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**COMMUNITY HEALTH IMPACTS OF A PETROLEUM REFINERY IN
OAKVILLE, ONTARIO**

By

ISAAC NMBANANOBA LUGINAAH, B.Sc. (Hons), M.Sc., MES.

A Thesis

Submitted to the School of Graduate Studies

in Partial Fulfilment of the Requirements

for the Degree

Doctor of Philosophy

McMaster University

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COMMUNITY HEALTH IMPACTS OF A PETROLEUM REFINERY

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ABSTRACT

This thesis examines community reappraisal of a petroleum refinery in Oakville, Ontario. Residents' concerns about the health impacts from refinery emissions led to a community health study in 1992. The results showed that residents' perceptions of refinery odours were associated with elevated levels of reported ill-health in the community. In response to community concerns, between 1992 and 1997, the refinery implemented extensive measures to reduce odorous emissions. The implementation of these odour reduction measures provided the basis to investigate residents' reappraisal of the refinery following the intervention. The significance of this research is based on a recognition of the importance of the role of the reappraisal process in environmental stress theory, and the relative absence of studies of this process in the environmental stress literature. Hence, using a longitudinal design and mixed-methods (i.e., quantitative and qualitative), the following objectives were addressed: (1) to determine the impacts of emissions from the Oakville Petro Canada refinery on the health and well-being of residents in the surrounding community; (2) to compare the impacts of emissions before (1992) and after (1997) implementation of odour reduction measures; (3) to relate pre-post changes in odour perception/annoyance and ill-health reporting to personal and situational factors; and, (4) to explore residents' responses and coping strategies after the implementation of the odour reduction measures.

The quantitative data come from two cross-sectional health surveys across three

comparable zones in 1992(n=391) and 1997(n=427). The quantitative analysis focused on examining changes in impacts, and the determinants of change in relation to the characteristics of the exposure. The qualitative analysis (n=29), focused on exploring refinery-related experiences, coping strategies and concerns within the broader context of residents' everyday lives.

Overall, both the quantitative and qualitative analyses show that despite the improvements in refinery impacts, some residents still view the refinery as a threat to their ways of life. Proximity to the refinery and the mediating role of odour perception and annoyance emerge as strong determinants of the observed changes in refinery effects over time. Uncertainty and lack of trust also emerge as salient factors determining residents' shifting concerns, coping strategies and reappraisal of the refinery.

This study makes contributions to the environmental stress theory and risk perception literature by focusing on residents' reappraisal of an environmental stressor in relation to changes in the characteristics of the exposure. The study also makes methodological contributions by demonstrating the value of using mixed-methods in environment and health research. For practice, the persistence of residents' concerns means that the Community Advisory Committee to Petro Canada and the refinery in their risk communication and management efforts, must do more than disclose technical information(complaint statistics) and give due consideration to the way the people respond to risk information. For future research a more explicit focus on how coping strategies vary in different places and with different types of exposures is warranted.

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PREFACE

The thesis is made up of a collection of papers which have been published or submitted for publication. The study problem, objectives and the relationship among the various papers are described in the introduction and the community context is described in chapter two. The research papers are the following:

Chapter Three: Luginaah N. I., Taylor S. M., Elliott S. J. and Eyles J. D., 2000, published: A Longitudinal Study of the Community Health Impacts of a Refinery. *Social Science and Medicine*. 50: 1155-1166.

Chapter Four: Luginaah N. I., Taylor S. M., Elliott S. J. and Eyles J. D., 2000: Community Reappraisal of the Perceived Health Effects of a Petrochemical Refinery, *Social Science and Medicine*, Submitted.

Chapter Five: Luginaah N. I., Taylor S. M., Elliott S. J. and Eyles J. D., 2000: Community Responses and Coping Strategies in the Vicinity of a Petrochemical Refinery, *Qualitative Health Research*, Submitted.

While all the papers were co-authored with my thesis supervisors, the first author and candidate conducted the actual research involving problem formulation, literature review, data collection, data analysis and writing. Dr. S. Matin Taylor, Dr. Susan J. Elliott, and Dr.

John D. Eyles provided guidance on the direction of research, critiqued all the papers and provided editorial advice.

Variations in style were necessary to satisfy the different journals and these are unchanged in the thesis.

CHAPTER ONE

INTRODUCTION

1.1 Background

The public health effects of environmental exposure from industrial sites and noxious facilities have been discussed extensively in the literature (Steinheider, 1999). Much past research on public exposure to environmental contaminants has studied possible physical health effects, such as cancer and adverse birth outcomes (e.g., Bhopal et al., 1999; Sans et al., 1995). Increasingly, research on environmental exposure has recognized the significance of focussing on psychosocial effects of exposure to environmental contaminants (Taylor et al., 1993) and the reappraisal process where there have been significant changes in the exposure characteristics (Elliott and Taylor, 1996; Taylor et al., 1997). This study examines the reappraisal of the impacts of a petrochemical refinery by residents living in the vicinity of the Petro Canada refinery in Oakville, Ontario.

Possible health effects of the refinery have been a long-standing community concern. In part in response to these concerns, the refinery implemented an odour reduction plan (ORP) designed to reduce emissions and odours in the vicinity of the refinery. The extensive intervention to reduce refinery impacts provided a rare opportunity to investigate residents' reappraisal of the refinery's efforts. From a practical perspective, it serves as a basis for an

improved understanding of how judgements about environmental health risks are made by individuals and groups, and thereby informs the development of effective risk management policies and risk communication programmes.

The importance of this type of research has been advocated by various authors (Elliott and Taylor, 1996; Munton, 1996; Taylor et al., 1997). Elliott and Taylor (1996) emphasized the role of the reappraisal process in environmental stress theory and drew attention to the fact that there are very few studies of the reappraisal process in the environmental literature. A limitation of most studies has been their reliance on cross-sectional design and analysis. Elliott and Taylor (1996) therefore emphasized the need for longitudinal and comparative analyses to investigate the reappraisal process in environmental stress theory. This recognition was based on the fact that the underlying theoretical model developed by Lazarus and Folkman (1984) presumes a temporal process of primary and secondary appraisal and reappraisal.

Central to the reappraisal process is the issue of public perception of technological risk. Technologies which were once largely ignored by the public are of increasing concern as people find it harder to ignore and/or cope with perceived threats (see Vyner, 1988; Beck 1992). A pervasive problem is the differential assessment strategies employed by laypeople versus experts (Slovic, 1987). Laypeople view and assess risks through various lenses such as their attachment to place, beliefs, values and expectations. Risks are thereby socially constructed and embedded in the social context within which they occur (Douglas and Wildavsky, 1982; Johnson and Covello, 1987; Eyles et al., 1993). On the other hand, experts

typically view risks quantitatively in terms of the probability of mortality or morbidity. The fact that risks considered by experts to be of low probability could nevertheless happen and indeed have deadly consequences adds to public concern (Beck, 1992; Mol and Spaargaren, 1993). More generally, there is increasing uncertainty among laypeople about technological risks and a growing lack of trust of experts and industry. This study will add to the literature by examining the concepts of uncertainty, trust and credibility in relation to the refinery's measures to reduce the risk of negative community impacts.

The merits of integrating quantitative and qualitative methodologies has also been strongly advocated in the social research and environment and health literature (e.g., Bryman, 1988; Taylor et al., 1989; Elliott and Taylor, 1996; Morgan, 1998), but there have been relatively few examples of using mixed-methods. The complexities involved in many environmental exposure situations point to the need for using mixed-methods to address effects that may be real or perceived, span a range of outcomes, and occur across various levels of social organization (see Elliott and Taylor, 1996). The use of mixed-methods is premised on the recognition that responses to environmental exposures are socially and culturally mediated in complex ways which are to some degree unique to the particular study setting. Hence, they cannot be understood in isolation from the social context in which they are embedded and by which they are framed (see Elliott, 1992). With a mixed-methods approach, quantitative methods ask such questions as *what* is experienced, *who* experiences health effects, and how many people experience similar health effects. Qualitative methods complement the quantitative information with answers to *why* individuals experience

psychosocial and other impacts, and how the experience of these impacts is manifested in their everyday lives (see Edelstein, 1988; Baxter and Eyles, 1999). Using the Petro Canada refinery as a case study, this research seeks to demonstrate the value of integrating quantitative and qualitative methods for environment and health research.

1.2 Objectives

The primary objectives of the research are as follows:

1. To determine the impacts of emissions from the Oakville Petro Canada refinery on the health and well-being of residents in the surrounding community.
2. To compare the impacts of emissions before (1992) and after (1997) implementation of odour reduction measures.
3. To relate pre-post changes in odour perception/annoyance and ill-health reporting to personal and situational factors.
4. To explore residents' responses and coping strategies after the implementation of the odour reduction measures.

1.3 The Geography of Risks and Hazards

Two areas of geographic enquiry address issues related to risk within urban industrial society: research on environmental hazards (Burton et al, 1978; Eyles et al 1993); and studies of the negative externalities associated with noxious facilities such as landfill sites (e.g., Elliott, 1998) and community mental health facilities (see Dear and Taylor, 1982).

Mitchell (1989) defined hazards as a “range of natural events, manufactured systems, and people that threaten our lives and life support systems, our emotional security, our property, and the functioning of our societies” (p. 410). Within geography, early hazards research centred on how people perceive and cope with risk and uncertainty when faced with natural disasters such as floods, hurricanes and earthquakes (White, 1964; Buton et al., 1978). These studies employed a number of theoretical approaches such as personality theory to explain human-environment relations, particularly as they relate to the perception of the environmental hazards, both natural and human made. The approach used in the analyses of natural disasters was later applied to issues of human made technological hazards associated with facilities like nuclear reactors, hazardous waste sites and industrial activities (Slovic, 1987).

More recently, geographers have paid increasing attention to the effects of technological hazards, such as exposure to hazardous waste (Greenberg et al., 1995; Hampson, 1997). Cutter (1993) argued that it is the geography of technological hazards that addresses the interaction between technology and society, the impacts of technology on society and the environment, and how society adjusts or adapts under these hazardous conditions.

Cutter (1993) developed several themes which she viewed as essential for understanding human-made environmental hazards. First, technological risk and hazards are socially produced (Douglas and Wildavsky, 1982; Eyles et al., 1993), not acts of God, and are therefore embedded in larger political, economic, social and historical contexts.

Technological hazards threaten people in the context of their everyday lives. Those who experience hazards, and the risk associated with them, do so against the backdrop of home life, community life, work and the threat of other local hazards (see also Baxter, 1997). Second, the very nature of technological hazards being socially produced leads to variations in risk perceptions between experts, activists, and lay people (see Baxter et al., 1999; Wakefield and Elliott, 2000), which can be the source of volatile politicized responses. Third, Cutter revealed the uneven burdens of risk and hazards related to sociodemographic, intergenerational, and regional inequities in exposure to technological hazards.

For the Oakville residents, the notion of socially related burdens of risks and hazards, is particularly appropriate. As a mostly working and family community, residents are especially vulnerable and strongly committed to protecting their core values (see Baxter and Eyles, 1999). The vulnerability concept has had many interpretations including: the potential for loss; the likelihood that an individual or group will be adversely affected by a hazard; and individual or group resilience or capacity to absorb or recover from a hazardous event (Cutter, 1993). The vulnerability of individuals in the Oakville community, confronted by the presence of the refinery, is an important consideration in understanding their reactions to the implementation of the odour reduction plan.

The location of noxious facilities (e.g., nuclear reactors, refineries) is the second area of geographic inquiry with relevance for the current research. Elliott and Taylor (1996) suggest public facility location theory as a useful framework for research on the impacts of noxious facilities as it emphasizes the importance of the spatial externalities associated with

their siting. The externalities include: impacts on the local environment, including increased levels of noise, dust/soot, odours and traffic; aesthetic concerns and poor neighbourhood image; and reduced property values (Lant and Sherrill, 1995). According to Elliott and Taylor (1996), there is a tendency for those concerned about a noxious facility in their community to overstate health concerns. The explanation they offer is related to the high priority our society places on health, and therefore, the legitimacy, seriousness and attention paid to health-related concerns. This viewpoint is consistent with Burger (1990) who argues that health is often used a surrogate for the environment to justify environmental actions which the scientific evidence may be insufficient to support.

1.4 Theoretical approaches

The theoretical approaches that inform this study are drawn from the environmental stress, risk society, risk perception and hazards literature. These approaches are reviewed where appropriate in the following chapters. However, central to the whole thesis is the literature on the psychosocial effects of environmental contamination. Edelstein (1989, p. 164) defined psychosocial effects of exposure as “the effects of an event or series of events on the behaviour, the cognitions and the emotions of the people exposed to the events.” Expanding the definition of psychosocial effects further, Taylor et al (1993) defined psychosocial impacts as “a complex of distress, dysfunction and disability manifested in a wide range of psychosocial, social and behavioural outcomes in individuals, groups and communities as a consequence of actual or perceived environmental contaminants.” They

may occur in conjunction with or independent of measurable physical effects (Bertazzi et al., 1989), and may be associated with actual or perceived exposure, for example, in advance of the siting of a waste facility. Psychosocial effects have a complex etiology and occur at various levels of social organization (Elliott, 1992).

According to Taylor et al (1993), the experience of environmental stress, the choice of a particular coping response and the incidence of psychosocial effects are dependent upon a number of mediating factors which can be categorised into four sets: characteristics of the environmental stressor (Vyner, 1988; Evans and Jacobs, 1982; Sims and Baum, 1983); characteristics of the individual (Pearlin and Scholar, 1978; Evans and Jacobs, 1982); characteristics of the social network (Edelstein, 1988); and characteristics of the wider community system (Edelstein, 1988; Sims and Baum, 1983). At the individual level, they include emotional (e.g., worry, anxiety, loss of control), behavioural (e.g., information seeking, task performance), and somatic (e.g., depression, fatigue) effects (Elliott, 1992). At the social group level, psychosocial effects include family disruption and social isolation as well as positive outcomes such as the adoption of cooperative coping strategies, which may result in greater social cohesion in response to environmental stress (e.g., emissions from a petrochemical refinery). Finally at the community level, the effects of environmental contamination can include stigmatization and dislocation, however, positive effects such as community empowerment may also occur.

Elliott (1992) noted that the process of psychosocial impacts cannot be divorced from the social and geographic context within which they occur, the implication being that

strategies aimed at addressing and alleviating psychosocial impacts need to be specific to the characteristics of the populations in a particular setting. The magnitude and range of the psychosocial effects of environmental exposure implies that there should be an ongoing effort to understand them and this thesis contributes to that effort.

1.5 Organization of Thesis

The thesis consists of six chapters including this introductory chapter. Chapter Two provides a detailed discussion of the research context. This chapter starts with a brief profile of the Oakville community, followed by a description of the refinery and its effects, community concerns about the refinery and a detailed account of the odour reduction measures that were implemented by the refinery.

The next three chapters in the thesis are papers accepted or submitted for publication. Together, the papers provide a comprehensive approach to address the main objectives of the research. Chapter three deals with objectives one and two. In this chapter, odour perception and annoyance, and ill-health reporting in the vicinity of the refinery are compared before (1992) and after (1997) the implementation of the refinery's odour reduction plan. The results set the context for Chapter Four and Five by showing that while there was a decline in odour perception and annoyance, ill-health reporting was virtually unchanged after the implementation of extensive and costly odour reduction measures.

The analysis in chapter four (objective three) examines the determinants of residents' reappraisal of the refinery in relation to changes in the characteristics of the exposure, and

the causal processes related to exposure and health effects. This chapter extends the analysis reported in the previous chapter using logistic regression modelling to estimate the effects of exposure and other variables plausibly associated with odour perception and ill-health reporting.

Chapter Five presents the findings from a complementary qualitative study which deals with objective four. Here, in-depth interviews were conducted with a subset of the 1997 survey respondents, with a principal focus on residents' responses and the coping strategies they continue to employ after the implementation of the odour reduction measures by the refinery. This chapter brings together theoretical constructs from environmental stress and coping theory and risk society theory to interpret the findings.

Chapter six summarizes the major findings and discusses its substantive, methodological and theoretical contributions. These are considered within the context of persistent health concerns in the vicinity of the refinery over time. The chapter concludes with a discussion of the implications of the study for theory, policy and practice, and the directions for future research.

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CHAPTER TWO

RESEARCH CONTEXT

2.1 Introduction

This chapter begins with a community profile of Oakville, which contains the study population living around the refinery. This is then followed by a brief history of the refinery and its impacts. A review of community concerns of the refinery is then presented. In the final section a detailed account of the refinery's odour reduction plan is described.

2.2 Oakville Community Profile

Founded in 1827, the Town of Oakville is located at the west end of Lake Ontario in the heart of the Golden Horseshoe between two major urban centres - Hamilton and Toronto (Figure 2.1). The town is part of Halton Region, within the Greater Toronto Area (GTA), which is Canada's largest metropolitan area with a total population of about 4.8 million. One quarter of Canada's population lives within 160 km radius of Oakville. Spread across an area of 144.9 square kilometres, Oakville is bisected by the Queen Elizabeth Way and is just 30-minute drive from downtown Toronto. With two GO transit stations, a local transit system and a network of provincial roads and superhighways at its doorstep, Oakville has been described as a "commuter's paradise" (see DiManno, 1995). Oakville is then a well

serviced urban centre, connected with destinations such as the US border and Toronto Pearson International Airport.

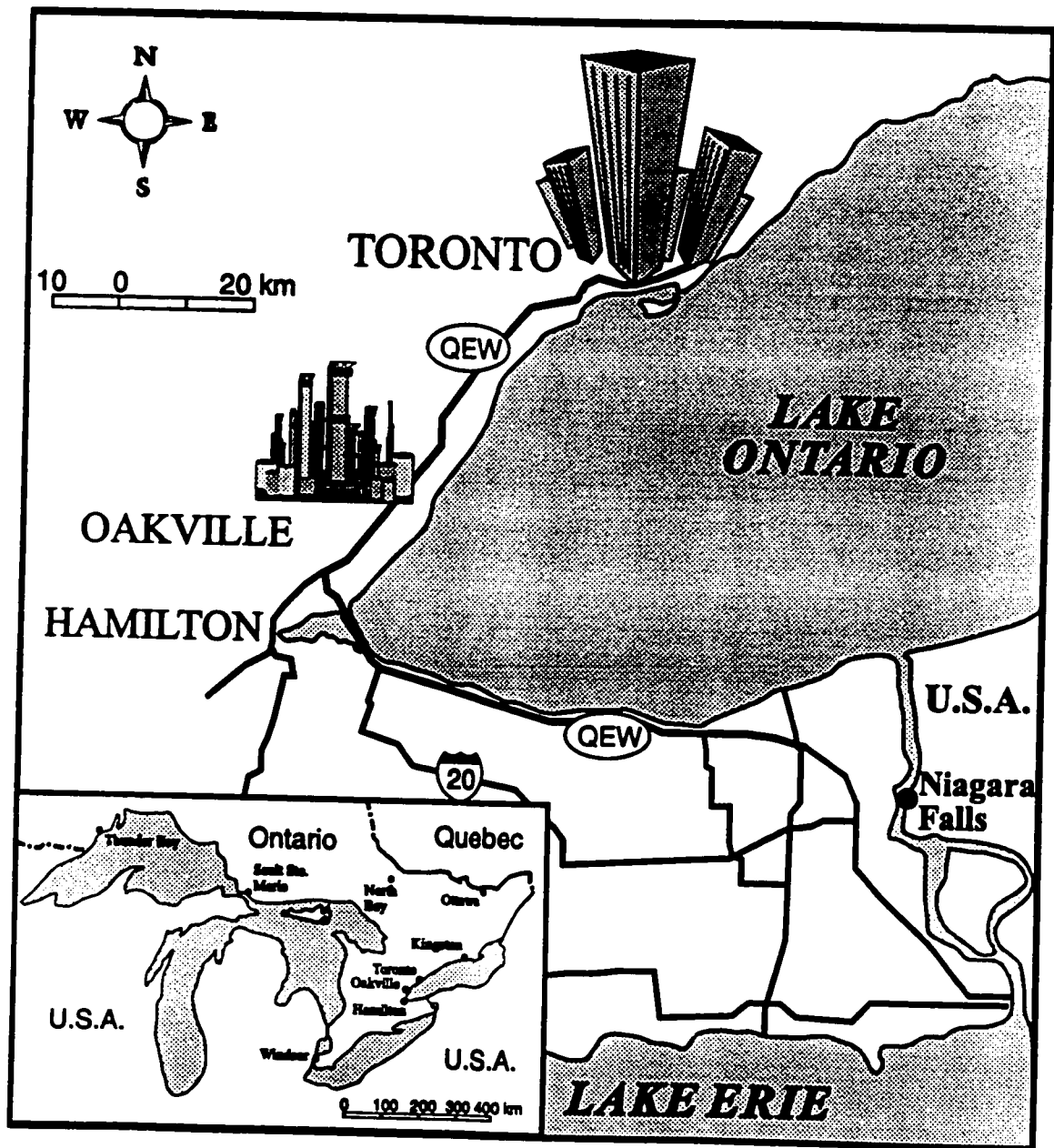


Figure 2.1 Study Area

Oakville has tried to preserve its heritage, especially in the downtown area which has many 19th century buildings. It is an attractive town and residents enjoy access to Sixteen Mile Creek, numerous parks, two harbours, cultural and historical amenities. The community has eight public swimming pools, four arenas, four private schools and nine golf courses, including Glen Abbey Golf Course, home of the Canadian Open. The community also boasts many service organizations (e.g., Oakville Historical Society, Oakville Drama Series, Oakville University Women's Club) as well as active youth clubs (e.g., Boy Scouts, Girl Guides) and a vibrant Chamber of Commerce.

Selected census characteristics of Ontario and Town of Oakville are displayed in Table 2.1. The population of Oakville in 1996 was 128,405 a 12% increase from 1991, which compares with 6.6% for Ontario as a whole. Many residents move to the community to get away from what they perceive are some of the problems of living in big cities. As such, both Oakville and the Halton Region have experienced rapid population growth over the last twenty years, and the trend is expected to continue (Oakville Economic Development Alliance (OEDA), 1999). Compared to the provincial characteristics, Oakville has a younger population. The majority of the Town's population (67.0%) are in the fifteen to sixty-five age range, with 20.6% of the population being 14 years and under. The Town's population is expected to reach 155,843 by the year 2006 (OEDA), 1999).

Table 2.1: Selected 1996 Census Characteristics of Ontario and City of Oakville

| Characteristic | Ontario | Oakville |
|--|----------|----------|
| Total Population Size 1996 | 10753573 | 128405 |
| Total Population Size 1991 | 10084885 | 114670 |
| Population Percentage Change 1991-1996 | 6.6 | 12 |
| Total Population 15 years or more | 8539350 | 99775 |
| Females % | 51.1 | 50.8 |
| Marital Status | | |
| Married % | 54.3 | 61.7 |
| Widowed/Separated/Divorced % | 16.2 | 12.5 |
| Never Married % | 29.5 | 25.8 |
| Children | | |
| Families with one or more children at home % | 55 | 74 |
| Average number of children at home | 1.2 | 1.3 |
| Age | | |
| 14 years and under % | 20.6 | 22.3 |
| 65 years and over % | 12.4 | 10.1 |
| Education | | |
| Some Completed High School % | 47.6 | 34.8 |
| Some/Completed Diploma/College % | 28 | 28 |
| Some Completed University % | 24.3 | 37.2 |
| Income | | |
| Average Family Income \$ | 59830 | 89224 |
| Incidence of Low Income % | 14.8 | 7.9 |
| Unemployment Rate % | 9.1 | 5.6 |
| Dwelling | | |
| Owned dwellings % | 64.3 | 76.8 |
| Average Value of Dwellings \$ | 177410 | 225740 |
| Mobility Status | | |
| Mobility 1 year ago % | 14.7 | 12.6 |
| Mobility 5 years ago % | 43.1 | 42.8 |

Source: Statistics Canada 1996 Census Profiles

Oakville has higher average family incomes and lower incidence of low income families. The average family income in Oakville in 1996 was \$89,224, with Oakville ranking third in the nation behind Markham and west Vancouver (see DiManno, 1995). Sixty-five percent of Oakville's population lives in single-detached dwellings, and in 1996, the average number of people living in each household was 3.2. Seventy nine percent of families in the community are 'traditional' households, or husband-wife families. Oakville has a higher percentage of prosperous owner-occupiers. While some estate properties overlooking Lake Ontario are valued as high as \$3.2 million (see DiManno, 1995), the average value of a dwelling in Oakville is \$225,740 compared to \$177,410 for the province of Ontario.

The Town has a strong diversified economic base, with more than 4000 employers and a labour force of more than 70,000. Sixty-five percent of Oakville's population is educated beyond post-secondary level, with 37% having university education. With a very educated population, it is not surprising that 39% of the labour force work in managerial, financial and administrative occupations. The Ford Motor Company of Canada, which is Oakville's largest employer with 4,750 workers, has expanded steadily in the past 43 years (see DiManno, 1995). With its heritage and historical assets, Oakville attracts one million visitors annually, with tourism estimated as a \$50 million industry (OEDA, 1999).

Boasting an excellent quality of life and family environment, Oakville is seen as a great place to live, work and enjoy leisure time. The unique, well educated and growing community has always been a desirable residential location and an outstanding centre for business and commerce (OEDA, 1999). Communities, such as Oakville, typically have well-

developed social and community support networks and therefore an enhanced capacity to cope with environmental stressors (see Elliott, 1992). However, other aspects of these communities such as a younger population with young children, a high proportion of prosperous owner-occupiers, imply greater susceptibility, and a greater likelihood of expressing concerns and fears about environmental risks (e.g., Dear and Taylor, 1982; Elliott, 1992).

2.3 The Petro Canada Oakville refinery

The Oakville refinery, located in the western portion of Oakville (referred to as the “Bronte” community), was built in 1958, by Canadian-Cities Services initially as a supplier of natural gas to municipalities. The refinery was purchased in 1964 by British Petroleum - Canada (BP), and later ownership switched to Petro Canada in 1983 when the corporation purchased BP. Petro Canada was created as a crown corporation in 1975, to develop and secure energy supplies for Canadians at a time when domestic and world energy supplies were uncertain (McKeon and McKeon, 1986). The refinery complex occupies 120 hectares to the south west of Bronte Creek, in a 310 hectare site known as the Burloak Industrial District. The predominant land use surrounding the refinery is residential with some light industrial. Residential areas are found less than one kilometre from the plant stacks to the northeast and east, southeast, southwest, and south. In every area where residential land has been developed, it has been built right up to the Petro Canada property boundary. For example, there are new homes on Shannon Crescent within a few hundred feet of the plant

fuel oil truck loading racks, and homes on Viewmount are directly across from the refinery processing area (Petro-Canada Products, 1994). Manufacturing industries and commercial development are situated 1.5-2 kilometres to the west of the refinery.

The refinery produces fuels, lubricant oils, sulphur and industrial asphalt, and currently has the capacity to refine up to 13,000 cubic metres of crude oil per day. Petroleum refining process involves a variety of processes (Table 2.2). The parallel processing units unique to the Oakville complex allow two different products to be simultaneously refined, or continuous production during the servicing of one unit. At the time this research was being conducted, more than two hundred people were permanently employed at the Oakville refinery, most of whom live in Oakville or the nearby city of Burlington. The Oakville refinery is the largest Canadian refinery and marketer of petroleum products in Canada. The refinery supplies petroleum products to the Ontario market and is the hub of the Ontario industry (Community Advisory Committee to Petro-Canada (CAC-PC), 1994).

Table 2.2: General Refinery Processes and Products

| | |
|--------------------------------|--|
| Separation Process | atmospheric distillation, vacuum distillation light ends recovery (gas processing) cracking (thermal and catalytic), coking, viscosity |
| Petroleum Conversion Processes | breaking, catalytic reforming, isomerization alkylation, polymerization hydrodesulfurization, hydrotreating, chemical |
| Petroleum Treating Processes | sweatening acid gas removal, deasphalting |
| Blending | motor gasoline, light fuel oil, heavy fuel oil |

2.3.1 Refinery Emissions and other Waste Products

Petrochemical refineries, such as Petro-Canada's Oakville complex, produce a wide variety of petroleum and chemical products as well as numerous odorous and non-odorous pollutants that are discharged into the air, surface and ground water (Special Task Force on Odours, 1975; Shusterman, 1992; Stieb et al., 1992). The numerous process heaters used in refineries are the potential source of many odorous airborne products. These pollutants include: combustion products (sulphur oxides, carbon monoxide and nitrogen oxides); particulates; reduced sulphur compounds (hydrogen sulphide and mercaptans); hydrocarbons (aliphatic, alicyclic and aromatic compounds, volatile organic compounds (VOCs)); ammonia, thiophenes and diolefins (see Sider, 1994). Sulphur oxides are produced by both the combustion of fossil fuels and sulphur-containing refinery compounds such as hydrogen sulphide and various disulphides. These are known to be the main offenders in a typical refinery because of their offensive smell and low olfactory levels (Special Task Force on Odours, 1975). Sulphur dioxide (SO₂) is one of the major pollutants produced by refineries and related industries. SO₂ is a colourless gas with a characteristic acrid smell, like that of a struck match. Most people can detect its acidic taste in the air at very low concentrations (see Shusterman, 1992). Chronic exposure to SO₂ can adversely affect pulmonary function, especially in elderly people with asthma, or chronic lung or heart disease and in children (see Pengelly and Goldsmith, 1991). Increases in hospital admissions for respiratory problems have been associated with 24 hour average SO₂ concentrations of 30 parts per billion (Bates and Szito, 1983). The current Ontario air quality criterion permits a 24 hour average for SO₂

concentration of 100 parts per billion (ppb), and an hourly average criterion of 250 ppb (Ontario Ministry of the Environment (MOE), 1999). SO_2 is a precursor to sulphates, which are associated with acidification of lakes and streams, accelerated corrosion of buildings and monuments (US. EPA, 1995).

Nitrogen oxides are principally produced by fossil fuel combustion. NO_2 is a reddish-brown gas with a pungent and irritating odour. NO_2 can produce mucous membrane and respiratory irritation above 0.250 parts per million and can indirectly produce health effects through the formation of secondary pollutants such as acid aerosols and ozone.

Another pollutant produced by refineries is carbon monoxide (CO). CO is produced by fuel combustion characteristic of many phases of refinery production and catalytic cracking. CO is a colourless, odourless, tasteless and poisonous gas produced primarily by incomplete combustion of fuel. Acute exposures to above 30 ppm can cause headaches, dizziness, nausea, vomiting and aggravation of cardiovascular disease. Exposure to high levels is linked with the impairment of vision, work capacity, learning ability and performance of difficult tasks (US. EPA, 1995). Effects of exposure to low level CO are less certain, though people with heart disease mean particularly sensitive (MOE, 1999).

Hydrogen sulphide (H_2S) and other reduced sulphur compounds (e.g., Total Reduced Sulphur) are also produced at various stages of the refining cycle, from distillation to the sulphur treatment processes. These are released into the atmosphere via fugitive emissions, handling or incomplete combustion (either via the incinerator or the flare stack). H_2S is a colourless gas with a potent "rotting egg" odour which is detectable at very low

concentrations compared to other substances. The health effects of chronic low-level exposure to reduced sulphur compounds are uncertain (see Shusterman, 1992). However, even when total reduced sulphur levels are well below Ontario air quality objectives (hourly criterion of 27 ppb), odours may be detectable and cause annoyance-related health effects (Sider, 1994). Methyl mercaptans are other prominent refinery-related reduced sulphur compounds, produced via catalytic cracking or may be used as process chemicals for liquid petroleum gas production. These are characterized by a “rotting cabbage” odour and very a low threshold of detection (Amoore and Hautala, 1983). They can enter the atmosphere via leaks or fugitive emissions, handling and incomplete combustion.

Refineries also produce hydrocarbons such as the complex mixtures of aliphatic, alicyclic and aromatic compounds, from the distillation and cracking processes. Hydrocarbon emissions result from fugitive emissions, evaporation and handling. Hydrocarbons such as propane also give offensive odours, but the olfactory level of detection is generally about a thousand times higher than for sulphur compounds. According to Murdock (1991), acute health effects from hydrocarbons include eye and respiratory irritation, fatigue, headache, and visual disorders; chronic health effects include depression, and impaired memory. Volatile organic compounds (VOCs) are released from burning fuel (e.g., gasoline, oil, natural gas), solvents, other products. VOCs include chemicals such as benzene, toluene, methylene chloride and methyl chloroform. When released into the atmosphere, VOCs contribute to ozone and smog formation. Chronic exposure to VOCs have adverse effects on human health including dizziness, headaches, and nausea. Long-term

exposure to certain VOCs, such as benzene, has been classified as a carcinogen (Murdock, 1991).

Refinery air emissions include point and non-point sources. Point sources are emissions that exit stacks and flares and, thus, can be monitored and treated. Non-point sources are “fugitive emissions” which are difficult to locate and capture. Fugitive emissions are especially problematic and occur throughout refineries and arise from the thousands of valves, pumps, tanks, pressure relief valves, flanges. While individual leaks are typically small, the cumulative effect of all fugitive leaks at a refinery can be one of its largest emission sources (see US. EPA, 1995).

Wastewater treatment plants are also a significant source of air emissions. Air releases arise from numerous tanks, ponds and sewer system drains. Process water, especially ‘sour water’, and drainage systems can produce sulphur compounds such as hydrogen sulphide and mercaptans. Refineries also produce solid wastes, generated in the form of sludges from a number of treatment units, including the waste water treatment plants. Sludges are often treated through methods including incineration, in-site and off-site land farming or filling and chemical fixation.

All the wastes produced by refineries are treated. However, air emissions are more difficult to capture than waste water or solid waste. Thus, air emissions are the largest source of untreated wastes released to the environment. When operating properly, and burning cleaner fuels these emissions can be relatively low. If however, combustion is not complete, or heaters are not functioning properly emissions can be significant (see US. EPA, 1995),

with impacts on the health and well-being of surrounding communities such as Oakville. In Ontario, despite the fact that there are many potential sources of emissions and odours within oil refineries, there are no regulations specific to oil refinery emissions, and refineries have to meet the same criteria regarding air quality as all other industries.

2.4 Community Concerns of Petro Canada Refinery

In the vicinity of the refinery, there are four air borne sources of potential human exposure to refinery emissions: air borne exposure to vapours, fumes, dusts, and soot resulting from on-site burning and open air release of volatile substances through stacks. Air borne emissions on residential properties create the possibility of contact through soil, indoor dust, window cleaning and other domestic activities. The use of numerous parks in the community also leaves open the potential of recreational exposure.

In Oakville, community concerns regarding potential health effects from the refinery emissions have existed for a number of years. These concerns are broad ranging in nature, and include acute (e.g., sinus congestion, eye irritation) and chronic (e.g., pregnancy defects, cancer) physical health concerns, as well as psychosocial (e.g., anxiety, stress) ones (see also Sider, 1994). Community concerns climaxed in a hostile public meeting in December 1990 (Wilson, 1996). In response to concerns about the effects of the refinery emissions on the health of their community, residents of West Oakville reacted in ways which have been shown to be typical for people faced with what they believe to be an environmental health hazard in their community (Edelstein, 1988). They vocalized their concerns, came together

in grass root action groups and lobbied Petro Canada and their political representatives to take action.

The majority of the residents in the community do not rely on the refinery for their economic well-being. The higher than average income and education levels of residents, no doubt contributed to residents' willingness and ability to articulate their concerns and to take action (Elliott, 1992). High property values in the community, and the uniquely attractive features of the Town, including its history, proximity to Lake Ontario and its access to high quality recreational facilities, also contributed to the community's desire to protect their environment (see Eyles et al., 1993). In addition, Oakville has a long history and strong culture of citizen participation in community decision-making (see Arnold, 1999). Most importantly, residents were also well aware of the health risks of air pollution and of the possibility of other environmental problems.

In response to the prolonged and mounting pressure a number of important developments took place from 1991 through to 1995 (Table 2.3). The Regional Municipality of Halton in 1991 requested a review (feasibility study) by the McMaster Institute of Environment and Health (MIEH) of: (1) the health effects of refinery emissions; (2) issues related to risk perception, communication and management; and (3) options for a community health study in the vicinity of the refinery. Based on the results of the feasibility study (Stieb et al., 1992), the Ministry of Health's Public Health Branch and the Regional Municipality of Halton co-funded a community health study to address these issues. A cross-sectional survey was conducted to determine if there was an association between self-reported somatic

and/ or psychosocial symptoms and exposure to odorous refinery emissions in the families living near the Petro Canada Refinery. This study found refinery odours to be associated with a measurable and potentially modifiable burden of illness in the community. The Petro Canada refinery management developed and instituted a comprehensive 'Odour Abatement Action Plan' (Sider et al., 1993).

In 1994-1995, media analysis and in-depth interviews with residents and key informants were conducted to examine residents' experiences of the effects of the refinery (Wilson, 1996). This was followed by an examination of the role and evolution of the multi-stakeholder Petro Canada environmental advisory committee, now known as the Community Advisory Committee to Petro Canada (Arnold, 1999). In 1997, most of the refinery's odour reduction measures were complete. Hence a second community health study to be undertaken to assess the effectiveness of the Petro Canada's efforts to reduce emissions and odours.

Table 2.3: McMaster Studies of the Petro Canada Refinery

| Date | Research |
|-----------|---|
| 1991-1992 | Feasibility Study |
| 1992 | Community Health Study |
| 1994 | In-Depth Interview Study |
| 1995 | Media Analysis and Key Informant Interviews |
| 1996 | Environmental Advisory Committee Study |
| 1997 | Community Health Study |
| 1998 | Qualitative Study |

2.5 The refinery's odour reduction plan

Since the late 1980s, in response to community concerns, Petro Canada refinery management undertook a number of special risk management steps including the construction of 100 metre tall stacks to more widely disperse emissions such as SO₂ (Sider, 1994). The corporation also put forward an "Action Plan: To reduce Odour Emissions" (Petro Canada Products, 1990, cited in Sider, 1994). Petro Canada noted that although it was in compliance with provincial air quality guidelines, it had instituted a series of initiatives to reduce odours and the potential health effects: switching from the use of bunker fuel (i.e., fuel for the refinery's own use) to cleaner natural gas for its operations; improvements in the sulphur plant operations; improvements in operating procedures (ensuring complete combustion at the flare, developing and implementing an SO₂ Action Plan, reinforcing environmental awareness) and caustic odour control.

As of October 1997, the following measures had been completed: a new thermal oxidizer to improve the refinery flare system to minimize odour, noise and visibility impacts on the community; an upgraded Waste Water Treatment Plant (WWTP) to control odour by improving chemical screening, biological treatment and the addition of an internal floating tank in the WWTP to prevent vapour from escaping; asphalt odour abatement systems for all asphalt tanks and loading racks; a program for monitoring asphalt odour control system performance with computer control monitoring equipment; modified equipment for optimum sulphur plant incinerator performance; an updated 'Sulphur Dioxide Action Plan' for emergency sulphur plant shutdowns; modified sour water strippers; revised environmental

complaints “hotline” investigation procedures, in order to more accurately document potential causes of community complaints; and a refinery computer system connected to the MOE Bronte Road Air Monitoring Station (CAC-PC, 1997). There is also an ongoing monthly review of “combustion/Flue Gas” complaints. Petro Canada is also monitoring the effectiveness of refinery Proactive Odour Investigations (CAC-PC, 1997). This involves a 24-hour monitoring of an odour complaints hotline and a daily community patrol by refinery staff. The hotline was established to provide an accessible, recognized and efficient means of recording and facilitating responses to community complaints of odour or other pollutant episodes. The entire cost of the odour reduction measures to this point has been estimated at 50 million dollars.

2.6 Conclusion

This description of the Petro Canada refinery and the Oakville community sets the context for this longitudinal study of the community health impacts of the refinery. The community profile shows a stable community with characteristics suggesting an enhanced capacity to cope with an environmental stressor. At the same time, other aspects of the community profile, such as younger population with children, prosperous owner-occupiers, imply greater susceptibility to anxiety and psychosocial morbidity. Oakville residents enjoy an excellent quality of life. With the community located in a formerly small-town that has been undergoing rapid suburbanization, quality of life issues and concerns about environmental exposure are increasingly noted and politicized. The community profile of

Oakville and the concerns of the residents provide a backdrop against which the events which led to the implementation of the odour reduction plan can be contextualized and interpreted. The odour reduction plan, is in turn central to understanding the changing levels and types of concerns held by residents.

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CHAPTER THREE

A Longitudinal Study of the Health Impacts of a Petroleum Refinery

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Abstract

Emissions from a petroleum refinery in Oakville, Ontario have been the source of longstanding health concerns among residents in the surrounding community. Between 1992 and 1997, the refinery implemented extensive odour reduction measures through improvements in waste water treatment, in sulphur recovery and combustion. In this paper, we present the main findings of a recent longitudinal analysis using data from community health surveys conducted in 1992 and 1997, before and after implementation of the odour reduction plan. The results show a decline in the frequency of odour perception and annoyance by residents whereas the reporting of cardinal and general symptoms among adults and children was virtually unchanged. Odour perception and annoyance were strongly related to symptom reporting in both years supporting the hypothesis that the effect of refinery emissions on residents' health is odour mediated. The findings extend our understanding of the psychosocial basis of symptom reporting in the vicinity of refineries.

Keywords: health and well-being, refinery emissions, symptom reporting, odour perception, odour annoyance

3.1 Introduction

Petrochemical refineries produce a wide variety of petroleum and chemical products as well as numerous pollutants that are discharged into the air, surface and ground water (Shusterman, 1992). Many of the airborne products from refineries are odorous, with sulphur compounds being the main offenders because of their smell and low olfactory detection levels (Special Task Force on Odours, 1975). Further, possible health effects from refinery and related emissions have been a long-standing community concern, despite evidence from methodologically rigorous studies showing little support for a direct toxicological effect at low levels of exposure typical of community settings (Neutra *et al.*, 1991; Taylor *et al.*, 1997). In contrast, evidence from previous studies strongly support the role of odour-annoyance mediated mechanisms for explaining symptom reporting by residents exposed to emissions (Neutra *et al.*, 1991; Shusterman *et al.*, 1991). Most studies have relied on cross-sectional designs, although their limitations for investigating the complex underlying environmental and psychosocial processes are increasingly recognized (Elliott and Taylor, 1996; Munton, 1996). In this context, this paper presents the results of a longitudinal study of the community health effects of a petroleum refinery in Oakville, Ontario. The implementation of an odour reduction plan by the refinery provided a unique opportunity to conduct a before and after study focusing on residents' reappraisal of refinery emissions and changes in self-reported health and well-being.

