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North Circular Road Environmental Improvement Initiative

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All the residents living along the NCR who assisted with our survey

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Abstract:

This project examined the environmental impacts of the North Circular Road (NCR) on residents living directly adjacent to the roadway. The focus of this project was to collect, organize, and present data for use in the London Borough of Brent's grant application to the European Union's LIFE-Environment fund. To assist with the application process, we collected data on air and noise pollution in the vicinity of the NCR, traffic and accidents on the NCR, and the health of residents living near the NCR. The project also included making recommendations to the London Borough of Brent for the usage of potentially allocated grant funds.

Executive Summary:

The North Circular Road (NCR) is the noisiest and second most polluted road in the United Kingdom [1]. This road was originally intended for use by through traffic as a direct route across northern London, linking the M1 and A40. The section of the road we concentrated on in the London Borough of Brent contains 153 residences within 10 meters from the road. Along this stretch, the noise and air pollution created by the high volume of motor vehicle traffic is at unacceptable levels to the Borough of Brent. These conditions have been linked to health problems, and Brent was concerned for the health of the residents along the NCR. For this reason, the Borough wanted to improve the quality of life for the residents alongside the NCR through improvement of the area to address these problems.

For the improvement of the NCR area, Brent would need both the financial ability to complete improvements and knowledge of remediation methods for reducing the negative environmental factors. For funding of the improvements Brent plans on submitting a bid to the European Union's (EU's) LIFE-Environment fund. In order to apply for a bid proposal from this fund, Brent needs to both show evidence of the health problems created by the environmental impacts of the roadway and proposed remediation methods. The aim of this project was to assist the London Borough of Brent with the collection, organization, and presentation of data as evidence for use in the submission of this bid. This included data on air pollution, noise pollution, accidents, and health problems present in the area directly surrounding the NCR. Additionally, best practice recommendations were made for use in improving the area surrounding the roadway. All

funds potentially allocated by the LIFE-Environment fund are for the improvement of the quality of life for residents living adjacent to the road.

Our collection of data included extracting information from sources both within and outside of the Borough of Brent. Some data had already been collected by Brent regarding the three main problems on the NCR, air pollution, noise pollution, and safety. The collection phase of this project focused on gathering and collating this data, and also gathering new data in the form of a photographic survey of the road and a survey of the residents. Additionally, the goal of this project was to make recommendations to the Borough regarding the best methods used to remedy similar situations in the past through the collection and analysis of case studies.

After our data was collected, we then organized and presented the data in visual manner. The data organization phase included the transformation of data from formats that were not directly usable for presentation (such as paper copy) to formats such as Microsoft Excel spreadsheets or GIS tables, which could then be used to create an effective visual presentation of our data. These visual representations of our data included maps of pollution levels and accidents, and also graphs of data such as air pollution levels and survey results. This presentation of data is a key element in the bid process, as it is direct evidence of the harmful conditions present in the NCR area.

The project team also presented the Borough of Brent with recommendations for the use of the grant money potentially allocated by the EU's LIFE-Environment fund. These recommendations were limited to suggestions for remediation methods that involved the land around the NCR, as the Borough of Brent does not control the upkeep of the road itself. In order to make these recommendations we first conducted background

research on the problems faced by the NCR and found case studies showing remediation of similar problems. Then, the most relevant case studies had to be analyzed and the remediation methods used were extracted.

Through the process discussed above, the project team was able to gather and present data showing that pollution, accidents, and health problems were all present in the area directly surrounding the NCR. Once these results were placed in the form of maps, charts, and tables, we were able to make these key findings:

- Yearly mean air pollution levels for nitrogen dioxide, sulfur dioxide, and particulate matter on the NCR are higher than national standards
- Noise pollution levels along the NCR are also above desired levels for the Borough of Brent
- Air and noise pollution levels present on the NCR have been linked by scientific research to an increased occurrence of health problems
- Most residents are unhappy with the current living and parking situation
- Most residents along the NCR are willing to allow the Borough to use part of their property to remedy the situation
- Accidents occur at many points along the NCR, and a major cause of these accidents is vehicles entering or exiting driveways on the NCR

The major findings our project resulted in will form a large part of the bid proposal made by Brent to the EU.

From these results, we then determined the most effective way of combating the problems that affect the residents on the NCR. From the best practices extracted from our case studies, we were able to find the most relevant remediation methods, and apply them

to the case of the NCR. Some of these remediation methods included noise barriers, landscaping, improved lighting, and redevelopment of road access. Once the bid to the EU's LIFE-Environment fund has been submitted and potentially granted funds allocated, the improvements recommended will be used to improve the quality of life for the residents surrounding the NCR.

Chapter I: Introduction

Advancements in transportation technology over the last century have enabled us to travel quicker, more efficiently, and less expensively. This brings added convenience to our lives, but with this convenience comes a significant cost. These advancements sometimes lead to negative effects, such as traffic and pollution, which can be detrimental to those the technology is intended to serve. Technology is advancing at such a rate, that these negative side effects are occurring increasingly.

