pdf

Kunzli, N., Kaiser, R., Medina, S., Studnicka, M., Chanel, O., Filliger, P., et al. (2000). Public-health impact of outdoor and traffic-related air pollution: A European assessment. *The Lancet, 356*(9232), 795-801.

Litman, T. (1999). *Transportation cost analysis: Techniques, estimates and implications.* Victoria, B.C: Victoria Transport Policy Institute.

Martens, P., & Rotmans, J. (1999). *Climate change: An integrated perspective.* Dordrecht: Kluwer Academic Publishers.

McCarthy, M. (1999). Transport and health. In M. Marmot & R.G. Wilkinson (Eds.), *Social Determinants of Health* (pp.132–154). New York: Oxford University Press.

Mindell, J., Hansell, A., Morrison, D., Douglas, M., & Joffe, M. (2001). What do we need for robust, quantitative health impact assessment? *Journal of Public Health Medicine, 23*(3), 173-178.

Morton, S.W. (2001). *Evidence of the impact of transport on health*. Retrieved June 22, 2001, from: http://www.who.dk/eprise/main/who/progs/hcp/UrbanHealthTopics/20020107_1.

Noland, R.B. (2001). Relationships between highway capacity and induced vehicle travel. *Transportation Research Part A, 35*, 47-72.

Organisation for Economic Cooperation and Development [OECD]. (1997). *Towards sustainable transportation: The Vancouver conference.* Paris: Author.

OECD. (1997b). *Integrated strategies for safety and environment.* Paris: Author.

Richter, E.D. & Reingold, S.M. (2002). Injury and environmental epidemiology: A converging agenda. *Global Change and Human Health, 3*(1), 2-8.

Scott-Samuel, A. (1998). Health impact assessment: Theory into practice. *Journal of Epidemiology and Community Health, 52*, 704-705.

Spadaro, J.V, & Rabl, A. (2001). Damage costs due to automotive air pollution and the influence of street canyons. *Atmospheric Environment, 35,* 4763-4775.

The Standing Advisory Committee on Trunk Road Assessment[SACTRA]. (1994). *Trunk roads and the generation of traffic*. London: HMSO.

Transport and Health Study Group. (1991). *Health on the move: Policies for health promoting transport.* Birmingham, U.K.: Public Health Alliance.

World Health Organization[WHO]. (1988). *Conference Statement of the 2nd International Conference on Health Promotion, Adelaide South Australia, 5-9 April 1988*. Retrieved August 13, 2002, from http://www.who.int/hpr/archive/docs/adelaide. html.

WHO (2000). *Guidelines for air quality.* Retrieved December 20, 2001 from http://www.who.int/peh/air/airqualitygd.htm

Appendix 1

Table 3 Number of Participants in each Stakeholder Group

Stakeholder Group	Final number of participants
City of Edmonton Transportation Planning Branch	4
City of Edmonton Councillors	8
Alberta Environment	6
Capital Health Authority	5
Local citizens in West Edmonton Transportation Coalition (WETC)	7
Local citizens not in WETC	6
Total	36

Table 4 Four Most Common Methods to Reduce Congestion on Whitemud Drive

Methods to reduce congestion	Number of Responses	Percentage
Widen Whitemud Drive	16	34
Use alternate routes	12	26
No answer due to Question 4 response	6	13
Improved public transit	5	11

Table 5 Four Most Common Health Concerns with Whitemud Drive

Health concerns	Number of responses	Percentage
Air pollution	18	42
Injuries from collisions/Safety concerns	7	16
Noise	7	16
No concerns	7	16

Table 6 Should Planners Consider Human Health when Deciding on Transportation Options?

	Number of respondents	Percentage
Strongly agree	11	31
Agree	18	50
Neutral	3	8
Disagree	1	3
Strongly disagree	2	6
No Answer	1	3
Total	36	100*

*Note: Because of rounding errors, percentage does not add to 100%

Appendix 2

Table 7 Estimate of Respiratory-Related Health Conditions from Traffic Pollution all of Edmonton

Column	(1)	(2)	(3)	4 = (2) * (3)	(5)
	Number of events per year	Number attributable to traffic pollution	Cost per outcome	Total cost per year in Edmonton	Vehicle-kms per event (000s)
Respiratory Admissions	2,395 (a)	72 (b)	$3,300 (d)	$237,600	50,188
Respiratory Deaths	168 (a)	5 (b)	$810,000 (e)	$4,050,000	722,700
Respiratory Emergency Room Visits	22,841 (a)	685 (b)	$111 (d)	$76,035	5,275

Source:(a) Capital Health Authority (2000)
(b) Kunzli et al. (2000)
(c) Applications Management Consulting (1995)
(d) Alberta Health (2001)
(e) Carrothers, Graham and Evans. (1999).

Table 8 Changes in Vehicle Kilometres for differing Transportation Scenarios

Transportation Scenario	Quesnell Bridge traffic volume (vehicles per day)	Length of Whitemud Drive (122nd to 149th streets)	Vehicle kilometres per year (000s)	Difference in veh. kms per year from baseline (000s)
2020 without widening	135,000	6 kms	295,650	0
2020 with widening	140,000	6 kms	306,600	+10,950
2020 with widening for public transport	135,000	6 kms	295,650	0
2020 with reduction by one lane	108,000	6 kms	236,520	-59,130

Appendix 3

Final Summary Table

Option Title: Widening of Whitemud Drive by one lane primarily for private vehicle use			
Category	**Impact**	**Quantitative Indicator**	**Qualitative Indicator**
Health	Air quality	♦ **0 exceedances of guidelines** ♦ **2 ER visits annually expected Contribution to hospital admissions and mortality**	**No change expected**
	Collisions		**No change expected**
	Noise		**Moderate increase expected**
	Fitness		**No change in fitness levels expected**
	Stress levels		**No change expected**
	Community cohesion		**No change expected**
Environment	Climate change		**No change expected**
	Water quality		**No change expected**
Economic	Traffic volume	**140,000 vehicles per day**	**Moderate increase in economic benefits expected**
	Journey times		**Moderate decrease in trip time expected**
	Real estate values		**No change expected**
Socio - Cultural	Gender		**No change expected**

Appendix 4

Additional Resources

Government Agencies

Transport Canada
http://www.tc.gc.ca/

National Highway and Traffic Safety Administration (United States)
http://www.nhtsa.dot.gov/

Department of Transport and Regional Services (Australia)
http://www.dotars.gov.au/

Department of Transport (United Kingdom)
http://www.dft.gov.uk/

Research Institutes

The Centre for Sustainable Transportation (Canada)
http://www.cstctd.org/

Victoria Transportation Policy Institute (Canada)
www.vtpi.org

Union of Concerned Scientists (United States)
http://www.ucsusa.org/transportation/

Tata Energy Research Institute (India)
http://www.teriin.org/urban/urban.htm