Oakville (population 115, 000) is located on the north shore of Lake Ontario. The refinery, located in west Oakville and now operated by Petro Canada, was built in 1958 and

produces fuels, lubricant oils, and industrial asphalt. The refinery has the capacity to process up to 13,000 cubic metres of crude oil per day. It occupies 120 hectares to the south west of Bronte Creek (Figure 3.1). Residential areas are found within one kilometre of the plant stacks to the east, southwest, and south. Housing development close to the refinery in recent years has increased the potential effects of emissions on the health and well-being of local residents.

<insert Figure 3.1>

Concern about the health effects from the refinery by residents led to a community health study in 1992. This study was carried out for the Halton Regional Public Health Department by a multi-disciplinary research team in consultation with a Community Advisory Committee to Petro Canada (CAC-PC). The results showed that perceptions of refinery odours were associated with elevated levels of reported ill-health in the community (Sider, 1994; Taylor *et al.*, 1997). In response to mounting public pressure, Petro Canada spent an estimated \$50 million (Canadian) to implement extensive odour reduction measures designed to reduce odour through improvements in major areas of its operation, specifically in waste water treatment, sulphur recovery, thermal oxidization, and asphalt odour abatement. A complaints hotline was also established to provide an accessible and efficient means of recording and facilitating responses to community complaints of odour or other pollutant episodes. Most of the odour reduction measures were completed by the summer

of 1997. This set of intervention measures complements the opportunity to conduct a longitudinal study of residents' reappraisal of refinery impacts on their health.

The Petro Canada refinery and its effects on community health and well-being appears to involve risk perceptions specifically linked to odour perception and annoyance as a primary mediating process. Lazarus and Folkman (1984) suggest that individual response to an environmental stressor (i.e., odorous refinery emissions) is an iterative process with two stages: primary appraisal, whereby the individual evaluates the stressor as a threat, harm or challenge; and secondary appraisal, which involves the evaluation of coping resources and strategies to deal with a stressor. In the case of secondary appraisal, one of two types of coping strategies is used: (1) problem-focused coping, or actions to remove or mitigate the effects of the stressor (e.g., complaints to industry or government officials); or (2) emotion-focused coping, or regulating emotional responses to the problem (e.g., denial of the problem or adapting to the problem). Feedback occurs through the process of reappraisal, that is, ongoing reevaluation of the stressor, coping resources and strategies, in response to changes in the characteristics, conditions and context of the stressor (e.g., odour abatement) and/or to changes in the individual's coping abilities (MacGregor and Fleming, 1996).

Environmental stress and risk perception are linked in that risk perception is central to the appraisal process. While government and industry tend to rely on formal risk assessment procedures, community members' perceptions of risk are based on a broader range of factors. Decisions about risk are value laden and do not necessarily reflect the

amount of danger, actual or potential, derived from quantitative risk assessment (Baxter *et al.*, 1992). It follows that attachment to a particular way of life on the part of citizens or a part of a community within a 'town' such as Oakville may have strong effects on risk perception and construction. Consequently, perceptions of risk are formed as much on the basis of what is valued as they are on what is known about the actual risks involved. Thus, risk appraisal is determined by 'world-view' (Kahneman *et al.*, 1982), shaped by core-assumptions as well as circumstances, by 'lifescape' as well as 'lifestyle' (Edelstein, 1988), and framed by the larger socio-political context (Beck, 1992). The perceived risk of refinery emissions is heightened by their apparently associated health consequences and by the fact that public exposure is involuntary and largely beyond the individual's control (Kraus *et al.*, 1992; Schiffman *et al.*, 1995). Finally, industrial risks are often not well understood by either the public or scientific community (Slovic *et al.*, 1980; Beck, 1992; MacGregor and Fleming, 1996), and this leads to high levels of uncertainty about the meaning of exposure and its consequence for an individual's health.

3.2 Methods

3.2.1 Longitudinal Study Design

Community health surveys were conducted in 1992 and 1997 to examine changes in odour perception and annoyance and self-reported health status attributable to the odour reduction plan. The defining characteristic of this longitudinal study was the repeat of the 1992 survey instrument in 1997. It was decided to conduct a follow-up cross-sectional

survey in 1997 rather than resurvey the cohort of 1992 respondents. This was primarily to minimize bias due to cohort attrition resulting from residential mobility and to maximize comparability in the sample composition of the two studies given that the main objective was to compare community impacts of the refinery pre (1992) and post (1997) implementation of Petro Canada's odour reduction plan. The 1991 and 1996 census data showed 35.8% and 32.2% mobility of residents into the study area in the prior five years respectively. Thus, a cohort study would not have been representative of the present population, and would have seriously reduced the power of the study.

3.2.2 Determination of Exposure Zones

In the absence of direct measurements of concentrations of odorous pollutants within the community, we used zone of residence as a proxy for odour exposure. In both years, the study sample was distributed across three zones (Figure 3.2). The three zones were:

- Zone 1 Situated to the northeast, east and south of the refinery and extending up to three kilometres and from the refinery's eastern border (bounded by Speers Rd. to the north, Third Line to the east, and the Lake to the south).
- Zone 2 From 3-5 km. to the east of the refinery (Third Line to Fourth Line, between Speers Rd. and the Lake to the south).
- Zone 3 A section 3.5-5.5 km. to the southwest of the refinery (bounded by New St., the lakefront, Appleby Line and Walker's Line), and another section 5.5-7.5

km. from the refinery (bounded by New St., Walker's Line, Cumberland Ave. and Fairview St.).

The three zones were comparable according to a number of census characteristics including socioeconomic status (Table 3.1), but variable in the extent to which they were exposed to odorous pollutants from the refinery.

<insert Figure 3.2 and Table 3.1>

The factors that were considered in determining the degree of odour exposure for the zones were: distance from the refinery; history of odour complaints as documented by a complaints hotline; distance from other odour sources in the area such as a meat packaging plant and prevailing wind patterns. The prevailing wind direction in the study area as measured by the Ministry of Environment meteorological station shows that over a five year period from 1992 to 1996, the predominant wind direction was from the West to North North-West sector (Figure 3.2).

Distance from odour sources has been widely used in determining exposure zone(s) in a number of environmental health studies, using zones of low exposure as an internal control (Hertzman et al., 1987; Taylor et al., 1991; Shusterman, 1992; Elliott and Taylor, 1996). Zones 1 and 2 in west Oakville were included as areas of high and intermediate exposure based on distance from the refinery and prevailing wind patterns. Zone 3 in Burlington served as the control area in both years and is sufficiently far from the refinery not to be significantly exposed to refinery emissions.

3.2.3 Survey Instrument

The epidemiologic survey instrument (Appendix A) used for this longitudinal study was originally developed for the 1992 community health survey (Sider, 1994). The instrument was designed to determine if there was an association between self-reporting of somatic and/or psychosocial symptoms and exposure to odorous emissions from the petrochemical refinery. The survey instrument consisted of eleven main sections: general health status from the Ontario Health Survey; self-reported cardinal and general health symptoms; measures of mental health from SF-36 (Stewart et al., 1988); chronic health problems; possible confounders (e.g. smoking); children's health symptoms; attitudes toward the neighbourhood; odour perception and annoyance; awareness of odour reduction measures; socio-demographic questions; tracking information. To provide a more detailed examination of the reappraisal process, several new items were added to the survey instrument in 1997. These items (section J) asked residents to compare the impacts of the refinery before and after the implementation of the odour reduction plan.

3.2.4 Sample Selection

The target sample size in both years was 400. The study sample was divided in a ratio of 2:1:1 across zones 1, 2 and 3 respectively. This was to allow sufficient power to assess zonal gradients in odour perception/ annoyance and symptom reporting. In both years, a two stage systematic random selection process was utilized to select the survey sample. In the first stage, randomly selected municipal tax assessment rolls containing names and

addresses, were provided by the Halton Planning Department in two sets, for property owners and tenants within the geographic boundaries of the three zones. In the second stage, systematic random sampling was used to select households from the assessment rolls for the sampling frame. Although the target sample size was 400 from the three geographic zones, the actual number selected was adjusted for telephone numbers which may be incorrect, out-of-service, and for a 40% sample non-response rate.

In 1992, households which were in the sampling frame, were manually linked with telephone numbers from the Oakville/Burlington telephone directories. However, in 1997, households that were selected were linked with telephone numbers from an updated Bell Canada Website: <http://Canada411.sympatico.ca>. In both years, letters were sent to each household in the study sample, informing them of the purpose of the study, the manner of their selection, the York University Institute for Social Research's (ISR) role in doing the actual interviews, steps being taken to protect confidentiality, and the importance of their participation (see Appendix B). Households with unlisted numbers were sent letters explaining the purpose of the study, the manner of their selection, the importance of their potential contribution to the study, and requesting their current phone number and a confirmation of their address (see Appendix C). If their new address was outside the study area, the household was replaced in the sample.

The sampling frame consisting of names of heads of households, identification number, addresses, postal codes and phone numbers, was provided to ISR. This was followed up by a separate list of the people (by zone) with unlisted phone numbers who

agreed to participate in the study. The unlisted numbers were distributed by ISR staff across the sample of households with listed phone numbers. Another list of 50 households distributed across the study area was randomly selected from the remaining households for the pretesting of the survey instrument. Out of this list, 10 households were selected for the pretest. The pretest results were used to make minor revisions to a few questions.

3.2.5 Survey Administration

Both community surveys were conducted by ISR in September/October of 1992 and 1997. The surveys were administered by phone, and introduced as a general health survey of residents in the vicinity of the Petro Canada refinery. All the interviews were completed from ISR's centralized telephone facilities using Computer Assisted Telephone Interviewing (CATI) techniques.

In order to maximize the chances of getting a completed interview from each telephone number, households that refused to take part in the survey the first time the interviewer called were contacted a number of times before the end of data collection. A minimum of 12 call attempts were made to each number, of which at least eight were made during the evening and weekend hours. Overall almost two-thirds of the interviews took four or fewer call attempts to complete, while nine and eight percent of the completed interviews required ten or more calls in 1992 and 1997 respectively (Table 3.2). In 1992, respondents in zone 3 required more call attempts to complete an interview. There was no significant zonal gradient in the number of call attempts in 1997. Differences in the number of calls

answered by zone were not significant in either year.

3.2.6 Respondent Selection and Response Rates

Research has shown that those who answer the telephone are not usually a random subset of the population; they are more likely to be women, the elderly, or people not in the labour force (Salmon and Nichols, 1983). As a result, an important step in ensuring that the study samples were representative was the random selection of a respondent in each selected household. This was done by selecting the adult (18 years of age or older) household member who has the next birthday (O'Rourke and Blair, 1983). The randomly selected household member was asked a series of questions about odour perception and annoyance; cardinal, general, and other symptoms, chronic illness, mental health; exposure to tobacco smoke and indoor air contaminants; attitudes toward the community and the refinery; sources of information about the refinery; beliefs about the health effects of the refinery emissions; and socio-demographic characteristics. Information on the three groups of health symptoms was obtained for the two-month period (July-August) preceding the surveys. The symptom reporting questions were asked early in the survey without reference to the refinery and prior to questions related to perceptions of refinery emissions or odours.

Cardinal symptoms were those which were likely to be the result of irritant properties of odours and included coughs, wheezing/breathing problems, nausea, sinus congestion, colds, skin rashes, eye, nose, or throat irritations, earaches, and nosebleeds. General symptoms were those more likely to result from stress-mediated mechanisms related to

odour annoyance and included headaches, sleep problems, dizzy spells, stomachaches, diarrhea, loss of appetite, and chest pains. Other or 'dummy' symptoms were those thought not to be plausibly related to refinery odour emissions such as joint pains, back pains, bruises, and were included in the survey to detect symptom over-reporting. The adult respondent also provided information on the health of children aged 12 and under in the household. In households with more than two children in this age group, two were selected based on birth dates closest to the interview date.

The sample sizes in 1992 and 1997 were 391 and 427 respectively. The response rate overall was 70% in 1992 and 71% in 1997, with no substantial differences across the three zones in either year. Based on the 1991 Census, the sampling fractions (interviews per 100 of the population over 15 years) for the study zones in both years are shown on Table 3.3 and span a relatively narrow range.

<insert Table 3.3>

3.2.7 Sample Characteristics by Zone and Time

The characteristics of the sample groups for the 1992 and 1997 surveys are summarized in Table 3.4. For each year, the groups were compared across zones; and for each zone, the groups were compared between years. Significant differences between years (within zones) are indicated by *italicized* values in Table 3.4 and significant differences across zones are shown by **bold** values. The characteristics of the two study samples are

similar overall and by zone.

The sample included a higher proportion of women in zone 3 of 1992 compared with the same zone in 1997 (Chi-square = 4.29, $p = .04$). There were several differences in age and length of residence which in part reflect what might be expected given the five year interval between the two surveys: in 1997 (vs 1992), respondents in zone 3 were older ($t = 2.01$, $p = 0.046$); respondents in zones 1 ($t = 4.38$, $p < .001$) and 3 ($t = 3.48$, $p = 0.001$) had lived longer at their present address; and respondents in zone 3 had lived longer in the community ($t = 2.03$, $p = 0.043$).

There was a significant difference across zones in the average household income in 1997 (Chi-square = 6.95, $p = 0.031$). In both years, length of residence at the present address (1992: Chi-square = 18.13, $p < .001$; 1997: Chi-square = 6.91, $p = 0.032$) and length of stay in the community (1992: Chi-square = 1.75, $p = 0.003$; 1997: Chi-square = 7.60, $p = 0.0224$) differed significantly. In general, the average length of stay at the present residence and in the community was over 10 years in both years, indicative of a generally stable population.

<insert Table 3.4>

3.3 Results

3.3.1 *Odour Perception and Annoyance*

Fifty six percent of study respondents noticed refinery odours at least once a month over the summer of 1992, compared to 47% in the summer of 1997 (Table 3.5). In both years, there was a strong and significant zonal gradient in the frequency of odour perception in the expected direction with more frequent reporting for zone 1 and least frequent for zone 3. The change in perception (1992 vs 1997) was significant for zone 1 only (Chi square = 12.81, $p < .0016$). Very frequent reporting decreased from 42% to 26% with a corresponding increase in the percentage perceiving odours less frequently or not noticing them at all.

<insert Table 3.5>

Respondents noticing odours at least once per month were asked how often they were bothered by the odours. In 1992, 35% of the respondents reported being bothered by odours 'every time to about half the time' as compared to 29% in 1997 (Table 3.6). There was a strong and statistically significant zonal gradient in the frequency of odour annoyance in both years. However, there was no significant change over time, overall, or by zone. Ratings of the degree of annoyance ('a great deal' to 'not at all') were not significantly associated with zone in either year and showed no change between years.

<insert Table 3.6>

Respondents who noticed odours during the summer months of 1997 were asked to recall their experience with odours over the past year and past five years. Thirty percent of respondents indicated situational concerns that the odours had improved in the past year, 42% reported it had stayed the same, 5% felt it had worsened, and the remainder (23%) didn't know (Table 3.7). There was a strong gradient across the three zones with those in the closest zones, especially in zone 1, more frequently reporting improvement in odours. A similar pattern emerged in the responses to perceived changes in odours over the previous five years, but the zonal gradient was not significant.

<insert Table 3.7>

3.3.2 Health Symptoms in Adults

There was no significant difference between 1992 and 1997 in the mean number of cardinal, general, or other symptoms reported by adults. Similarly, there was no difference in either year in the mean number of symptoms reported across zones. Moreover, the individual symptom prevalence rates were generally similar in 1992 and 1997 (Table 3.8).

<insert Table 3.8>

The odds of symptom reporting by zone (zones 1 vs 3) were compared between years (Table 3.9). If proximity to the refinery was associated with elevated symptom

reporting, the results would show odds ratios consistently in excess of 1.0 and lower bounds of the 95 percent confidence interval above 1.0. There are very few cases in which this applies in either year; so few, in fact, that they could be attributed to chance variations in the data given the multiple tests involved with the large number of symptoms included in the analysis. Moreover, there is no consistent pattern in the odds ratios between years and therefore no evidence of lower odds in 1997 to support the hypothesis of an association between changes in exposure to refinery emissions (related to odour reduction) and symptom reporting.

<insert Table 3.9>

An odour perception variable was constructed by dichotomizing the range of perception of refinery odours to every day - once/week ("frequent") vs less than once/week - never noticed odours ("not frequently perceiving odours"). The odds of symptom reporting by odour perception (frequently vs not frequently perceiving odours) show that in both years most of the *cardinal* symptoms were two or three times more prevalent in those who noticed odours frequently (Table 3.10). In 1992, six of the 11 cardinal symptoms had a significant odds ratio greater than 2.0 compared with eight of 11 in 1997. Similar results apply to the *general* symptoms. All but one had significant odds ratios greater than 1.5. The odds ratios for all general symptoms (except for diarrhea) increased in 1997. While two of the four *other* symptoms had significant odds ratios in 1992, none were significant in 1997. The odds of symptom reporting by odour annoyance (frequent vs not frequently annoyed)

showed a similar pattern to those for odour perception. Taken together, the results show that symptom reporting was strongly mediated by odour perception and annoyance in both years.

<insert Table 3.10>

Respondents were asked if they thought their symptoms were brought on or worsened by exposure to odours from the refinery. Four of the eleven cardinal symptoms reported in 1992 (nausea, sinus congestion, eye irritation and nose congestion), and for three of the same four in 1997 (excluding nausea), the odds ratios (zones 1 vs 3) were significant, indicating that respondents in zone 1 were more likely to attribute their symptoms to odours from the refinery than those in zone 3. Among the general symptoms, the odds ratios were significant for two symptoms in 1992 (headaches and sleep problems) but for only one in 1997 (headaches). The differences between years are not very meaningful because low prevalence rates meant that odds ratios could not be calculated for several symptoms.

Symptom attribution to refinery odours was also examined in relation to odour perception. In 1992, odds ratios (frequent vs infrequent odour perception) were significant for eight of the 11 cardinal symptoms. In 1997, this had dropped to five symptoms. The odds of attributing symptoms to odours were generally lower in 1997. Five of 7 general symptoms had significant odds ratios in 1992; this dropped to three symptoms in 1997. Except for joint pains in 1997, none of the 'other' symptoms were more likely to be attributed to refinery odours by those frequently perceiving odours.

3.3.3 Health Symptoms in Children

In the households with at least one child under twelve years of age (1992: n=100; 1997: n=110), an adult respondent acted as a proxy for providing health information. The analysis showed evidence of health effects in children related to refinery odours. The odds of proxy respondents reporting at least two cardinal symptoms by zone (zone 1 vs 3) increased significantly from 1.4 in 1992 to 2.9 in 1997. None of the individual cardinal symptoms were associated with proximity to the refinery in either year. While combined child general symptom reporting by zone was significant in 1992, this was not the case in 1997. In both years, none of the other symptoms had significant elevated odds.

Adults who frequently noticed odours were substantially more likely to report that their child(ren) experienced cardinal symptoms. The odds of proxy respondents who frequently perceived odours, reporting at least two cardinal symptoms in their children, increased from 3.1 in 1992 to 5.1 in 1997. In 1992, three of the individual symptoms (cough, wheezing, eye irritation) were significantly associated with frequent odour perception, and this increased to five in 1997 (cough, nausea, nose congestion, throat irritation and nosebleeds). Odds ratios for general and 'other' symptoms in children were not significantly related to the adult's perception of odours.

In 1997, but not in 1992, proxy respondents who were frequently bothered by odours were more likely to report at least two or three cardinal symptoms in their children. The odds of reporting two or more child cardinal symptoms by proxy respondents who were frequently bothered by odours increased from 2.0 in 1992 to 6.5 in 1997. Among the

individual symptoms, only nose congestion and throat irritation were significantly associated with odour annoyance in both years. However, in 1997, the odds ratios of three other symptoms (cough, nausea, nosebleeds) were also significant. None of the general or 'other' symptoms were significantly associated with frequent odour annoyance in either year.

3.3.4 Perceptions of the Community and the Refinery

The study investigated the effects of the refinery and other environmental factors on residents' satisfaction with their community. In both years, more than 90% of the respondents indicated they were generally satisfied living in their community. However, in both years, those respondents living in zone 1 (compared to zone 3) who noticed odours frequently, or who were frequently bothered by odours, were more likely to express dissatisfaction with their community. They also stated that the refinery affected satisfaction with the community, and considered moving away from the area due to the refinery. They were less likely to believe that there were benefits associated with the presence of the refinery in the community.

In 1992 and 1997, more than 80% of the respondents expressed the belief that the Oakville refinery causes health problems in the community. The zonal effect was not significant in either year and there was no significant difference between years. Respondents were also asked about other concerns about the refinery apart from odour emissions. They were concerned about issues such as noise, groundwater contamination, black soot deposition on their properties, and worst-case scenarios (e.g., fire and explosion).

Overall, 30% of the study participants in 1997 were at least somewhat informed about the odour reduction measures implemented by the Petro Canada refinery. Only 23% were aware of the complaints hotline. There was a strong gradient of awareness across the three zones (Chi-square = 34.1, $p < .00001$). Respondents living in Zone 1 (compared to Zone 3), or noticing odours frequently, or frequently bothered by odours, were more likely to be informed about the odour reduction measures and to have ever called the complaints hotline. Respondents who reported three or more cardinal symptoms were also more likely to have called the hotline.

3.4 Discussion and Conclusions

There is evidence that odour perception, odour annoyance, and other concerns in the vicinity of the refinery have decreased since the odour reduction measures were implemented in 1992. In both years, zone of residence was consistently associated with odour perception and odour annoyance. A decrease in the proportion of residents who perceived odours or were annoyed by them in 1997, was most evident for zone 1 residents (those closest to the refinery and downwind). Residents in zone 1 were more likely to report improvement in odours since the odour reduction measures were implemented six years ago. Consistent with this reduction in odour perception and annoyance, psychosocial concerns of residents such as dissatisfaction with their community, desire to move because of the refinery, and belief that refinery odours affected health, generally decreased from 1992 to 1997, but none of these changes were statistically significant.

The prevalence rates for cardinal and general symptoms in both years were similar. While the pattern of increased odds for a number of cardinal and general symptoms for residents living in zone 1 was suggestive of an association between zone and symptom reporting, these associations were statistically weak. Consequently, zone of residence, used as a proxy for exposure to odours from the Petro Canada refinery, was not strongly associated with general measures of health status of residents living in the vicinity of the refinery. However, both odour perception and odour annoyance were consistently associated with symptom reporting in both adults and children. Residents who frequently noticed or were frequently bothered by odours, were more likely to report two or three cardinal and/or general symptoms. There was a slight decrease in the strength of association between symptom reporting, and odour perception and annoyance in 1997. Symptom attribution to odours (i.e., symptoms brought on or worsened by odours) was also weakly associated to zone of residence, but strongly associated with frequent odour perception and annoyance.

The similarity in symptom prevalence rates and the consistent association of symptom reporting with odour perception and annoyance in both years, indicate persistence in the community of health impacts of refinery emissions despite the odour reduction measures introduced by the industry. Furthermore, data compiled by the Community Advisory Committee show that the number of odour incidents and associated complaints have substantially declined with the implementation of those measures (CAC-PC, 1997).

Perceptual and behavioural sensitization of residents is suggested as one explanation for the persistence of odour-mediated health concerns from 1992 to 1997. This phenomenon

is an involuntary condition after an initial traumatic exposure whereby residents react to low-level exposures with a variety of symptoms, including headaches, anxiety and nausea (Neutra *et al.*, 1991; Shusterman, 1992). Related to this is MacGregor and Fleming's (1996) notion of mental models, whereby residents' responses may be based on their intuitive models of the meaning of refinery emissions rather than exposure to emissions *per se*. High levels of uncertainty about health consequences may result in residents unconsciously amplifying symptoms and associating them with their experience of odours from the refinery (Dalton, 1996; MacGregor and Fleming, 1996). According to Neutra *et al* (1991), in many cases the only remedy for behavioural sensitization is either to abate the exposure to sub-odourant levels or to remove the people from the exposure. The first has yet to be fully achieved through the odour reduction measures and the second only occurs in the relatively few cases where residents choose to move. The net result is that the persistence of odour-mediated health concerns is to be expected, especially in sensitized situations like that in west Oakville, where refinery odours in the past have resulted in widespread and highly vocal community reaction. The persistence of concern is further reinforced in this case given the association between odour perception and the reporting of health symptoms in children. Perceived threats to children's health strike at core values and elicit strong and sustained reactions at the individual and community level (see Baxter and Eyles, forthcoming), which the odour reduction measures may be insufficient to counter.

Trust and accountability can also affect residents' reappraisal of the refinery emissions. Any level of distrust residents may hold for industry and government can

translate into a high level of uncertainty and a deep skepticism about the odour abatement measures that have been implemented (Slovic *et al.*, 1980; Beck, 1992). With sufficient distrust, no level of emissions (however low) from the refinery will be tolerated and no demonstration of safety measures will be believed by some residents (e.g., vulnerable groups such as residents with children). In a separate study, Wilson (1996) has shown that distrust of the refinery remains high among some residents living in the vicinity of the refinery.

Following the odour reduction measures, Petro Canada refinery is expected to reach a stage of high automation, thus, maintaining refinery emissions at a very low level. Nevertheless, other factors can still influence the community's reaction to refinery emissions. The improvements, as indicated by the reductions in odour perception and odour annoyance, do not alter the fact that it is almost impossible to construct a totally odourless situation in a multipurpose refinery with a production capacity of up to 13,000 cubic metres of petroleum products a day. Intermittent exposure to emissions can occur during maintenance, operation, and unscheduled events such as a leak or spillage (CAC-PC, 1997). Meanwhile, residents consider the odours from the refinery as something they do not have to endure, thus, any smell from the refinery can generate concerns resulting in elevated symptom reporting. In addition, visual cues such as refinery stacks may trigger somatic changes (MacGregor and Fleming, 1996).

The underpinnings of these responses are linked to the "apparent pursuit of a zero-risk society" (Slovic, 1987, p. 280) in North America and the belief that advances in knowledge about the consequences of risk or technological solutions will make it possible

to avoid encounters with risk in daily life. The belief that a risk-free society is achievable generates unrealistic expectations of communities where the presence of any risk (perceived or actual) is unacceptable. Consequently, residents may be shifting expectations in response to real or perceived odour improvements with the 'gold standard' being total elimination of odour emissions. However, as Cutter (1993, p.33) points out "there is no such thing as risk-free environment despite American preoccupation with a zero-risk society." Nevertheless, it is not surprising that residents would strive to eliminate, through all means at their disposal, perceived risks in their community, especially in this case given the evidence of progress towards this end in the form of the refinery's odour reduction measures.

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Table 3. 1. Characteristics of the Study Population*

| Characteristic | Zone 1 | | Zone 2 | | Zone 3 | |
|-----------------------------------|--------|-------|--------|------|--------|------|
| | 1991 | 1996 | 1991 | 1996 | 1991 | 1996 |
| Total Population Size | 17549 | 17226 | 8764 | 8527 | 8334 | 8068 |
| Total Population 15 years or more | 14350 | 14295 | 7230 | 6980 | 6880 | 6675 |
| Females % | 50.9 | 51.6 | 50.3 | 50.4 | 50.1 | 50.6 |
| Marital Status | | | | | | |
| Married/Partner % | 62.9 | 59.5 | 64.8 | 63.7 | 65.3 | 65.3 |
| Widowed/Separated/Divorced % | 13.8 | 16.5 | 11.2 | 13.5 | 8.3 | 10.6 |
| Never Married % | 24.4 | 24 | 25.2 | 22.8 | 26.4 | 24.1 |
| Age | | | | | | |
| Less than 20 years % | 24 | 22.9 | 22.5 | 23.3 | 26.8 | 24 |
| 20 - 39 years % | 29.4 | 26.4 | 28.5 | 26.6 | 25 | 23.7 |
| 40 - 59 years % | 27.2 | 27.8 | 27.9 | 25.3 | 32.9 | 32.5 |
| 60 - 74 years % | 14.2 | 16.3 | 17.1 | 19.2 | 13.1 | 16.5 |
| 75 + years % | 5.2 | 6.6 | 4 | 5.6 | 2.5 | 3.3 |
| Education | | | | | | |
| Some/Completed High School % | 41.9 | 38.1 | 45.2 | 38.3 | 39.7 | 32.8 |
| Some/Completed College % | 28.5 | 29.5 | 28.1 | 30.8 | 25.6 | 27.9 |
| Some/Completed University % | 29.6 | 32.4 | 26.6 | 30.9 | 34.7 | 39.3 |
| Employment | | | | | | |
| In Labour Force % | 72.6 | 68.3 | 69.3 | 65.6 | 71.7 | 70.8 |
| Employed % | 94.1 | 95.3 | 93.3 | 92.8 | 94.6 | 95.6 |
| Unemployed % | 5.9 | 4.7 | 6.6 | 7.2 | 5.6 | 4.4 |
| Income Category % | | | | | | |
| Less than \$20,000 | 40 | 41.3 | 43.3 | 44.6 | 43 | 40 |
| \$20,000 - \$29,999 | 15.2 | 14.5 | 17.1 | 15 | 12 | 13.7 |
| \$30,000 - \$39,999 | 14.2 | 12.2 | 13.8 | 14 | 10.7 | 11.8 |
| \$40,000 - \$49,999 | 9.4 | 9 | 10 | 7.8 | 10.1 | 8.3 |
| \$50,000 and over | 21.2 | 23 | 15.7 | 18.6 | 23.3 | 26.2 |

* Source: Statistics Canada 1991 and 1996 Census Profiles

Table 3.2. Number of Call Attempts

| Call Attempts | Zone 1 | | Zone 2 | | Zone 3 | | Total | |
|---------------|--------------|--------------|-------------|-------------|-------------|-------------|--------------|--------------|
| | 1992 | 1997 | 1992 | 1997 | 1992 | 1997 | 1992 | 1997 |
| 1-4 | 132 (67%) | 141 (67%) | 67 (70%) | 73 (72%) | 53 (54%) | 80 (69%) | 252 (65%) | 294 (69%) |
| 5-9 | 49 (25%) | 48 (23%) | 17 (18%) | 23 (22%) | 37 (38%) | 26 (22%) | 103 (26%) | 97 (23%) |
| 10+ | 17 (8%) | 20 (10%) | 11 (12%) | 6 (6%) | 8 (8%) | 10 (9%) | 36 (9%) | 36 (8%) |
| Total | 198 | 209 | 95 | 102 | 98 | 116 | 391 | 427 |

1992 Chi-square = 10.72 p <.03
1997 Chi-square = 1.29 p <.86

Table J.3. Sampling Rates of Community Surveys Based on the 1991 Census

| Zone | Total Population 1991 Census | Total Population > 15 years of age | Target sample size | | Completed Interviews | | Completed Interviews/100 of Population > 15 yrs old | |
|--------------|------------------------------------|--|--------------------|------------|-------------------------|------------|--|-------------|
| | | | 1992 | 1997 | 1992 | 1997 | 1992 | 1997 |
| 1 | 16320 | 14345 | 200 | 200 | 198 | 209 | 1.46 | 1.46 |
| 2 | 8230 | 7225 | 100 | 100 | 95 | 102 | 1.23 | 1.41 |
| 3 | 7945 | 6888 | 100 | 100 | 98 | 116 | 1.39 | 1.68 |
| Total | 32495 | 28458 | 400 | 400 | 391 | 427 | 1.38 | 1.31 |

Table 3.4. Characteristics of Study Samples by Zone by Time

| Characteristic | Zone 1 | | Zone 2 | | Zone 3 | |
|--|-------------|-------------|-------------|-------------|-------------|-------------|
| | 1992 | 1997 | 1992 | 1997 | 1992 | 1997 |
| Sample Size | 198 | 209 | 95 | 102 | 98 | 116 |
| Respondents/100 of Population > 15 years | 1.46 | 1.46 | 1.23 | 1.41 | 1.39 | 1.68 |
| Females % | 58.6 | 52.6 | 56.8 | 56.9 | <i>63.3</i> | <i>49.1</i> |
| Marital Status | | | | | | |
| Married/Partner % | 72.6 | 79.7 | 75.8 | 74.3 | 71.1 | 76.7 |
| Widowed/Separated % | 16.8 | 14 | 15.8 | 12.9 | 15.5 | 11.2 |
| Never Married % | 10.7 | 6.3 | 8.4 | 12.9 | 13.4 | 12.1 |
| Age | | | | | | |
| Mean Age | 48.2 | 48.6 | 49.7 | 51.5 | <i>46.3</i> | <i>50.5</i> |
| 18 - 40 years % | 35.9 | 30.9 | 34.7 | 34.3 | 35.1 | 25.4 |
| 41 - 50 years % | 19.5 | 30.4 | 15.8 | 13.1 | 30.9 | 22.8 |
| 51 - 60 years % | 20 | 14.5 | 16.8 | 14.1 | 16.5 | 21.1 |
| > 60 years % | 24.6 | 24.2 | 32.6 | 38.4 | 17.5 | 30.7 |
| Education | | | | | | |
| Some Completed High School % | 47.2 | 41.5 | 48.4 | 44 | 37.8 | 30.7 |
| Some Completed College % | 22.2 | 23.2 | 24.2 | 24 | 28.6 | 29.8 |
| Some Completed Bachelors % | 22.8 | 26.1 | 20 | 23 | 26.5 | 33.3 |
| Postgrad/Professional % | 7.6 | 9.2 | 7.4 | 9 | 7.1 | 6.1 |
| Mean Household Income (Thousands) | 73.2 | 77.7 | 68.9 | 63.2 | 73.9 | 84 |
| Length in Present Address | | | | | | |
| Mean number of years | <i>10.3</i> | <i>14.9</i> | <i>16.2</i> | <i>18.4</i> | <i>12.5</i> | <i>17.8</i> |
| 0 - 4 years % | 27.8 | 21.1 | 20 | 16.7 | 26.5 | 14.7 |
| 5 - 9 years % | 35.3 | 15.3 | 20 | 17.6 | 25.5 | 14.7 |
| >= 10 years % | 36.9 | 63.6 | 60 | 65.7 | 48 | 70.7 |
| Length in Community | | | | | | |
| Mean Number of Years | 16.9 | 18 | 20.6 | 21.6 | <i>17.8</i> | <i>21.5</i> |
| 0 - 4 years % | 16.2 | 15.3 | 11.6 | 9.8 | 12.2 | 9.6 |
| 5 - 9 years % | 20.7 | 13.9 | 12.6 | 16.7 | 17.3 | 11.3 |
| 10 - 19 years % | 27.8 | 29.2 | 21.1 | 25.5 | 25.5 | 26.1 |
| >= 20 years % | 35.4 | 41.6 | 54.7 | 48 | 44.9 | 53 |

* Cell values in italics show significant effects by time (within zone).

** Cell values in bold show significant differences across zones.

Table 3.5. Frequency of odour perception, by zone of residence

| Frequency | Zone 1 | | Zone 2 | | Zone 3 | | Total | |
|-----------------------------------|-------------|-------------|-------------|-------------|-------------|-------------|--------------|--------------|
| | 1992 | 1997 | 1992 | 1997 | 1992 | 1997 | 1992 | 1997 |
| Every day - once/week | 82 (42%) | 53 (26%) | 13 (14%) | 12 (12%) | 5 (5%) | 2 (2%) | 100 (26%) | 67 (16%) |
| Several/month- once/month | 69 (35%) | 83 (40%) | 29 (31%) | 24 (24%) | 17 (19%) | 20 (18%) | 115 (30%) | 127 (31%) |
| Never notice | 44 (23%) | 69 (34%) | 52 (55%) | 64 (64%) | 70 (76%) | 90 (80%) | 166 (44%) | 223 (53%) |
| Total | 195 | 205 | 94 | 100 | 92 | 112 | 381 | 417 |
| 1992 Chi-square = 90.25 p< .00001 | | | | | | | | |
| 1997 Chi-square = 73.71 p< .00001 | | | | | | | | |

Table 3.6. Frequency of odour bother, by zone of residence

| Frequency of Odour Bother | Zone 1 | | Zone 2 | | Zone 3 | | Total | |
|-----------------------------------|-------------|-------------|-------------|-------------|-------------|-------------|--------------|--------------|
| | 1992 | 1997 | 1992 | 1997 | 1992 | 1997 | 1992 | 1997 |
| Every time-half the time | 99 (51%) | 95 (47%) | 26 (27%) | 17 (17%) | 10 (10%) | 9 (8%) | 135 (35%) | 121 (29%) |
| Less than half the time | 18 (9%) | 14 (7%) | 6 (6%) | 8 (8%) | 4 (4%) | 4 (4%) | 28 (7%) | 26 (7%) |
| Never bothered | 78 (40%) | 95 (47%) | 63 (66%) | 74 (75%) | 84 (86%) | 99 (88%) | 225 (58%) | 268 (65%) |
| Total | 195 | 204 | 95 | 99 | 98 | 112 | 388 | 415 |
| 1992 Chi-square = 60.39 p <.00001 | | | | | | | | |
| 1997 Chi-square = 66.82 p <.00001 | | | | | | | | |

Table 3.7. Perceived change in odours in the last 12 months and five years

| Improvement | Zone 1 | | Zone 2 | | Zone 3 | | Total | |
|-------------------------------------|-------------|--------------|-------------|-------------|-------------|-------------|--------------|--------------|
| | 1 year | 5 years | 1 year | 5 years | 1 year | 5 years | 1 year | 5 years |
| Improved | 84 (40%) | 108 (52%) | 28 (28%) | 49 (49%) | 17 (15%) | 42 (36%) | 129 (30%) | 199 (47%) |
| Stayed the same | 91 (44%) | 46 (22%) | 45 (45%) | 23 (23%) | 42 (36%) | 29 (25%) | 178 (42%) | 98 (23%) |
| Worsened | 15 (7%) | 12 (6%) | 3 (3%) | 4 (4%) | 4 (3%) | 6 (5%) | 22 (5%) | 22 (5%) |
| Don't Know | 19 (9%) | 43 (21%) | 25 (25%) | 25 (25%) | 53 (46%) | 39 (34%) | 97 (23%) | 107 (25%) |
| Total | 209 | 209 | 101 | 101 | 116 | 116 | 426 | 426 |
| 1 year Chi-square = 64.91 p <.00001 | | | | | | | | |
| 5 years Chi-square = 9.69 p = .14 | | | | | | | | |

Table 3.8. Comparison of adult symptom prevalence in 1992 and 1997

| Symptom | <i>Cardinal symptoms</i> | | | |
|-------------------|--------------------------|---------|------------|---------|
| | 1992 | | 1997 | |
| | Prevalence | Percent | Prevalence | Percent |
| 2+ vs. 0-1 | 227/391 | 58 | 215/414 | 52 |
| 3+ vs. 0-2 | 158/391 | 40 | 141/414 | 34 |
| Cough | 84/390 | 22 | 88/426 | 21 |
| Wheeze | 58/390 | 15 | 67/425 | 16 |
| Nausea | 45/390 | 12 | 32/427 | 8 |
| Sinus congestion | 143/387 | 37 | 155/424 | 37 |
| Eye irritation | 110/389 | 28 | 125/424 | 30 |
| Colds | 113/389 | 29 | 70/426 | 16 |
| Nose congestion | 148/389 | 38 | 167/425 | 39 |
| Throat irritation | 86/389 | 22 | 75/426 | 18 |
| Earaches | 39/390 | 10 | 36/427 | 8 |
| Skin rashes | 39/389 | 10 | 47/426 | 11 |
| Nosebleeds | 34/390 | 9 | 15/427 | 4 |
| | <i>General symptoms</i> | | | |
| 1+ vs. 0 | 225/391 | 58 | 248/420 | 59 |
| 2+ vs. 0-1 | 134/391 | 34 | 131/420 | 31 |
| Headaches | 130/389 | 33 | 126/425 | 30 |
| Sleep problems | 126/390 | 32 | 143/424 | 34 |
| Dizzy spells | 44/389 | 11 | 43/427 | 10 |
| Appetite loss | 35/355 | 9 | 23/427 | 5 |
| Stomach pains | 55/390 | 14 | 69/426 | 16 |
| Diarrhea | 69/389 | 18 | 87/427 | 20 |
| Chest pains | 36/390 | 9 | 43/426 | 10 |
| | <i>Other symptoms</i> | | | |
| Joint pains | 140/389 | 36 | 147/427 | 34 |
| Back pains | 150/390 | 39 | 169/426 | 40 |
| Bruising | 83/387 | 21 | 54/425 | 13 |
| Dysuria | 19/389 | 5 | 20/427 | 5 |