The trends in worldwide automobile use are leading to significant environmental impacts and reduced standards of living for people residing directly adjacent to high-traffic roadways, such as the North Circular Road (NCR) in the London Borough of Brent. The NCR is the noisiest and second most polluted road in the greater London area [1]. This road is one of the more extreme cases of the way advancements in transportation can have negative consequences. As the area urbanized, council owned residences were constructed along the road, placing households within close proximity of the roadway. The larger volume of motor vehicles passing through the area creates a dangerous situation for motorists, pedestrians, and residents. With the influx of urbanization, in exchange for the convenience the NCR has provided, residents have had to tolerate high levels of noise and air pollution, traffic, and accidents. With air pollution levels as much as 10ug/m3 higher than national standards and noise pollution levels 10db higher than desired, this can contribute to an increased risk of health problems.

The Borough of Brent collects data about air pollution, noise pollution, accidents, and health as part of their daily operations. While this data had already been collected, the majority of the data pertains to the entire Borough of Brent. Specific data about the

NCR had not been extracted from the Borough wide statistics, and had not been presented to show specific problems and their locations along the NCR.

The main goal of our project was to assist the London Borough of Brent with the collection, organization, and presentation of data relevant to the problems experienced by residents of the NCR. The result of the presentation of relevant data will be the submission of a bid to the European Union's LIFE-Environment fund. Our collection of data included locating, collating, and extracting data from sources both within and outside of the Borough of Brent. After our data was collected, we then organized and presented the data using maps, charts, and graphs to make a solid case for the need to remediate the problems facing the residents.

In addition to our data collection, the team gathered best practice information for the recommendation of methods to remediate the problems facing the NCR. We began this by collecting case studies of the best remediation methods that similar situations to the NCR used. Through these case studies, we extracted and presented the Borough of Brent with a range of recommendations for the use of the grant money potentially allocated by the LIFE-Environment fund. The severity of the situation on the NCR compared to these case studies leads us to suggest something must be done to remediate the problems present on the NCR.

Chapter II: Background

The specific problem this project looked at was the way transportation technology affected the lives of those residing around the North Circular Road (NCR) in the London Borough of Brent. The road began as a throughway between two major highways, the M1 and the A40, and is the only major road running east to west through North London. There are six lanes of traffic, three traveling in each direction. The NCR, also known as the A406, has become a concern for the Borough of Brent, after being named the nosiest and second most polluted road in London [1].

2.1. The North Circular Road

The NCR was originally designed to be a major trunk route through North London, and over time, rapid urbanization in the area led to the construction of many council residences along the roadway. As the residences were built, the population density increased, many local access points were added to the road [2], and the amount of people traveling the NCR every day increased. The roads design remains essentially unchanged, however.

High traffic on the NCR has led to problems in three main areas: air quality, noise pollution, and safety. These problems are all affected primarily by the combination of road traffic on the NCR and the proximity of residences to the road. With approximately 450 people living directly adjacent to the road, these effects are a major problem for the Borough. In the past, some efforts have been made for the improvement of safety along the road, such as the addition of overpasses, traffic lights, and the re-pavement of the

road. These measures have only touched upon the safety of the road and its travelers, and have not focused on reducing the effects of air and noise pollution.

2.1.1 Proximity of Houses to the Road

The NCR is densely populated with approximately 450 residents living in close proximity to the road. The residents' houses are as close as 7.5 meters from the road, creating dangerous conditions for residents (Figure 2.1). Nitrogen dioxide, a pollutant known to cause health problems, is a pollutant which can be extremely dangerous to the well-being of an individual. Table 1 shows the relation of distances from the road and levels of NO_2 present. In this case, the effect of a high population density could be a contributing factor towards a decreased quality of life. The consequences of high population density affect all sectors of life, especially environmental and sociological [3]. Air and noise pollution become factors as the location of the residences prohibit the existence of parks and green areas.