Table 3.9. Adult symptom reporting by zone - zone 1 : zone 3

| <i>Cardinal symptoms - Zone 1 : Zone 3</i> | | | | | | | |
|--|----------------|--------------|------------|-------------|-------------|-------------|-------------------|
| Symptom | Prevalence (%) | | Odds Ratio | | 95% CI | | |
| | 1992 | 1997 | 1992 | 1997 | 1992 | 1997 | |
| 2+ vs. 0-1 | 173/296 (58) | 163/313 (52) | 1.08 | 0.94 | .66 | 1.77 | .59 1.49 |
| 3+ vs. 0-2 | 126/296 (43) | 108/313 (35) | 1.35 | 1.15 | .82 | 2.21 | .71 1.88 |
| Cough | 58/295 (20) | 65/324 (20) | 1.55 | 1.19 | .81 | 2.95 | .67 2.13 |
| Wheeze | 44/295 (15) | 50/323 (16) | 1.59 | 2.54 | .77 | 3.30 | 1.22 5.29* |
| Nausea | 36/295 (12) | 26/325 (8) | 1.57 | 0.74 | .71 | 3.48 | .33 1.66 |
| Sinus congestion | 113/293 (39) | 121/322 (38) | 0.76 | 1.28 | .47 | 1.25 | .79 2.06 |
| Eye irritation | 88/294 (30) | 96/322 (30) | 1.75 | 1.14 | 1.00 | 3.07 | .69 1.88 |
| Colds | 86/294 (29) | 52/324 (16) | 0.91 | 1.05 | .53 | 1.54 | .56 1.95 |
| Nose congestion | 114/294 (39) | 125/323 (39) | 0.88 | 0.97 | .54 | 1.44 | .61 1.55 |
| Throat irritation | 67/295 (23) | 56/325 (17) | 1.47 | 1 | .80 | 2.69 | .55 1.82 |
| Earaches | 33/295 (11) | 21/325 (7) | 0.99 | 0.9 | .46 | 2.14 | .36 2.23 |
| Skin rashes | 30/295 (10) | 36/324 (11) | 1.72 | 1.3 | .71 | 4.16 | .62 2.76 |
| Nosebleeds | 30/295 (10) | 11/325 (3) | 0.99 | 2.57 | .45 | 2.22 | .54 12.08 |
| <i>General symptoms - Zone 1 : Zone 3</i> | | | | | | | |
| 1+ vs. 0 | 171/296 (58) | 191/318 (60) | 0.98 | 1.11 | .60 | 1.59 | .70 1.78 |
| 2+ vs. 0-1 | 103/296 (35) | 99/318 (31) | 1.01 | 1.4 | .61 | 1.67 | .84 2.33 |
| Headaches | 100/294 (34) | 100/323 (31) | 1.07 | 1.93 | .64 | 1.79 | 1.14 3.24 |
| Sleep problems | 97/295 (33) | 110/322 (34) | 1.09 | 0.77 | .65 | 1.83 | .48 1.24 |
| Dizzy spells | 34/294 (12) | 31/325 (10) | 2.04 | 1.18 | .86 | 4.87 | .54 1.61 |
| Appetite loss | 22/295 (7) | 19/325 (6) | 1.36 | 1.59 | .51 | 3.58 | .56 4.54 |
| Stomach pains | 42/295 (14) | 54/324 (17) | 1.99 | 0.94 | .91 | 4.34 | .51 1.72 |
| Diarrhea | 55/294 (19) | 65/325 (20) | 1.15 | 1.11 | .61 | 2.15 | .62 1.96 |
| Chest pains | 30/295 (10) | 35/324 (11) | 1.41 | 1.08 | .61 | 3.30 | .52 2.25 |
| <i>Other symptoms - Zone 1 : Zone 3</i> | | | | | | | |
| Joint pains | 101/294 (34) | 105/325 (32) | 0.8 | 1.5 | .48 | 1.33 | .91 2.48 |
| Back pains | 115/295 (40) | 130/324 (40) | 1.08 | 1.07 | .66 | 1.78 | .67 1.70 |
| Bruising | 63/294 (21) | 41/324 (13) | 1.59 | 0.67 | .85 | 2.97 | .34 1.29 |
| Dysuria | 15/295 (5) | 16/325 (5) | 1.39 | 0.7 | .43 | 4.48 | .25 1.93 |

* Significant odds ratios are in bold

Table 3.10. Adult symptom reporting by odour perception

| <i>Adult cardinal symptoms - odour perception</i> | | | | | | | | |
|---|----------------|--------------|------------|------|-------------|--------------|-------------|--------------|
| Symptom | Prevalence (%) | | Odds Ratio | | 95% CI | | | |
| | 1992 | 1997 | 1992 | 1997 | 1992 | 1997 | 1992 | 1997 |
| 2+ vs. 0-1 | 222/381 (58) | 212/405 (52) | 2.73 | 3.03 | 1.64 | 4.55* | 1.66 | 5.48 |
| 3+ vs. 0-2 | 154/381 (40) | 140/405 (35) | 2.81 | 3.28 | 1.76 | 4.50 | 1.90 | 5.66 |
| Cough | 83/381 (22) | 87/417 (21) | 1.84 | 1.96 | 1.09 | 3.11 | 1.09 | 3.51 |
| Wheeze | 58/381 (15) | 67/415 (16) | 1.32 | 4.07 | .72 | 2.43 | 2.24 | 7.37 |
| Nausea | 43/381 (11) | 32/417 (8) | 2.8 | 2.62 | 1.46 | 5.37 | 1.18 | 5.81 |
| Sinus cong. | 138/378 (37) | 154/414 (37) | 2.63 | 2.52 | 1.64 | 4.21 | 1.48 | 4.30 |
| Eye irritation. | 107/380 (28) | 123/415 (30) | 2.3 | 2.58 | 1.42 | 3.74 | 1.51 | 4.41 |
| Colds | 109/380 (38) | 70/416 (17) | 1.04 | 2.8 | .63 | 1.72 | 1.54 | 5.08 |
| Nose cong. | 144/380 (38) | 164/415 (40) | 2.09 | 2.48 | 1.32 | 3.33 | 1.46 | 4.23 |
| Throat irritation. | 85/380 (22) | 73/416 (18) | 1.88 | 2.87 | 1.12 | 3.15 | 1.58 | 5.15 |
| Earaches | 38/381 (10) | 36/417 (9) | 2.54 | 1.05 | 1.28 | 5.03 | .42 | 2.63 |
| Skin rashes | 39/380 (10) | 47/416 (11) | 3.43 | 1.96 | 1.75 | 6.75 | .96 | 4.00 |
| Nosebleeds | 34/381 (9) | 15/417 (4) | 1.85 | 3.73 | .89 | 3.85 | 1.28 | 10.85 |
| <i>Adult general symptoms - odour perception</i> | | | | | | | | |
| 1+ vs. 0 | 219/381 (57) | 245/410 (60) | 2.5 | 3.15 | 1.52 | 4.12 | 1.65 | 6.00 |
| 2+ vs. 0-1 | 131/381 (34) | 129/410 (32) | 2.62 | 3.11 | 1.63 | 4.18 | 1.81 | 5.36 |
| Headaches | 127/380 (33) | 125/415 (30) | 2.96 | 3.25 | 1.84 | 4.75 | 1.89 | 5.57 |
| Sleep problems | 121/381 (32) | 141/414 (34) | 1.75 | 1.86 | 1.09 | 2.81 | 1.09 | 3.15 |
| Dizzy spells | 44/380 (12) | 42/417 (10) | 2.39 | 2.66 | 1.25 | 4.57 | 1.30 | 5.45 |
| Appetite loss | 34/381 (9) | 23/417 (6) | 1.61 | 3.03 | .76 | 3.38 | 1.23 | 7.46 |
| Stomach pains | 54/381 (14) | 69/416 (17) | 2 | 2.94 | 1.09 | 3.65 | 1.61 | 5.35 |
| Diarrhea | 69/380 (18) | 86/417 (21) | 2.13 | 2 | 1.23 | 3.70 | 1.12 | 3.58 |
| Chest pains | 36/381 (9) | 41/416 (10) | 2.18 | 2.41 | 1.08 | 4.43 | 1.16 | 5.00 |
| <i>Adult other symptoms - odour perception</i> | | | | | | | | |
| Joint pains | 135/380 (36) | 144/417 (35) | 1.3 | 1.68 | .81 | 2.08 | .99 | 2.85 |
| Back pains | 144/381 (38) | 163/416 (39) | 2.23 | 1.52 | 1.40 | 3.54 | .90 | 2.57 |
| Bruising | 83/378 (22) | 54/416 (13) | 2.09 | 0.91 | 1.25 | 3.52 | .41 | 2.03 |
| Dysuria | 19/380 (5) | 19/417 (5) | 1.68 | 1.94 | .64 | 4.40 | .67 | 5.57 |

* Significant odds ratios are in bold

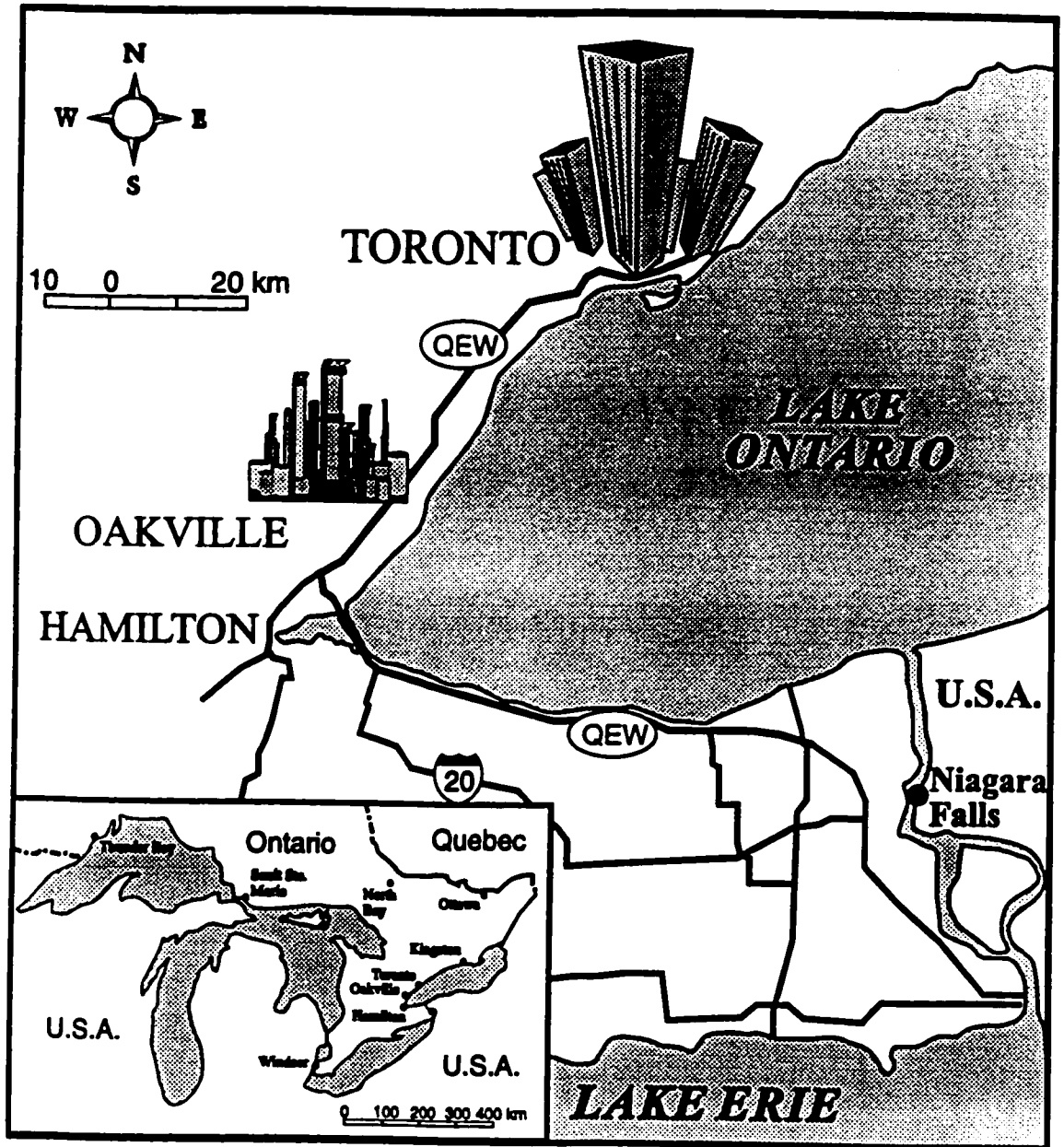


Figure 3.1 Study Area

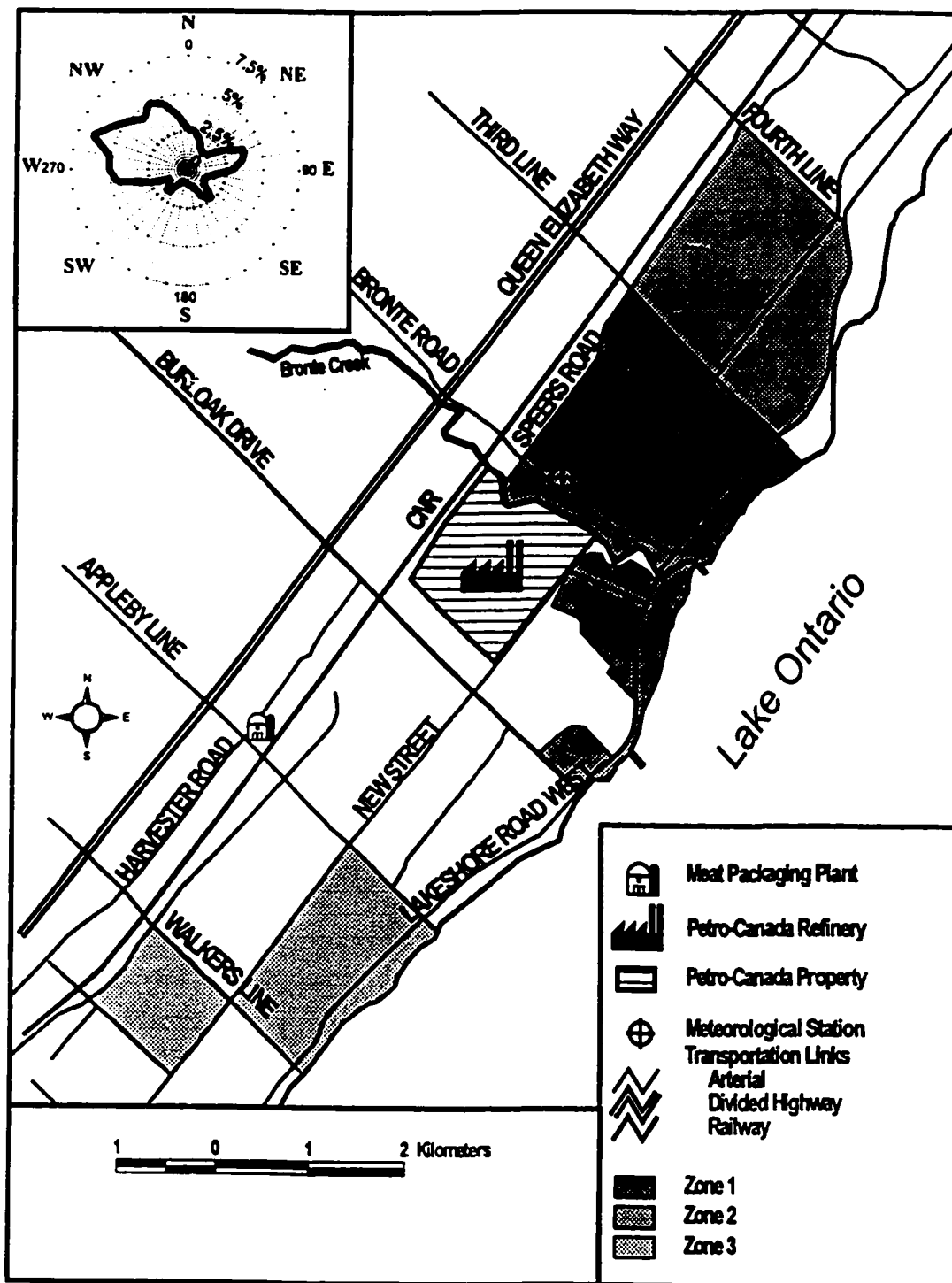


Figure 3.2 Map Showing the Study Zones and Predominant Wind Direction (Inset)

CHAPTER FOUR

Community Reappraisal of the Perceived Health Effects of a Petroleum Refinery

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Abstract

This paper presents results from a study of the community health impacts of a petroleum refinery in Oakville, Ontario. The research is informed by the environmental stress and coping literatures and the focus is on community reappraisal of the refinery's impacts before and after the implementation of a substantive odour reduction initiative on the part of the refinery operators. Community health surveys were conducted in 1992 (n=391) and 1997 (n=427) to examine changes in odour perception and annoyance and self-reported health status attributable to the odour reduction plan. The findings reported here suggest an on-going process of cognitive reappraisal, whereby negative perceptions and concerns decreased between 1992 and 1997. Irrespective of this positive reappraisal of the refinery efforts, those living close to the refinery continue to report negative health impacts. A strong mediating effect of odours on the refinery exposure-symptom reporting relationship was confirmed by our results. While the relationship between odour perception and symptom reporting indicates the importance of odour perception and annoyance as the principal mechanism mediating ill-health reporting, the plausibility of other causal pathways is recognized. Residents' sensitivity to the negative effects of the refinery on their health and the health of their children suggests a psychosocial reaction to the environmental stress associated with perceived and actual refinery emissions.

Keywords: reappraisal, health and well-being, refinery emissions, odour perception environmental stress, Ontario

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main mechanisms for adverse health effects have been identified: direct toxicological mechanisms based on exposure to specific pollutants at determined toxic concentrations; and indirect odour annoyance-mediated mechanisms, which result in stress-related symptoms or heightened symptom awareness (Neutra, Lipscomb, Satin & Shusterman, 1991). Although the toxicity of refinery pollutants remains an issue of debate (see Ziem & Davidoff, 1992), particularly at the relatively low levels of exposure typical of community settings, the balance of evidence indicates little support for a direct toxicological effect. In a cohort study of pregnancy outcomes in Sweden, Axelsson and Molin (1988) showed no clinically important or statistically significant differences in miscarriage rates between women living near petrochemical plants and matched controls. Similarly, Bhopal, Tate, Foy, Moffatt & Phillimore (1999) found that birth outcomes in women living near major steel and petrochemical industries in England were not associated with proximity to the industrial sites. In a study of community health status in the vicinity of Alberta sour gas refineries, no differences between index and control communities were found with respect to physical abnormalities, laboratory tests, cancer, all-cause mortality, or pulmonary function (Dales, Spitzer, Suissa, Schechter, Tousignant & Steinmetz, 1989), although various symptoms were reported more frequently by residents in the exposed (versus control) areas. In South Wales, Sans, Elliott, Kleinschmidt, Shaddick, Pattenden, Walls, et al (1995) studied cancer incidence and mortality near a petrochemical plant and found no apparent decline in incidence with distance from the plant. Also, Lyons, Monaghan, Heaven, Littlepage, Vincent & Draper (1995) found no excess cancers in young people in the vicinity of the

plant. In a small area study of cancer mortality among people living near multiple sources (a waste disposal site, a waste incinerator plant and an oil refinery) in Italy, Michelozzi, Fusso, Forastiere, Ancona, Dell' Orco & Perrucci (1998) showed no association between proximity to the sites and cancer mortality. Toxicological hypothesis may have validity in the Petro Canada situation, especially as odour reduction may result in increased SO₂ in the process of reducing H₂S.

In contrast, exposure to odours from industrial sources, such as oil refineries and chemical plants, has been shown to have considerable impact on general health and well-being, affecting both physiological and psychosocial status (Winneke, 1992). This impact can be reinforced when odorant molecules are absorbed by household and building materials and then released slowly over time (see Schiffman, Miller, Suggs & Graham, 1995). Odour, in particular, appears to contribute substantially to lay people's judgements regarding environmental quality and provides important diagnostic information in appraising the potential threats of health (Shusterman, 1991). Intuitive or implicit ideas about toxicity seem to suggest that "if environments smell bad, they're probably damaging to health" (Williams & Less-Haley, 1997, p. 412; see also Schiffman et al., 1995); at the very least, they cause annoyance.

Annoyance describes a feeling of displeasure associated with agents or conditions believed to have adverse effects on an individual or groups of individuals, and reactions are dependent on sensory/perceptual cues related to environmental stressors such as odours (Steinheider & Winneke, 1993). Neutra et al (1991) identified odour complaints as a

powerful effect modifier in several studies of symptom rates around hazardous waste sites and their findings can be extended to refinery situations. Shusterman, Lipscomb, Neutra & Satin (1991) reviewed three cross-sectional studies of symptom reporting around hazardous waste sites, and reported that both odour perception and worry about environmental health effects from the sites were strongly related to symptom reporting (e.g., headaches, nausea), and that the combined effects of odour perception and worry were even stronger. The authors concluded that odour perception and annoyance may act as sensory cues for the manifestation of stress-related illness (or heightens awareness of underlying symptoms) among individuals concerned about the quality of their environment, particularly since exposures at these sites were well below those at which adverse effects would be expected as a result of recognized toxicological mechanisms.

In several other investigations, odour exposure has been found to be the most important predictor of annoyance and negative evaluations of the immediate environment. Some individuals are more sensitive to odours than others, including asthmatics and pregnant women (Shusterman, 1992). Annoyance responses are modified by personal factors, such as age, gender and perceived health status (Winneke, 1992; Steinheider & Winneke, 1993; Taylor, Sider, Hampson, Taylor, Kelly, Walter, et al., 1997; Steinheider, 1999), attitudes toward the exposure source, and sociodemographics (Evans, Colome & Shearer, 1988). Cavalini, Koeter-Kemmerling & Pulles (1991) found age to be negatively related to annoyance. They also reported annoyance was less for those who used an emotion-oriented rather than a problem-oriented coping style.

Two gaps in the literature pertain to the reappraisal of odour sources in relation to changes in the characteristics of the exposure (Lazarus and Folkman 1984; Edelman, 1988; Taylor, Eyles, Elliott & Streiner, 1993), and to the notion of reverse causality (Cavalini 1994; Taylor et al., 1997; Steinheider, Both & Winneke, 1998). Issues related to both the reappraisal process and reverse causality are design related. Except in a few cases where dispersion models are used to investigate the health impacts of exposure to nearby industrial facilities (see Cavalini, 1994), most studies have used single cross-sectional designs to determine the impacts of exposure. These studies are therefore not able to investigate the reappraisal process, and so the need for longitudinal studies has been increasingly recognized (Lazarus, 1993; Elliott & Taylor, 1996). While the evidence from previous studies strongly supports the importance of odour annoyance mechanisms for explaining ill-health reporting by residents exposed to refinery and related emissions, the reverse causality hypothesis (i.e., odour perception may lead to symptom reporting, ill-health symptoms can also sensitize people to perceive odours) has been proposed (see Cavalini 1994; Taylor et al., 1997; Steinheider, 1999), but not clearly demonstrated.

This study therefore contributes to this literature by examining the mediating role of odour perception and annoyance with a particular focus on factors affecting the reappraisal of odours from the refinery after the implementation of an extensive odour reduction program. The findings also extend our understanding of the causal processes involved in the health impacts of exposure to odorous emissions in surrounding communities.

4.1.1 Community Context

Oakville (population 128,405 - Census 1996) is located on the north shore of Lake Ontario. The refinery, located in west Oakville and now operated by Petro Canada, was built in 1958 and produces fuels, lubricant oils, and industrial asphalt. The refinery has the capacity to process up to 13,000 cubic metres of crude oil per day. It occupies 120 hectares to the south west of Bronte Creek (Figure 4.1). Residential areas are found within one kilometre of the plant stacks to the east, southwest, and south. Housing development close to the refinery in recent years has increased the potential effects of emissions on the health and well-being of local residents.

<insert Figure 4.1>

Residents' concern about the health effects from the refinery led to a community health study in 1992. This study was carried out for the Halton Regional Public Health Department by a multi-disciplinary research team in consultation with a Community Advisory Committee to Petro Canada (CAC-PC). The results showed that perceptions of refinery odours were associated with elevated levels of reported ill-health in the community (Sider, 1994; Taylor et al., 1997). In response to mounting public pressure, Petro Canada spent an estimated \$50 million (Canadian) to implement extensive odour reduction measures designed to reduce odorous emissions through improvements in major areas of its operation, specifically in waste water treatment, sulphur recovery, thermal oxidization, and asphalt odour abatement. A complaints hotline was also established to provide an accessible and

efficient means of recording and facilitating responses to community complaints of odour or other pollutant episodes. Most of the odour reduction measures were completed by the summer of 1997. This set of intervention measures provides the opportunity to examine residents' reappraisal of refinery impacts on their health.

A means by which the people in Oakville learn about the Petro Canada refinery and the odour reduction plan is through the media. However, there has been a downward trend in media coverage of issues addressing the refinery from 1990 to 1995 (see Wilson, 1996) and through to 1997 when most of the odour reduction measures were completed. It appears that issues pertaining to the refinery no longer warrant the media coverage they once received, which in itself may reflect a decrease in community concern related to the positive effects of the odour reduction plan.

4.1.2 The conceptual Framework

The conceptual framework for this investigation is based on the environmental stress and risk perception literatures. Environmental stress and risk perception are linked through the perceptual processes used to appraise environmental threats (Taylor et al., 1993). Essentially, the relationships between environmental exposures, such as refinery emissions, and health are mediated by perceptions of the exposure which are in turn influenced by individual and contextual factors (Cutter, 1993). In the case of exposure to refinery emissions, the effects on community health and well-being involve risk perceptions specifically linked to odour perception and annoyance as a primary mediating process (see

Neutra et al., 1991; Shusterman, 1992; Cavalini, 1994; Taylor et al., 1997; Steinheider et al., 1998).

Lazarus and Folkman (1984) suggest that individual response to an environmental stressor (e.g., odorous refinery emissions) is a transactive and an iterative process with two stages: primary appraisal, whereby the individual evaluates the stressor as a threat, harm or challenge; and secondary appraisal, which involves the evaluation of coping resources and strategies to deal with a stressor. In the case of secondary appraisal, one of two types of coping strategy is used: (1) problem-focused coping, or actions to remove or mitigate the effects of the stressor (e.g., complaints to industry or government officials); or (2) emotion-focused coping, or regulating emotional responses to the problem (e.g., denial of the problem or adapting to the problem). Feedback occurs through the process of reappraisal, that is, ongoing reevaluation of the stressor, coping resources and strategies, in response to changes in the characteristics, conditions and context of the stressor (e.g., odour abatement) and/or to changes in the individual's coping abilities (MacGregor & Fleming, 1996). Taylor et al (1991) proposed that the (re)appraisal of threat and the selection of a coping response is influenced by four sets of mediating factors related to the characteristics of the stressor (Evans & Jacobs, 1982; Vynner, 1988), the individual (Pearlin & Scholer, 1978; Evans & Jacobs, 1982), the social network (Edelstein, 1988) and the wider community system (Simms & Baumann, 1983; Edelstein, 1988).

The conceptual framework described above informs the analytical model used for this investigation (Figure 4.2). Essentially, the model is composed of three main components: external variables - individual and exposure related-variables (Taylor et al., 1993; Steinheider, 1999); mediating variables - those variables which influence perception of or sensitivity to refinery impacts, for example, general health status and environmental stressors (Elliott, Taylor, Walter, Stieb, Frank & Eyles, 1993; Steinheider et al., 1998); and outcome variables (Cavilini, 1994; Taylor et al., 1997; Steinheider, 1999). The reappraisal process is assessed by examining the changes in community responses over time. To examine the direction of the relationships between odour emissions and ill-health reporting, the analytical framework includes two types of outcome variable: odour perception/annoyance and ill-health reporting. The reverse arrow between the outcome variables (odour perception/annoyance and health symptoms) is the hypothesized bidirectional relationship between odour responses and ill-health reporting (see Cavalini, 1994; Taylor et al., 1997; Steinheider et al., 1998).

<insert Figure 4.2>

4.2 Methods

Community health surveys were conducted in 1992 and 1997 to examine changes in odour perception and annoyance and self-reported health status attributable to the odour reduction plan. A second cross-sectional survey was conducted in 1997 rather than a resurvey of the cohort of 1992 respondents. This was primarily to minimize bias through attrition in the sample due to residential mobility over the five years between the two

surveys. The 1991 and 1996 census data showed 35.8% and 32.2% mobility of residents into the study area in the prior five years.

In the absence of direct measurements of concentrations of odorous pollutants within the community, distance from site was used as a proxy for odour exposure. In both years, the study sample was distributed across three zones which were comparable according to a number of socioeconomic characteristics (see Luginaah et al., 2000), but variable in the extent to which they were exposed to odorous pollutants from the refinery. Distance from odour sources has been widely used in determining exposure zones in a number of environmental health studies, using zones of low exposure as an internal control (Hertzman, Hayes, Singer and Highland, 1987; Shusterman, 1992; Elliott, 1998; Steinheider, 1999).

The sample sizes in 1992 and 1997 were 391 and 427 respectively. The response rate overall was 70% in 1992 and 71% in 1997, with no substantial differences across the three zones in either year. The characteristics of the two study samples were similar overall and by zone (see Luginaah et al., 2000).

In both years, the surveys were conducted by the Institute for Social Research at York University using computer assisted telephone interview methods. The questionnaire on average took 27.2 minutes and 22.9 minutes to complete in 1992 and 1997 respectively. A randomly selected household member, 18 years of age or older, was asked a series of questions about odour perception and annoyance; cardinal, general, and other symptoms, chronic illness, psychosocial health; exposure to tobacco smoke and indoor air contaminants; attitudes toward the community and the refinery; sources of information about the refinery;

beliefs about the health effects of the refinery emissions; and socio-demographic characteristics. Information on the three groups of health symptoms was obtained for the two-month period (July-August) preceding the surveys. The symptom reporting questions were asked early in the survey without reference to the refinery and prior to questions related to perceptions of refinery emissions or odour.

Cardinal symptoms were those which were likely to be the result of irritant properties of odour and included coughs, wheezing/breathing problems, nausea, sinus congestion, colds, skin rashes, eye, nose, or throat irritations, earaches, and nosebleeds. General symptoms were those more likely to result from stress-mediated mechanisms related to odour annoyance and included headaches, sleep problems, dizzy spells, stomach aches, diarrhea, loss of appetite, and chest pains. Other or 'dummy' symptoms were those not thought to be plausibly related to refinery odour emissions such as joint pains, back pains, bruises, and were included in the survey to detect symptom over-reporting. The adult respondent also provided information on the health of children aged 12 and under in the household. In households with more than two children in this age group, two were selected based on birth dates closest to the interview date. As a result of the random occurrence of health symptoms (e.g., nausea and nasal congestion) in the general population (Neitzert, Davis & Kennedy, 1997), dichotomized outcome variables were created (e.g., two or less vs. three or more symptoms) for both adults and children to improve the reliability of our health symptom models.

Psychosocial functioning was measured using three sub-scales from the SF-36 Health Survey (see Ware & Sherbourne, 1992). The social functioning scale assessed the extent to which physical and emotional problems interfered with normal social activities. The role-emotional functioning scale assessed the extent to which emotional problems affected time spent on work or other activities, led to accomplishing less than the person wanted, or led to the person not working as carefully as usual. Finally, the mental health scale assessed respondents general mental health such as depression, anxiety, behavioural-emotional control and general positive affect.

4.2.1 Analysis

Based on the key variables in our investigation, we advanced three sets of hypotheses on odour perception and annoyance, adult symptom reporting and child symptom reporting (Table 4.2), to explain community reappraisal of the refinery after the implementation of odour reduction measures. These key variables were: time, distance, years in community, odour perception and annoyance, adult and child symptom reporting. For the odour perception and annoyance hypotheses, we assumed that if the refinery's odour reduction measures had a positive impact on the community, the levels of reported odour perception and annoyance would be higher in 1992 than in 1997. We expected distance to be negatively related to odour perception and annoyance, such that those living closer to the refinery would be more likely to report outcomes, though with a decreasing distance gradient in 1997 compared to 1992. We also hypothesized a negative relationship between length of stay in

the community and odour perception/annoyance, expecting that those who had lived in the community for a longer period would adapt to the refinery and hence be less likely to report frequent odour perception and annoyance. A positive relationship between adult symptoms (cardinal and general) and odour perception/annoyance was also hypothesized, while recognizing that the relationship could be bidirectional.

<insert Table 4.2>

The hypotheses related to changes in adult symptom reporting were similar to those for odour perception and annoyance (Table 4.2). We assumed levels of symptom reporting would be higher in 1992 than they were in 1997. Again, we assumed a negative relationship between proximity to the refinery and ill-health reporting. Also, those who lived in the community for a longer period were expected to report fewer health impacts. Odour perception was expected to mediate ill-health reporting near the refinery.

The final set of hypotheses address changes in children's ill-health reporting by parents or guardians (Table 4.2). The first four hypotheses are the same as those we proposed for adult ill-health reporting. In addition, we expected that adults reporting cardinal and general symptoms would be more likely to report symptoms in their children. Also, parents of a child who had a chronic health problem were expected to report more symptoms in their child.

Logistic regression was chosen as the method of analysis for three reasons: (1) the outcomes of interest are dichotomous; (2) the external and mediating factors are a mix of

continuous and categorical variables; (3) the relationship between the explanatory and outcome variables are sensibly described by a logistic function. Logistic regression models were estimated (using SPSS 9.0) for a series of outcome variables. For each outcome, a hierarchical model was constructed by entering each block of explanatory variables (Table 4.3) in the order shown in the analytical model (individual, exposure, general health status, environmental stressor). The variables which made a significant contribution to the model¹ at each stage were retained. Models were run using a stepwise backward elimination algorithm within each block. Due to their *a priori* importance, distance, time, age and gender were forced into every model regardless of their contribution. First order interaction terms were entered into the model using forward-stepwise selection. The interaction terms were of two types: (1) *a priori* variables (distance, time, age and gender) by each significant independent variable, and (2) each significant independent variable with all others.

<insert Table 4.3>

¹ Variables were judged to contribute to the model if: (a) the significance level of the Wald inclusion test statistic was 0.10 or lower; or (b) the significance level was greater than 0.10 but a contribution to the model was indicated via a partial correlation greater than zero and/or an improvement in the percentage of respondents correctly classified.

4.3 Results

4.3.1 Odour Perception

The outcome variable for this model was the frequency of odour perception defined as reporting odours infrequently (less than once a month) vs frequently (more than once a month) in the two months prior to the survey administration. The odds ratios for the predictor variables indicate the effect of each variable on the probability of reporting frequent odour perception (Table 4.4). The Relative Odds (R.O.) and associated 95% confidence interval are reported for the variables in the table. Relative odds (e^{β} - exponent of β) is the factor by which the odds of having the outcome variables changes when the independent variable increases by one unit (or, in the case of categorical variables, changes from one category to another) (Norusis, 1990). If β is positive, the relative odds are greater than 1, which means that the odds are increased. If β is negative, the relative odds are less than 1, meaning the odds are decreased. Using time as an example, the relative odds was 7.71, indicating that respondents in 1992 sample as opposed to 1997, were more likely to report frequent odour perception. The confidence interval shows that the range of the relative odds for this variable was between 2.63 and 22.64.

<insert Table 4.4>

The significant variables in the odour perception model included those from the exposure, individual, general health status and environmental stressor blocks (Figure 4.2). With reference to our hypotheses (Table 4.2), the strongest predictors of odour perception

were: time, distance from the refinery, and cardinal symptom reporting.

The strong significant effect of time in the model shows that residents in the 1992 study were several times more likely to report perceiving odours frequently than their counterparts in the 1997 study. Further support of this positive reappraisal of the refinery odour reduction efforts was provided by the significant interaction of time and distance, indicating the probability of reporting frequency of odour perception was highest for residents living closer to the refinery in 1992 compared to those in 1997.

As expected, proximity to the refinery was negatively related to odour perception such that those living close to the refinery were more likely to perceive odours in both years. This is consistent with our earlier findings where we reported a strong zonal gradient for frequent odour perception (Luginaah et al., 2000). Residents reporting cardinal symptoms were also more likely to perceive odours frequently. Length of stay in the community was not significant.

Also emerging from this model is the strong effect of residents' dissatisfaction with the refinery in the community. Residents who were generally dissatisfied with having the refinery located in their community or who believed that the refinery affected their health, were also more likely to perceive odours frequently. Younger residents were more likely to frequently perceive odours. This finding is consistent with the literature which suggests that age exerts an effect on olfactory sensitivity, with the elderly having decreased sensitivity to smell (Cavalini et al., 1991; Steinheider and Winneke, 1993; Steinheider, 1999).

The goodness of fit statistics - rho square (0.36), sensitivity (65.4%), specificity (88.7%) and the percentage of cases correctly classified (84.7%) - indicate that the model is moderately strong overall.²

4.3.2 Degree of Odour Annoyance

This model predicted the probability of individuals reporting a great deal of annoyance associated with perceived odours. The significant variables included those from the exposure, individual, general health status, and environmental stressor blocks (Figure 4.2). In relation to the study hypotheses the significant single effects were: time, distance from the refinery; and cardinal symptom reporting (Table 4.4). Respondents in 1992 were almost twice as likely to be greatly annoyed by odours compared to those in 1997. The effect of time was weaker than in the odour perception model. Nevertheless, this positive reappraisal appears to further underscore the positive impact of the odour reduction measures.

Exposure to emissions was a strong predictor of odour annoyance, with those living closer to the refinery more likely to report a great deal of annoyance. Those who experienced a higher number of cardinal symptoms such as nausea, eye irritation and wheezing were more likely to be greatly annoyed by odours from the refinery. Length of stay in the community was not significant.

² Rho square is defined as one minus the ratio of the maximum log likelihood values of the fitted and constant only-term (null) models (Wrigley, 1985). Calculated values for rho square range from zero to one, and values ranging from 0.2 to 0.4 represent a very good fit of the model (Wrigley, 1985, p.50).

Other significant effects indicated that those residents who were dissatisfied with the refinery in the community or who believed that the refinery affected their health, reported a great deal of odour annoyance. This also the case for younger residents. Males who were also dissatisfied with the refinery in the community were more likely to express a great deal of annoyance. Females who lived in the community longer were also more likely to report being highly annoyed.

4.3.3 Adult Cardinal Symptoms

The outcome variable for the adult cardinal symptoms model was defined as reporting 0-2 vs 3 or more cardinal symptoms (Table 4.5). The odds ratios for the predictor variables indicate the effect of each variable on the probability of reporting at least three cardinal symptoms. Cardinal symptoms are those likely to be the result of irritant properties of refinery emissions (e.g., nausea, wheezing). The significant explanatory variables were from all the analytical blocks. In relation to the main hypotheses (Table 4.2), the significant single effects in the model showed that respondents reporting three or more cardinal symptoms were more likely to: be in 1992 sample as opposed to 1997, frequently perceive odours, and live further away from the refinery.

<insert Table 4.5>

The significant effect of time again shows a positive reappraisal of the refinery's odour reduction plan, such that residents in the 1992 study were nearly twice as likely to

report three or more cardinal symptoms compared with those surveyed in 1997.

Those who reported frequent odour perception were nearly twice as likely to report three or more cardinal symptoms. This corresponds to Steinheider's (1999) findings that the perception of strong odours such as those from refinery emissions (containing pungent compounds such as SO₂ and H₂S) can result in symptom reporting directly. When we controlled for odour perception, those who were frequently annoyed by odours reported more symptoms. This is also consistent with the literature where odour-mediated mechanisms have been shown to heighten symptom awareness and reporting (also see Neutra et al., 1991; Taylor et al, 1997; Steinheider et al., 1998).

It is interesting to note that instead of the hypothesized negative relationship between distance from the refinery and cardinal symptom reporting, our results showed a positive (albeit low odds) relationship. This provides additional evidence of the weak association between exposure and symptom reporting in the refinery situation (see Luginaah et al., 2000).

Other significant effects in this model showed that those who were dissatisfied with their perceived health status were more likely to report three or more cardinal symptoms. Further, respondents reporting three or more cardinal symptoms were more likely to: be younger, have scored low on the social functioning scale, and see no benefits from the refinery in the area. Females or highly educated individuals in the 1992 study were also more likely to report three or more cardinal symptoms. The significant interaction effects showed that residents reported three or more cardinal symptoms if they lived closer to the refinery

and were dissatisfied or believed the refinery affected their health. These findings suggest residents' sensitivity to the negative effects of the refinery on their physical and psychosocial health.

4.3.4 Adult General Symptoms

For the adult general symptom model (Table 4.5), the odds ratios indicate the effect of each variable on the probability of reporting at least three general symptoms. General symptoms were those more likely to result from stress-mediated mechanisms related to odour annoyance such as headaches and dizzy spells. The significant explanatory variables were from individual, exposure, general health status and environmental stressor blocks. With reference to the hypotheses outlined in Table 4.2, the significant effects showed that respondents reporting three or more general symptoms were more likely to: frequently perceive odours, and live closer to the refinery. Though significant, both distance and odour frequency were relatively weak. Time was not significant. This is to be expected as general symptoms (e.g., headache) are widely distributed in the general population (Neitzert et al., 1997) and result from many (perceived) associations.

Residents were also likely to report three or more general symptoms if they: were dissatisfied with their perceived health status; experienced chronic health problems; or had no partner (single, divorced or widowed). This was more so if a respondent had no partner and was dissatisfied with his or her perceived health status. Women who saw no benefits of the refinery in the area and men who were dissatisfied with the refinery, were also more

likely to report three or more general symptoms. Respondents who reported low scores for the psychosocial functioning variables were more likely to report general symptoms. None of these effects are necessarily linked to refinery emissions, and may well be explained by more general stress-related and psychosocial mechanisms. The implication is that general symptom reporting in the surrounding community may have little to do with the refinery. The strong and negative relationship between the number of indoor air appliances in a household and general symptom reporting suggests that those without these appliances are reporting more general symptoms. The role of indoor air appliances such as air filters and air conditioners in general symptom reporting is not obvious, since this relationship may be attributable to confounders (e.g, socioeconomic factors).

4.3.5 Child Cardinal Symptoms

The outcome variable for the child cardinal symptom model was defined as the proxy reporting of 0-2 vs 3 or more child cardinal symptoms per child (Table 4.6). In relation to the main hypotheses (Table 4.2), the strongest effects in this model were: odour perception, adult cardinal symptoms and child chronic symptoms.

Both time and distance from the refinery were not significant in this model. This means that, despite the improvement in odour emissions, proxy respondents continued to report the same levels of symptoms in their children. More importantly, the lack of a distance effect suggests that reporting these symptoms was not necessarily related to exposure from the refinery. The strong effect of odour perception showed that proxy

respondents who reported frequent odour perceptions were more likely to report three or more cardinal symptoms in their children.

<insert Table 4.6>

Respondents who themselves reported cardinal symptoms were also more likely to report those symptoms in their child. This effect was even stronger for respondents who also reported frequent odour perception. In both years, parents or guardians of children with chronic health symptoms such as asthma were more likely to report cardinal symptoms in those children. In addition, women were nearly three times more likely than men to report child cardinal symptoms which probably reflects the fact that the women were more often the primary care givers.

4.3.6 Child General Symptoms

For this model (Table 4.6), the odds ratios indicate the effect of each variable on the probability of a parent or adult reporting at least three general symptoms in their child. Neither distance nor odour perception were significant predictors. The strongest hypothesized predictors were: time, adult cardinal and general symptoms.

The 1992 respondents were more likely to report child general symptoms than those surveyed in 1997, and the time effect was even stronger for residents living closer to the refinery. However, this apparently positive reappraisal has to be interpreted in relation to

the significant contribution of both adult cardinal and general symptoms in the model, whereby respondents who experienced either cardinal or general symptoms were more sensitized to report general symptoms in their children.

4.4 Discussion and Conclusions

The principal objective of this paper was to provide a clearer understanding of the determinants of residents' reappraisal of the refinery and the processes related to exposure and health effects after the implementation of the odour reduction plan. Table 4.7 summarizes the results of the main hypotheses of the study.

<insert Table 4.7>

Overall, the results show the community's positive reappraisal of the refinery. The strong effect of time in the odour perception model confirms the (perceived) improvement in odour emissions between 1992 and 1997, the period when most of the abatement measures were completed. Residents were also more likely to report cardinal symptoms (those likely to be the result of irritant properties of refinery emissions) in 1992 compared to their counterparts in 1997. However, there was no significant time effect in the reporting of adult general symptoms (those more likely to result from stress-mediated mechanisms). The lack of significant change in the reporting of general symptoms from 1992 to 1997 may be explained by the random occurrence of these symptoms in the general population (see

Neitzert et al., 1997). Since length of stay in the community was not significant in any of the models, there is no evidence to indicate that people in the community were becoming acclimatized over time. This strengthens the conclusion that, the odour reduction plan itself had a positive effect on residents' reappraisal of the refinery impacts.

The beneficial effects of the odour reduction plan were differentially felt in relation to several other factors. Consistent with our hypotheses, distance from the refinery emerged as an important factor in the reappraisal process. Those living close to the refinery continued to report more frequent odour perception and a higher degree of annoyance. The implication is that any remaining odour from the refinery will likely continue to produce negative impacts in some parts of the community, especially with new residential developments being built close to the facility. However, we observed a positive (albeit weak) relationship between distance from site and cardinal symptom reporting, and a relatively weak relationship between distance and general symptom reporting. These mixed findings are noteworthy, as they suggest that exposure itself may not be the main cause of ill-health reporting (see also Cavalini, 1994; MacGregor & Fleming, 1996). This view is supported by the psychosocial variables that were significant in the final symptom models, especially the general symptom model, where the variables with the strongest effects were stress rather than exposure related.

The persistence of community health impacts, despite the changes in exposure, could be the result of perceptual and behavioural sensitization. This refers to an involuntary conditioning after an initial traumatic exposure whereby residents react to low-level

exposures with a variety of symptoms, including headaches, anxiety and nausea (Neutra et al., 1991; Shusterman, 1992). According to Neutra et al. (1991), in many cases the only remedy for behavioural sensitization is either to remove the people from the exposure or abate the exposure to sub-odorant levels. The first remedy has only occurred in a few cases where residents chose to move (see Wilson, 1996; Arnold, 1999). The second remedy was the main focus of the refinery's odour reduction plan. At the time this study was conducted, most of the odour reduction measures had been completed, and yet residents still reported persistent health concerns. One explanation for this could be that there is a 'sensitized' group in the community which continues to experience anxiety about the refinery's impacts even after the implementation of the odour reduction plan (see also Taylor et al., 1993; Sly, 1997); anxiety reinforced by occasional odour incidents and visual cues such as smoke and the refinery stacks.

Residents who reported cardinal symptoms were more likely to frequently perceive and be annoyed by odours. Similarly, those who perceived odours frequently were nearly twice as likely to report adult health symptoms. Interpreting the causal links between odour emissions, odour perception, and symptom reporting is problematic. There are four possible causal mechanisms. The first is a direct link between refinery emissions and ill-health reporting. The refinery produces numerous pollutants including sulphur dioxide (SO_2), hydrogen sulphide (H_2S) and other reduced sulphur compounds (e.g., Total Reduced Sulphur) at various stages of the refining cycle. These are released into the atmosphere via fugitive emissions, handling or incomplete combustion (either via the incinerator or the flare

stacks). These compounds are known to produce pungent (e.g., rotten egg) odours which are detectable at very low concentrations and can directly result in ill-health such as nausea or headache. In our analysis of residents' complaints data, we found a link between intermittent odours from the refinery (actual exposure) and odour complaints, suggesting that residents complain when the air is odorous. This finding is consistent with that of Steinheider (1999), who found that strong odours may result in ill-health reporting directly. Second, the relationship between exposure and ill-health may be mediated by odour perception, whereby residents perceiving odours are sensitized to possible health effects and are more likely to report ill-health and attribute it to refinery emissions. Third, the direction of the relationship could be the reverse, such that people experiencing ill-health are sensitized to perceive and be annoyed by odours. Finally, the the relationship could be bidirectional, such that odour perception and ill-health reporting are mutually reinforcing.

Overall, the balance of the evidence from this analysis provides strongest support for the second mechanism, that the relationship between exposure to refinery emissions and ill-health reporting is mediated by odour perception and annoyance (see also Shusterman, 1992; Taylor et al., 1997; Steinheider, 1999). This mediating role is supported by two other findings: the weak distance effect in the symptom reporting models; and the evidence of symptom overreporting, whereby those who frequently perceive odours report an elevated number of dummy symptoms (those not thought to be plausibly related to refinery emissions such as joint pains, and bruises). Nevertheless, other mechanisms are possible given that they are not necessarily mutually exclusive and that the evidence from these results is not

sufficient to reject them.

The strong effect of dissatisfaction with the refinery in the odour perception and annoyance models is also noteworthy. Those who were dissatisfied with the refinery in their community were more likely to perceive and be annoyed by odours. Also, residents who strongly believed that the refinery causes health effects, and provides few benefits to the community were more likely to report negative effects. The dissatisfaction with the refinery and perceived lack of benefits of the refinery point to the importance of the *place* (wider community context) within which residents are reappraising the impacts of the refinery. DiManno (1995) describes Oakville as an attractive town with several amenities, where 79% of the families in the community are 'traditional' households or husband-wife families. In this context, the refinery represents an environmental and technological threat to residents' security, investment, and core values, and more generally their sense of place (Eyles, 1989). Thus, place and the meanings attached to it, become important factors in the reappraisal of environmental stress (see Eyles, 1997). This theme is examined in detail elsewhere using the data collected in the qualitative component of the research (Luginaah et al., 2000a).

The strong effect of odour perception in the child cardinal symptom model (Table 4.7) again indicates symptom reporting may be odour-mediated (see also Taylor et al., 1997). Although the hypothesis for children's health was that exposure to refinery emissions is related to a variety of health problems, it is also plausible that parents of children with symptoms or chronic health problems were more likely to notice odours and attribute the child's complaints to them (see also Dales et al., 1989). Another plausible explanation for

respondents reporting the same types of symptoms for themselves and in their children is that they are exposed to the same environmental influences, or that they have the same genetic disposition.

In the absence of time and distance effects in the child symptom models, the significant contributions of odour perception, adult symptom reporting and child chronic symptoms have three possible explanations. First, since the 1992 baseline study was prompted by highly vocal community health concerns especially in West Oakville (see Arnold, 1999), these heightened concerns and worries may have sensitized the parents resulting in increased self- and children- symptom reporting. Second, recall bias could have resulted in the differential recollection or the misclassification of the reports of symptoms in children by their parents. Finally, and perhaps most importantly, children represent a core value of parents. Any perceived threats to children's health strike at these core values and elicit strong and sustained reactions at the individual and community level (see Baxter and Eyles, 1999).

Our results are consistent with Neutra et al's (1991) hypotheses explaining ill-health reporting around hazardous waste and related sites, specifically those related to psychosomatic reaction to environmental stress and to odour mediated effects. The results provide evidence of reappraisal consistent with the Lazarus and Folkman (1984) model of human response to an environmental stressor. We have shown that in the community, there is an on-going process of reappraisal whereby odour perception and annoyance and some other concerns decreased as residents experienced a reduction in odorous emissions from the

refinery. However, the beneficial effects of the odour reduction plan were differentially felt in relation to several other factors. Despite the evidence of improvement from 1992 to 1997, some respondents in both time periods still reported health impacts. The persistence of health concerns points to the existence of sensitive individuals in the surrounding community, who may be reporting ill-health in the absence of harmful effects from the refinery. The implication is that reappraisal is a complex process involving personal and situational factors in addition to changes in exposure.

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Table 4.1: Comparison of adult symptom prevalence in 1992 and 1997

| Symptom | <i>Cardinal symptoms</i> | | | |
|-------------------|--------------------------|---------|------------|---------|
| | 1992 | | 1997 | |
| | Prevalence | Percent | Prevalence | Percent |
| 2+ vs. 0-1 | 227/391 | 58 | 215/414 | 52 |
| 3+ vs. 0-2 | 158/391 | 40 | 141/414 | 34 |
| Cough | 84/390 | 22 | 88/426 | 21 |
| Wheeze | 58/390 | 15 | 67/425 | 16 |
| Nausea | 45/390 | 12 | 32/427 | 8 |
| Sinus congestion | 143/387 | 37 | 155/424 | 37 |
| Eye irritation | 110/389 | 28 | 125/424 | 30 |
| Colds | 113/389 | 29 | 70/426 | 16 |
| Nose congestion | 148/389 | 38 | 167/425 | 39 |
| Throat irritation | 86/389 | 22 | 75/426 | 18 |
| Earaches | 39/390 | 10 | 36/427 | 8 |
| Skin rashes | 39/389 | 10 | 47/426 | 11 |
| Nosebleeds | 34/390 | 9 | 15/427 | 4 |
| | <i>General symptoms</i> | | | |
| 1+ vs. 0 | 225/391 | 58 | 248/420 | 59 |
| 2+ vs. 0-1 | 134/391 | 34 | 131/420 | 31 |
| Headaches | 130/389 | 33 | 126/425 | 30 |
| Sleep problems | 126/390 | 32 | 143/424 | 34 |
| Dizzy spells | 44/389 | 11 | 43/427 | 10 |
| Appetite loss | 35/355 | 9 | 23/427 | 5 |
| Stomach pains | 55/390 | 14 | 69/426 | 16 |
| Diarrhea | 69/389 | 18 | 87/427 | 20 |
| Chest pains | 36/390 | 9 | 43/426 | 10 |
| | <i>Other symptoms</i> | | | |
| Joint pains | 140/389 | 36 | 147/427 | 34 |
| Back pains | 150/390 | 39 | 169/426 | 40 |
| Bruising | 83/387 | 21 | 54/425 | 13 |
| Dysuria | 19/389 | 5 | 20/427 | 5 |

Table 4.2: Hypotheses to examine impacts of refinery's odour reduction plan

| Explanatory variable | Reappraisal of Refinery's Odour Reduction Efforts | | | | Adults Reappraisal of Children's Health Impacts | |
|--|---|---------------------|-------------------------|------------------------|---|------------------------|
| | Odour Perception | Degree of Annoyance | Adult Cardinal Symptoms | Adult General Symptoms | Child Cardinal Symptoms | Child General Symptoms |
| Time (1997 [†] vs 1992) | +ve' | +ve | +ve | +ve | +ve | +ve |
| Distance (Close vs Further) | -ve* | -ve | -ve | -ve | -ve | -ve |
| Length of Stay in Community (Short vs Long) | -ve | -ve | -ve | -ve | -ve | -ve |
| Odour Perception (Infrequent [‡] vs Frequent) | N/A | N/A | +ve | +ve | +ve | +ve |
| Adult Cardinal Symptoms (Less vs More) | +ve | +ve | N/A | N/A | +ve | +ve |
| Adult General Symptoms (Less vs More) | +ve | +ve | N/A | N/A | +ve | +ve |
| Child Chronic Symptoms (Less vs More) | N/A | N/A | N/A | N/A | +ve | +ve |

[†] Reference category; ' +ve - Elevated odds; * -ve - Decreased odds

Table 4.3: Explanatory variables in final logistic models

| Variable (Name) | Type | Coding (reference category *) | |
|--|-------------------------------|-------------------------------|----------------------------|
| <i>Individual Variables</i> | | | |
| Age of respondent | Continuous | Older vs younger | |
| Gender | Categorical | Male * vs Female | |
| Marital Status | Categorical | Partner * vs No partner | |
| Length of stay in community (Years in community) | Continuous | More vs Less | |
| Level of education (Education) | Categorical | Less * vs More | |
| Employment status (Employment) | Categorical | Unemployed * vs Employed | |
| <i>Exposure Variables</i> | | | |
| Time | Categorical | 1997 (post) * vs 1992 (pre) | |
| Distance from the refinery | Continuous | Close vs Further | |
| Number of indoor air appliances (Indoor air) | Continuous | More vs Less | |
| <i>General Health Status</i> | | | |
| Perceived satisfaction with health (Health satisfaction) | Categorical | Satisfied * vs Not | |
| Transformed Emotional function scores (Emotional functioning) | Continuous | High vs Low | |
| Transformed Social functioning scores (Social functioning) | Continuous | High vs Low | |
| Transformed Mental Health Scores (Mental health) | Continuous | High vs Low | |
| Adult self-reported chronic health problems (Chronic symptoms) | Continuous | More vs Less | |
| Adult cardinal symptoms | Continuous | More vs Less | |
| Adult general symptoms | Continuous | More vs Less | |
| Child cardinal symptoms | Continuous | More vs Less | |
| Child general symptoms | Continuous | More vs Less | |
| Child chronic symptoms | Continuous | More vs Less | |
| <i>Environmental Stressors</i> | | | |
| Belief that the refinery causes health problems (Degree of belief) | Categorical | Disbelieve * vs Believe | |
| Refinery affects satisfaction with community (Dissatisfaction) | Categorical | No* vs Yes | |
| Benefits from the refinery in area (No benefits) | Categorical | Yes * vs No | |
| Information about nature and sources of odours (Awareness) | Categorical | Yes* vs No | |
| <i>Outcomes</i> | | | |
| <i>Odour</i> | Frequency of odour perception | Categorical | Infrequent * vs Frequent |
| | Degree of odour annoyance | Categorical | Not at all * vs Great deal |
| | Adult cardinal symptoms | Categorical | 0 - 2 * vs 3+ |
| <i>Symptoms</i> | Adult general symptoms | Categorical | 0 - 2 * vs 3+ |
| | Child cardinal symptoms | Categorical | 0 - 2 * vs 3+ |
| | Child general symptoms | Categorical | 0 - 2 * vs 3+ |

Table 4.4: Logistic regression results for Odour Perception and Degree of Odour Annoyance

| Odour Perception (Infrequent vs. Frequent) | | | | Degree of Odour Annoyance (Not at all vs. Great deal) | | | |
|--|--------------|---------------|--------------|---|--------------|---------------|--------------|
| Variable | Significance | Relative Odds | 95% CI | Variable | Significance | Relative Odds | 95% CI |
| Dissatisfaction | *** | 14.06 | 6.05 - 32.66 | Degree of belief | *** | 13.24 | 2.96 - 59.17 |
| Time | *** | 7.71 | 2.63 - 22.64 | Dissatisfaction | *** | 12.84 | 7.70 - 21.40 |
| Degree of belief | * | 1.87 | 1.12 - 3.10 | Time | * | 1.63 | 1.04 - 2.55 |
| Adult cardinal symptoms | *** | 1.28 | 1.14 - 1.43 | Adult cardinal symptoms | *** | 1.26 | 1.12 - 1.42 |
| Distance | *** | 0.58 | 0.47 - 0.70 | Employment status | * | 0.55 | 0.32 - 0.92 |
| Age of respondent | * | 0.98 | 0.97 - 1.00 | Distance | *** | 0.59 | 0.50 - 0.71 |
| Gender | | 1.39 | 0.88 - 2.20 | Age of respondent | *** | 0.97 | 0.95 - 0.99 |
| Awareness | | 1.56 | 0.99 - 1.02 | Adult general symptoms | | 1.01 | 0.85 - 1.20 |
| Time x Degree of belief | * | 0.28 | 0.11 - 0.74 | Emotional functioning | | 1.01 | 1.00 - 1.02 |
| Distance x Time | * | 0.66 | 0.45 - 0.97 | Social functioning | | 0.99 | 0.98 - 1.00 |
| Adult cardinal symptoms x Dissatisfaction | * | 0.77 | 0.61 - 0.96 | Years in community | | 0.98 | 0.96 - 1.00 |
| | | | | Gender | | 0.82 | 0.38 - 1.76 |
| | | | | Age x Degree of belief | * | 0.97 | 0.94 - 0.99 |
| | | | | Gender x Dissatisfaction | ** | 0.22 | 0.08 - 0.60 |
| | | | | Gender x Years in community | * | 1.04 | 1.01 - 1.08 |
| | | | | Rho-square | | 0.44 | |
| | | | | Sensitivity | | 74.2 | |
| | | | | Specificity | | 87.4 | |

* $P < 0.05$, ** $P < 0.01$, *** $P < 0.001$

Table 4.5. Logistic regression results for Adult Cardinal Symptoms and Adult General Symptoms

| Adult Cardinal Symptoms (0-2 vs. 3+) | | Adult General Symptoms (0-2 vs. 3+) | |
|---|--------------|-------------------------------------|--------------|
| Variable | Significance | Relative Odds | 95% CI |
| Health Satisfaction | ** | 2.65 | 1.40 - 4.99 |
| No Benefits | ** | 1.84 | 1.27 - 2.66 |
| Odour frequency | * | 1.79 | 1.11 - 2.89 |
| Time | ** | 1.65 | 1.15 - 2.37 |
| Education | * | 1.57 | 1.09 - 2.25 |
| Distance | * | 1.2 | 1.04 - 1.38 |
| Social functioning | *** | 0.98 | 0.97 - 0.99 |
| Age of respondent | ** | 0.98 | 0.97 - 1.00 |
| Chronic symptoms | | 0.92 | 0.60 - 1.41 |
| Degree of belief | | 0.72 | 0.14 - 3.68 |
| Gender | | 0.7 | 0.49 - 1.01 |
| Dissatisfaction | | 0.49 | 0.19 - 1.26 |
| Distance x Dissatisfaction | ** | 1.58 | 1.19 - 2.10 |
| Distance x Degree of Belief | ** | 0.72 | 0.57 - 0.92 |
| Time x Gender | * | 2.14 | 1.07 - 4.26 |
| Time x Education | * | 0.47 | 0.24 - 0.96 |
| Social Functioning x Chronic symptoms | * | 1.01 | 1.00 - 1.01 |
| Social Functioning x Degree of Belief | ** | 1.02 | 1.01 - 1.04 |
| Health satisfaction | ** | 3.59 | 1.56 - 8.29 |
| Marital status | ** | 3.19 | 1.37 - 7.38 |
| No Benefits | * | 2.04 | 1.17 - 3.58 |
| Odour frequency | * | 1.93 | 1.09 - 3.43 |
| Chronic symptoms | *** | 1.43 | 1.21 - 1.70 |
| Social functioning | * | 0.99 | 0.97 - 1.00 |
| Emotional functioning | * | 0.99 | 0.98 - 1.00 |
| Mental health | * | 0.98 | 0.97 - 1.00 |
| Distance | * | 0.69 | 0.50 - 0.96 |
| Indoor Air | *** | 0.36 | 0.21 - 0.62 |
| Age of respondent | | 1 | 0.98 - 1.02 |
| Gender | | 0.96 | 0.53 - 1.72 |
| Dissatisfaction | | 0.81 | 0.23 - 2.87 |
| Time | | 0.77 | 0.48 - 1.24 |
| Distance x Indoor air | ** | 1.27 | 1.09 - 1.49 |
| Gender x Dissatisfaction | ** | 0.16 | 0.56 - 0.44 |
| Gender x No benefits | * | 3.84 | 1.24 - 11.88 |
| Marital x Health satisfaction | * | 6.96 | 1.35 - 35.92 |
| Dissatisfaction x Emotional functioning | * | 1.02 | 1.00 - 1.03 |
| Rho-square | | 0.30 | |
| Sensitivity | | 71.4 | |
| Specificity | | 87.8 | |

* $P < 0.05$, ** $P < 0.01$, *** $P < 0.001$

Table 4.6: Logistic regression results for Child Cardinal Symptoms and Child General Symptoms

| Variable | Child Cardinal Symptoms (0-2 vs. 3+) | | | Child General Symptoms (0-2 vs. 3+) | | | |
|---|--------------------------------------|---------------|--------------|-------------------------------------|--------------|---------------|--------------|
| | Significance | Relative Odds | 95% CI | Variable | Significance | Relative Odds | 95% CI |
| Odour frequency | *** | 18.71 | 3.82 - 91.57 | Time | ** | 13.3 | 2.24 - 78.98 |
| Gender | * | 2.71 | 1.18 - 6.23 | Adult cardinal symptoms | *** | 1.63 | 1.28 - 2.07 |
| Child chronic symptoms | *** | 2.65 | 1.62 - 4.35 | Adult general symptoms | * | 1.44 | 1.06 - 1.97 |
| Adult cardinal symptoms | *** | 1.63 | 1.30 - 2.03 | Degree of belief | | 2.03 | 0.83 - 4.94 |
| Health satisfaction | * | 0.1 | 0.02 - 0.57 | Age | | 1.03 | 0.97 - 1.10 |
| Time | | 1.15 | 0.54 - 2.49 | Social functioning | | 0.99 | 0.97 - 1.01 |
| Distance | | 1.07 | 0.81 - 1.42 | Gender | | 0.94 | 0.40 - 2.21 |
| Age | | 1 | 0.94 - 1.06 | Distance | | 0.88 | 0.67 - 1.17 |
| Odour frequency x Adult cardinal symptoms | * | 0.61 | 0.39 - 0.95 | Distance x Time | * | 0.47 | 0.26 - 0.84 |
| Rho-square | | 0.32 | | Rho-square | | 0.31 | |
| Sensitivity | | 75.9 | | Sensitivity | | 71.9 | |
| Specificity | | 84.3 | | Specificity | | 85.5 | |

* $P < 0.05$, ** $P < 0.01$, *** $P < 0.001$

Table 4.7: Summary of the main findings

| Explanatory variable | Reappraisal of Refinery's Odour Reduction Efforts | | | | Adults Reappraisal of Children's Health Impacts | |
|--|---|---------------------|-------------------------|------------------------|---|------------------------|
| | Odour Perception | Degree of Annoyance | Adult Cardinal Symptoms | Adult General Symptoms | Child Cardinal Symptoms | Child General Symptoms |
| | <i>Observed</i> | | | | | |
| Time (1997 [†] vs 1992) | +ve [†] | +ve | +ve | N/S* | N/S | +ve |
| Distance (Close vs Further) | -ve ^{**} | -ve | +ve | -ve | N/S | N/S |
| Length of Stay in Community (Short vs Long) | N/S | N/S | N/S | N/S | N/S | N/S |
| Odour Perception (Infrequent [‡] vs Frequent) | N/A | N/A | +ve | +ve | +ve | N/S |
| Adult Cardinal Symptoms (Less vs More) | +ve | +ve | N/A | N/A | +ve | +ve |
| Adult General Symptoms (Less vs More) | N/S | N/S | N/A | N/A | N/S | +ve |
| Child Chronic Symptoms (Less vs More) | N/A | N/A | N/A | N/A | +ve | N/S |

[†] Reference category; [‡] +ve - Elevated odds; ^{**} -ve - Decreased odds; * N/S - Not significant

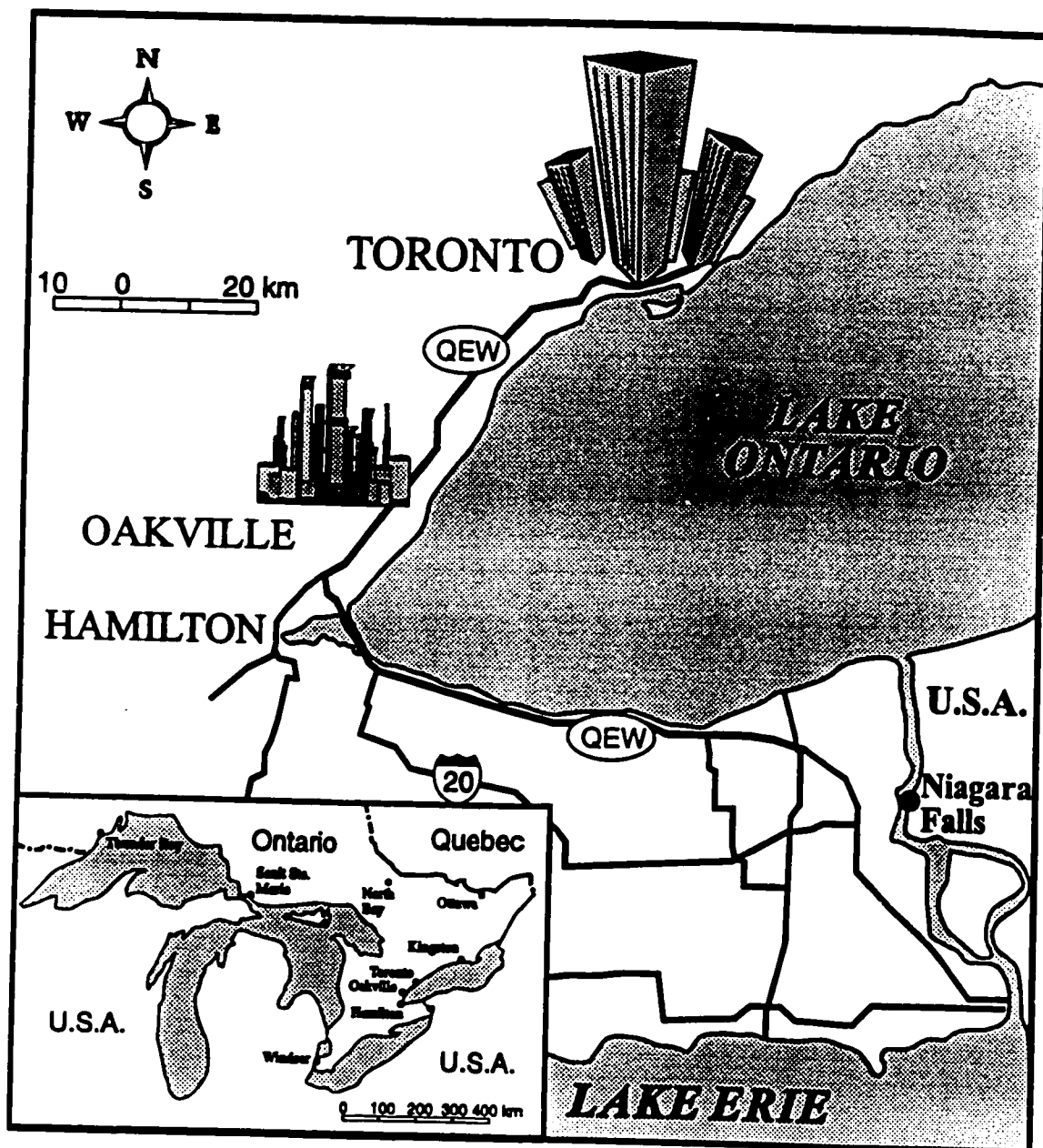


Figure 4.1 Study Area

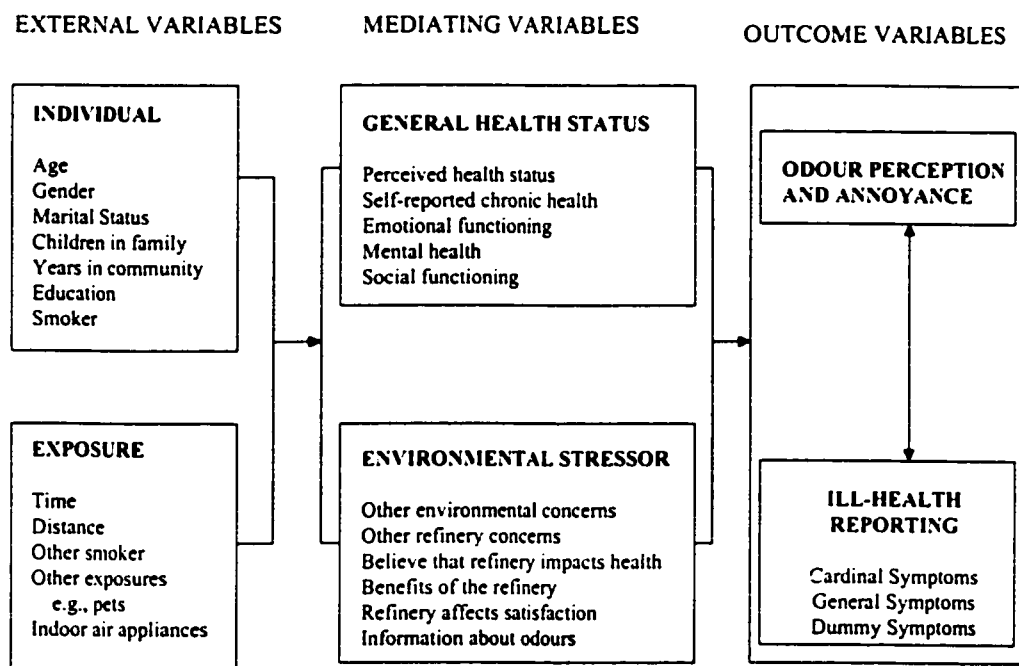


Figure 4.2. Analytical Model: Health Impacts of a Refinery

Source: Based on theoretical frameworks by Taylor et al (1993), Cavilini (1994) and Steinheider (1999)

CHAPTER FIVE

Community Responses and Coping Strategies in the Vicinity of a Petroleum Refinery

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Abstract

This paper investigates community perceptions of and coping responses to a petrochemical refinery in Oakville, Ontario. The analysis of in-depth interviews (n=29) revealed the effects of social and community factors on residents' everyday life experiences of refinery emissions, and the factors that shape residents' perceptions and responses after the refinery's implementation of extensive measures to reduce emissions and odours. Overall, residents reported an improvement in odours from the refinery. While the refinery now poses a minimal or tolerable level of risk to some people in the community, it is still intolerable to others. The results show residents' shifting concerns, with their fears now focused on invisible emissions. Residents continue to employ both action-focused and emotion-focused coping strategies. These findings suggest that refinery intervention may have to move beyond the focus on technological measures to reduce odours to address the psychological and social concerns of residents.

5.1 Introduction

Public concerns about technological hazards have been increasing since major accidents such as Love Canal (Levine & Stone, 1986) and Three Mile Island (Baum, Singer, & Baum, 1982). Earlier work on risk perception has demonstrated that experts are mostly persuaded by quantitative risk assessment and typically judge risk in terms of fatalities, while laypeople often disagree with experts about the meaning of risk (e.g., Elliott, 1998; Elliott, Cole, Krueger, Vooberg, & Wakefield, 1999; Gregory, Slovic, & Flynn, 1996; Slovic, 1987). Studies of subjective estimation of environmental risk show that public perceptions of and reactions to risk depend among other things on: the extent to which it is under their control, its involuntariness, its fairness, the extent to which it represents something to be dreaded, the extent to which it has delayed (or latent) effects, and whether it has the potential to reduce gains or increase losses (Covello, 1992; Slovic, 1987). People focus on particular risks because of their attachment to place, beliefs, values, social institutions, and moral behaviour, not necessarily on the amount of danger actual or perceived (Douglas & Wildavsky, 1982). Further, social context is important, affecting how risk is socially constructed. In this regard, this paper examines residents' responses and coping strategies in the vicinity of the Petro Canada refinery in Oakville, Ontario.

Oakville (population 128, 000 - 1996 census) was founded in 1827 on the north shore of Lake Ontario (Figure 1). Residents value its small town heritage, and actively seek to preserve the quality of life in the community (DiManno, 1995). The refinery, located in west Oakville and now operated by Petro Canada, was built in 1958 and produces fuels,

lubricant oils, and industrial asphalt. The refinery has the capacity to process up to 13,000 cubic metres of crude oil per day. It occupies 120 hectares to the south west of Bronte Creek. Residential areas are found within one kilometre of the plant stacks to the east, southwest, and south. New housing development close to the refinery in recent years has increased the potential effects of emissions on the health and well-being of local residents.

<insert Figure 5.1>

Community concerns about the refinery have existed for many years and grew as residents became increasingly worried about the potential health effects of refinery emissions. The growth in community concern paralleled the apparent worsening of odour incidents in the community. This culminated in the organization of grass roots community groups and the formation of an Environmental Advisory Committee, now known as the Community Advisory Committee to Petro Canada (CAC-PC) to help manage the situation. The increasing community concerns led to a community health study in 1992 which was conducted for the Halton Regional Public Health Department by a multi-disciplinary research team at McMaster University in consultation with the CAC-PC. The results showed that perceptions of refinery odours were associated with elevated levels of reported ill-health in the community (Sider, 1994; Taylor, Sider, Hampson, Taylor, Wilson, Walter, & Eyles, 1997). In response to mounting public pressure, Petro Canada spent an estimated \$50 million (Canadian) to implement extensive odour reduction measures designed to reduce

emissions and odours through improvements in major areas of its operation, specifically in waste water treatment, sulphur recovery, thermal oxidization, and asphalt odour abatement. A complaints hotline was also established to provide an accessible and efficient means of recording and facilitating responses to community complaints of odour or other pollutant episodes. Most of the odour reduction measures were completed by the summer of 1997.

The measures taken by Petro Canada to reduce odours from the refinery provide an excellent opportunity to examine how judgements about risks are made by individuals and groups, and how such understanding can inform risk management and risk communication . As one component of a larger study, this paper addresses community responses and perceptions, and the coping strategies residents adopt, after the implementation of the odour reduction plan. Community responses to and coping strategies in response to environmental hazards are dynamic and nonlinear (see Lazarus, 1993; McGee, 1999) and therefore not well understood. Thus, this qualitative analysis of residents' perceptions and coping strategies in response to an environmental stressor will extend our understanding and facilitate the development of more effective mitigation measures in the refinery and similar situations.

Consequently, this study addresses the following objectives:

- to explore the extent to which residents reappraise refinery impacts after technological intervention;
- to explore the nature and concerns about the impacts of the refinery within the broader context of residents' everyday lives;
- to examine residents' coping strategies after the implementation of the odour

reduction measures; and

- to explore residents' perceptions of the ultimate solution to the refinery situation.

5.1.1 Theoretical Context

The theoretical framework for this study draws on the risk society (Beck, 1992a; Giddens, 1990, 1991) and environmental stress and coping literature (e.g., Edelstein, 1988; Evans, 1982; Lazarus & Folkman, 1984). A major theme of the risk society literature is that the pervasiveness of perceived risk in Western societies signals a fundamental shift in the way individuals view the world. Modern risks, often the by-products of techno-industrial economic activity (such as refinery emissions), are seen as fundamentally different from their historical counterparts, as they represent the 'dark side of progress' as opposed to the dreaded but familiar risks associated with nature such as floods (Beck, 1992a; Giddens, 1990). The realization that modern risks result from techno-economic decision-making by humans, driven primarily by a profit motives led to critical reflection on the once taken-for-granted societal order, a process which Beck and Giddens refer to as "reflexive modernization."

Building on historical social processes, risk society theory explains how technological and environmental risks are increasingly dominating social life thus potentially leading to profound individual and societal anxieties (see Eyles, Taylor, Baxter, Sider, & Willms, 1993). This theory broadens issues concerning the implications of risk from 'How safe is safe enough?' or even 'How fair is safe enough?' to 'How do we wish to live?' (Beck,

1992a, p. 119; see also Slovic, 1987). Thus, an activity or technology such as the Petro Canada refinery which poses a minimal or tolerable level of risk to one person after mitigation measures, may still be intolerable to another, leading to prolonged controversy over its management and operations.

Further, there is a lay realization that the justifications given by the political and industrial actors to tolerate particular risks may no longer be acceptable and trustworthy (Beck, 1992b). Modern risks such as very low concentrations and invisible contaminants from refinery emissions are not necessarily detectable. To detect such risks necessitates the need to rely on sophisticated scientific methods, which are not without their limitations. Lay people, therefore, increasingly recognize the uncertainty associated with scientific assessments of these hazards and the lack of available data upon which to make such assessments. Consequently, the public is increasingly challenging expert decisions regarding technological risks (Beck, 1992a). This raises the issue of individual and collective trust in science and technology, whereby lay judgements of who to trust are constantly open to renegotiation (Wynne, 1994).

In the climate of pervasive risk and distrust, Giddens (1990) developed theoretical constructs of peoples' adaptive reactions to the risk of modernity. Giddens argues that in the context of the risk society, people's responses to environmental threats involve adaptive or coping strategies that take four main forms: radical engagement; pragmatic acceptance; sustained optimism and cynical pessimism. Radical engagement, as an adaptive reaction to environmental threats, involves practical contestations of social and institutional forces

perceived as the sources of danger. According to Giddens, those who take this position hold that although they are surrounded by major problems, they can mobilize either to reduce their impacts or to overcome them. The prime vehicles for radical engagement are social organizations or social movements.

Pragmatic acceptance is characterised by a concentration on “surviving.” This does not involve a withdrawal from the outside world, but rather a pragmatic participation which maintains a focus on the challenges of everyday life. According to Giddens (1990), pragmatic acceptance is not without psychosocial consequences since it may involve “numbness” towards the issue (e.g., refinery impacts), which frequently reflects deep-seated anxieties. Beck (1992a) refers to this adaptive strategy as “turning inwards” - turning away from the risk and finding comfort in other activities.

Sustained optimism is essentially a persistent faith in science and technology, and providential reason, despite the dangers that may threaten society and regardless of the lack of trust in and credibility of scientific experts and government. It is a perspective that often resonates with lay people and has emotional appeal based on the conviction that science and the latest technology offer sources of long-term security and solutions to their problems.

Finally, cynical pessimism is an attitude which is dissimilar from pragmatic acceptance and sustained optimism. Cynical pessimism is neither indifference nor doom-laden. It is a “mode of dampening the emotional impact of anxieties through either humorous or a world-weary response to them,” usually leading to “black humour” as a protective mechanism (Giddens, 1990, p. 136). These theoretical constructs were developed

by Giddens to explain adaptive responses in society in general. However, these ideas explicate context and values by showing how risk is connected to wider social phenomena like laypeople's faith in science and government, threatened security, and changes to institutionalized social structures (Beck, 1992a). The risk society theory makes the connection between the individual and the broader social and institutional structures (see Beck, 1992a, 1992b; Giddens, 1990, 1991). Therefore, while this theory was developed to explain broad social changes in the face of risks from global hazards, implicit in this theory is the importance of local context shaping values and risk perceptions (see Baxter, Eyles, & Elliott, 1999; Wakefield & Elliott, 2000). In the Oakville case, the residents' values and expectations become the basis for their safety and ontological security, and determine their responses and reactions to the impacts of the refinery.

Lazarus and Folkman (1984) developed environmental stress and coping theory which indicates that individual-level response to an environmental stressor, is an iterative process with two stages: primary appraisal, whereby the individual evaluates the stressor as a threat, harm or challenge; and secondary appraisal, which involves the evaluation of coping resources and strategies to deal with a stressor. In the case of secondary appraisal, one of two types of coping strategy may be used: (1) action or problem-focused coping, actions or strategies directed towards management of a problem or removal of the effects of the stressor; and, (2) emotion-focused coping, or regulating emotional responses to the problem (e.g., denial of the problem or adapting to the problem). Feedback occurs through the process of reappraisal, that is, ongoing reevaluation of the stressor, coping resources and

strategies, in response to changes in the characteristics (e.g., exposure intervention), conditions and context of the stressor (Taylor, Elliott, Eyles, Frank, Haight, Streiner, Walter, Norman, & Willms, 1991) and/or to changes in the individual's coping abilities (MacGregor & Fleming, 1996).

Environmental stress theory also makes connections to the importance of the local community setting (e.g., Edelstein, 1988; Elliott, 1992; Taylor et al., 1991). Community perceptions and responses involve a number of cognitive and behavioural processes (e.g., Edelstein, 1988; McGee, 1999; Taylor et al., 1991), involving people's beliefs and feelings about the hazard and the alteration of emotional responses to the negative situation (see also MacGregor & Fleming, 1996). In the Petro Canada situation, this may involve a change in the way people think about the refinery after the implementation of the odour reduction plan. There may also be behavioural response processes which include changes in the situation to reduce aversive outcomes such as moving from the community or staying indoors with windows closed when the air quality is poor. Both cognitive and behavioural efforts to manage specific external and internal demands can be appraised as taxing, or exceeding the person's resources (see Lazarus & Folkman, 1984).

Consequently, there are connections between the theoretical constructs of Giddens (1990) and Lazarus and Folkman's (1984) stress and coping theory at the community level. With this recognition we integrate these two theories to explore the coping strategies the Oakville residents continue to employ after the implementation of odour reduction measures. We have categorised Giddens (1990) notion of radical engagement under action or problem-

focused coping strategies. We categorised pragmatic acceptance, sustained optimism and cynical pessimism, a detailed classification provided by Giddens, under emotion-focused coping strategies by Lazarus and Folkman (1984).

As the Oakville residents confront the refinery issue, they may not only hold contradictory views toward the refinery's odour reduction measures, but they may also doubt the effectiveness and trustworthiness of the measures implemented by Petro Canada. That is, there may be a lack of trust in technical experts and expertise as lay members reconsider their views of science and technology. This lack of trust may in turn influence the types of coping strategies employed by the residents. These ideas form the conceptual background of risk reappraisal in the refinery situation and will guide the selection of methods and analysis of community perceptions and coping responses in the vicinity of the refinery.

5.2 Methods

5.2.1 Sample Selection

While the 1992 and 1997 health surveys focused on respondents' attention to issues related specifically to the refinery, depth interviews allow for the exploration of refinery-related experiences and concerns within the broader context of their lives in the community. Thus, the central thesis of this qualitative study is that environmental health issues are socially constructed and cannot be divorced from the broader social context within which they are situated (Elliott, 1992). This research was purposively designed to extend the findings of the two surveys in 1992 and 1997, and an in-depth study in 1995. In order to

integrate the quantitative and qualitative components of the ongoing research, we selected a sub-sample of respondents who participated in the 1997 epidemiologic study to participate in face-to-face interviews (see Morgan, 1998). To achieve maximum variation in residents' diverse opinions on the refinery effects, survey respondents were included in the sub-sample based on having lived in the community for at least five years and the following variables: zone of residence; degree of odour annoyance; change in odour perception over the past five years. Three main groups were defined (Table 5.1): Group A - residents who indicated in the survey that they were bothered a great deal by odours in 1997, but, thought odours had improved over the past five years; Group B - residents who indicated in the survey that they were bothered a great deal by odour in 1997 and thought odours were the same or had gotten worse over the past five years; and Group C - those who indicated in the survey that they never noticed odours or if they noticed odours, were never bothered by those odours, and thought odours had improved over the past five years.

< insert Table 5.1 >

Twenty of the 427 residents who completed the 1997 survey were in Group A, 17 in Group B, and 95 in group C . All respondents from groups A and B were selected , and twenty respondents from group C were randomly selected. A total sub-sample size of 57 respondents was deemed necessary to reach the target of 30 interviews - ten per group. Each of the 57 prospective respondents was contacted by letter (Appendix D) and phone to

inform them of the significance of the study, ask if they would like to participate, and solicit their consent. Overall, there was a 50% response rate across the three groups. Slightly more male (16) than female (13) respondents were interviewed. The age range was 32 to 78 years with a mean age of 49.1 years. Respondents average length of residence in the community was 18.0 years (Table 5.1).

5.2.2 Depth Interview Checklist

An interview checklist (Appendix E) of topics (semi-structured open-ended questions) for discussion provided the format for the depth interviews. The checklist went through several stages of review and revisions by the researchers. It was pre-tested (one researcher asked questions, and another took on the role of a resident) for clarity, organizational flow and length. It probed several different topics including: residents' quality of life and satisfaction with their community; perceptions of change in odour perception and annoyance; strategies used to cope with refinery effects; residents' health concerns; perceptions of vulnerable populations most affected by refinery emissions; other concerns and worries about living near the refinery; knowledge and opinions of the odour reduction measures implemented by the refinery; residents' information seeking behaviour about refinery-related issues; participation in citizens' groups and public meetings dealing with issues of the refinery; knowledge and opinions of the environmental hotline; and possible solutions to the problem of refinery odours. In addition, the checklist was designed to be flexible in allowing new questions to be added during the data collection process to facilitate

addressing issues that arose earlier on in that particular interview, or in previous interviews. All interviews were taped with the permission of the respondents who were guaranteed confidentiality.

5.2.3 Depth Interview Analysis

The interviews averaging 30 minutes in length were transcribed verbatim in order to accurately represent residents' views. The data were entered into NUD.IST qualitative software for further thematic analysis (see Richards & Richards, 1994). The analysis was guided by themes and constructs related to risk perception and reappraisal derived from environmental stress and risk literature (Baum et al., 1982; Baxter, et al., 1999; Edelstein, 1988; Lazarus and Folkman, 1984). The key categories of response for questions asked in the interview were created (based on a review of the key categories in the 1995 study - Wilson, 1996) prior to line-by-line coding, which is generally considered the most appropriate coding mechanism (see Corbin & Strauss, 1990). This was done in order to give a basic structure to the arrangement of the data gathered. This is an interactive and inductive process allowing for the data to direct the development of hierarchically organized key categories and subcategories. All twenty-nine transcripts were coded using the same coding scheme (see Appendix F for the detailed in-depth coding system). This was seen to be the most effective way of identifying similarities across and differences between groups. After coding was completed, the coding scheme was reorganized to increase the coherence of the categories and their linkages, and to better reflect the importance of the various categories

and subcategories as observed in the data (see also Wakefield & Elliott, 2000).

The key themes in this study were identified according to a number of criteria. First, since a predetermined set of research questions was identified, the elements or categories which best correspond to those topics were selected. Second, the theme codes with the largest number of mentions across stakeholder interviews were considered important. Third, the predominance of the same themes (universality) across different types of research participants was considered. Fourth, the differences of codes between participants were also assessed. Fifth, the relative importance of the categories within interviews was determined, as indicated by the number of mentions of a topic within an interview, the amount of text taken up to address an issue. Lastly, the emphasis given to a certain theme (“emphasis” here being a qualitative measure of emphatic speech) by the participants was assessed (see Wakefield, 1998).

Once the key theme codes were identified, the linkages between the various themes were examined, as were the relationships between these themes and individual differences. This analysis was undertaken to identify how different themes interact and influence each other, and also why differences between groups occur.

5.3 Results

The findings are organized around the main study objectives and the emergent themes related to: perceived changes in refinery impacts after the implementation of the odour reduction measures; community values and expectations; images and concerns about the refinery; coping strategies, and residents’ views on the ultimate solution of the refinery

situation. Tables (5.2 to 5.8) present numerical information on the occurrence of the themes in the interview texts, and reveal group differences. These numerical results only give a sense of how many respondents talked about the subjects represented by the themes. The frequency of mentions indicates the prominence of themes relative to other themes among the interview transcripts (see Silverman, 1993). From left to right, the columns in Tables 5.2 to 5.8 contain the theme from the NUD.IST index system; the next three columns indicate how often a topic was talked about by all three groups; the number of respondents who said something related to the theme (also expressed as a percentage of the total data set); and, the number of lines of text devoted to the theme as a percentage of the set of transcripts containing that theme respectively. The remaining columns show the frequency of mentions as well as the number of respondents mentioning that theme by group. The last row on every table shows the maximum number of mentions by the respondents for a particular theme (in this case general health concerns) in the entire data set. These tables provide context since they represent the range of sub-themes related to broad topics within the study (see Baxter et al., 1999; see also Morgan, 1993). Direct quotations from transcripts illustrate selected themes and serve to contextualize the responses.

5.3.1 Perceived Changes in Refinery Impacts

We examined residents' reappraisal of the impacts of the refinery by asking respondents if they perceived any changes in refinery odours and other pollution episodes since the odour reduction measures were implemented by the refinery (Table 5.2). Eight of

the 29 respondents reported that odours have stayed the same or gotten worse. The perception that there were no improvements was more common in group B. Bob's comments below reveals this feeling among residents:

For the eleven years I have been living here, there has been no real change in odours . . . nothing drastic to make me go "wow, that's not bad." . . . I still notice odour . . . It still stinks. **(Bob - group B)**

Rob goes further to express that even with the implementation of specific measures such as the installation of new stacks, odours from the refinery have not really improved:

. . . Even with the new stacks, I don't think that has made any difference whatsoever. I particularly notice it in the winter. I think they blast it [emissions] out when they think people aren't outside . . . There is no improvement. No, not even with the new stacks. No. **(Rob -group A)**

<insert Table 2>

While some residents reported no change in refinery impacts, overall, most of the respondents in the three groups expressed the view that odours have improved in the community in the past five years. There were 109 mentions by 21 (72%) respondents that odours had improved. This positive reappraisal of Petro Canada's odour reduction measures is demonstrated in the following passages:

We don't smell odours as much as we used to . . . Like in the summers when we first

moved here we would notice odour on a fairly regular basis, maybe every couple of weeks . . . It is a lot better now. We used to hate having visitors come here. It was embarrassing when you had visitors in the garden for a barbecue, and the smell would start coming. It was such a bad smell. **(Kristi - group A)**

Nevertheless, this positive reappraisal of the refinery efforts was punctuated by expressions of persistent concerns:

. . . we don't seem to have that putrid smell and the deposits on our cars or doorknobs . . . It was very bad, and it still exists but not to the same extent . . . It used to get right into your nostrils and you felt actually ill . . . It is not that choking . . . I haven't noticed that in the last 5 years. They have controlled it a lot, but it is still a concern . . . **(Colin -group B)**

. . . I would say odour is less . . . overall from the time that we first moved here up to now, it's better. It is not 100%, but it is better . . . Actually, no matter how much odours have improved, we still have concerns about the refinery. **(Jamie - group C)**

These signals of concern are centred around threats to residents' values and expectations, which are deeply held and connected to their ways of life.

5.3.2 Community Values and Expectations: Things People Value

Residents' values and expectations (Tables 5.3 and 5.4) serve as underlying reasons for many of them having initially moved to the community. The most frequently mentioned value by the residents in all three groups was peace and quiet. Other community values included safety, friendly neighbourhood, proximity to Lake Ontario and harbour and the good property values and sizes (Table 5.3). Table 5.4 displays residents' expectations from

the community. The most frequently mentioned expectation was the desire for a small town to raise children. Residents also expected to have access to fresh air in their community. As a community made up largely of parents, there was also a strong desire for amenities for their children, green space and the ability to move around freely without congestion.

<insert Tables 5.3 and 5.4>

Kaya and Godwin's comments were echoed by residents in all three groups. These comments are indicative of the type of place most of the residents in Oakville call home:

It is clean and relatively a crime-free . . . I like the wide open spaces. There's not a lot of traffic congestion so far . . . It is pretty nice place to live. I could never certainly go back to an urban area or a more congested suburban area. We like being close to the country. The Bruce Trail is just over the way . . . We came here to be close to a private school that my daughter goes to . . . This place is safe for children. (Kaya - group A)

I have lived here since 1984 . . . I like the fact that it seems more rural than it actually is. It's sort of like a rural area inside a city. So from that point of view it's quite nice . . . It's quiet. We've a park in the backyard, and lots of trees. And of course we have the Bronte Creek right there, running up the side. You can walk along the trails down there. Our children play down there. You don't have to go very far to be away from people, even though you're in an urban environment . . . that's why I like it. (Godwin - group B)

These quotations suggest an appreciation of a small town, supporting family life and raising children. Hence, irrespective of any improvements in refinery impacts, there may be profound problems if these values and expectations are perceived to be threatened by the

refinery. Yet, residents' images and concerns about the refinery reinforce their continued anxiety.

5.3.3 Images of and Concerns about the Refinery

Residents had various ways of characterizing risk around the refinery and expressing their underlying concerns. Overall, residents in groups A and B were more likely to hold negative images of the refinery. They frequently mentioned fears of invisible emissions, odours and accidents (Table 5.5).

<insert Table 5.5>

The images of and concerns about the refinery, together with other physical manifestations of contamination were linked to worries about possible effects of invisible contaminants. Consequently, some of the residents who indicated that odours have improved still recognized the dangers of invisible and odourless emissions, those that may be delayed in onset of effects (see Slovic, 1987; Vyner, 1988). These fears about invisible and odourless emissions are legitimated or heightened by soot deposits and residue on outdoor furniture, which are perceived as evidence of harmful and apparently invisible contaminants:

What makes me suspicious is that although there may be no odour, there's still that stuff going into the air . . . To me the odour is superficial . . . Okay, the odour frequency is down, but that doesn't mean in my mind the emissions are down. I still cough, cough, cough even when there's no smell. And as far as the emissions are concerned, what about the emissions we can't smell? (**Michelle - group A**)

It is not the smell that bothers me as much as the worry of what is emitted . . . The smell is secondary. I could live with the smell if I knew whether what is emitted is toxic or harmful in any way . . . I don't know whether they're masking the odours. I'm sure they have all the technology to do that [mask odours] if they wish, especially if it's causing a lot of grief . . . But you just don't smell it anymore. **(Godwin - group B)**

Also, provocative images like fears of fire or explosions reveal a profound dislike and a challenge to existing impressions of the community:

. . . There is really nothing else to complain about in this area, other than the refinery . . . if it were ever to blow up like the one in Mississauga, all those houses near the pipe lines would be gone. If you think about fire . . . all those tank farms there have many millions of gallons of fuel . . . and they [the refinery] can have all the safety features, but accidents happen . . . with all the pipe lines if an accident ever happened, the stuff will be blowing sky high. **(Bob - group B)**

The above comment lends lay support to Perrow's (1984) view that there is a public recognition that technological systems are so tightly coupled, that if something goes even remotely wrong in one segment it can lead to wide system failures and disastrous consequences. Further, visual cues, such as pipe lines and refinery stacks, compound residents' concerns:

The only thing we think about is the pipe lines that run from the refinery . . . If there ever was a mass explosion, we will be affected. **(Liz - group A)**

These negative images have far-reaching implications for the health and safety of the residents, as many of the concerns were related to health either directly or indirectly. It is not surprising that health concerns dominated the discussions of the impacts of the refinery in

all three groups (Table 5.6). The frequency with which health in general was mentioned in all groups showed the importance residents attach to their health and well-being (164 mentions, 25(86%) respondents). On balance, future health anxieties outweighed more immediate ones.

<insert Table 5.6>

5.3.3.1 *Children's Health*

Uncertainty and worry about health effects of the refinery strike directly at the core values of residents. Children's health stood out as the most frequently mentioned health concern (52 mentions, 20 respondents). Threats to core values trigger intense fear and worry as demonstrated by the comments below:

My concern is about the kids. There's a lot of cancer in the area . . . and my concern is, if it is related to the refinery . . . years ago when we first moved here, we would take our kids up to the field to fly their kites, and they come home with all their shoes looking black. **(Jamie - Group C)**

Well, my concern is about the kids. Respiratory problems seem to affect a lot of the kids in this neighbourhood. I know a couple who were living next door, and both their sons had asthma. And they've now moved to Waterdown and their symptoms have pretty well cleared up . . . Children are susceptible. **(Helen - group B)**

Some respondents viewed children as the 'victims' (see Williams, 1998) of the refinery situation. For instance Kaya questioned the involuntariness and unfairness of children's exposure to emissions:

. . . We have two children, and they're growing up, and they have to deal with this too. The long term basis for them it's even more of a risk . . . I think the children are the ones who are probably the worst off, because they're growing. And again without knowing what the actual implications of the emissions from the plant [refinery] are, I would think that they're the ones who are most affected. **(Kaya - group A)**

Concerns about children's health were typically greater among residents with children, and were reinforced by others voicing the same fears and concern on their behalf, as demonstrated by Kristi's comments:

I don't think the [refinery] problem is exaggerated . . . I think people with young children really have to worry about the refinery . . . because when it is bad, it is really bad . . . **(Kristi - group A)**.

5.3.3.2 Long Term Health Impacts

Linked to the refinery impacts on children was the fear of long term health impacts. Fifteen (52%) of the 29 respondents, especially those in Groups A and B, expressed concern about the long term impacts of the refinery on their health (Table 5.6):

My concern is about long term health effects. Right now we're having short term effects such as nausea and I don't know if we're going to have long term effects . . . **(Erica - group A)**

I think of the long term effects on my children. You know, I am afraid of birth defects and things like that . . . **(Angela - group B)**

The toxicity of refinery pollutants have remained an issue of debate, particularly at the relatively low levels of exposure typical of community settings (e.g., Bhopal, Tate, Foy, Moffatt, & Phillimore, 1999; Ziem, & Davidoff, 1992). Despite the equivocal nature of evidence, many of the residents seem to regard their health concerns in direct causal terms rather than in terms of probabilities (see Slovic, 1992), such that the refinery is seen as necessary and sufficient to cause long term health effects such as cancer. This idea is reinforced by Colin who talks about the cancer cases associated with the refinery:

. . . one major concern is that Halton county has one of the highest incidences of cancer. . . I was speaking to a friend of mine, and she said there are 14 people with cancer on her street alone . . . and that the street behind her has twelve . . . I really believe that Petro Canada is part of it. **(Colin - group B)**

However, some residents recognize the difficulties in the attribution of health effects to the refinery. For instance, Bret talks about the difficulties in determination of exposure and attribution of health effects to the refinery as a result of multiple exposures:

. . . as far as things affecting my health and my lungs, I've worked in the coal mines, and I worked there for so long. Where I work now, there are asbestos, there is mercury and all types of contaminants. I think if anything is going to kill me it is not the refinery . . . **(Bret - group C)**

While there was uncertainty surrounding the possibility of long term health effects in the vicinity of the refinery, residents were unequivocal about the short term effects. Typical short term health effects which were frequently mentioned were nausea, eye irritation and loss of sleep (see also Luginaah, Taylor, Elliott, & Eyles, 2000).

5.3.3.3 Psychosocial Impacts

Uncertainty and fears of long term health effects translate into psychosocial impacts in chronic exposure situations (see Elliott, 1998; Greenberg, Schneider, & Parry, 1995; Vyner, 1988). These impacts threaten deeply-held core values and thereby residents' security and stability. Hence, some respondents reported that the long term uncertainty with which they have to deal presents them with a difficult and stressful situation:

The long term health effect is a really creeping thing . . . That is my one nagging concern. Boy, I would be pissed off in 15 years if I found out I had some sort of cancer just from living downwind from that thing [refinery] when they knew what they were putting out into the air . . . I hope it's not something insidious and long term. **(Mike - group C)**

. . . It is just sort of an annoyance and a bit of outrage too. And that's stressful, you know... And just the outrage that you feel is because you know that they invading your environment like that and it's allowed to go on. I think that is unfair. **(Kaya - group A)**

5.3.3.4 Interconnectedness of Concerns

The effects of environmental risk are not limited to issues of public health. There are social issues such as threats to property values, jobs, and the regional economy in general (Eyles et al., 1993; Zeiss, 1999). In this respect, such risks threaten the health of the entire community. The community values and expectations (Tables 5.3 and 5.4) succinctly demonstrate that there is more at stake than health concerns. Further, the interconnections of these concerns point to the complexities in environment and health relationships and the fundamental importance of community values and expectations. This is demonstrated by Mike's comments below:

I love living here, but if I discovered tomorrow that there is a serious health problem from this stuff I will be gone. Probably lose all the money in our houses. It is a little nagging thing in the background. **(Mike - group C)**

For others, effects of the refinery are not really an issue. For these people, their good health is evidence of the lack of health risks in the area:

. . . I have not noticed any change in my health or any sort of symptoms that I would attribute to the plant . . . It doesn't bother me. **(Ron, group A)**

Overall, residents' images of the refinery, the fears of invisible emissions and concerns about future health impacts are set against the backdrop of a general lack of credibility and lack of trust for the refinery. As trust is eroded, residents' fears about invisible risks and other hazards intensify, increasing the potential for further misunderstanding and mistrust.

5.3.4 Trust and credibility of refinery emissions reduction

The notions of trust and credibility apply to the extent to which the residents believe Petro Canada is genuinely responding to their concerns, and to their conception of what is desirable or undesirable about the changes since 1992. These are important mediators of community responses and risk reappraisal in the Petro Canada situation (see Taylor et al., 1991). Table 6 reveals that for the most part the residents felt the refinery could not be trusted (57 mentions, 18(62%) respondents). It is interesting to note that most respondents in group C (those who indicated in the survey that they never noticed odours or if they

noticed odours, were never bothered by those odours, and thought odours had improved over the past five years) also reported a lack of trust in the operation of the refinery. Residents view the refinery management as not doing enough and/or not speaking the truth about the impacts of refinery emissions. In their view, the refinery appears to underplay the threats to everyday life and values that the residents themselves hold dear. In some cases, this marked mistrust of the refinery is extended to government as well. These perceptions are captured in Sarah's comments:

It is just that I'm very cynical about corporations and what they promise to do . . . And I don't have a lot of faith in government officials either . . . I have a daughter who is working in the government in several levels, and I just know the shit that goes on when it comes to the environment. What if the refinery says "oh well, we'll close it [emissions] off now but we'll let it out later in the night." So I don't trust them. No! You've got to earn trust. **(Sarah - group A)**

According to Beck (1992b), 'progress' and 'scientific rationality' are particular victims of this critical appraisal by the public, engendering a further decline of trust in both science and technology. The result is that technological risks are seen as less tolerable and/or justifiable. These views are captured in Godwin's comments below:

I think the Petro chemical industry over the years has built themselves a reputation of being untrustworthy . . . We know they're making products that we probably use on a daily basis, but what are the by-products of that. What will be the fallout when things go wrong? Those are the sort of worries I get from that place [the refinery]. You are left wondering some nights whether you should be breathing it at all. They seem to release emissions at night when people are sleeping so that they don't get any phone calls. So I just basically don't trust them . . . I have no confidence in them. And I wouldn't even trust the government either, they are agreement with these people because they make money from them. **(Godwin - group B)**

This lack of trust and tolerance for risk have implications not only for the experience of environmental stress and contaminant effects on well-being, but also for the type of coping strategies employed by residents.

5.3.5 Coping Strategies

In this climate of distrust and anxiety respondents resorted to both action-focused and emotion focused strategies in response to the threats the refinery (Table 5.7). It is important to emphasize that coping is an iterative process characterised by reevaluation of the risk depending on the characteristics of the exposure, the individual, the community and the social network (Lazarus & Folkman, 1984; Edelstein, 1988; Taylor et al., 1991).

<insert Table 5.7>

5.3.5.1 Action-focused strategies

Respondents in groups A and B more frequently talked about the coping strategies they employ to reduce the impacts of the refinery. The most common action taken to cope with the effects of the refinery was to stay indoors and/or close their windows. Nevertheless, this was not seen as a pleasant option by many residents:

It [refinery] makes me feel nauseous. I can't really sit outside for long periods of time . . . sometimes the whole house would smell, and I would get up in the middle of the night to close the windows . . . I like to have my window open when I sleep since we don't have a central air conditioner. So I open the windows at night, but if it starts

to smell I have to close all the windows and then I start to feel claustrophobic.
(Peggy - group A)

Residents' determination to stay in the neighborhood meant the employment of other coping strategies such as using indoor air appliances to minimize the impacts of the refinery:

In order to cope, I have a high quality air filter. I don't smell emissions inside the house. My indoor quality air is very high. Outdoor is different, it is really bad. **(Bob - group B)**

Even though some residents can choose to move, moving was not a popular choice among residents who were strongly attached to their community. This is consistent with our survey findings whereby in both 1992 and 1997 more than 80% of those interviewed reported they were not likely to move from the community because of the refinery. The choice to stay was motivated by residents' appreciation of the community and the characteristics of their social networks (see Edelstein, 1988; Taylor et al., 1991):

It is a shame . . . this is a beautiful neighbourhood. I just don't want to move out of here, but we have thought about it a couple of times. Because some of the summers, sometimes you just want to sit outside for an hour, but when the smell is so bad you have come in, and you can't open the windows . . . if something comes out of the refinery now, I would have to run around and close everything up. I keep everything closed most of the time . . . I don't think there's anybody in this street who open their windows at night . . . **(Michelle - group A)**

We have gone through a lot of bad times because of the refinery . . . My son lived across the street and he said his daughter developed a very bad allergy. My son said he came outside one night and was actually choking, so that's when they decided to move . . . I knew a woman up in Wyandotte, she moved because of the refinery . .

. Our minister and his family lived on Bronte Road, they moved because the rectory was right across the creek which borders the refinery property . . . You know, for me I keep saying every year, we're going to move to where the air is a little purer or whatever, but we're still here because it's hard to break away when you have a lot of friends and family's close by. **(Colin - group B)**

Other action focused strategies reported by respondents included talking to neighbours, information gathering, attendance at the refinery 'open house' during which residents are taking on a tour of the refinery to learn about the processes that go on and the safety measures the refinery has in place. While respondents supported radical engagement as a helpful strategy in "forcing the refinery to do something", none of the people interviewed was involved in organized community opposition or liaison. However, the evidence of radical engagement in the overall refinery situation stems from the community concerns that led to the formation of the Community Advisory Committee to Petro Canada (Arnold, 1999), the 1992 health study, the refinery's implementation of odour reduction measures, and the follow-up study of 1997.

5.3.5.2. Emotion-focused strategies

The emotion-focused strategies reported by respondents (Table 5.7) were consistent with the theoretical constructs developed in the environmental stress literature (Lazarus & Folkman, 1984), and in the risk society literature (see Giddens, 1990).

Pragmatic Acceptance

For the most part the three groups adopted the attitude of pragmatic acceptance and seemed to have resigned themselves to the presence of the refinery in their community, acknowledging that when you live close to a refinery you have to expect some odours:

I don't worry about the refinery. I mean, it's just like if you live on a farm . . . you're going to have a smell of manure and cattle, especially in warm weather. Well, if you are living close to a refinery you're going to smell something, same as people who live close to Stelco or live in Hamilton. They get black soot and what have you. You're going to get something, you have to accept it. **(Erica - group A)**

Others, while concentrating on surviving, “denied the dangers” or “turned inwards” (Giddens 1990, p.135). In this way, residents separated their concerns from the routines of everyday life (see also Wakefield and Elliott, 2000). Others reported that they tried not to think about the refinery in order to remain focused on what they considered more important issues in their lives. As Beck (1987, p.161) puts it “in the end, no one wants to know about things they cannot change and which turn their way of life upside-down.” This withdrawal into their everyday lives could be seen as an attempt to preserve their ontological security by bracketing out (Beck 1992a; Giddens, 1990) the distressing issues and images of the refinery:

. . . they keep it [refinery] decorated nicely in winter . . . You know, if you really think about it . . . I don't like to think that it is possible it can blow up. If it blows up, we would all be gone with it. So I really don't want to focus on it and think about it, it could scare the heck out of me. I don't think about it. **(Colin - group B)**

The pervasiveness of risk may also have resulted in some degree of public acceptance . This

is indicated by Kaya's comments :

There is a great irony in my particular situation because I moved from one industrial place near the beach where it was all noise pollution to High Park. There, they had a meat packaging plant and it stunk really bad. So I moved to Etobicoke and found myself in one of the most highly polluted areas in Canada . . . And then I moved out here I thought I was coming to paradise only to find out I'm right downwind of a big refinery. So I was back to my initial concern! . . . There is no way you can get away from these things. You have to suffer through it. You have no choice but to accept them. **(Kaya - group A)**

Some respondents accepted the refinery by acknowledging that "the refinery was in the community first".

I would have to say it's never been a problem for us, to be quite honest. Do I worry about it, day in and day out? Or does it bother me? No. I mean, I chose to live here. It wasn't as if we bought this house and the refinery was built after the housing development. I mean, we knew, and that was some years ago. The refinery was here first. **(Ron - group A)**

The precedence argument (the refinery was there first) was used by some to place blame onto those residents who were expressing concerns:

. . . Now sometimes we do get it, but I figure it was here when we moved here, so why complain? . . . A lot of people will bitch about it, but they have to accept it because the refinery was here first . . . I would say if you're going to live here, there's nothing to bitch about. **(Sean - group C).**

Other residents effectively distanced themselves from the impacts of the refinery by focusing

on the high-risk groups, and by separating young children and their families from the rest of the community, as those who are sensitive and should worry:

I have no problems. Some people are more susceptible. People who are maybe not in really good health, older people, or people with asthma or something. . . Or mothers' may worry about children, if there is a smell around but I don't. **(Bret - group C)**

Sustained Optimism

While pragmatic acceptance is characterized by a sense of powerlessness and distancing from the refinery issue, sustained optimism is a means of coping whereby respondents relinquish power to 'experts' (in this case the CAC-PC and the refinery management), hoping that this expertise, and science more generally (Giddens, 1990, p. 136), offer long-term sources of security and will protect them from negative consequences. Sustained optimism is essentially the persistent faith in science and technology, and providential reason despite the dangers that threaten society and regardless of the lack of trust and credibility for scientific experts and government (see Beck, 1996; Giddens, 1990). Sustained optimism was a common theme based on the conviction that the 'latest technology' offers sources of long-term solutions to the refinery problem:

Actually, with the technologies out there, I am sure that at one point they're going to be able to find the technology that will eliminate everything [all emissions and odours]. **(David - group A)**

Sustained optimism has also resulted in "apparent pursuit of zero-risk" (Slovic, 1987, p.

280) by some respondents. This is consistent with public belief that advances in knowledge about the consequences of risk or technological solutions will make it possible to avoid encounters with risk in daily life (see Beck, 1996; Cutter, 1993; Slovic, 1987). This view is demonstrated by Michelle and Amy's comments:

I would not necessarily like to see the refinery closed down, but realistically, I would like the odours stopped. And I don't see why they can't do that. The technology is out there today . . . sure we've got things to do that. I don't expect that to be so difficult **(Michelle - group A)**

I hope that with modern technology the refinery will improve to the point that odours are removed . . . I hope perhaps they would continue to improve as best as they can with the technologies that we have this point in time. **(Amy - group C)**

Others were less optimistic as they doubted the refinery's credibility and willingness to incur the necessary cost to reduce emissions:

. . . I've heard of new high-tech systems that are available . . . I'm just saying that the technology is out there to really cap off the stacks so that they're almost at zero emission. But the problem is that Petro Canada would have to spend money to do that, and unless their hands are forced as they were with the abatement issue, that won't happen. **(Kaya - group A)**

There was little evidence of cynical pessimism. Giddens (1990) indicated that cynical pessimism involves the use of "black humour". It is an emotional coping strategy whereby humour or world-weary responses are used as demonstrated by Fiona and Godwin's comments:

. . . what concerns me is the alarms and sirens we hear quite often . . . Yes, there is a loud siren . . . and we hear it quite frequently . . . then you stop and go 'hmm', what is happening. But my husband keeps assuring me that if the refinery ever blew up, we would be gone [died] before we have to worry about it. Great security! **(Fiona - group B)**

. . . I was awakened by a colossal ka-boom noise, and I heard the sirens going over there . . . I wondered what has exploded. Well, I thought if it really blows up we will all be cooked here. **(Godwin - group B)**

5.3.6 Ultimate Solution of the Refinery Situation

One theme that best captures residents' views on an ultimate solution to the refinery problem was in some ways related issues of environmental equity and to the NIMBY syndrome (see Munton, 1996). This is the view that the refinery should "go somewhere else" (Table 5.8), especially 'up North' where it is rural with a lot of open space:

I usually don't even want to look at it [refinery], it is depressing. As far as I am concerned, I'd like to see them gone . . . I can't understand how the city of Oakville can allow houses to be that close to such a refinery. It must have some sort of effect on people . . . Refineries don't belong in communities like this. Refineries belong up north where there are no residential houses around . . . There's a lot of land up north, where you can put these refineries . . . They shouldn't be here. **(Mark - group B)**

They've got to go somewhere. It's a bit like "not in my backyard." But I don't know where they should be going. **(Sunny - group C)**

While some residents felt that the refinery should be somewhere else, others acknowledged that the refinery predated much of the surrounding residential development.

The refinery was here first . . . But the only solution that would satisfy everybody would be the plant to go . . . and they don't seem to want to go. That would make everybody happy. Either go, or be told to go somewhere and pollute in a vast open space . . . or stop polluting. If they want to stay here, they can't pollute. **(Mike - group C)**

<insert Table 5.8>

A majority felt that the refinery should continue its efforts to reduce emissions with the ultimate solution being to eliminate odours entirely.

. . .I think they should continue to improve. They should never think that they have solved the problem, because they haven't. Until it is totally odour free, they have not solved it . . . what they have to do is develop the best possible strategy to keep the emissions as low as possible. **(Kristi - group A)**

The attractiveness of zero risk has been demonstrated by Tversky & Kahneman (1981). They showed that “a protective action which reduces the probability of harm from 1% to zero, say, will be valued more highly than an action that reduces the probability of the same harm from 2% to 1%” (p. 456). The pursuit of zero-risk is linked to the public's belief that the technology is out there to eliminate emissions and odours completely (see Nakayachi, 1998; Slovic, 1987). However, some respondents suggested that the ultimate solution of the refinery situation is an improved partnership with the community as demonstrated by Peggy's comments:

Well, I think that the most important thing is just to keep the liaison open . . . educate the residents to understand exactly what the refinery is doing. But then, we also have to be a little more tolerant of the refinery. **(Peggy - group A)**

Although there was a positive reappraisal of the odour reduction measures, residents still reported concerns about the impacts of the refinery. The findings also show that residents may be shifting their concerns, as they continued to employ various coping strategies.

5.4 Discussion and Conclusions

Oakville is a community in which many residents enjoy a comfortable lifestyle and are concerned to protect themselves against dangers that threaten their core values (see Baxter et al., 1999). Perceived threats to residents' core values resulted in community opposition which triggered the implementation of the odour reduction plan by the refinery. The links between residents' responses, coping strategies, and the refinery after the implementation of the odour reduction plan are shown in Figure 5.2.

<insert Figure 5.2>

Within the framework the residents confront the refinery issue through dual lenses (societal and/or individual). In a risk society, technologies which were invisible to the public in the past are now more visible as people find it harder to ignore and/or cope with the threats from these technologies (see Beck 1992a; Vyner, 1988). On the one hand, society starts to question the uncertainties and decisions by experts associated with technological hazards as their exposure to risks increase, with constant threats to their everyday lives. On the other, there is a belief that advances in knowledge about the consequences of risk or

technological solutions will make it possible to avoid encounters with risk in daily life.

Many of the Oakville residents moved to the community expecting a place that is safe, quiet, clean and slow growing, for raising children. However, the presence of the refinery in the community is seen as a constant threat to residents' everyday lives, and in conflict with their values and expectations. Most of the residents' concerns are centred around threats to their core values, which are deeply held and connected to ways of life that have long histories in the community or have been vigorously sought out and created by residents (Baxter and Eyles, 1999). Concerns about future health risks were typically greater among residents with children and were reinforced by others voicing the same concerns on their behalf. This is consistent with earlier studies where children's health emerged as one of the strongest factors motivating action and prompting thoughts about moving from the area (see Taylor et al., 1997; Wilson, 1996).

In the wake of the refinery's intervention (odour reduction plan), the majority (109 mentions; 21(72%) respondents) indicated that the odorous emissions had improved from 1992 to 1997. Yet some residents still perceived the refinery as a threat to their way of life, and continue to demand the refinery should close down or relocate somewhere else. Catastrophic fears about the refinery (e.g., explosions and fire), together with dreadful images in the form of visual cues (e.g., flares, smoke stacks) constantly remind residents of the threats to their values and expectations, and therefore create considerable anxiety. Further, residents view the refinery as a technology with impacts that are, in some respects, unknown to experts and unknown to science (see Slovic, Fischhoff, & Lichtenstein, 1982).

Consistent with the theoretical constructs of this study, in situations of uncertainty, trust in technical experts, in science and technology, and in government becomes particularly problematic (see Beck, 1992a; Giddens, 1990). This was evident as some respondents (62%) persistently raised the issue of lack of trust and credibility of the refinery's efforts. The cumulative effect of uncertainty, lack of trust and credibility is that the residents perceive the refinery impacts in direct causal terms. As a result, the incidence of cancer and ill-health reporting by residents was subject to over-interpretation and unfounded attribution to the refinery (see Luginaah et al., 2000).

As the reappraisal process is ongoing, residents' fear and anxiety as a result of the high level of uncertainty and lack of trust, may have determined much of the direction and nature of residents' shifting concerns in two respects. First, expectations shifted in response to perceived improvements in odours, to a focus on the threats of invisible and odourless contaminants, and the demands for the total elimination of emissions and odours. Fear about invisible emissions reinforced the lack of trust of the refinery. With sufficient distrust, no emissions from the refinery will be tolerated and no demonstration of safety measures will be believed by some residents (e.g., vulnerable groups such as residents with children). Second, there was a shift in the experiences of physical health effects through psychosocial health to a focus on the health of a community where residents can live without any threats to their deeply held values and expectations.

Uncertainty, lack of trust and shifting concerns influenced residents' coping strategies even after the implementation of the odour reduction measures (Figure 5.2).

Vyner (1988) indicates that when a threat itself is fraught with uncertainty, people often find it difficult to cope with the threat. Amidst these difficulties, the Oakville residents employed a variety of coping strategies to help minimize the impacts of the refinery. Overall, both action- and emotion- focused coping strategies as identified by Lazarus and Folkman (1984) and Giddens (1990) were used depending on such factors as intensity of odours, seasonality, time of day and wind direction. The action focused strategies uncovered in this study suggest that Giddens' (1990) notion of radical engagement which involves practical contestations of social and institutional forces, is only one possible action residents can take in response to complex environmental hazard situations. For instance, adaptive reactions outlined by Giddens do not account for actions such as information gathering, moving from the community and talking to neighbours as means of coping.

With emotion focused coping, the categorization of pragmatic acceptance, sustained optimism and cynical pessimism, outlined by Giddens, provides a detailed list of the types of emotional coping strategies in environmental risk situations. The reduced impacts of refinery emissions reported by the respondents may suggest why many of them adopted the attitude of pragmatic acceptance - "there is nowhere to hide, we just accept it." However, the irony of this type of coping strategy is that people become so shocked when something actually does happen. Ongoing feelings of powerlessness and a sense that even everyday life is outside of one's control can limit the effectiveness of these strategies and necessitate the use of multiple coping strategies, either consecutively or concurrently (see also Wakefield & Elliott, 2000). Also, the nature of Oakville (an upper-middle class community) fosters an

independence in local residents, which probably encouraged the use of individual coping strategies, and hence the lack of collective coping responses (see McGee, 1999). While residents do not trust the refinery, their desire for a healthy community resulted in some residents sustaining an optimism that with the “latest technology” the refinery will be able to ultimately eliminate all emissions (see also Slovic, 1987).

The belief that a risk-free society is achievable generates unrealistic expectations in communities where the presence of any risk (perceived or actual) is unacceptable. In a risk society, the appeal of zero risk is very strong (see Kahneman, Slovic, & Tversky, 1982; Nakayachi, 1998; Tversky & Kahneman, 1981). However, as Cutter (1993) points out there is no such thing as risk-free environment despite public preoccupation with a zero-risk society. Nevertheless, if residents perceive that their values and expectations are threatened, they will strive to eliminate perceived risks in their community, even as those risks diminish and their environment becomes safer, unless they are told that zero risk is impossible (see Nakayachi, 1998).

This study contributes to the literature on technological and environmental risks, particularly to our understanding of how communities respond to industry’s efforts to mitigate widespread chronic exposure. Even though our findings are mostly consistent with Lazarus and Folkman’s (1984) theory of environmental stress and coping, there are some points of departure. By revealing the nature of residents’ shifting concerns in the community, we have unearthed potentially obscured layers and the multiple stages of concern that have implications for the reappraisal of environmental risk. Lazarus and Folkman’s (1984) model

is flexible and very useful for the empirical study of the reappraisal process. However, as a general model it does not discriminate between different types of stressors nor different layers of concern by exposed individuals (see also Hampson, 1997).

The findings also show that residents' expressed concerns in a chronic exposure situation may be indicators of more fundamental concerns, like threats to life and core values (see also Baxter et al., 1999). Therefore even if expressed concerns are dealt with appropriately through mitigation measures, this does not ensure that the underlying concerns are also addressed. The implication is that psychosocial impacts as a result of chronic exposure involve not only the appraisal of the hazard and use of coping resources, but also the appraisal of the institutional experts (refinery management) to manage the hazard appropriately.

In Oakville, the threats to residents' values and expectations resulted in community opposition and subsequently the refinery's odour reduction plan. Hence, this study shows that environmental threats to peoples' valued way of life can lead to individuals effecting extensive institutional changes through opposition (Arnold, 1999). The risk society theory is therefore useful for understanding the context of everyday life and for describing how individual effects and actions may be tied to social and institutional changes. By providing evidence at the local community level which supports many of the risk society concepts developed with a global focus, this study adds to the emerging studies that have used Giddens' and Beck's theory at the local level (e.g., Baxter et al., 1999; Wakefield & Elliott, 2000).

The flexibility of Lazarus and Folkman's model enabled us to bring together two different but complementary theories to explain complex environment and health relationships. Lazarus and Folkman's (1984) environmental stress and coping theory is related to individual processes (micro level) and does not encompass the complex social processes embedded at the community level. On the other hand, risk society theory (Beck, 1992a, 1992b; Giddens, 1990, 1991) was developed with a societal and global focus (macro level). We suggest that the community is the social scale at which it makes sense to connect these two theories.

Our findings also support the notion that risks are more a consequence of the way people view them, than of any objective measure of risk or mitigation intervention. This is consistent with the literature on lay vs. expert perceptions of risks (see Beck, 1996; Giddens, 1990; Slovic, 1987). Much of the refinery's response to community concerns has been to find ways to control fugitive and accidental emissions. Meanwhile, the technically successful risk mitigation measures by the refinery, which have resulted in the declining number of complaints about odours (see CAC-PC, 2000), have failed to achieve a corresponding reduction in public concern because any remaining hazard is considered dangerous and unacceptable. Yet the CAC-PC and the refinery continue to focus their attention on the decline in complaints, so much so that convincing the community of low risk seemed less of a priority than presenting numbers that odour complaints are on the decline (see Arnold, 1999). In this case, there are and will always be competing and conflicting value claims, interests and viewpoints implicated in the process of defining the risks as

residents continue to view the refinery in a critical way (see Beck, 1992a; Douglas & Wildavsky, 1982; Giddens, 1990). This critical process led some individuals to the conclusion that the refinery is not 'doing enough' to eliminate emissions completely, and that neither the refinery nor the government can be trusted, and that their core values were in danger. Therefore, the CAC-PC, refinery and government must recognize people do not socially construct belief systems only in relation to hazard itself, but that hazard perception itself is part of deeply-rooted core values about life itself.

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TABLE 5.1: Characteristics of Study Samples by Group

| Characteristic | Group A | Group B | Group C | Total |
|---|---------|---------|---------|-------|
| Sample Size | 11 | 8 | 10 | 29 |
| Females | 7 | 3 | 3 | 13 |
| Marital Status | | | | |
| Married/Partner | 9 | 5 | 5 | 19 |
| Widowed/Separated/Never Married | 2 | 3 | 5 | 10 |
| Mean Age | 47.5 | 46.5 | 52.7 | 49.1 |
| Education | | | | |
| Some/Completed High School | 4 | 3 | 2 | 9 |
| Some/Completed College | 7 | 5 | 8 | 20 |
| Bachelors/Postgrad | | | | |
| Mean Annual Household Income (Thousands) | 72 | 71.6 | 61.6 | 67.6 |
| Mean Number of Years in Current Residence | 12 | 18.3 | 16.2 | 15.2 |
| Mean Number of Years in Community | 13.7 | 19.3 | 22.3 | 18.2 |

TABLE 5.2: Reappraisal of Refinery Efforts

| Improvement | Total (n=29) | | | Group A (n=11) | | | Group B (n=8) | | | Group C (n=10) | | |
|--|--------------------|---------------------------|------------------------------|--------------------|-----------------------|--------------------|-----------------------|--------------------|-----------------------|--------------------|-----------------------|--|
| | Number of Mentions | Number of Respondents (%) | Percentage of all Interviews | Number of Mentions | Number of Respondents | Number of Mentions | Number of Respondents | Number of Mentions | Number of Respondents | Number of Mentions | Number of Respondents | |
| Improved | 109 | 21(72) | 2.9 | 45 | 9 | 30 | 4 | 34 | 8 | | | |
| Stayed the same | 15 | 5(17) | 0.8 | 3 | 1 | 9 | 2 | 3 | 2 | | | |
| Worse | 10 | 3(10) | 0.3 | 2 | 1 | 8 | 2 | . | . | | | |
| Maximums for community data set: Number of Mentions - 164; Number of residents who mentioned topic - 25 (86%) | | | | | | | | | | | | |

TABLE 5.3: Things people value in the community

| Theme/Topic | Total (n=29) | | | Group | | | | | |
|--|--------------------|---------------------------|------------------------------|--------------------|-----------------------|--------------------|-----------------------|--------------------|-----------------------|
| | Number of Mentions | Number of Respondents (%) | Percentage of all Interviews | A (n=11) | | B (n=8) | | C (n=10) | |
| | | | | Number of Mentions | Number of Respondents | Number of Mentions | Number of Respondents | Number of Mentions | Number of Respondents |
| Quiet/Peaceful | 32 | 23 (79) | 0.28 | 13 | 10 | 7 | 5 | 12 | 8 |
| Safe | 19 | 14(48) | 0.21 | 10 | 6 | 3 | 2 | 6 | 6 |
| Lake and Harbour | 16 | 11 (38) | 0.27 | 10 | 5 | 1 | 1 | 5 | 5 |
| Friendly | 12 | 10(34) | 0.15 | 3 | 3 | 4 | 4 | 5 | 3 |
| Property values | 11 | 6(21) | 0.12 | 3 | 1 | 3 | 2 | 5 | 3 |
| Good property sizes | 9 | 6(21) | 0.2 | 4 | 2 | 2 | 1 | 3 | 3 |
| Privacy | 4 | 3(10) | 0.2 | 1 | 1 | 2 | 1 | 1 | 1 |
| Maximums for community data set : Number of Mentions - 164; Number of residents who mentioned topic - 25 (86%) | | | | | | | | | |

TABLE 5.4: Residents expectations from the community

| Theme/Topic | Number of Mentions | Number of Respondents (%) | Percentage of all Interviews | Group | | | | | |
|---|--------------------|---------------------------|------------------------------|--------------------|-----------------------|--------------------|-----------------------|--------------------|-----------------------|
| | | | | A (n=11) | | B (n=8) | | C (n=10) | |
| | | | | Number of Mentions | Number of Respondents | Number of Mentions | Number of Respondents | Number of Mentions | Number of Respondents |
| Small nice town vs. city | 23 | 18(62) | 0.35 | 13 | 11 | 8 | 5 | 2 | 2 |
| Place to raise kids | 24 | 13(45) | 0.27 | 11 | 5 | 8 | 5 | 5 | 3 |
| Fresh air | 21 | 15(52) | 0.31 | 8 | 7 | 10 | 6 | 3 | 2 |
| Access to amenities | 19 | 12(41) | 0.26 | 10 | 6 | 7 | 4 | 2 | 2 |
| Green space | 14 | 10(34) | 0.15 | 3 | 3 | 2 | 1 | 9 | 6 |
| Access to highway | 12 | 9(31) | 0.16 | 4 | 4 | 3 | 3 | 5 | 2 |
| No congestion | 11 | 9(31) | 0.24 | 6 | 4 | 5 | 3 | 2 | 2 |
| Bicycle/Walking trails | 9 | 5(17) | 0.27 | 7 | 4 | 2 | 1 | - | - |
| Nature | 4 | 4(14) | 0.11 | 1 | 1 | 1 | 1 | 2 | 2 |
| Max imums for community data set : Number of Mentions - 164; Number of residents who mentioned topic - 25 (86%) | | | | | | | | | |

TABLE 5.5: Residents Images of the Refinery

| Images | Total (n=29) | | | Group | | | | | |
|-------------------------------|--------------------|---------------------------|------------------------------|--------------------|-----------------------|--------------------|-----------------------|--------------------|-----------------------|
| | Number of Mentions | Number of Respondents (%) | Percentage of all Interviews | A (n= 11) | | B (n=8) | | C (n=10) | |
| | | | | Number of Mentions | Number of Respondents | Number of Mentions | Number of Respondents | Number of Mentions | Number of Respondents |
| Invisible/Odourless emissions | 51 | 18 (62) | 1.4 | 26 | 8 | 19 | 6 | 6 | 4 |
| Refinery odours | 49 | 13 (45) | 1.1 | 13 | 5 | 33 | 7 | 3 | 1 |
| Accidents | 34 | 13 (45) | 0.8 | 12 | 6 | 20 | 5 | 2 | 2 |
| Noise annoyance | 34 | 7 (24) | 0.55 | 6 | 2 | 14 | 3 | 14 | 3 |
| Traffic | 24 | 6 (21) | 0.18 | 11 | 3 | 7 | 2 | 6 | 1 |
| Soot & other deposits | 21 | 6 (21) | 0.32 | 11 | 2 | 9 | 3 | 1 | 1 |
| Fire from flares | 11 | 6 (21) | 0.18 | 1 | 1 | 8 | 3 | 3 | 2 |

Maximums for community data set : Number of Mentions - 164; Number of residents who mentioned topic - 25 (86%)

TABLE 5.6: Residents Concerns of the Refinery

| Concerns | Total (n=29) | | | Group | | | | | |
|---|--------------------|---------------------------|------------------------------|--------------------|-----------------------|--------------------|-----------------------|--------------------|-----------------------|
| | Number of Mentions | Number of Respondents (%) | Percentage of all Interviews | A (n=11) | | B (n=8) | | C (n=10) | |
| | | | | Number of Mentions | Number of Respondents | Number of Mentions | Number of Respondents | Number of Mentions | Number of Respondents |
| Health in general | 164 | 25 (86) | 3.7 | 69 | 11 | 62 | 8 | 33 | 7 |
| Health <i>Children's health</i> | 52 | 20 (69) | 1.5 | 22 | 9 | 20 | 7 | 10 | 4 |
| <i>Long-term</i> | 47 | 15 (52) | 1.2 | 15 | 7 | 22 | 5 | 10 | 3 |
| <i>Short-term</i> | 36 | 12 (41) | 0.45 | 21 | 6 | 12 | 5 | 3 | 1 |
| <i>Psychosocial</i> | 29 | 13 (45) | 0.56 | 11 | 7 | 8 | 4 | 10 | 2 |
| Lack of trust and credibility | 57 | 18 (62) | 2.6 | 27 | 8 | 21 | 4 | 9 | 6 |
| Satisfaction with community | 33 | 15 (52) | 0.66 | 13 | 6 | 14 | 6 | 6 | 3 |
| Poor involvement in community | 21 | 10 (34) | 0.46 | 6 | 4 | 10 | 4 | 5 | 2 |
| Property values | 12 | 6 (21) | 0.18 | 5 | 1 | 3 | 2 | 4 | 3 |
| No where to hide | 9 | 7 (24) | 0.27 | 2 | 2 | 3 | 2 | 4 | 3 |
| Maximums for community data set: Number of Mentions - 164; Number of residents who mentioned topic - 25 (86%) | | | | | | | | | |

TABLE 5.7: Coping Strategies

| Coping Strategy | Number of Mentions | Number of Respondents (%) | Percentage of all Interviews | Group | | | | | |
|---|--------------------|---------------------------|------------------------------|--------------------|-----------------------|--------------------|-----------------------|--------------------|-----------------------|
| | | | | A (n=11) | | B (n=8) | | C (n=10) | |
| Problem/Action - Focused | | | | Number of Mentions | Number of Respondents | Number of Mentions | Number of Respondents | Number of Mentions | Number of Respondents |
| Stay indoors/Close windows | 34 | 16 (55) | 0.89 | 22 | 8 | 9 | 6 | 3 | 2 |
| Considered moving | 16 | 7 (24) | 0.37 | 6 | 4 | 9 | 2 | 1 | 1 |
| Use air filters/ conditioner | 9 | 8 (28) | 0.17 | 2 | 2 | 6 | 5 | 1 | 1 |
| Emotion-Focused | | | | | | | | | |
| Pragmatic acceptance | 54 | 22 (76) | 0.97 | 21 | 10 | 17 | 6 | 16 | 6 |
| Sustained optimism | 10 | 7 (24) | 0.46 | 4 | 3 | 5 | 3 | 1 | 1 |
| Cynical pessimism | 3 | 3 (10) | 0.25 | 1 | 1 | 2 | 2 | . | . |
| Maximums for community data set: Number of Mentions - 164; Number of residents who mentioned topic - 25 (86%) | | | | | | | | | |

TABLE 5.8: Ultimate Solution of Refinery Problem

| Solution | Total (n=29) | | | Group | | | | | |
|---|--------------------|---------------------------|------------------------------|--------------------|-----------------------|--------------------|-----------------------|--------------------|-----------------------|
| | Number of Mentions | Number of Respondents (%) | Percentage of all Interviews | A (n=11) | | B (n=8) | | C (n=10) | |
| | | | | Number of Mentions | Number of Respondents | Number of Mentions | Number of Respondents | Number of Mentions | Number of Respondents |
| Go somewhere else | 37 | 12 (41) | 0.78 | 7 | 5 | 22 | 5 | 8 | 2 |
| Strive to improve | 30 | 16 (55) | 0.72 | 16 | 6 | 7 | 5 | 7 | 5 |
| Zero odours from refinery | 30 | 12 (41) | 0.84 | 13 | 4 | 10 | 5 | 7 | 3 |
| Use latest technology | 22 | 16 (55) | 0.46 | 10 | 6 | 7 | 6 | 5 | 4 |
| Improve involvement in community | 19 | 11 (38) | 0.61 | 7 | 4 | 4 | 2 | 8 | 5 |
| Close down the refinery | 10 | 7 (24) | 0.24 | 6 | 4 | 2 | 1 | 2 | 2 |
| Maximums for community data set: Number of Mentions - 164; Number of residents who mentioned topic - 25 (86%) | | | | | | | | | |

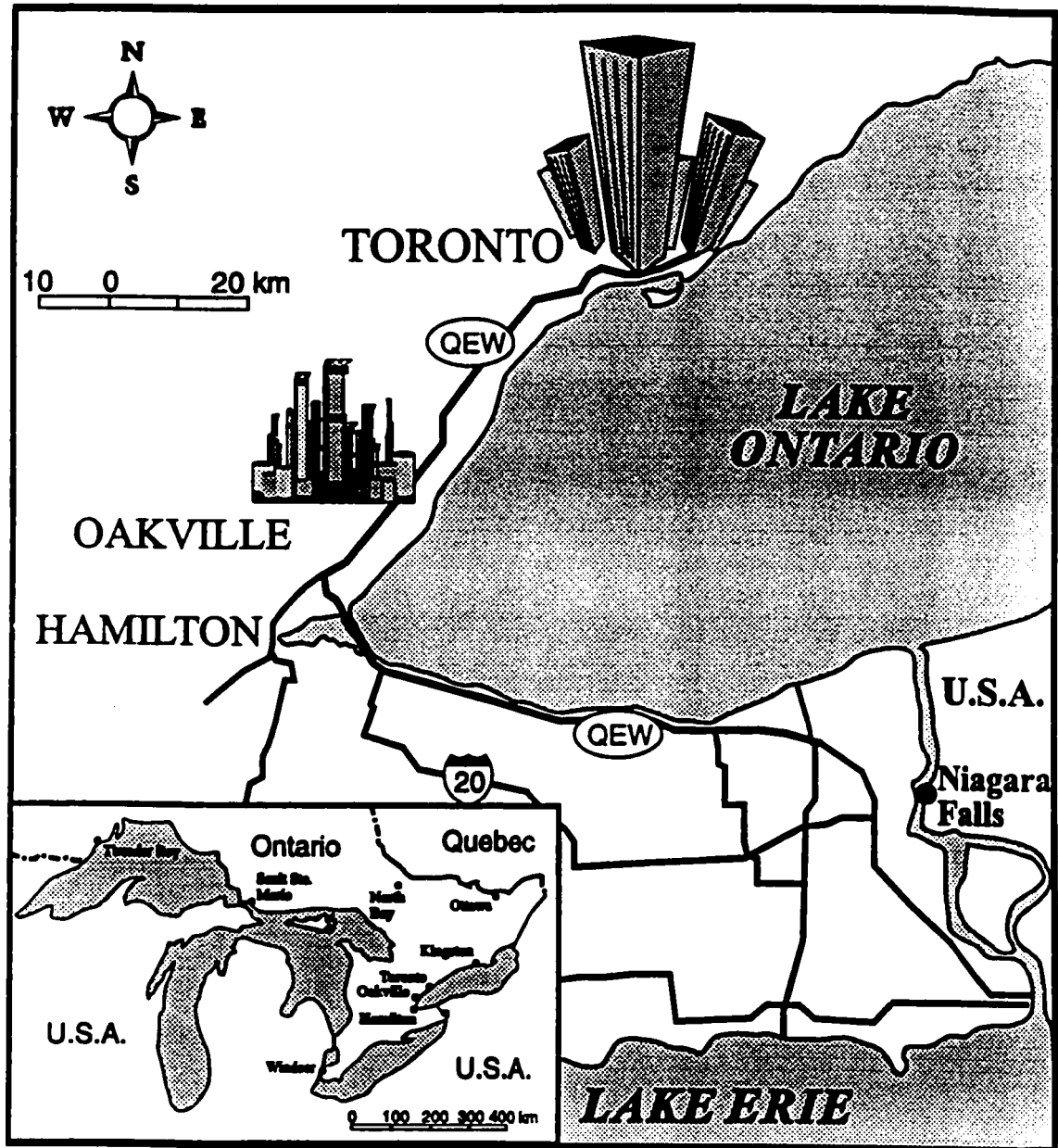


Figure 5.1 Study Area

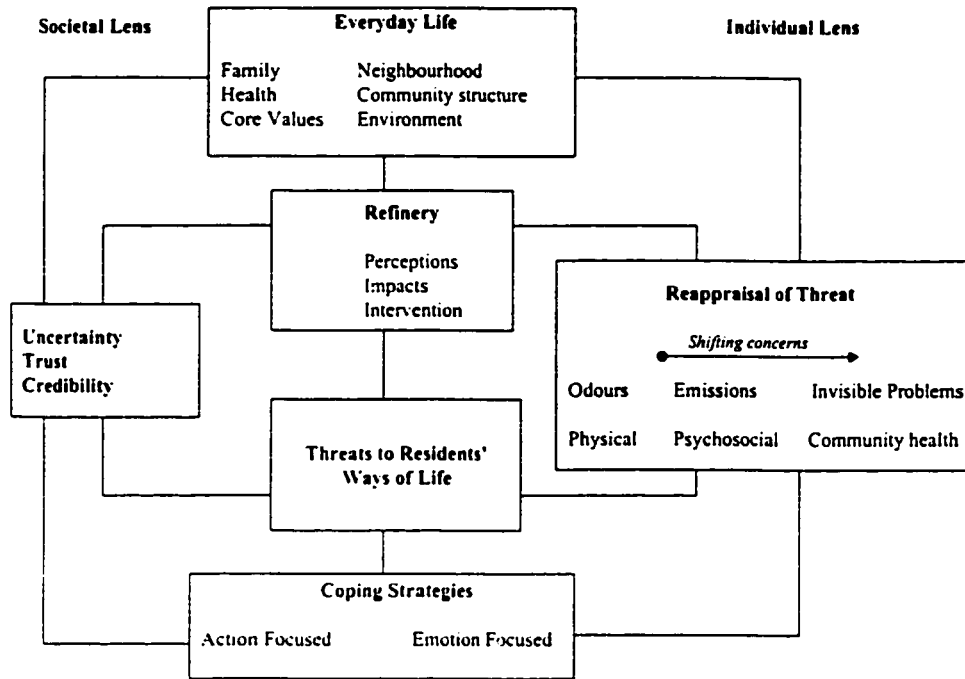


Figure 5.2. Conceptual Framework of Community Responses and Coping Strategies in the Vicinity of a Petroleum Refinery

CHAPTER SIX

SUMMARY AND CONCLUSION

6.1 Introduction

The main purpose of this study was to examine community reappraisal of a petroleum refinery after the implementation of extensive measures to reduce odorous emissions in Oakville, Ontario. Residents' concern about the health impacts from refinery emissions led to a community health study in 1992. The results showed that residents' perceptions of refinery odours were associated with elevated levels of reported ill-health in the community (Sider, 1994; Taylor et al., 1997). In response to community concerns, Petro Canada implemented an odour reduction plan (ORP) designed to reduce odorous emissions. This research combined quantitative and qualitative methods to examine changes in the impacts of the refinery on the residents in the community after the implementation of the ORP. The primary objectives of the research were as follows:

1. To determine the impacts of emissions from the Oakville Petro Canada refinery on the health and well-being of residents in the surrounding community.
2. To compare the impacts of emissions pre (1992) and post (1997) implementation of odour reduction measures, and to examine whether the intervention of Petro Canada has a desired effect on the people's perceptions of their health.

3. To relate pre-post changes in odour perception/annoyance and ill-health reporting to personal and situational factors.
4. To explore residents' responses and coping strategies after the implementation of the odour reduction measures.

6.2 Summary of Findings

6.2.1 Objective One: Impacts of Emissions

Overall, the results show that in both 1992 and 1997, odours attributed to the refinery were experienced by a substantial number of respondents in the community. Fifty-six percent and 47% of the study respondents noticed refinery odours at least once a month over the summer of 1992 and 1997 respectively. Similarly, in 1992, 35% of the respondents reported being annoyed by odours 'every time to about half the time' while 29% of respondents were frequently annoyed by odorous emissions in 1997. In both years, there was a significant zonal gradient in odour perception and annoyance whereby residents in zone one and closest to the refinery were more likely to perceive and to be annoyed by odours.

Residents also reported a number of ill-health symptoms (cardinal, general and 'other' symptoms) they experienced over the summer of months prior to the two surveys. Cardinal symptoms were those which were likely the result of irritant properties of odours and included coughs, wheeze/breathing problems, nausea, sinus congestion, colds, skin rashes, eye, nose or throat irritations, earaches, and nosebleeds. General symptoms were those likely to result from stress-mediated mechanisms related to odour annoyance and

included headaches, sleep problems, dizzy spells, stomach aches, diarrhea, loss of appetite, and chest pains. Other or 'dummy' symptoms were those thought not to be plausibly related to refinery odour emissions, and were included in the survey to detect symptom over-reporting.

While the pattern of increased odds for a number of cardinal and general symptoms for residents living in zone 1 was suggestive of an association between zone and symptom reporting, these associations were statistically weak. Consequently, zone of residence, used as a proxy for exposure to odours from the refinery, was not strongly associated with general measures of health status of residents living in the vicinity of the refinery. However, both odour perception and odour annoyance were consistently associated with ill-health reporting in both adults and children. That is, those who frequently noticed or were frequently bothered by odours, were more likely to report two or three cardinal and/or general symptoms. Symptom attribution to odours (i.e., symptoms brought on or worsened by odours) was also weakly associated to zone of residence, but strongly associated with frequent odour perception and annoyance.

6.2.2 Objective Two: Nature of Changes in Impacts

The evidence shows that with the implementation of the ORP, there was a decline in the reporting of odour perception and annoyance in the vicinity of the refinery, with a corresponding increase in the percentage perceiving odours less frequently or not noticing them at all. Even though zone of residence was consistently associated with odour perception

and odour annoyance, a decrease in the proportion of residents who perceived odours or were annoyed by them in 1997, was most evident for zone 1 residents (those closest to the refinery and downwind). Residents in zone 1 were also more likely to report improvement in odours. Further, 35% of respondents who noticed odours during the summer months of 1997 indicated odours had improved in the past year, while 47% reported it had improved in the past five years.

Consistent with the decrease in frequency of odour perception and annoyance, and in the self-reporting of perceived changes over the last one and five years, the trend in odour complaints also decreased over time (CAC-PC, 1997). This provides further evidence of some real changes in odorous emissions following the implementation of the odour reduction measures. Also, psychosocial concerns of residents such as dissatisfaction with their community, desire to move because of the refinery, and belief that refinery odours affected health, generally decreased from 1992 to 1997, even though none of these changes were statistically significant.

Irrespective of the improvements in refinery impacts, the prevalence rates for cardinal and general symptoms in both years were similar. There was no significant difference between 1992 and 1997 in the mean number of cardinal, general, or other symptoms reported by adults. Similarly, there was no difference in either year in the mean number of symptoms reported across zones. There was a slight decrease in the association between symptom reporting, and odour perception and annoyance in 1997. The implication of these findings is a persistence in the community of health impacts of refinery emissions

despite the odour reduction measures introduced by the refinery.

6.2.3 Objective three: Determinants of (Changes in) Impacts

Logistic regression models were estimated to determine the combined effects of exposure, individual and community factors on various measures of the impacts of the refinery on residents' health and well-being. The effect of time in the models (Chapter four) supports the improvement in odour emissions from 1992 to 1997, the period when most of the abatement measures were completed. Residents were more likely to report cardinal symptoms in 1992 compared to their counterparts in 1997. This strengthens the conclusion that, the odour reduction plan itself had a positive effect on residents' reappraisal of the refinery impacts.

The beneficial effects of the odour reduction plan were differentially felt in relation to several other factors. Distance from the refinery emerged as an important factor in the reappraisal process. Those living close to the refinery continued to report more frequent odour perception and a higher degree of annoyance. The implication is that any remaining odour from the refinery will likely continue to produce negative impacts in some parts of the community, especially with new residential developments being built close to the facility. However, a positive (albeit weak) relationship between distance from site and cardinal symptom reporting, and a relatively weak relationship between distance and general symptom reporting were observed. These findings suggest that exposure *per se* may not be the main cause of ill-health reporting in the vicinity of the refinery. This view is supported

by the psychosocial variables that were significant in the final symptom models, especially the general symptom model, where the variables with the strongest effects were stress rather than exposure related. Several other factors were significant predictors of refinery impacts in the regression models, including age, level of satisfaction with the refinery in the community, perceived benefits of the refinery, and belief that the refinery causes health impacts. These findings indicate the complex determination of refinery impacts involving a combination of exposure, personal and community factors.

The evidence from this analysis provides strongest support for an odour mediated mechanism. Such that the relationship between exposure to refinery emissions and ill-health reporting is mediated by odour perception and annoyance (see also Shusterman, 1992; Taylor et al., 1997; Steinheider, 1999). This mediating role is supported the weak distance effect in the symptom reporting models; and an evidence of symptom overreporting, whereby those who frequently perceive odours report an elevated number of dummy symptoms (those not thought to be plausibly related to refinery emissions such as joint pains, and bruises).

6.2.4 Objective four: Residents' Responses and Coping Strategies

In-depth interviews were used to explore residents' refinery-related experiences, concerns and coping strategies within the broader context of their everyday lives. The findings show that many of the Oakville residents moved to the community expecting a place that is safe, quiet, clean and slow growing, for raising children. However, the presence

of the refinery in the community is seen as a constant threat to residents' everyday lives, and in conflict with their values and expectations. Concerns about future health risks were typically greater among residents with children and were reinforced by others voicing the same concerns on their behalf.

In the wake of the refinery's intervention, the majority (109 mentions; 21(72%) respondents) indicated that the odorous emissions had improved from 1992 to 1997. Yet some residents still perceived the refinery as a threat to their ways of life. Catastrophic fears about the refinery (e.g., explosions and fire), together with dreadful images in the form of visual cues (e.g., flares, smoke stacks) remind residents of the threats to their values and expectations, and therefore create considerable anxiety and uncertainty. Further, residents view the refinery as a technology with impacts that are, in some respects, unknown to experts and unknown to science (see Slovic et al., 1982). Hence, some respondents (62%) expressed a lack of trust in the refinery's efforts and questioned their credibility. The cumulative effect of uncertainty, lack of trust and credibility is that some residents perceive the refinery as a direct threat to their physical health, for example, as possibly causing cancer in the community.

As the reappraisal process is ongoing, residents' fear, anxiety, uncertainty and lack of trust, determined much of the direction and nature of residents' shifting concerns. There was a shift in response to perceived improvements in odours, to a focus on the threats of invisible and odourless contaminants, and the demands for the total elimination of emissions and odours. There was also a shift in the experiences of physical health effects through

psychosocial health to a focus on the health of a community where residents can live without any threats to their deeply held values and expectations.

Uncertainty, lack of trust and shifting concerns influenced residents' coping strategies even after the implementation of the odour reduction measures. Thus, residents employed both action- and emotion- focus coping strategies to help minimize the impacts of the refinery. These coping strategies were used depending on such factors as intensity of odours, seasonality, time of day and wind direction.

6.3 Contributions of the Study

6.3.1 Theoretical Contributions

This study makes contributions to the environmental stress theory and risk perception literature by focusing on residents' reappraisal of an environmental stressor in relation to changes in the characteristics of the exposure. The Petro Canada case is instructive because the industry implemented odour reduction measures over a five-year period in response to community concerns about the possible adverse effects of the refinery emissions on the health and well-being of adults and children.

The finding of decreased levels of odour perception/annoyance and other negative concerns is consistent with the process of reappraisal as conceptualized by Lazarus and Folkman (1984). They suggested that the feedback of new information from the environment can result in a threat or harm being reassessed more favourably. The change in the nature of the stressor after the implementation of the odour reduction plan, resulted in a decline in

reported levels of impacts.

The findings also point to the importance of the wider community context within which residents reappraise the impacts of an environmental exposure (Taylor et al., 1991; see also Edelstein, 1988). Oakville residents who in many ways view themselves as 'victims' (see Williams, 1998), are engaged in efforts to protect themselves against existing environmental and technological dangers that threaten their security and core values. Residents' core values are associated with an attachment to their community or their sense of place (see Eyles, 1989). The effects of dissatisfaction with the refinery and perceived lack of benefits of the refinery, point to the multiple influences that can operate in a place such as Oakville, and how place and environment affect the experience of health and well-being (see Eyles and Donovan, 1990; Kearns, 1993). Thus, place and the meanings attached to it, become important factors in both the development and mitigation of effects of exposure.

Several concepts in the environmental stress, risk, and risk society literature are employed in this thesis in order to explain the determinants of the reappraisal process. These concepts include: uncertainty, trust and invisible contaminants. While uncertainty generally has to do with whether a hazard is (un)observable, has delayed effects, is unknown to those exposed, new or unknown to science, this research has revealed the salience of both uncertainty and trust as pivotal concepts in the reappraisal process.

With the improvement in odorous emissions, residents' shifting concerns reinforce a lack of trust of the refinery. Any level of distrust residents may hold for industry and government enhances a high level of uncertainty and a deep skepticism about the odour

abatement measures that have been implemented (see Slovic et al., 1980; Beck, 1992). With sufficient distrust, no level of emissions (however low) from the refinery will be tolerated and no demonstration of safety measures will be believed by some residents (e.g., vulnerable groups such as residents with children). By revealing the nature of these shifting concerns (from odours to invisible emissions, and from physical health to the health of the entire community) among the residents in the community, this study has revealed layers of concern that affect resident's reappraisal of the refinery.

These shifting concerns also describe the multiple stages of fears (see Beck, 1992) that residents have gone, or are going, through in the refinery situation. Hence, residents continue to employ both action- and emotion- focused coping strategies as outlined by Lazarus and Folkman (1984) and by Giddens (1990). Some residents sustained an optimism that with the "latest technology" the refinery will be able to ultimately eliminate all emissions. The findings also suggest psychosocial impacts involve more than just the appraisal of a hazard (primary appraisal) and coping resources (secondary appraisal), but also the appraisal of the institutional experts (refinery management) to manage the hazard appropriately (institutional appraisal) (see Baxter, 1997).

Further, the evidence shows the presence of a 'sensitized group' in the community which continues to experience impacts even after the implementation of the odour reduction plan. Sensitization may also reflect the presence of a toxicological reaction to ambient concentrations of SO₂, which is plausible given the odour reduction measures. This sensitization seems to affect residents' reappraisal of the refinery efforts. The implication

of this finding is that Lazarus and Folkman's (1984) model, though very useful for the empirical study of the reappraisal process, does not explain how certain types of individuals, such as the 'sensitized group' will react when confronted with certain types of stressors. As a general model, it does not discriminate between different types of stressors nor different types of reactions by exposed individuals. However, being a general model, its flexibility proved to be very useful in terms of integrating with other relevant theoretical constructs.

The flexibility of the model allowed the integration of the environmental stress and coping theory (micro level) with the risk society theory (macro level). This research suggests that the community is the social scale at which it makes most sense to connect environmental stress theory (Lazarus and Folkman, 1984) and the risk society theory (Giddens, 1990, 1991; Beck, 1992a, 1992b). While Lazarus and Folkman's (1984) theory generally describes individual-level processes, the notion of systems appraisal makes the explicit connection between the individual and the broader social and institutional structures that are characteristic of the risk society (see Giddens, 1990; Beck, 1992; Baxter, 1997).

This research has shown that risk society theory is useful for understanding the context of everyday life and for describing how individual effects and actions may be tied to social and institutional changes. The empirical evidence at the local level supports many of the risk society concepts developed with a global focus in mind. In Oakville, the threats to residents' 'ontological security' resulted in community opposition and subsequently the refinery's ORP. The Petro Canada case indicates that environmental threats to a valued way of life can lead to extensive institutional changes through opposition (Arnold, 1999; see also

Baxter, 1997). There are very few studies that have used the risk society theory explicitly to explain the social implications of local-scale (e.g., Baxter, 1997; Wakefield and Elliott, 2000), as opposed to global-scale, technological environmental hazards. This study adds to these emerging studies in this respect.

6.3.2 Methodological Contributions

The use of mixed-methods remains relatively rare in studies of environmental exposure and risk, which have traditionally relied on quantitative methods. This study makes methodological contributions by demonstrating the value of combining quantitative and qualitative methods in environment and health research. The longitudinal design of the quantitative component reflects the fact that the underlying theoretical model from environmental stress theory presumes a temporal process of primary and secondary appraisal and reappraisal. The longitudinal comparison yielded results confirming that some changes had taken place with the implementation of the refinery's odour reduction plan. The analysis also provided a clearer understanding of the determinants of residents' reappraisal of the refinery and the process related to exposure and health effects after the implementation of the odour reduction measures.

The qualitative analysis extended these findings by allowing for the construction of residents' meanings of technological risks in their community. This analysis was important in unearthing the core values of residents that are generally difficult for individuals to express in responses to quantitative designs, since they are tacitly understood in everyday

life and often not sorted out explicitly. Further, the in-depth interviews revealed the role of deeply-rooted values in the social construction of risk. The qualitative results also showed the importance of the wider community context and residents' sense of place in the reappraisal of the impacts of an environmental exposure.

Consistent with the quantitative analysis, the qualitative results also showed that, irrespective of the improvements in refinery impacts, some residents still perceived impacts and view the refinery as a threat to their ways of life. Residents view the refinery impacts as unknown to experts, unknown to science and hence, the refinery cannot be trusted. To that extent, most of the respondents in group C who indicated in the survey that they never noticed odours and were never bothered by them, still reported concerns and a lack of trust in the operation of the refinery. In their view, the refinery appears to underplay the threats to their everyday life and values. These concerns resulted in residents' shifting concerns and the coping strategies which were uncovered by the in-depth interview analysis.

6.3.3 Practical Contributions

This thesis made several practical contributions which have application for risk communication and management for refineries and other noxious facilities. This study is one of the few environmental risk studies that has conducted comprehensive (before and after) assessment of the effectiveness of extensive mitigation measures implemented by a petrochemical refinery to reduce odorous emissions. This comprehensive study assessed changes in odour perception and annoyance, ill-health reporting and residents' responses and

coping strategies. The results show that with the implementation of the odour reduction plan both odour perception and annoyance declined from 1992 to 1997. There was also an improvement in psychosocial concerns. Further, high levels of satisfaction with Oakville as an excellent place to live were not significantly affected by the refinery.

While the CAC-PC and the refinery have been working together on risk management and communication in the community, this study has shown that very few residents in the community are aware of the efforts to reduce the impacts of the refinery. Overall, 29% of the study participants were at least somewhat informed about the implementation of odour reduction measures by the refinery. Also, the 1997 data showed that only 20% of respondents who were surveyed were aware of the environmental complaints hotline which was established in 1992 to provide an accessible, recognized and efficient means of recording and facilitating responses to community complaints of odour or other pollutant episodes. The implication is that more has to be done to make the people aware of what exists or improve risk communication in the community. The CAC-PC should strengthen its efforts to increase residents' awareness of the odour reduction measures and the complaints hotline, to build public trust in efforts to mitigate the negative effects of the refinery, and to reduce public concerns about risks to personal health and well-being.

The research also revealed the importance of social and cultural factors in the formation of residents' perceptions and concerns of the risks from the refinery. The findings support the notion that risks are based more on the way people view them, than on any objective measure of risk. Regardless of the actual impacts of the Petro Canada refinery,

residents were concerned about threats to their valued ways of life. The concerns expressed by residents may be indicators of more fundamental concerns, like threats to life and core values. Therefore even if the residents' expressed concerns are dealt with appropriately through mitigation measures, this does not ensure that the underlying concerns will also be addressed. The implication is that the refinery and Community Advisory Committee to Petro Canada must recognize the role of deeply-rooted values in the social construction of risk (see Baxter, 1997). Given the evidence that many different perspectives exist in the community, as well as evidence of continuing distrust of the refinery among residents, there is a clear need to incorporate these perspectives and the values they represent into the management of the refinery situation. Thus, the CAC-PC and the refinery in their risk communication and management efforts, must do more than disclose technical information (e.g., complaint statistics) and give due consideration to the way the people respond to risk information. This may have to involve broadening the mandate of the CAC-PC to include other issues of concern to the community (see Arnold, 1999). This will reassure the community that Petro Canada is responsive to community concerns and prepared to take responsibility for the impact of the refinery on the community.

6.4 Directions for Future Research

Arising from the consideration of the implications of this research for theory, several avenues for further research are apparent. A more explicit focus on coping, looking at the convergence of the environmental stress theory (Lazarus and Folkman, 1984) and risk

society theory (Giddens, 1990; 1991) is warranted. These studies should be designed to examine the various forms of both problem- and emotion- focused coping and the determinants associated with a switch from one coping strategy to the other. The question remains what leads to the adoption and abandonment of the various strategies over time?

Finally, the relevance of the findings of this research to other areas of study needs to be addressed. How similar are individual and community experiences to those shown in the refinery situation when confronted with different types of stressors? How do coping strategies vary in different places and with different types of exposures, and what are the links between coping and community mobilization around other stressors, and in other community contexts? Oakville is a relatively wealthy community compared to the rest of the province. The dynamics of concern and coping in less advantaged communities need further investigation in order to better understand how the experience of other sources of stress such as poverty may influence stress, coping, and community mobilization around possible and actual environmental contamination.

Wynne (1992) indicates that one of the keys to success in risk management will be institutional flexibility and the ability for institutions to reflect on their implicit assumptions about risks and hazards. For instance, the CAC-PC and the refinery attribute the improvement in odorous emissions and the declining number of the odour complaints to their successful management of the risk of the refinery. On the other hand, although residents reported reduced impacts, their perceptions and levels of concern about the continuous threat of the refinery remain high. Wynne (1992) suggests that in situations like this, residents and

experts (CAC-PC and refinery) may be speaking different languages of risk (see Wynne, 1992; Baxter et al., 1999). Future work should seek ways to bridge the gap between lay perceptions and expert views about risk on such issues as the meaning of uncertainty, since this is at the heart of the refinery situation and reappraisal process.

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APPENDIX A

COMMUNITY HEALTH IMPACTS OF A PETROLEUM REFINERY

FINAL SURVEY INSTRUMENT

INTERVIEWER: Enter respondent's gender

- Male
- Female
- don't know

SECTION A: GENERAL HEALTH STATUS

(a1) I'd like to ask you a couple of questions about your health in general. In general, compared to other people your age, would you say your health is Excellent, Very Good, Good, Fair or Poor?

- Excellent
- Very Good
- Good
- Fair
- Poor
- Don't Know
- Refused

(a2) How satisfied are you with your health? Would you say you are Very Satisfied, Somewhat Satisfied, Not Too Satisfied, or Not At All Satisfied?

- Very Satisfied
- Somewhat Satisfied
- Not Too Satisfied
- Not At All Satisfied
- Don't Know
- Refused

SECTION B: SYMPTOMS

(b1a) Now I'd like to ask you a series of questions about POSSIBLE health problems you MAY be experiencing. DURING THE PAST SUMMER (by summer we mean The months of July and August) , have you had any problems with HEADACHES?

- Yes [goto b1b]
 - No
 - Don't Know
 - Refused
- [goto b2a]

(b1b) How often have you had problems with HEADACHES over the PAST SUMMER? Would you say DAILY, ALMOST EVERY DAY, ONCE A WEEK, ONCE A MONTH, or LESS OFTEN THAN ONCE A MONTH?

- Daily
- Almost every day
- Once a week
- Once a month
- less often than once a month
- Don't Know
- Refused

(b2a) Over the past SUMMER, have you had TROUBLE SLEEPING?

- Yes [goto b2b]
- No
- Don't Know
- Refused
[goto b3a]

(b2b) How often have you had TROUBLE SLEEPING over the PAST SUMMER? Would you say DAILY, ALMOST EVERY DAY, ONCE A WEEK, ONCE A MONTH, or LESS OFTEN THAN ONCE A MONTH?

- Daily
- Almost every day
- Once a week
- Once a month
- less often than once a month
- Don't Know
- Refused

(b3a) Over the PAST SUMMER, ... have you had DIZZY SPELLS?

- Yes [goto b3b]
- No
- Don't Know
- Refused
[goto b4a]

(b3b) How often have you had DIZZY SPELLS? Would you say DAILY, ALMOST EVERY DAY, ONCE A WEEK, ONCE A MONTH, or LESS OFTEN THAN

ONCE A MONTH?

- Daily
- Almost every day
- Once a week
- Once a month
- less often than once a month
- Don't Know
- Refused

(b4a) Over the PAST SUMMER, ... have you had NAUSEA?

INTERVIEWER: if asked, "that is the feeling that you might throw up"

- Yes [goto b4b]
- No
- Don't Know
- Refused
- [goto b5a]

(b4b) How often have you had NAUSEA? ...over the PAST SUMMER? Would you say DAILY, ALMOST EVERY DAY, ONCE A WEEK, ONCE A MONTH, or LESS OFTEN THAN ONCE A MONTH?

INTERVIEWER: if asked, "that is the feeling that you might throw up"

- Daily
- Almost every day
- Once a week
- Once a month
- less often than once a month
- Don't Know
- Refused

(b5a) Over the PAST SUMMER, ... have you had JOINT PAIN OR SWELLING?

- Yes [goto b5b]
- No
- Don't Know
- Refused
- [goto b6a]

(b5b) How often have you had JOINT PAIN OR SWELLING? ...over the PAST SUMMER? Would you say DAILY, ALMOST EVERY DAY, ONCE A WEEK,

ONCE A MONTH, or LESS OFTEN THAN ONCE A MONTH?

- Daily
- Almost every day
- Once a week
- Once a month
- less often than once a month
- Don't Know
- Refused

(b6a) Over the PAST SUMMER, ...have you been LOSING YOUR APPETITE?

- Yes [goto b6b]
- No
- Don't Know
- Refused
[goto b7a]

**(b6b) How often have you LOST YOUR APPETITE? ...over the PAST SUMMER?
Would you say DAILY, ALMOST EVERY DAY, ONCE A WEEK, ONCE A MONTH, or LESS OFTEN THAN ONCE A MONTH?**

- Daily
- Almost every day
- Once a week
- Once a month
- less often than once a month
- Don't Know
- Refused

(b7a) Over the PAST SUMMER, ...have you had STOMACH PAINS?

- Yes [goto b7b]
- No
- Don't Know
- Refused
[goto b8a]

**(b7b) How often have you had STOMACH PAINS? ...over the PAST SUMMER?
Would you say DAILY, ALMOST EVERY DAY, ONCE A WEEK, ONCE A**

MONTH, or LESS OFTEN THAN ONCE A MONTH?

- Daily
- Almost every day
- Once a week
- Once a month
- less often than once a month
- Don't Know
- Refused

(b8a) Over the PAST SUMMER, ...have you had DIARRHEA?

- Yes [goto b8b]
- No
- Don't Know
- Refused
[goto b9a]

(b8b) How often have you had DIARRHEA? ...over the PAST SUMMER? Would you say DAILY, ALMOST EVERY DAY, ONCE A WEEK, ONCE A MONTH, or LESS OFTEN THAN ONCE A MONTH?

- Daily
- Almost every day
- Once a week
- Once a month
- less often than once a month
- Don't Know
- Refused

(b9a) Over the PAST SUMMER, ...have you had SINUS CONGESTION THAT IS NOT RELATED TO A COLD?

- Yes [goto b9b]
- No
- Don't Know
- Refused
[goto b10a]

(b9b) How often have you had SINUS CONGESTION THAT IS NOT RELATED TO A COLD? ...over the PAST SUMMER? Would you say DAILY, ALMOST EVERY DAY, ONCE A WEEK, ONCE A MONTH, or LESS OFTEN THAN ONCE A MONTH?

- Daily
- Almost every day
- Once a week
- Once a month
- less often than once a month
- Don't Know
- Refused

(b10a) Over the PAST SUMMER, ...have you had IRRITATED, SORE OR RED EYES?

- Yes [goto b10b]
- No
- Don't Know
- Refused
[goto b12a]

(b10b) How often have you had IRRITATED, SORE OR RED EYES? ...over the PAST SUMMER? Would you say DAILY, ALMOST EVERY DAY, ONCE A WEEK, ONCE A MONTH, or LESS OFTEN THAN ONCE A MONTH?

- Daily
- Almost every day
- Once a week
- Once a month
- less often than once a month
- Don't Know
- Refused

(b12a) Over the PAST SUMMER, ...have you had COLDS?

- Yes [goto b12b]
- No
- Don't Know
- Refused
[goto b13a]

(b12b) How often have you had COLDS ...over the PAST SUMMER? Would you say DAILY, ALMOST EVERY DAY, ONCE A WEEK, ONCE A MONTH, or LESS OFTEN THAN ONCE A MONTH?

- Daily
- Almost every day
- Once a week
- Once a month

- less often than once a month
- Don't Know
- Refused

(b13a) Over the PAST SUMMER, ...have you had a RUNNY OR STUFFY NOSE THAT IS NOT RELATED TO A COLD?

- Yes [goto b13b]
 - No
 - Don't Know
 - Refused
- [goto b14a]

(b13b) How often have you had a RUNNY OR STUFFY NOSE THAT IS NOT RELATED TO A COLD?...over the PAST SUMMER? Would you say DAILY, ALMOST EVERY DAY, ONCE A WEEK, ONCE A MONTH, or LESS OFTEN THAN ONCE A MONTH?

- Daily
- Almost every day
- Once a week
- Once a month
- less often than once a month
- Don't Know
- Refused

(b14a) Over the PAST SUMMER, ...have you had a SORE THROAT THAT IS NOT RELATED TO A COLD?

- Yes [goto b14b]
 - No
 - Don't Know
 - Refused
- [goto b15a]

(b14b) How often have you had a SORE THROAT THAT IS NOT RELATED TO A COLD? ...over the PAST SUMMER? Would you say DAILY, ALMOST EVERY DAY, ONCE A WEEK, ONCE A MONTH, or LESS OFTEN THAN ONCE A MONTH?

- Daily
- Almost every day
- Once a week

- Once a month
- less often than once a month
- Don't Know
- Refused

(b15a) Over the PAST SUMMER, ...have you had EARACHES?

- Yes [goto b15b]
 - No
 - Don't Know
 - Refused
- [goto b16a]

(b15b) How often have you had EARACHES? ...over the PAST SUMMER? Would you say DAILY, ALMOST EVERY DAY, ONCE A WEEK, ONCE A MONTH, or LESS OFTEN THAN ONCE A MONTH?

- Daily
- Almost every day
- Once a week
- Once a month
- less often than once a month
- Don't Know
- Refused

(b16a) Over the PAST SUMMER, ...have you had CHEST PAINS?

- Yes [goto b16b]
 - No
 - Don't Know
 - Refused
- [goto b17a]

(b16b) How often have you had CHEST PAINS...over the PAST SUMMER? Would you say DAILY, ALMOST EVERY DAY, ONCE A WEEK, ONCE A MONTH, or LESS OFTEN THAN ONCE A MONTH?

- Daily
- Almost every day
- Once a week
- Once a month
- less often than once a month
- Don't Know

- Refused

(b17a) Over the PAST SUMMER, ...have you had any COUGHING THAT IS NOT RELATED TO A COLD?

- [goto b17b]
- No
- Don't Know
- Refused
[goto b18a]

(b17b) How often have you had COUGHING THAT IS NOT RELATED TO A COLD?...over the PAST SUMMER? Would you say DAILY, ALMOST EVERY DAY, ONCE A WEEK, ONCE A MONTH, or LESS OFTEN THAN ONCE A MONTH?

- Daily
- Almost every day
- Once a week
- Once a month
- less often than once a month
- Don't Know
- Refused

(b18a) Over the PAST SUMMER, ...have you had any WHEEZING OR OTHER TROUBLE BREATHING?

- Yes [goto b18b]
- No
- Don't Know
- Refused
[goto b19a]

(b18b) How often have you had WHEEZING OR OTHER TROUBLE BREATHING? ...over the PAST SUMMER? Would you say DAILY, ALMOST EVERY DAY, ONCE A WEEK, ONCE A MONTH, or LESS OFTEN THAN ONCE A MONTH?

- Daily
- Almost every day
- Once a week
- Once a month
- less often than once a month

- Don't Know
- Refused

(b19a) Over the PAST SUMMER, ...have you had HIVES OR SKIN RASHES?

- Yes [goto b19b]
- No
- Don't Know
- Refused
[goto b20a]

(b19b) How often have you had HIVES OR SKIN RASHES?...over the PAST SUMMER? Would you say DAILY, ALMOST EVERY DAY, ONCE A WEEK, ONCE A MONTH, or LESS OFTEN THAN ONCE A MONTH?

- Daily
- Almost every day
- Once a week
- Once a month
- less often than once a month
- Don't Know
- Refused

(b20a) Over the PAST SUMMER, ...have you had LOW BACK PAIN?

- Yes [goto b20b]
- No
- Don't Know
- Refused
[goto b21a]

(b20b) How often have you had LOW BACK PAIN? ...over the PAST SUMMER? Would you say DAILY, ALMOST EVERY DAY, ONCE A WEEK, ONCE A MONTH, or LESS OFTEN THAN ONCE A MONTH?

- Daily
- Almost every day
- Once a week
- Once a month
- less often than once a month
- Don't Know
- Refused

(b21a) Over the PAST SUMMER, ...have you had any NOSEBLEEDS?

- Yes [goto b21b]
- No
- Don't Know
- Refused
[goto b22a]

(b21b) How often have you had NOSEBLEEDS ?...over the PAST SUMMER? Would you say DAILY, ALMOST EVERY DAY, ONCE A WEEK, ONCE A MONTH, or LESS OFTEN THAN ONCE A MONTH?

- Daily
- Almost every day
- Once a week
- Once a month
- less often than once a month
- Don't Know
- Refused

(b22a) Over the PAST SUMMER, ...have you had any problems with EASY BRUISING?

- Yes [goto b22b]
- No
- Don't Know
- Refused
[goto b23a]

(b22b) How often have you had a problem with EASY BRUISING? ...over the PAST SUMMER? Would you say DAILY, ALMOST EVERY DAY, ONCE A WEEK, ONCE A MONTH, or LESS OFTEN THAN ONCE A MONTH?

- Daily
- Almost every day
- Once a week
- Once a month
- less often than once a month
- Don't Know
- Refused

(b23a) Over the PAST SUMMER, ...have you had any BURNING OR DISCOMFORT URINATING? (passing your water)

- Yes [goto b23b]
- No
- Don't Know

- Refused
[goto b24]

(b23b) How often have you had BURNING OR DISCOMFORT URINATING? ...over the PAST SUMMER? Would you say DAILY, ALMOST EVERY DAY, ONCE A WEEK, ONCE A MONTH, or LESS OFTEN THAN ONCE A MONTH?

- Daily
- Almost every day
- Once a week
- Once a month
- less often than once a month
- Don't Know
- Refused

(b24) Have you had any other health problems over the PAST SUMMER that I have not asked you about?

- Yes [goto b24a]
- No
- Don't Know
- Refused
[goto d1]

(b24a)What is that? INTERVIEWER: Enter FIRST PROBLEM ONLY, enter text, maximum 25 letters

(b24b) How often have you had a problem with [fill b24a]? ...over the PAST SUMMER? Would you say DAILY, ALMOST EVERY DAY, ONCE A WEEK, ONCE A MONTH, or LESS OFTEN THAN ONCE A MONTH?

- Daily
- Almost every day
- Once a week
- Once a month
- less often than once a month
- Don't Know
- Refused

THIS CONTINUES FOR UP TO THREE OTHER HEALTH PROBLEMS

SECTION D: MENTAL HEALTH INDEX

- (d1)** Next I would like to ask you about some other aspects of your life. During the **PAST FOUR WEEKS**, have you had any of the following problems with work or other daily activities **AS A RESULT OF EMOTIONAL PROBLEMS** such as feeling depressed or anxious.

First, have you cut down the **AMOUNT OF TIME** you spent on work or other daily activities as a result of emotional problems?

- yes
- no
- don't know
- refused

- (d2)** During the **PAST FOUR WEEKS**, have you **ACCOMPLISHED LESS** than you would like **AS A RESULT OF EMOTIONAL PROBLEMS** such as feeling depressed or anxious

- yes
- no
- don't know
- refused

- (d3)** During the **PAST FOUR WEEKS...Didn't do work or other activities as CAREFULLY as usual AS A RESULT OF EMOTIONAL PROBLEMS** such as feeling depressed or anxious?

- yes
- no
- don't know
- refused
-

- (d4)** During the **PAST FOUR WEEKS**, to what extent has your physical health or emotional problems interfered with your normal social activities with family, friends, neighbours, or groups?

Would you say **NOT AT ALL, SLIGHTLY, MODERATELY, QUITE A BIT, or EXTREMELY?**

- Not at all
- Slightly
- Moderately

- Quite a bit
- Extremely
- Don't know
- Refused

(d5) These next questions are about how you feel and how things have been with you **DURING THE PAST FOUR WEEKS**. For each question, please give the one answer that comes closest to the way you have been feeling.

First, how much of the time during the **PAST FOUR WEEKS** did you feel full of PEP?

Would you say **ALL OF THE TIME**, **MOST OF THE TIME**, a **GOOD BIT OF THE TIME**, **SOME OF THE TIME**, a **LITTLE OF THE TIME**, or **NONE OF THE TIME**?

- All of the time
- Most of the time
- A good bit of the time
- Some of the time
- A little of the time
- None of the time
- Don't Know
- Refused

(d6) **DURING THE PAST FOUR WEEKS**, have you been a very nervous person? Would you say **ALL OF THE TIME**, **MOST OF THE TIME**, a **GOOD BIT OF THE TIME**, **SOME OF THE TIME**, a **LITTLE OF THE TIME**, or **NONE OF THE TIME**?

- All of the time
- Most of the time
- A good bit of the time
- Some of the time
- A little of the time
- None of the time
- Don't Know
- Refused

(d7) **DURING THE PAST FOUR WEEKS**, have you felt so down in the dumps, nothing could cheer you up? Would you say **ALL OF THE TIME**, **MOST OF THE TIME**, a **GOOD BIT OF THE TIME**, **SOME OF THE TIME**, a **LITTLE OF**

THE TIME, or NONE OF THE TIME?

- All of the time
- Most of the time
- A good bit of the time
- Some of the time
- A little of the time
- None of the time
- Don't Know
- Refused

(d8) DURING THE PAST FOUR WEEKS...have you felt calm and peaceful? Would you say ALL OF THE TIME, MOST OF THE TIME, a GOOD BIT OF THE TIME, SOME OF THE TIME, a LITTLE OF THE TIME, or NONE OF THE TIME?

- All of the time
- Most of the time
- A good bit of the time
- Some of the time
- A little of the time
- None of the time
- Don't Know
- Refused

(d9) DURING THE PAST FOUR WEEKS...did you have a lot of energy? Would you say ALL OF THE TIME, MOST OF THE TIME, a GOOD BIT OF THE TIME, SOME OF THE TIME, a LITTLE OF THE TIME, or NONE OF THE TIME?

- All of the time
- Most of the time
- A good bit of the time
- Some of the time
- A little of the time
- None of the time
- Don't Know
- Refused

(d10) DURING THE PAST FOUR WEEKS...have you felt downhearted and blue? Would you say ALL OF THE TIME, MOST OF THE TIME, a GOOD BIT OF THE TIME, SOME OF THE TIME, a LITTLE OF THE TIME, or NONE OF THE TIME?

- All of the time
- Most of the time
- A good bit of the time
- Some of the time
- A little of the time
- None of the time
- Don't Know
- Refused

(d11) DURING THE PAST FOUR WEEKS...did you feel worn out? Would you say ALL OF THE TIME, MOST OF THE TIME, a GOOD BIT OF THE TIME, SOME OF THE TIME, a LITTLE OF THE TIME, or NONE OF THE TIME?

- All of the time
- Most of the time
- A good bit of the time
- Some of the time
- A little of the time
- None of the time
- Don't Know
- Refused

(d12) DURING THE PAST FOUR WEEKS...have you been a happy person? Would you say ALL OF THE TIME, MOST OF THE TIME, a GOOD BIT OF THE TIME, SOME OF THE TIME, a LITTLE OF THE TIME, or NONE OF THE TIME?

- All of the time
- Most of the time
- A good bit of the time
- Some of the time
- A little of the time
- None of the time
- Don't Know
- Refused

(d13) DURING THE PAST FOUR WEEKS...did you feel tired? Would you say ALL OF THE TIME, MOST OF THE TIME, a GOOD BIT OF THE TIME, SOME OF THE TIME, a LITTLE OF THE TIME, or NONE OF THE TIME?

- All of the time
- Most of the time

- A good bit of the time
- Some of the time
- A little of the time
- None of the time
- Don't Know
- Refused

(d14) [# option 3 "a good bit ..." deleted per jp]

DURING THE PAST FOUR WEEKS, how much of the time has your PHYSICAL HEALTH OR EMOTIONAL PROBLEMS interfered with your social activities, like visiting with friends, relatives, etc.

Would you say **ALL OF THE TIME, MOST OF THE TIME, SOME OF THE TIME, a LITTLE OF THE TIME, or NONE OF THE TIME?**

- All of the time
- Most of the time
- Some of the time
- A little of the time
- None of the time
- Don't Know
- Refused

SECTION E: CHRONIC HEALTH PROBLEMS

(e1) Now I'd like to ask you a number of questions about long term health problems you may have. Do you have skin allergies or other skin disease?

- Yes
- No
- Never been told/Don't Know
- Refused

(e2) Do you have hay fever or other allergies?

- Yes
- No
- Never been told/Don't Know
- Refused

- (e3) Do you have asthma?
- Yes
 - No
 - Never been told/Don't Know
 - Refused
- (e4) Do you have emphysema or chronic bronchitis or persistent cough?
- Yes
 - No
 - Never been told/Don't Know
 - Refused
- (e5) Do you have high blood pressure or hypertension?
- Yes
 - No
 - Never been told/Don't Know
 - Refused
- (e6) Do you have circulatory problems?
- Yes
 - No
 - Never been told/Don't Know
 - Refused
- (e7) Do you have heart disease?
- Yes
 - No
 - Never been told/Don't Know
 - Refused
- (e9) Do you have urinary problems or kidney disease?
- Yes
 - No
 - Never been told/Don't Know
 - Refused
- (e10) Do you have stomach ulcer or ulcers?
- Yes
 - No
 - Never been told/Don't Know
 - Refused

(e11) Do you have other digestive problems?

- Yes
- No
- Never been told/Don't Know
- Refused

SECTION F: CONFOUNDERS

(f1) Next, I'd like to switch topics a bit and look at whether you smoke or are exposed to tobacco smoke.

First, do you smoke cigars, cigarettes or pipes?

- yes [goto f2]
- No
- Don't Know
- Refused
[goto f4]

(f2) At the present time how often do you smoke cigarettes? Would you say DAILY, OCCASIONALLY, or NOT AT ALL?

- Daily [goto f3]
- Occasionally [goto f3]
- Not at all
- Don't Know
- Refused
[goto f4]

(f3) How many cigarettes do you smoke each day now?

- Enter number
- 97 or more
- Don't know
- refused

(f4) [if f2 eq <Daily>][goto f7][endif] Have you ever smoked cigarettes daily?

- yes [goto f5]
- no
- don't know
- refused
[goto ch21]

- (f5) At what age did you stop smoking cigarettes daily?
- Enter age
 - 97 or more
 - Don't Know
 - Refused
- (f6) How many cigarettes a day did you usually smoke?
- Enter number
 - 97 or more
 - Don't know
 - refused
- (f7) [if f1 eq <5>][goto f11][endif] At the present time how often do you smoke cigars? Would you say DAILY, OCCASIONALLY, or NOT AT ALL?
- Daily [goto f8]
 - Occasionally [goto f8]
 - Not at all
 - Don't Know
 - Refused
[goto f9]
- (f8) How many cigars do you smoke each day now?
- Enter number
 - 97 or more
 - Don't know
 - refused
- (f9) At the present time how often do you smoke pipes? Would you say DAILY, OCCASIONALLY, or NOT AT ALL?
- Daily [goto f10]
 - Occasionally [goto f10]
 - Not at all
 - Don't Know
 - Refused
[goto f11]
- (f10) How many pipes do you smoke each day now?

- Enter number
- 97 or more
- Don't know
- Refused

(f11) Does anyone else living in your household smoke cigars, cigarettes or pipes regularly?

- yes [goto f12]
- no
- don't know
- refused
[goto int1]

(f12) Do they smoke CIGARETTES?

- yes [goto f13]
- no
- don't know
- refused
[goto f14]

(f13) How many cigarettes a DAY do OTHER people in your household smoke?
INTERVIEWER: we would like a TOTAL of the number of cigarettes smoked in the household by OTHER people.

- Enter number
- 97 or more
- Don't know
- Refused

(f14) Does anybody, other than yourself, smoke cigars in your household?

- yes [goto f15]
- no
- don't know
- refused
[goto f16]

(f15) How many cigars are usually smoked in your HOUSEHOLD each day?

- Enter number

- 97 or more
- Don't know
- Refused

(f16) Does anybody other than yourself smoke pipes in your household?

- yes [goto f17]
- no
- don't know
- refused
[goto f18]

(f17) How many pipes are usually smoked in your HOUSEHOLD each day?

- Enter number
- 97 or more
- Don't know
- Refused

(f18) How many hours a day are you exposed AT HOME to smoke from cigarettes cigars or pipes?

- enter number of hours
- Don't Know
- Refused

Next we would like to know about the types of materials you may have worked with around the home, for example as a result of housework, hobbies or recreational activities.

(f20) In the past twelve months have you been exposed to fumes from solvents, paints or gasoline AROUND THE HOME?

- yes
- no
- don't know
- refused

(f21) How often in the past twelve months have you been exposed to fumes from solvents, paints or gasoline AROUND THE HOME?

Would you say:

- Occasionally
- Often

- Always
- Don't know
- Refused

(f22) In the past twelve months have you been exposed to pesticides (bug or weed killers) AROUND THE HOME?

- yes
- no
- don't know
- refused

(f23) How often in the past twelve months have you been exposed to pesticides (bug or weed killers) AROUND THE HOME?

Would you say:

- Occasionally
- Often
- Always
- Don't know
- Refused

(f24) Do you have a gas stove or water heater?

- yes
- no
- don't know
- refused

(f25) In the past twelve months have you used a fireplace (wood/gas) in your home?
[code as no if respondent has no fireplace]

- yes
- no
- don't know
- refused

(f26) How often in the past twelve months have you used a fireplace AROUND THE HOME?

Would you say:

- Occasionally
- Often
- Always
- Don't know
- Refused

(f27) In the past twelve months have you been exposed to cats, dogs or birds in your home?

- yes
- no
- don't know
- refused

(f28) How often in the past twelve months have you been exposed to cats, dogs or birds AROUND THE HOME?

Would you say:

- Occasionally
- Often
- Always
- Don't know
- Refused

(f29) In the past twelve months has an air conditioner been used in your home?

- yes
- no
- don't know
- refused

(f30) How often in the past twelve months did you use and air conditioner in your home?

Would you say:

- Occasionally
- Often
- Always
- Don't know
- Refused

(f31) In the past twelve months have you used an air humidifier in your home?

- yes
- no
- don't know
- refused

(f32) How often in the past twelve months have you used an air humidifier AROUND THE HOME?

Would you say:

- Occasionally
- Often

- Always
- Don't know
- Refused

(f33) In the past twelve months have you used an air filter in your home?

- yes
- no
- don't know
- refused

(f34) How often in the past twelve months has an air filter been used AROUND THE HOME?

Would you say:

- Occasionally
- Often
- Always
- Don't know
- Refused

(f35) What type of heating system does your house or apartment have? Does it have:

- Radiators
- Warm air furnace (oil or gas)
- Electric baseboard heaters
- Other (specify)
- Don't know
- Refused

SECTION G: CHILDREN'S HEALTH

(g1) I'd now like to ask you about any children you may have, and some questions about their health.

First, do you have any children under twelve years of age in your family?

- Yes [goto g2]
- No
- refused
[goto h1]

(g2) How many children under twelve do you have?

- Enter number
- Six or more
- Refused [goto h1]

(cnm1) Could you please tell me your child's FIRST name or initial
INTERVIEWER: If R refuses, enter YOUR CHILD'S

(cnm2) Would you tell me the first name, or first initial of your OLDEST CHILD please.
This will allow us to keep track of which child you and I are talking about.
INTERVIEWER: If Respondent refuses, enter "ref"

(cnm3) And could you please tell me the first name, or first initial of your YOUNGEST
CHILD please. This will allow us to keep track of which child we are talking
about.
INTERVIEWER: If Respondent refuses, enter "ref"

(cnm4) We would like to randomly select TWO of your children under the age of twelve
to ask some questions about. Could you please tell me the FIRST name or initial
of the child under twelve years of age who had the LAST birthday.
INTERVIEWER: If needed:

- How long ago did you have a birthday for one of your children?
- Is that child under twelve?
- What is that child's name or initial

INTERVIEWER: Enter child's name or initial, enter "ref" if refused

_____ (Child A)
[goto cnm5]

(cnm5) Now could you please tell me the FIRST name or initial of the child under twelve
years of age who will have the NEXT birthday.
INTERVIEWER: If needed:

- Which of your children will have the next birthday
- Is that child under twelve?
- What is that child's name or initial

INTERVIEWER: Enter child's name or initial, enter "ref" if refused

_____ (Child B)

(g3a) We'd like to ask you the following questions. First what is [Child A] date of birth?

INTERVIEWER: Enter YEAR only here.

- enter last TWO digits of year
- Don't know
- Refused

(g3b) INTERVIEWER: Enter MONTH only here

- | | | | | | |
|---|------------|---|---------|---|-----------|
| - | January | - | May | - | September |
| - | February | - | June | - | October |
| - | March | - | July | - | November |
| - | April | - | August | - | December |
| - | Don't Know | - | Refused | | |

(g3c) INTERVIEWER: Enter only DAY of child's birth here

- Enter day of birth here
- Don't Know
- Refused

(g4) Is [Child A] a male or female?

- Male
- Female
- Refused

(g5) In general compared to other children [Child A's] age would you say [Child A's] health is Excellent, Good, Fair, or Poor?

- Excellent
- Good
- Fair
- Poor
- Don't Know
- Refused

(g6a) Now I'd like to ask you about symptoms [Child A] may be suffering from. Some of these symptoms may be difficult to be certain about if you have an infant or young child. If you don't think you can tell whether or not your child has had a symptom over the past summer, you can answer "can't tell".

First, OVER THE PAST SUMMER, has [Child A] had any headaches?

- Yes [goto g6b]
- No
- Don't Know/Can't Tell
- Refused
[goto g7a]

(g6b) How often has [Child A] had HEADACHES over the PAST SUMMER?
Would you say DAILY, SEVERAL TIMES A WEEK, ONCE A WEEK, ONCE
A MONTH or LESS OFTEN THAN ONCE A MONTH?

- Daily
- Several times a week
- Once a week
- Once a Month
- Less often than once a month
- Don't Know
- Refused

(g7a) Over the PAST SUMMER, has [Child A] had TROUBLE SLEEPING?

- Yes [goto g7b]
- No
- Don't Know
- Refused
[goto g8a]

(g7b) How often has [Child A] had TROUBLE SLEEPING over the PAST SUMMER?
Would you say DAILY, SEVERAL TIMES A WEEK, ONCE A WEEK, ONCE
A MONTH or LESS OFTEN THAN ONCE A MONTH?

- Daily
- Several times a week
- Once a week
- Once a Month
- Less often than once a month
- Don't Know
- Refused

(g8a) Over THE PAST SUMMER, has [Child A] had DIZZY SPELLS?

- Yes [goto g8b]
- No
- Don't Know
- Refused
- [goto g9a]

(g8b) How often has [Child A] had DIZZY SPELLS over the PAST SUMMER?
Would you say DAILY, SEVERAL TIMES A WEEK, ONCE A WEEK, ONCE A MONTH or LESS OFTEN THAN ONCE A MONTH?

- Daily
- Several times a week
- Once a week
- Once a Month
- Less often than once a month
- Don't Know
- Refused

(g9a) Over THE PAST SUMMER, has [Child A] had NAUSEA, that is feeling that might throw up?

- Yes [goto g9b]
- No
- Don't Know
- Refused
- [goto g10a]

(g9b) How often has [Child A] had NAUSEA, that is feeling that [fill E008] might throw up, over the PAST SUMMER
Would you say DAILY, SEVERAL TIMES A WEEK, ONCE A WEEK, ONCE A MONTH or LESS OFTEN THAN ONCE A MONTH?

- Daily
- Several times a week
- Once a week
- Once a Month
- Less often than once a month
- Don't Know
- Refused

(g10a) ...JOINT PAIN OR SWELLING? Over THE PAST SUMMER, has [Child A] had JOINT PAIN OR SWELLING?

- Yes [goto g10b]
 - No
 - Don't Know
 - Refused
- [goto g11a]

(g10b) How often has [Child A] had JOINT PAIN OR SWELLING? How often has [Child A] had JOINT PAIN OR SWELLING over the past SUMMER? Would you say DAILY, SEVERAL TIMES A WEEK, ONCE A WEEK, ONCE A MONTH or LESS OFTEN THAN ONCE A MONTH?

- Daily
- Several times a week
- Once a week
- Once a Month
- Less often than once a month
- Don't Know
- Refused

(g11a) ...has [Child A] been LOSING [fill E007] APPETITE?

- Yes [goto g11b]
 - No
 - Don't Know
 - Refused
- [goto g12a]

(g11b) ...How often has [Child A] been LOSING [fill E007] APPETITE Over the PAST SUMMER, how often has [Child A] been LOSING [fill E007] APPETITE? Would you say DAILY, SEVERAL TIMES A WEEK, ONCE A WEEK, ONCE A MONTH or LESS OFTEN THAN ONCE A MONTH?

- Daily
- Several times a week
- Once a week
- Once a Month
- Less often than once a month
- Don't Know
- Refused

(g12a) ...has [Child A] had STOMACH ACHES or PAINS? Over the PAST SUMMER, has [Child A] had stomach aches or pain?

- Yes [goto g12b]
- No
- Don't Know
- Refused
[goto g13a]

(g12b) ...how often has [Child A] had STOMACH ACHES or PAINS? Over the PAST SUMMER, how often has [Child A] had STOMACH ACHES or PAINS? Would you say DAILY, SEVERAL TIMES A WEEK, ONCE A WEEK, ONCE A MONTH or LESS OFTEN THAN ONCE A MONTH?

- Daily
- Several times a week
- Once a week
- Once a Month
- Less often than once a month
- Don't Know
- Refused

(g13a) ...has [Child A] had DIARRHEA? Over the PAST SUMMER, has [Child A] had DIARRHEA?

- Yes [goto g13b]
- No
- Don't Know
- Refused
[goto g15a]

(g13b) ...how often has [Child A] had DIARRHEA? Over the PAST SUMMER, how often has [Child A] had DIARRHEA? Would you say DAILY, SEVERAL TIMES A WEEK, ONCE A WEEK, ONCE A MONTH or LESS OFTEN THAN ONCE A MONTH?

- Daily
- Several times a week
- Once a week
- Once a Month
- Less often than once a month
- Don't Know
- Refused

(g15a) ...has [Child A] had IRRITATED, SORE or RED EYES? Over the PAST

SUMMER, has [Child A] had IRRITATED, SORE or RED EYES?

- Yes [goto g15b]
- No
- Don't Know
- Refused
[goto g17a]

(g15b) ..how often has [Child A] had IRRITATED, SORE or RED EYES? Over the PAST SUMMER, how often has [Child A] had IRRITATED, SORE or RED EYES?

Would you say DAILY, SEVERAL TIMES A WEEK, ONCE A WEEK, ONCE A MONTH or LESS OFTEN THAN ONCE A MONTH?

- Daily
- Several times a week
- Once a week
- Once a Month
- Less often than once a month
- Don't Know
- Refused

(g17a) ... has [Child A] had COLDS? Over the PAST SUMMER, has [Child A] had COLDS?

- Yes [goto g17b]
- No
- Don't Know
- Refused
[goto g18a]

(g17b) ...how often has [Child A] had COLDS? Over the PAST SUMMER, how often has [Child A] had COLDS?

Would you say DAILY, SEVERAL TIMES A WEEK, ONCE A WEEK, ONCE A MONTH or LESS OFTEN THAN ONCE A MONTH?

- Daily
- Several times a week
- Once a week
- Once a Month
- Less often than once a month
- Don't Know

- Refused

(g18a) ...has [Child A] had a RUNNY OR STUFFY NOSE THAT IS NOT RELATED TO A COLD?

Over the PAST SUMMER, has [Child A] had a RUNNY OR STUFFY NOSE THAT IS NOT RELATED TO A COLD?

- Yes [goto g18b]
- No
- Don't Know
- Refused
[goto g19a]

(g18b) ...how often has [Child A] had a RUNNY NOSE OR STUFFY NOSE THAT IS NOT RELATED TO A COLD?

Over the PAST SUMMER, how often has [Child A] had a RUNNY OR STUFFY NOSE THAT IS NOT RELATED TO A COLD?

Would you say DAILY, SEVERAL TIMES A WEEK, ONCE A WEEK, ONCE A MONTH or LESS OFTEN THAN ONCE A MONTH?

- Daily
- Several times a week
- Once a week
- Once a Month
- Less often than once a month
- Don't Know
- Refused

(g19a) ...has [Child A] had a SORE THROAT THAT IS NOT RELATED TO A COLD?
Over the PAST SUMMER, has [Child A] had a SORE THROAT THAT IS NOT RELATED TO A COLD?

- Yes [goto g19b]
- No
- Don't Know
- Refused
[goto g20a]

(g19b) ...how often has [Child A] had a SORE THROAT THAT IS NOT RELATED TO A COLD? Over the PAST SUMMER, how often has [Child A] had a SORE

THROAT THAT IS NOT RELATED TO A COLD?

Would you say **DAILY, SEVERAL TIMES A WEEK, ONCE A WEEK, ONCE A MONTH** or **LESS OFTEN THAN ONCE A MONTH?**

- Daily
- Several times a week
- Once a week
- Once a Month
- Less often than once a month
- Don't Know
- Refused

(g20a) ...has [Child A] had **EARACHES?** Over the **PAST SUMMER**, has [Child A] had **EARACHES?**

- Yes [goto g20b]
- No
- Don't Know
- Refused
[goto g21a]

(g20b) ...how often has [Child A] had **EARACHES?** Over the **PAST SUMMER**, how often has [Child A] had **EARACHES?**
Would you say **DAILY, SEVERAL TIMES A WEEK, ONCE A WEEK, ONCE A MONTH** or **LESS OFTEN THAN ONCE A MONTH?**

- Daily
- Several times a week
- Once a week
- Once a Month
- Less often than once a month
- Don't Know
- Refused

(g21a) ...has [Child A] had **CHEST PAINS?** Over the **PAST SUMMER**, has [Child A] had **CHEST PAINS?**

- Yes [goto g21b]
- No
- Don't Know
- Refused
[goto g22a]

(g21b) ...how often has [Child A] had CHEST PAINS? Over the PAST SUMMER, how often has [Child A] had CHEST PAINS?
Would you say DAILY, SEVERAL TIMES A WEEK, ONCE A WEEK, ONCE A MONTH or LESS OFTEN THAN ONCE A MONTH?

- Daily
- Several times a week
- Once a week
- Once a Month
- Less often than once a month
- Don't Know
- Refused

(g22a) ...Has [Child A] had COUGHING THAT IS NOT RELATED TO A COLD?

Over the PAST SUMMER, has [Child A] had COUGHING THAT IS NOT RELATED TO A COLD?

- Yes [goto g22b]
- No
- Don't Know
- Refused
- [goto g23a]

(g22b) ...how often has [Child A] had COUGHING THAT IS NOT RELATED TO A COLD?

Over the PAST SUMMER, how often has [Child A] HAD COUGHING THAT IS NOT RELATED TO A COLD?

Would you say DAILY, SEVERAL TIMES A WEEK, ONCE A WEEK, ONCE A MONTH or LESS OFTEN THAN ONCE A MONTH?

- Daily
- Several times a week
- Once a week
- Once a Month
- Less often than once a month
- Don't Know
- Refused

(g23a) ...has [Child A] had WHEEZING OR OTHER TROUBLE BREATHING?

Over the PAST SUMMER, has [Child A] had WHEEZING OR OTHER

TROUBLE BREATHING?

- Yes [goto g23b]
- No
- Don't Know
[goto g24a]

(g23b) ...how often has [Child A] had WHEEZING OR OTHER TROUBLE BREATHING?

Over the PAST SUMMER, how often has [Child A] had WHEEZING OR OTHER TROUBLE BREATHING?

Would you say DAILY, SEVERAL TIMES A WEEK, ONCE A WEEK, ONCE A MONTH or LESS OFTEN THAN ONCE A MONTH?

- Daily
- Several times a week
- Once a week
- Once a Month
- Less often than once a month
- Don't Know
- Refused

(g24a) ...has [Child A] had HIVES OR SKIN RASHES? Over the PAST SUMMER, has [Child A] had HIVES OR SKIN RASHES?

- Yes [goto g24b]
- No
- Don't Know
- Refused
[goto g26a]

(g24b)...how often has [Child A] had HIVES OR SKIN RASHES?

Over the PAST SUMMER, how often has [Child A] had HIVES OR SKIN RASHES?

Would you say DAILY, SEVERAL TIMES A WEEK, ONCE A WEEK, ONCE A MONTH or LESS OFTEN THAN ONCE A MONTH?

- Daily
- Several times a week
- Once a week
- Once a Month
- Less often than once a month

- Don't Know
- Refused

(g26a)...has [Child A] had NOSEBLEEDS?

Over the PAST SUMMER, has [Child A] had NOSEBLEEDS?

- Yes [goto g26b]
- No
- Don't Know
- Refused
[goto g27a]

(g26b)...how often has [Child A] had NOSEBLEEDS?

Over the PAST SUMMER, how often has [Child A] had NOSEBLEEDS?
Would you say DAILY, SEVERAL TIMES A WEEK, ONCE A WEEK, ONCE A MONTH or LESS OFTEN THAN ONCE A MONTH?

INTERVIEWER: we are interested in ongoing or chronic problems, not accidents. For example a nosebleed from falling off a bike should not be counted

- Daily
- Several times a week
- Once a week
- Once a Month
- Less often than once a month
- Don't Know
- Refused

(g27a) ...has [Child A] had problems with EASY BRUISING?

Over the PAST SUMMER, has [Child A] had problems with EASY BRUISING?

INTERVIEWER: we are interested in ongoing or chronic problems, not accidents. For example bruising from falling off a bike should not be counted

- Yes [goto g27b]
- No
- Don't Know
- Refused
[goto g28a]

(g27b)...how often has [Child A] had problems with EASY BRUISING?

Over the PAST SUMMER, how often has [Child A] had problems with EASY BRUISING?

Would you say DAILY, SEVERAL TIMES A WEEK, ONCE A WEEK, ONCE A MONTH or LESS OFTEN THAN ONCE A MONTH?

- Daily
- Several times a week
- Once a week
- Once a Month
- Less often than once a month
- Don't Know
- Refused

(g28a) ...has [Child A] had any BURNING OR DISCOMFORT URINATING?

Over the PAST SUMMER, has [Child A] had any BURNING OR DISCOMFORT URINATING?

- Yes [goto g28b]
- No
- Don't Know
- Refused
[goto g29]

(g28b)...how often has [Child A] had BURNING OR DISCOMFORT URINATING?

Over the PAST SUMMER, how often has [Child A] had BURNING OR DISCOMFORT URINATING?

Would you say DAILY, SEVERAL TIMES A WEEK, ONCE A WEEK, ONCE A MONTH or LESS OFTEN THAN ONCE A MONTH?

- Daily
- Several times a week
- Once a week
- Once a Month
- Less often than once a month
- Don't Know
- Refused

(g29) Has [Child A] had any other health problems over the PAST SUMMER that I have not asked you about?

- Yes [goto g30a]
- No
- Don't Know
- Refused
- [goto g35]

(g30a) [allow 30] What is the problem?

INTERVIEWER: Enter only first mention here, up to 30 characters.

(g30b) How often has [Child A] had a problem with [fill g30a] over the PAST SUMMER?

Would you say DAILY, SEVERAL TIMES A WEEK, ONCE A WEEK, ONCE A MONTH or LESS OFTEN THAN ONCE A MONTH?

- Daily
- Several times a week
- Once a week
- Once a Month
- Less often than once a month
- Don't Know
- Refused

THIS CONTINUES FOR THREE OTHER HEALTH PROBLEMS

(g35) Now I'd like to ask you a number of questions about long term health problems [Child A] may have.

Does [Child A] have skin allergies or other skin diseases?

- yes
- no
- don't know
- refused

(g36) Does [Child A] have hay fever or other allergies?

- yes
- no
- don't know
- refused

(g37) Does [Child A] have middle ear infections?

- yes
- no
- don't know
- refused

(g38) Does [Child A] have asthma?

- yes
- no
- don't know
- refused

(g39) Does [Child A] have other lung problems? **[bold][yellow]** INTERVIEWER: For Example cystic fibrosis?

- yes
- no
- don't know
- refused

(g40) Does [Child A] have heart disease?

- yes
- no
- don't know
- refused

(g41) Does [Child A] have diabetes?

- yes
- no
- don't know
- refused

(g42) Does [Child A] have urinary problems or kidney disease?

- yes
- no
- don't know
- refused

(g43) Does [Child A] have digestive problems?

- yes
- no
- don't know
- refused

THE QUESTIONS ON THE CHILD A ARE REPEATED FOR THE SECOND OLDEST CHILD

SECTION H: ATTITUDES TOWARDS THE NEIGHBOURHOOD

(h1) I'd like to ask you some questions about your community.
Can you please tell me in general, how satisfied are you with this community as a place to live? Would you say VERY SATISFIED, SOMEWHAT SATISFIED, NOT TOO SATISFIED, or NOT AT ALL SATISFIED?

- Very satisfied
- Somewhat satisfied
- Not too satisfied
- Not at all satisfied
- Don't Know
- Refused

(h2) Does the Petro Canada refinery affect your satisfaction with this area as a place to live?

- yes
- no
- don't know
- refused

(h3) Have you ever considered moving because of the refinery?

- yes
- no
- don't know
- refused

SECTION I: PERCEPTION OF ODOURS

- (i2)** I'd now like to ask you some questions about odours from the refinery.
We're interested in what odours were like during this past July and August.

Were you away from home for one or more weeks during July and/or August?

- yes [goto i3]
- no
- don't know
- refused
[goto i8]

- (i3)** How many weeks were you away for in July?

- not away in July
- one week
- two weeks
- three weeks
- four weeks
- refused

- (i4)** How many weeks were you away for in August?

- not away in August
- one week
- two weeks
- three weeks
- four weeks
- refused

- (i8)** During this past July and August, how often, if ever, did you notice odours
WHICH YOU THINK WERE FROM THE REFINERY when you were at home
or in your yard?

Would you say every day, several times a week, about once a week, several times
a month, about once a month, or did you never notice any odours which you think
were from the refinery?

- every day
- several times a week
- about once a week

- several times a month
- about once a month
- never notice [goto j1] [# corrected 30 Sept]
- don't Know [goto j1]
- refused [goto j1]

(i9) When you noticed the odour during July and/or August HOW OFTEN did it bother you?

Would you say EVERY TIME, ALMOST every time, MORE THAN HALF THE TIME, ABOUT half the time, LESS THAN HALF THE TIME, or did it NEVER BOTHER YOU?

- every time
- almost every time
- more than half the time
- about half the time
- less than half the time
- never bothered [goto j1]
- don't Know [goto j1]
- refused [goto j1]

(i10) When you noticed the odour, HOW MUCH did it bother you?
Would you say a GREAT DEAL, SOMEWHAT, ONLY A LITTLE, or did it NOT BOTHER YOU AT ALL?

- Great deal
- Somewhat
- Only a little
- Not bothered
- Don't Know
- Refused

(i11) Did odours cause disruption in your family or social activities during July and/or August?

- Yes [goto i12a]
- No
- Don't Know
- Refused

[goto i18]

(i12a) I'm going to ask you a number of questions about HOW odours disrupted your family and/or social activities during July and/or August.

First, did you have to keep the windows closed?

- Yes [goto i12b]
 - No
 - Don't Know
 - Refused
- [goto i13a]

(i12b) How often did you have to keep the windows closed because of odours in July and/or August?

Would you say OFTEN, OCCASIONALLY, or only ONCE?

- Often
- Occasionally
- Only Once
- Don't Know
- Refused

(i13a) Did you stop your child from playing outside because of odours in July and/or August?

- Yes [goto i14a]
 - No
 - Don't Know
 - Refused
- [goto i13b]

(i13b) How often did you stop your child from playing outside because of odours in July and/or August?

Would you say OFTEN, OCCASIONALLY, or only ONCE?

- Often
- Occasionally
- Only Once
- Don't Know

- Refused

(i14a) Were you unable to spend time or work outside because of odours in July/August?

- yes [goto i14b]
- no
- don't know
- refused
[goto i15a]

(i14b) How often were you unable to spend time or work outside because of odours in July and/or August?

Would you say **OFTEN**, **OCCASIONALLY**, or only **ONCE**?

- Often
- Occasionally
- Only Once
- Don't Know
- Refused

(i15a) Was your or a family member's sleep affected by odours in July and/or August?

- Yes [goto i15b]
- No
- Don't Know
- Refused
[goto i16a]

(i15b) How often was your or a family member's sleep affected by odours in July and/or August?

Would you say **OFTEN**, **OCCASIONALLY**, or only **ONCE**?

- Often
- Occasionally
- Only Once
- Don't Know
- Refused

(i16a) Were you unable to entertain friends outside because of odours in July and/or August?

- [goto i16b]
- no
- don't know
- refused
- [goto i17a]

(i16b) How often were you unable to entertain friends outside because of odours in July and/or August?

Would you say **OFTEN**, **OCCASIONALLY**, or only **ONCE**?

- Often
- Occasionally
- Only Once
- Don't Know
- Refused

(i17a) Were there any other ways that odours disrupted your family and/or social activities during July and/or August?

INTERVIEWER: Enter **ONLY ONE** mention here please.

- Enter text [specify]
- No other way
- Don't Know
- Refused

(i18) If you noticed odours during July and August of this year, how would you compare them with what you remember from July and August of the previous summer?

Would you say they were **LESS NOTICEABLE** than last summer, **ABOUT THE SAME** as last summer, or **MORE NOTICEABLE** than last summer?

- Less noticeable
- About the same
- More noticeable
- Wasn't here July/August 1996
- Can't remember/don't know
- Refused

(i19) Earlier in this interview, you said that you experienced a number of symptoms over the past summer. I'm interested in knowing which, if any, of the symptoms may be brought on or worsened by exposure to odours.

For each of the symptoms you have told us about, could you please tell us whether, in your opinion, they are brought on or made worse by odours you may be smelling, and how frequently the symptoms are related to odours. I'll read the symptoms to you again.

(i20) If **b1a** is "yes", do you think your HEADACHES are brought on by odours? Would you say USUALLY, SOMETIMES, ONCE or TWICE, or are they not brought on by odours?

- Usually
- Sometimes
- Once or Twice
- Not brought on by odours
- Don't Know
- Refused

THIS CONTINUES FOR ALL THE SYMPTOMS IN SECTION B IF THE RESPONSE IS "YES".

SECTION J: AWARENESS, CONCERNS

(j1) Do you have any other concerns about the Petro Canada refinery that we haven't mentioned?

- Yes [goto j2a]
- No
- Don't Know
- Refused
[goto j7]

(j2a) What are your concerns about the refinery?
INTERVIEWER: Enter FIRST mention only!

- Enter text, end with /// [specify][goto j2b]
- Mistake, NO PROBLEMS.
- Don't Know
- Refused
[goto j7]

(j2b) How would you rate your overall level of concern about that issue? Would you say you are SLIGHTLY concerned, MODERATELY concerned, or

EXTREMELY concerned?

INTERVIEWER: Read text above if necessary

- Slightly concerned
 - Moderately concerned
 - Extremely concerned
 - Don't Know
 - Refused
- (j7) Would you say there are benefits to having the refinery in this area?**
- Yes [goto j8]
 - No
 - Don't Know
 - Refused
- [goto j11]
- (j8) What are the benefits to having the refinery in this area?**
INTERVIEWER: Enter FIRST MENTION ONLY.
- Enter text, end with /// [specify][goto j9]
 - Mistake, **NO BENEFITS.**
 - Don't Know
 - Refused
- [goto j11]
- (j9) Are there any other benefits to having the refinery in this area?**
INTERVIEWER: Enter one benefit at a time
- Enter text, end with /// [specify]
 - **NO MORE BENEFITS.**
 - Don't Know
 - Refused
- (j11) Aside from the refinery, do you have any concerns about other environmental problems in your neighbourhood?**
- INTERVIEWER: For example Lake Ontario contaminants, QEW etc.**
- Yes [goto j12]
 - No
 - Don't Know
 - Refused

[goto j16]

- (j12)** What are the concerns you have?
INTERVIEWER: Enter FIRST MENTION only
- Enter text, end with /// [specify][goto j13]
 - Mistake, NO CONCERNS.
 - Don't Know
 - Refused
- [goto j16]
- (j13)** What other environmental concerns do you have?
INTERVIEWER: Enter SECOND MENTION only.
- Enter text, end with /// [specify][goto j14]
 - NO MORE CONCERNS.
 - Don't Know
 - Refused
- [goto j15]
- (j14)** What other environmental concerns do you have?
INTERVIEWER: Enter THIRD MENTION only.
- Enter text, end with /// [specify]
 - NO MORE CONCERNS.
 - Don't Know
 - Refused
- (j15)** How would you rate your OVERALL level of concern? Would you say you are SLIGHTLY concerned, MODERATELY concerned or EXTREMELY concerned?
- Slightly concerned
 - Moderately concerned
 - Extremely concerned
 - Don't Know
 - Refused
- (j16)** How informed would you say you are about the nature and sources of the odour problems associated with the refinery?
Would you say VERY informed, SOMEWHAT informed, NOT TOO informed, or NOT AT ALL informed?

- Very informed
- Somewhat informed
- Not too informed
- Not at all informed
- Don't Know
- refused

(j17a) How informed would you say you are about the activities that have been put in place to reduce odour from the refinery.
Would you say VERY informed, SOMEWHAT informed, NOT TOO informed, or NOT AT ALL informed?

- Very informed [goto j17b]
- Somewhat informed [goto j17b]
- Not too informed [goto j17b]
- Not at all informed
- Don't Know
- refused
[goto j26a]

(j17b) Do you recall any specific measures that have been put in place to reduce odour from the refinery?

- yes [goto j17c]
- no
- don't know
- refused
[goto j18a]

(j17c) What is ONE of the major odour reduction measures that you can recall?

- Enter text, end with ///[specify][goto j17d]
- don't know
- refused
[goto j18a]

(j17d) Do you recall any other measures?...that have been put in place to reduce odour from the refinery?

- Enter text, end with ///[specify][goto j17e]
- No other measures
- don't know

- refused
[goto j18a]

(j17e) Any others? Do you recall any other measures that have been put in place to reduce odour from the refinery?

- Enter text, end with ///[specify]
- No other measures
- don't know
- refused

(j18a) How important have the following sources been in keeping you informed about the odour reduction activities in the refinery?

First, local newspapers such as the Oakville Beaver and the Burlington Spectator, have they been very important, somewhat important, not too important, or not at all important in keeping you informed about the odour reduction activities in the refinery?

- Very important
- Somewhat important
- Not too important
- Not at all important
- Don't Know
- refused

(j18b) What about television?

Has television been very important, somewhat important, not too important, or not at all important in keeping you informed about the odour reduction activities in the refinery?

- Very important
- Somewhat important
- Not too important
- Not at all important
- Don't Know
- refused

(j18c) Ratepayers meetings?

Have ratepayer meetings been very important, somewhat important, not too important, or not at all important in keeping you informed about the odour reduction activities in the refinery?

- Very important
- Somewhat important
- Not too important
- Not at all important
- Don't Know
- refused

(j18d) Environmental Groups such as ICARE?

Have environmental groups such as ICARE been very important, somewhat important, not too important, or not at all important in keeping you informed about the odour reduction activities in the refinery?

- Very important
- Somewhat important
- Not too important
- Not at all important
- Don't Know
- refused

(j18e) The "Community Advisory Committee to Petro Canada" newsletter?

Has the "Community Advisory Committee to Petro Canada" newsletter been very important, somewhat important, not too important, or not at all important in keeping you informed about the odour reduction activities in the refinery?

- Very important
- Somewhat important
- Not too important
- Not at all important
- Don't Know
- refused

(j18f) Local word of mouth?

Has local word of mouth been very important, somewhat important, not too important, or not at all important in keeping you informed about the odour reduction activities in the refinery?

- Very important
- Somewhat important
- Not too important
- Not at all important

- Don't Know
- refused

(j18g) Public Meetings?

Have public meetings been very important, somewhat important, not too important, or not at all important in keeping you informed about the odour reduction activities in the refinery?

- Very important
- Somewhat important
- Not too important
- Not at all important
- Don't Know
- refused

(j18h) Have any other sources been important in keeping you informed about the odour reduction activities in the refinery?

- Yes (specify) [specify]
- no
- don't know
- refused

(j26a) Do you believe that refinery odours are causing health problems in the communities in the vicinity of the refinery?

- yes [goto j26b]
- no
- don't know
- refused
[goto j27]

(j26b) Would you say you strongly believe, believe, are neutral, disbelieve or strongly disbelieve that the refinery odours are causing health problems (in the communities in the vicinity of the refinery?)

- strongly believe
- believe
- neutral
- disbelieve
- strongly disbelieve

- don't know
- refused

(j27) Over the past TWELVE months would you say that odours have improved greatly, improved slightly, stayed the same, worsened slightly or worsened greatly?

- improved greatly
- improved slightly
- stayed the same
- worsened slightly
- worsened greatly
- don't know
- refused

(j28) What about over the past FIVE years, would you say that odours have improved greatly, improved slightly, stayed the same, worsened slightly or worsened greatly?

- improved greatly
- improved slightly
- stayed the same
- worsened slightly
- worsened greatly
- don't know
- refused

(j29a) Are you aware of the environmental complaints hotline (1-800-66PETRO)?

- yes [goto j29b]
- no
- don't know
- refused
[goto k1]

(j29b) Have you ever called the hotline?

- yes [goto j29c]
- no
- don't know
- refused
[goto k1]

(j29c) In general, how satisfied were you with the response to your call, would you say very satisfied, somewhat satisfied, not too satisfied, or not at all satisfied?

- very satisfied
- somewhat satisfied
- not too satisfied
- not at all satisfied
- don't know
- refused

SECTION K: SOCIO-DEMOGRAPHIC QUESTIONS

(k1) Now I'd like to ask a few final questions about your background. First, how many years have you lived at your current address?

- Less than 1 year
- Enter number of years
- Don't Know
- Refused

(k2) How many years have you lived in this NEIGHBOURHOOD?

- Less than 1 year
- Enter number of years
- Don't Know
- Refused

(k3) In what year were you born?

- <1880-1980> Enter year of birth
- Don't Know
- Refused

(k4) What is the highest level of education you have completed?

- no schooling
- some elementary school
- completed elementary school
- some high school/junior high school
- completed high school (NS+PQ = 11, Ont. = 13, other =12)

- some community college
- some technical school (CEGEP, College Classique)
- completed community college
- completed technical school (CEGEP, College Classique)
- some University
- completed Bachelor's Degree (Arts, Science, etc.)
- Post Graduate Training: MA, MSc, MLS, MSW, etc.
- Post Graduate Training: PhD, "doctorate"
- Professional Degree (Law, Medicine, Dentistry)
- Refused

(k5) At present are you married, living with a partner, widowed, divorced, separated, or have you never been married?

- Married or living with a partner
- Widowed
- Divorced
- Separated
- Never Married
- Don't know
- Refused

(sd4) Are you presently working for pay in a full-time or in a part-time job, are you unemployed, retired, a homemaker, a student or something else?

- Full-time job, including during vacations from work
- Part-time job
- Sick leave, maternity leave, strike, etc.
- Unemployed
- Retired
- Homemaker [goto sd8]
- Student (students working part-time) [goto sd8]
- Other [goto sd8]
- Don't know [goto sd8]
- Refused [goto sd8]

(sd5) What is your main occupation? _____

If sd4 is "Retired", before you retired, what was your occupation? _____

If sd4 is "Unemployed", when you were last employed? _____

What was your occupation? _____

INTERVIEWER: IF MORE THAN ONE JOB, ASK ABOUT MAIN JOB

IF NOT CLEAR, PROBE WITH:

What do you do at work?

What exactly does the job entail?

What kind of industry do you work in?

- (sd8)** Could you please tell me how much income you and other members of your household received in 1996? Be sure to include income FROM ALL SOURCES such as savings, pensions, rent, and unemployment insurance as well as wages.

TO THE NEAREST THOUSAND DOLLARS, what was your TOTAL HOUSEHOLD Income before taxes and other deductions were made?

- Actual income [goto sd20]
- Don't know
- Refused

- (sd9)** We don't need the exact amount; could tell me which of these broad categories it falls into...

- ...less than \$20,000
- ...between \$20,000 and \$30,000 (\$29,999.99)
- ...between \$30,000 and \$40,000
- ...between \$40,000 and \$50,000
- ...between \$50,000 and \$60,000
- ...between \$60,000 and \$70,000
- ...between \$70,000 and \$80,000
- ...between \$80,000 and \$100,000, or
- ...more than \$100,000?
- Don't know
- Refused

- (sd20)** In general, would you say these questions were VERY interesting, SOMEWHAT interesting, or NOT VERY interesting?

- Very interesting
- Somewhat interesting
- Not very interesting
- Don't know

- Refused
(sd21) Can you tell me how many minutes you think it took to complete this questionnaire?

- Enter exact number
- Don't know
- Refused

APPENDIX B

LETTER OF INTRODUCTION TO SELECTED HOUSEHOLDS

FIELD(2)
FIELD(8)
FIELD(10) FIELD(11)

June 29, 1997

Dear Resident:

Your household has been randomly chosen to participate in a study of the health of both adults and children living in the Halton Region. The study is being conducted by McMaster University Institute of Environment and Health and the Halton Regional Health Department and is funded by the Social Science Humanities Research Council.

An interviewer from the Institute for Social Research at York University will phone you several days after you receive this letter, and will ask a selected person in your household to complete an approximately 30 minute telephone interview. A range of questions will be asked about his/ her health, the health of children in the household, exposure to outdoor and indoor air pollutants, and environmental concerns.

All the information obtained from people participating in the study will be strictly confidential. Responses to study questions will be recorded, analyzed and reported in ways that guarantee anonymity.

The results of this study will help the Health Department determine the extent to which air quality is affecting the health of people living in Halton.

Thank you in advance for your cooperation and participation in this important study.

Yours sincerely,

S. Martin Taylor
Professor of Geography

and

Robert M. Nosal, M.D.
Medical Officer of Health, Halton Region

APPENDIX C

**LETTER REQUESTING RESPONDENT'S ADDRESS AND TELEPHONE
NUMBER**

FIELD(2)
FIELD(3)
FIELD(8)
FIELD(10) FIELD(11)

29 June, 1997

Dear Resident:

Your household has been randomly chosen to participate in a study of the health of both adults and children living in the Halton Region. The study is being conducted by McMaster University Institute of Environment and Health and the Halton Regional Health Department and is funded by the Social Science Humanities Research Council.

All the information obtained from people participating in the study will be strictly confidential. Responses to study questions will be recorded, analyzed and reported in ways that guarantee anonymity.

The study will be conducted using telephone interviews. We have been unable to locate a telephone number for your household at the above address. In order for the study to interview as many of the randomly selected households as possible, we would appreciate if you could let us know your telephone number. You can do this simply by calling Medy Espiritu at McMaster University (905-525-9140 ext 23535) OR by completing the enclosed sheet and mailing it in the envelope provided. If your telephone number is unlisted, we assure you that it will only be used for purposes of the study.

The telephone interviews will be conducted by the Institute for Social Research at York University. The interview, which lasts about 30 minutes, will take place during the latter half of September. A range of questions will be asked of a selected person in the household about his/ her health, the health of children in the household, exposure to outdoor and indoor air pollutants, and environmental concerns.

Thank you in advance for your cooperation and participation in this important study.

Yours sincerely,

S. Martin Taylor
Professor of Geography

and

Robert M. Nosal, M.D.
Medical Officer of Health, Halton Region

APPENDIX D

LETTER REQUESTING IN-DEPTH INTERVIEW WITH RESIDENTS

name
address
city
postal code

May 15, 1998

Dear name:

You may recall participating in a telephone survey conducted in your area last September by the Institute for Social Research at York University on behalf of a research group at McMaster University. The purpose of the survey was to examine the impacts of emissions from the Oakville Petro Canada refinery on the health and well-being of residents in your community. We are now planning follow-up interviews to examine some of the issues related to the impacts of the refinery in more depth.

You have been selected from the list of previous respondents to participate in this follow-up. We thank you for your participation in the earlier survey and would greatly appreciate it if you would take part in a personal interview. Questions will focus on your attitudes toward odours from the refinery, concerns (if any) related to your health and the environment, and more generally, your level of satisfaction with the community in which you live. The results will be used to extend the findings of the 1997 survey, and to provide information to the Halton Regional Health Department as part of their on-going monitoring of the situation. Your name and address will not be used in any way in reporting the results.

Within the next few days Kelly Wilson from McMaster University will be contacting you to arrange a convenient time for the interview which should take approximately 30 minutes. Should you have any questions, please contact Kelly Wilson or Isaac Luginaah at (905) 525-9140 (ext. 23533).

Thank you in advance for your participation in this important phase of the study.

Sincerely,

S. Martin Taylor (Principal Investigator)
Professor of Geography

APPENDIX E

CHECKLIST FOR IN-DEPTH INTERVIEWS

**PETRO CANADA REFINERY:
1998 CHECKLIST FOR DEPTH INTERVIEWS
May 20, 1998.**

Preamble:

I am a researcher from McMaster University working as part of a research team on a study examining the impacts of emissions from the Petro Canada refinery on the health and well-being of area residents, like yourself. We are especially interested in the effects of Petro Canada's Odour Reduction Plan on area residents' perceptions of and reactions to refinery odours.

Today's interview should take about 30 minutes. If you have any questions at any point do not hesitate to ask. With your agreement, we would like to tape record the interview to accurately document your views. Your name or address will not appear on any tapes or manuscripts.

| TOPIC | QUESTION | PROBES |
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| 1. QUALITY OF LIFE | How long have you lived in this area? | |
| | How would you describe the area where you live to someone who was not familiar with it? | <ul style="list-style-type: none"> - likes and dislikes? - safety issues? What makes a place safe vs. unsafe? - environmental issues? - What do you value about this place? - Why did you move here? Is it what you expected? - Are you planning to stay? |
| | What are your main concerns/worries about living here? Where do your concerns about the refinery fit in/rank relative to these? Have your concerns changed over the past five years? past year? How? Why? | <ul style="list-style-type: none"> - any risks related to living here? stemming from...? - how are you defining risk? |
| | <i>In the survey [Zone 1: 75%; Zone 2: 78%] of people in your area rated themselves as very satisfied with this community as a place to live, and yet [Zone 1: 53%; Zone 2: 29%] said that the refinery affected their satisfaction. Do you agree with this finding? Why/Why not?</i> | |
| 2. ODOUR PERCEPTION | Over the course of the X years you have lived here, do you think that odours from the refinery have changed? Why do you think these changes have occurred? | <ul style="list-style-type: none"> - Has there been an improvement? How much? How can you tell? - Have odours stayed the same? - Have odours worsened? |

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| | <i>Our 1997 survey findings showed that over the past five years [Zone 1: 52%; Zone 2: 49%] of the people in your area think that the odour problem has improved, and [Zone 1: 28%; Zone 2: 27%] think it has stayed the same or gotten worse. Do these results surprise you? Why do you think this was the finding?</i> | <ul style="list-style-type: none"> - their perception of odour change versus overall findings; agreement versus disagreement. - knowledge of odour reduction plan? - tolerance/ acceptance by community? |
| | Do you think the odour-related problems associated with the refinery have been exaggerated in any way, given the overall high quality of life that people in this area experience and report? Do you think the odour-related problems have been underplayed at all? | |
| | Do you think residents in this area should expect <i>some</i> odours? | <ul style="list-style-type: none"> -refinery came first? - industry as a part of life? - buyer beware? |
| 3. ODOUR ANNOYANCE & COPING STRATEGIES | How annoyed are you by odours from the refinery? What annoys you about the odours? | <ul style="list-style-type: none"> -level of annoyance. - What annoys you: what you can versus you can't smell.? -odour annoyance and/or annoyance to site in general.? -life-style disruption? |
| | In the x number of years you have lived here, has your level of annoyance due to odours from the refinery changed? How has it changed? Why has it changed? | <ul style="list-style-type: none"> -increase/decrease in annoyance? -reasons for change? |
| | Do you think that most people adapt to odours over time? Have you adapted to the odours? | <ul style="list-style-type: none"> -refinery as a part of everyday life. -habituation? -resignation? |
| | What do you usually do or think when you notice and/or become annoyed by odours? | <ul style="list-style-type: none"> - information/ communication related: e.g. talk about it with friends/neighbours, call hotline. - action: close windows, stay inside, alter activities. - emotions: get angry, try not to think about it, ignore it. |
| 4. HEALTH CONCERNS | Do you feel that the odours/emissions from the refinery have affected your health or the health of others in this household in any way? How? Have you always felt this way? | <ul style="list-style-type: none"> -children's health? - mental health? (e.g., stress) -physical health? (e.g., respiratory, eye irritation). |

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| | Why do you feel that the odours/emissions from the refinery have affected your/others' health? Have you always felt this way? | -Why do you think it is the refinery per se? - do your symptoms disappear when out of area? -symptoms correlate with incidents |
| | What concerns you most about possible health effects of the refinery? When are you most concerned? Why? Have you always felt this way? | -do odours trigger to you to worry about your health? -uncertain risk -perception of health problems in the community. |
| | How do you deal with your health concerns? How could your health concerns (if any) be minimized? Who do you talk to for information on these issues? | coping with health concerns: talk to physician? talk to neighbours? minimizing health concerns: more info in papers etc. |
| 5. VULNERABLE POPULATIONS | 1. Do you think there are particular groups of people in your area who are more affected by the refinery emissions/odours than others? What do you think those most affected by emissions/odours should do? | Who? - high risk groups: children, elderly, those with existing health conditions. Why? Basis for judgement (ask for example) |
| | In previous interviews conducted with residents living near the refinery, we found that the area between Bronte Creek and Burloak Drive (show map) was perceived by most residents to be the worst area to live with respect to odours and increased health risks? Do you agree? Why/Why not? How does that make you feel, based on where you live? | - buffer zone? - effects of winds? - folklore of risk? |
| 6. OTHER REFINERY-RELATED CONCERNS | Do you have any other types of concerns related to the refinery? How would you rank these concerns, relative to odours? Have you always felt this way? | -pollution (air, water, noise)? -trucks/traffic? -visual effects? (plumes, flares) -property values? -accidents/ safety concerns? - other? |
| | How do you manage/deal with these concerns? How could these concerns be minimized? | - coping strategies: call hotline; talk to neighbours; do nothing |
| 7. ODOUR REDUCTION PLAN | <i>In response to community concerns about the impacts of refinery emissions, Petro Canada introduced a comprehensive 'Odour Abatement Action Plan' beginning in 1991.</i> | |

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| | 1. Are you aware of Petro Canada's odour reduction plan? If yes, how? What does it consist of? | How? - local newspaper? t.v? public meeting? participation in past studies? What? - who is involved? when did it start,? why did it start? |
| | Do you think that the odour abatement efforts by Petro Canada have been successful to date? | -Have measures brought any changes to odours in the community? -evidence of change? -positive effects of change? |
| | Do you think more needs to be done to reduce odours from the refinery? | - what more needs to be done? |
| | Who do you think should be responsible for taking actions and monitoring the effects of emissions from the refinery? Why do you think they should be responsible? | - industry? - government? - other? |
| 8. INFORMATION & COMMUNICATION | <i>In order for me to better understand your attitudes and concerns related to the refinery, it is important for me to know what information is available to you (e.g., public meetings and newspapers).</i> | |
| | Do you consider yourself informed about the nature and sources of the odour problems associated with the refinery? What are the main sources of information available to you? Have these sources always been available/change in using sources over time? Which source do you find the most believable/credible? Why? | - availability of information? - information sources: (CAC newsletter, local newspapers, Petro Canada open house) |
| | Have you ever belonged to a volunteer citizen's group or attended a public meeting that dealt with issues related to the refinery? | -why (not) involved? - awareness of CAC-PC? - what do you think of CAC-PC? - W.O.R Inc.? - I.C.A.R.E? - other community group? |
| | What do you have to say about the community groups opposed to the refinery? Do you think these kinds of groups are effective? In what ways? | -are they credible? - which one's are more credible than others? Why? |
| | How effectively have Petro Canada (Oakville Refinery) and government representatives communicated with community residents about their concerns related to the refinery? | -examples of good and poor communication? -how could it be improved? |

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| | <p><i>In July 1991, the Petro Canada hotline (1-800-66-PETRO) was created to provide residents with a means of registering complaints about odours or any other problem associated with the refinery.</i></p> <p><i>Our survey indicated that only [Zone 1: 35%; Zone 2: 12%] of people in your area were aware of the Petro Canada hotline for odour complaints, and only [Zone 1: 14%; Zone 2: 1%] had ever called the hotline</i></p> | |
| | Do these findings (low awareness and use of hotline) surprise you? Why/Why not? | <ul style="list-style-type: none"> -Are you aware of the hotline? If yes: <ul style="list-style-type: none"> -how did you become aware? -when did you become aware? -Have you ever called? Why? Why not? |
| | Do you think the hotline is useful? Why/why not? | <ul style="list-style-type: none"> - does hotline make any improvement in risk communication process? -can you suggest ways to improve the hotline? |
| | Overall, what is your impression of Petro Canada's (Oakville Refinery) partnership with the community? Has this perception changed over the past five years? | <ul style="list-style-type: none"> - Petro's relationship with community agencies/groups? - are there benefits to having the refinery in your community? - changes over time? |
| 9. TRUST | What would the experts at Petro Canada have to do to convince you that the refinery odour problem had been solved to a large extent? | <ul style="list-style-type: none"> -what would it take to convince you? -how much confidence do you have in their facts? |
| | When it comes to issues around the refinery, who do you feel best represents your interests? | <ul style="list-style-type: none"> - Who do you trust/ believe most when getting info. about refinery? Why? - Who don't you believe? Why? |
| | Who would you/do you trust most to oversee any further odour reduction measures? Why? | how would someone gain your trust? Why type of person could you/do you trust? |
| | Who do you see as the experts around issues related to the Petro Canada Oakville Refinery? Why? | <ul style="list-style-type: none"> -who says they are the experts? -is one group of experts more believable to you than other? Why? - how do their views differ from yours? |

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| 10. SOLUTIONS | <i>Finally, I would like to find out what your views are with regard to finding a possible solution to the problem of refinery odours.</i> | |
| | What do you think is the ultimate solution to the problem of refinery odours in this area? Is there an ultimate solution? | <ul style="list-style-type: none"> -industry leaves?. - continued reduction of odours? - acceptance? - no solution? - other? |
| | Realistically, do you think that there can ever be a solution which will satisfy everyone in the community? Y/N? Why? | -refinery and odours are part of everyday life? |
| | Do you think people have shifted their expectations in light of past improvements in the odour situation? In what ways have your expectations changed? | |
| | Who do you feel should be held accountable for finding and implementing a solution to odour problems from the refinery? Why do you think this? | <ul style="list-style-type: none"> - Petro Canada? - CAC? - MOEE? -Health Dept.? - combination? |
| 11. CONCLUSIONS | Is there anything more you would like to add? | |
| | | |

APPENDIX F

IN-DEPTH INTERVIEW CODING SYSTEM

Q.S.R. NUD.IST Power version, revision 4.0.**PROJECT: PetroCanada, User Isaac Luginaah, 11.30 p.m., Oct. 18, 2000.**

- (1) /Respondent Group
- (1 1) /Respondent Group/Group A
- (1 2) /Respondent Group/Group B
- (1 3) /Respondent Group/Group C
- (1 4) /Respondent Group/Sex
- (1 4 1) /Respondent Group/Sex/Male
- (1 4 2) /Respondent Group/Sex/Female
- (1 5) /Respondent Group/Length of stay in residence
- (1 6) /Respondent Group/Age
- (2) /Quality of Life in Community
- (2 1) /Quality of Life in Community/Community Values
- (2 1 1) /Quality of Life in Community/Community Values/quiet-peaceful
- (2 1 2) /Quality of Life in Community/Community Values/safety
- (2 1 3) /Quality of Life in Community/Community Values/respect for privacy
- (2 1 4) /Quality of Life in Community/Community Values/good property sizes
- (2 1 5) /Quality of Life in Community/Community Values/property values
- (2 1 6) /Quality of Life in Community/Community Values/friendly
- (2 1 7) /Quality of Life in Community/Community Values/lake and harbour
- (2 1 8) /Quality of Life in Community/Community Values/hard working
- (2 2) /Quality of Life in Community/Community Expectations
- (2 2 1) /Quality of Life in Community/Community Expectations/small nice town
- (2 2 2) /Quality of Life in Community/Community Expectations/place to raise kids
- (2 2 3) /Quality of Life in Community/Community Expectations/fresh air
- (2 2 4) /Quality of Life in Community/Community Expectations/access to amenities
- (2 2 5) /Quality of Life in Community/Community Expectations/green space
- (2 2 6) /Quality of Life in Community/Community Expectations/access to highway
- (2 2 7) /Quality of Life in Community/Community Expectations/no congestion
- (2 2 8) /Quality of Life in Community/Community Expectations/bicycle-walking trails
- (2 2 9) /Quality of Life in Community/Community Expectations/nature
- (2 3) /Quality of Life in Community/Citizens group membership
- (2 3 1) /Quality of Life in Community/Citizens group membership/yes
- (2 3 1 1) /Quality of Life in Community/Citizens group membership/yes/environmental
- (2 3 1 2) /Quality of Life in Community/Citizens group membership/yes/church group
- (2 3 1 3) /Quality of Life in Community/Citizens group membership/yes/social service
- (2 3 1 4) /Quality of Life in Community/Citizens group membership/yes/neighbourhood
- (2 3 1 5) /Quality of Life in Community/Citizens group membership/yes/political
- (2 3 1 6) /Quality of Life in Community/Citizens group membership/yes/other
- (2 3 2) /Quality of Life in Community/Citizens group membership/no
- (2 4) /Quality of Life in Community/General concerns
- (2 4 1) /Quality of Life in Community/General concerns/air pollution
- (2 4 2) /Quality of Life in Community/General concerns/noise from highway
- (2 4 3) /Quality of Life in Community/General concerns/crime
- (2 4 4) /Quality of Life in Community/General concerns/growth of city
- (2 4 5) /Quality of Life in Community/General concerns/allergies
- (2 4 6) /Quality of Life in Community/General concerns/water pollution
- (2 4 6 1) /Quality of Life in Community/General concerns/water pollution/leachate
- (2 4 7) /Quality of Life in Community/General concerns/traffic and congestion

- (2 4 8) /Quality of Life in Community/General concerns/NIMBY
- (3) /Refinery
- (3 1) /Refinery/Images of the refinery
- (3 1 1) /Refinery/Images of the refinery/invisible emissions
- (3 1 2) /Refinery/Images of the refinery/odourless emissions
- (3 1 3) /Refinery/Images of the refinery/refinery odours
- (3 1 3 1) /Refinery/Images of the refinery/refinery odours/odour perception
- (3 1 3 1 1) /Refinery/Images of the refinery/refinery odours/odour perception/frequent
- (3 1 3 1 2) /Refinery/Images of the refinery/refinery odours/odour perception/infrequent
- (3 1 3 1 3) /Refinery/Images of the refinery/refinery odours/odour perception/never noticed
- (3 1 3 1 4) /Refinery/Images of the refinery/refinery odours/odour perception/seasonal
- (3 1 3 1 4 1) /Refinery/Images of the refinery/refinery odours/odour perc./seasonal/mostly summer
- (3 1 3 1 5) /Refinery/Images of the refinery/refinery odours/odour perception/exaggerated
- (3 1 3 1 5 1) /Refinery/Images of the refinery/refinery odours/odour perception/exaggerated/yes
- (3 1 3 1 5 2) /Refinery/Images of the refinery/refinery odours/odour perception/exaggerated/no
- (3 1 3 2) /Refinery/Images of the refinery/refinery odours/odour annoyance
- (3 1 3 2 1) /Refinery/Images of the refinery/refinery odours/odour annoyance/frequent
- (3 1 3 2 2) /Refinery/Images of the refinery/refinery odours/odour annoyance/infrequent
- (3 1 3 2 3) /Refinery/Images of the refinery/refinery odours/odour annoyance/never bothered
- (3 1 4) /Refinery/Images of the refinery/accidents
- (3 1 5) /Refinery/Images of the refinery/noise annoyance
- (3 1 6) /Refinery/Images of the refinery/traffic
- (3 1 7) /Refinery/Images of the refinery/soot and other deposits
- (3 1 8) /Refinery/Images of the refinery/fire from flares
- (3 1 9) /Refinery/Images of the refinery/aesthetics
- (3 2) /Refinery/Concerns
- (3 2 1) /Refinery/Concerns /Health
- (3 2 1 1) /Refinery/Concerns /Health/children's health
- (3 2 1 1 1) /Refinery/Concerns /Health/children's health/respiratory
- (3 2 1 1 2) /Refinery/Concerns /Health/children's health/cancer
- (3 2 1 2) /Refinery/Concerns /Health/long-term health
- (3 2 1 2 1) /Refinery/Concerns /Health/long-term health/cancer
- (3 2 1 2 2) /Refinery/Concerns /Health/long-term health/birth defects
- (3 2 1 2 3) /Refinery/Concerns /Health/long-term health/uncertainty
- (3 2 1 3) /Refinery/Concerns /Health/short-term health
- (3 2 1 3 1) /Refinery/Concerns /Health/short-term health/headache
- (3 2 1 3 2) /Refinery/Concerns /Health/short-term health/wheezing
- (3 2 1 3 3) /Refinery/Concerns /Health/short-term health/loss of sleep
- (3 2 1 3 4) /Refinery/Concerns /Health/short-term health/eye irritation
- (3 2 1 3 5) /Refinery/Concerns /Health/short-term health/nose congestion
- (3 2 1 3 6) /Refinery/Concerns /Health/short-term health/fatigue
- (3 2 1 3 7) /Refinery/Concerns /Health/short-term health/blood pressure
- (3 2 1 4) /Refinery/Concerns /Health/psychosocial health
- (3 2 1 4 1) /Refinery/Concerns /Health/psychosocial health/hostility
- (3 2 1 4 2) /Refinery/Concerns /Health/psychosocial health/worry
- (3 2 1 4 3) /Refinery/Concerns /Health/psychosocial health/anxiety
- (3 2 1 4 4) /Refinery/Concerns /Health/psychosocial health/outrage
- (3 2 1 4 5) /Refinery/Concerns /Health/psychosocial health/annoyed
- (3 2 1 4 6) /Refinery/Concerns /Health/psychosocial health/guilt
- (3 2 1 4 7) /Refinery/Concerns /Health/psychosocial health/frustration

- (3 2 2) /Refinery/Concerns /Mismanagement
- (3 2 2 1) /Refinery/Concerns /Mismanagement/Monitoring
- (3 2 2 1 1) /Refinery/Concerns /Mismanagement/Monitoring/independent body
- (3 2 2 1 2) /Refinery/Concerns /Mismanagement/Monitoring/Halton health department
- (3 2 2 1 3) /Refinery/Concerns /Mismanagement/Monitoring/MOE
- (3 2 2 1 4) /Refinery/Concerns /Mismanagement/Monitoring/government body
- (3 2 2 1 5) /Refinery/Concerns /Mismanagement/Monitoring/refinery itself
- (3 2 2 1 6) /Refinery/Concerns /Mismanagement/Monitoring/the people affected
- (3 2 2 1 7) /Refinery/Concerns /Mismanagement/Monitoring/CAC-PC
- (3 2 2 1 8) /Refinery/Concerns /Mismanagement/Monitoring/local politicians
- (3 2 3) /Refinery/Concerns /Accountability
- (3 2 3 1) /Refinery/Concerns /Accountability/who should be accountable
- (3 2 3 1 1) /Refinery/Concerns /Accountability/who should be accountable/refinery management
- (3 2 3 1 2) /Refinery/Concerns /Accountability/who should be accountable/Halton health dept.
- (3 2 3 1 3) /Refinery/Concerns /Accountability/who should be accountable/MOE
- (3 2 3 1 4) /Refinery/Concerns /Accountability/who should be accountable/government
- (3 2 3 1 5) /Refinery/Concerns /Accountability/who should be accountable/local politicians
- (3 2 4) /Refinery/Concerns /Property values
- (3 2 5) /Refinery/Concerns /Satisfaction with community
- (3 2 5 1) /Refinery/Concerns /Satisfaction with community /yes
- (3 2 5 1 1) /Refinery/Concerns /Satisfaction with community /yes/frustrations with refinery
- (3 2 5 2) /Refinery/Concerns /Satisfaction with community /no
- (3 2 5 3) /Refinery/Concerns /Satisfaction with community /impossible to satisfy everyone
- (3 2 6) /Refinery/Concerns /Poor involvement in community
- (3 2 7) /Refinery/Concerns /No where to hide
- (3 2 8) /Refinery/Concerns /Community opposition
- (3 2 8 1) /Refinery/Concerns /Community opposition/good for community
- (3 2 8 2) /Refinery/Concerns /Community opposition/not worth it
- (3 2 9) /Refinery/Concerns /Uncertainty
- (3 2 10) /Refinery/Concerns /Shifting concerns
- (3 2 11) /Refinery/Concerns /Lack of trust and credibility
- (3 3) /Refinery/Ultimate solution of refinery problem
- (3 3 1) /Refinery/Ultimate solution of refinery problem/go somewhere else
- (3 3 2) /Refinery/Ultimate solution of refinery problem/strive to improve
- (3 3 3) /Refinery/Ultimate solution of refinery problem/zero odours from refinery
- (3 3 4) /Refinery/Ultimate solution of refinery problem/use latest technology
- (3 3 5) /Refinery/Ultimate solution of refinery problem/improve community involvement
- (3 3 6) /Refinery/Ultimate solution of refinery problem/close down the refinery
- (3 4) /Refinery/Perceived changes in refinery impacts
- (3 4 1) /Refinery/Perceived changes in refinery impacts/impacts have improved
- (3 4 2) /Refinery/Perceived changes in refinery impacts/impacts have stayed the same
- (3 4 3) /Refinery/Perceived changes in refinery impacts/impacts are worse
- (3 5) /Refinery/The refinery came first
- (3 5 1) /Refinery/The refinery came first/did not know it was there
- (3 5 2) /Refinery/The refinery came first/knew but was not concerned
- (3 5 3) /Refinery/The refinery came first/knew but bought my house
- (3 5 4) /Refinery/The refinery came first/knew but had no choice
- (3 5 5) /Refinery/The refinery came first/people should do their homework
- (3 6) /Refinery/Benefits of the refinery
- (3 6 1) /Refinery/Benefits of the refinery/yes

- (3 6 2) /Refinery/Benefits of the refinery/no benefits
- (3 7) /Refinery/Risk communication
- (3 7 1) /Refinery/Risk communication/Awareness of hotline
- (3 7 1 1) /Refinery/Risk communication/Awareness of hotline/yes
- (3 7 1 1 1) /Refinery/Risk communication/Awareness of hotline/yes/hotline is useful
- (3 7 1 1 2) /Refinery/Risk communication/Awareness of hotline/yes/hotline is not useful
- (3 7 1 2) /Refinery/Risk communication/Awareness of hotline/no
- (3 7 2) /Refinery/Risk communication/Media
- (3 7 3) /Refinery/Risk communication/CAC-PC Newsletter
- (3 7 3 1) /Refinery/Risk communication/CAC-PC Newsletter/ever received
- (3 7 3 1 1) /Refinery/Risk communication/CAC-PC Newsletter/ever received/yes
- (3 7 3 1 2) /Refinery/Risk communication/CAC-PC Newsletter/ever received/no
- (3 7 4) /Refinery/Risk communication/Open house
- (3 7 4 1) /Refinery/Risk communication/Open house/ever attended?
- (3 7 4 1 1) /Refinery/Risk communication/Open house/ever attended?/yes
- (3 7 4 1 2) /Refinery/Risk communication/Open house/ever attended?/no
- (3 7 5) /Refinery/Risk communication/Public meetings
- (3 7 6) /Refinery/Risk communication/Poor communication
- (3 7 7) /Refinery/Risk communication/Good communication
- (3 7 8) /Refinery/Risk communication/Informed about odour reduction measures
- (3 7 8 1) /Refinery/Risk communication/Informed about odour reduction measures/very info.
- (3 7 8 2) /Refinery/Risk communication/Informed about odour reduction measures/somewhat
- (3 7 8 3) /Refinery/Risk communication/Informed about odour reduction measures/not at all
- (3 7 9) /Refinery/Risk communication/Word of mouth
- (4) /Coping Strategies
- (4 1) /Coping Strategies/Action Focused
- (4 1 1) /Coping Strategies/Action Focused/stay indoors
- (4 1 2) /Coping Strategies/Action Focused/close windows
- (4 1 3) /Coping Strategies/Action Focused/considered moving
- (4 1 3 1) /Coping Strategies/Action Focused/considered moving/yes
- (4 1 3 2) /Coping Strategies/Action Focused/considered moving/no
- (4 1 4) /Coping Strategies/Action Focused/air appliances
- (4 1 5) /Coping Strategies/Action Focused/radical engagement
- (4 1 6) /Coping Strategies/Action Focused/talk to neighbours
- (4 1 7) /Coping Strategies/Action Focused/research
- (4 2) /Coping Strategies/Emotion Focused
- (4 2 1) /Coping Strategies/Emotion Focused/pragmatic acceptance
- (4 2 1 1) /Coping Strategies/Emotion Focused/pragmatic acceptance/acceptance
- (4 2 1 2) /Coping Strategies/Emotion Focused/pragmatic acceptance/get use to it
- (4 2 1 3) /Coping Strategies/Emotion Focused/pragmatic acceptance/expect some odours
- (4 2 1 4) /Coping Strategies/Emotion Focused/pragmatic acceptance/don't think about impacts
- (4 2 1 5) /Coping Strategies/Emotion Focused/pragmatic acceptance/refinery was there first
- (4 2 1 6) /Coping Strategies/Emotion Focused/pragmatic acceptance/those not happy should move
- (4 2 1 7) /Coping Strategies/Emotion Focused/pragmatic acceptance/some are more sensitive
- (4 2 1 8) /Coping Strategies/Emotion Focused/pragmatic acceptance/some people are winners
- (4 2 1 9) /Coping Strategies/Emotion Focused/pragmatic acceptance/worse elsewhere
- (4 2 1 10) /Coping Strategies/Emotion Focused/pragmatic acceptance/think positive
- (4 2 2) /Coping Strategies/Emotion Focused/sustained optimism
- (4 2 2 1) /Coping Strategies/Emotion Focused/sustained optimism/latest technology
- (4 2 3) /Coping Strategies/Emotion Focused/cynical pessimism

(4 2 3 1) /Coping Strategies/Emotion Focused/cynical pessimism/fatalism
(4 2 4) /Coping Strategies/Emotion Focused/no problem at all