Figure 2.1: Overhead Picture of NCR

Road Name	Road Number	Distance to objective from road centre line (m)
EDGWARE ROAD	A5	20
CRICKLEWOOD BROADWAY	A5	20
HARROW ROAD	A404	15
BRENTFIELD	A404	30
HILLSIDE	A404	30
CRAVEN PARK	A404	30
NORTH CIRCULAR ROAD	A406(T)	100
CRAVEN PARK	A407	25
CHURCH ROAD	A407	25
HIGH ROAD	A407	25
EALING ROAD	A4005	20
MANOR PARK ROAD	A404	60
NORTH CIRCULAR ROAD	A406(T)	30
HARROW ROAD	A404	30
BURNT OAK BROADWAY	A5	5
EDGWARE ROAD THE HYDE	A5	5
WATFORD ROAD	A404	10
HIGH ROAD	A404	25
HARROW ROAD	A404	15
NORTH CIRCULAR ROAD	A406(T)	65
WALM LANE	A407	10
CHICHELE ROAD	A407	10
STATION ROAD	A4000	50
HIGH STREET HARLESDEN	A4000	65
OLD OAK LANE	A4000	40
STATION ROAD	A4000	40
EDGWARE ROAD WEST HENDON BROADWAY	A5	15
EDGWARE ROAD	A5	15
BRIDGEWATER ROAD	A4005	8
KINGSBURY ROAD	A4006	5
EAST LANE	A4088	5
FORTY AVENUE	A4088	5
SCRUBS LANE	A219	70
WOOD LANE	A219	70
CRAVEN PARK ROAD	A404	70
EDGWARE ROAD THE HYDE	A5	10
HIGH STREET HARLESDEN	A404	70
NORTH CIRCULAR ROAD	A406(T)	70
SHEEPCOTE ROAD	A409	8
	A4088	10
DUDDEN HILL LANE	A4088	10
HIGH STREET HARLESDEN	A404	70
HARROW ROAD	A404	70
WATFORD ROAD	A404	5
HIGH ROAD	A404	10
HARROW ROAD	A404	10
HARROW ROAD	A404	10
HIGH ROAD	A407	15
WILLESDEN LANE	A4003	15

Table 2.1: Distances from the road to objective levels

2.1.2 Traffic conditions on the NCR

The NCR contains a high volume of traffic, bringing with it a high amount of undesirable factors. Traffic backups of a mile or more occur on the road because of traffic

lights and accidents. An example of such a traffic backup is in Figure 2.2. This slow moving, high volume of traffic brings increased air pollution, noise pollution, and dirt. When traffic is not as severe, high speed traveling is more prevalent. The speed limit on this road is only 40 kilometers per hour in the area of the council housing, which from our observation is not observed by most motor vehicles.

Figure 2.2: Traffic backup on NCR

2.1.3 Accidents and the Parking Situation

Parking along the NCR presents a dangerous condition for residents as well as those traveling the road. Most of the houses have no car access other than off the NCR (Figure 2.1). The residents are forced to use their front yard as a parking place for their vehicles leaving the cars parked 3.5 meters away from the street (Figure 2.3). This results

in parked cars being forced to exit their driveways by backing out onto the NCR, creating an extremely dangerous condition for everyone using the NCR. Reversing onto the NCR can be the cause of accidents along the roadway, such as the accident shown in Figure 2.4. Accidents cause injury to travelers and cause added congestion along a roadway.

Figure 2.3: Parking situation along NCR

Figure 2.4: Accident picture from NCR

2.2. Air Pollution

With the large number of motor vehicles traveling through the NCR area in Brent, the residents are subjected to the emissions being introduced into the atmosphere by exhaust fumes. This combined with the high number of people living in council housing, creates a dangerous situation for many residents. This section discusses the known effects caused by air pollution from motor vehicles and the specific effects in Brent.

2.2.1 Health Effects

Air pollution is commonly known to cause or exacerbate health complications, mainly respiratory problems such as asthma [7]. Air pollutants such as sulfur dioxide, carbon dioxide, and particulate matter, which are known to be emitted by motor vehicles, can cause the reduction of respiratory functions for those already prone to respiratory ailments [4]. Particulate matter, defined as tiny particles of carbon and un-burnt carbon compounds, is thought to increase the risk of heart and lung disease [5]. It is also known that air pollution causes other diseases, especially in children. The occurrence of childhood leukemia has been found to be at least eight times more likely if the child lives close to a high traffic roadway [6].

2.2.2. Effects in Brent

The London Borough of Brent is concerned with the levels of air pollution present in the Borough, and the NCR is the area with the highest level of concern. A high volume

of vehicles traveling through the area, especially the volumes traveling on the NCR, creates a significant pollution problem for the residents living in council housing along the NCR. Known pollutants in the Brent area are sulfur dioxide, nitrogen dioxide, and particulate matter [7]. Brent has made predictions and simulations in their stage 3 and 4 reports that show that nitrogen dioxide and particulate matter levels will exceed national air quality objectives, mostly because of motor vehicles and the traffic resulting from their usage [7].

2.3. Noise Pollution

The NCR is a high traffic road, and has been voted the noisiest road in London [1]. The health effects that stem from noise pollution are a large concern for the Brent council. This section discusses known health effects from the presence of environmental noise pollution and the presence of noise pollution in the Borough of Brent.

2.3.1 Health Effects

Noise pollution can affect the health of individuals who are exposed to it on a regular basis. Sound, such as motor vehicle noise, can pose health problems for those residing adjacent to a road, such as the NCR. For example, constant exposure to high levels of noise has been linked to ischemic heart disease [8]. Not only does noise affect the heart rate, rest can be hindered also, making it even harder to recuperate [9]. The health effects of noise pollution can be anywhere from a minor nuisance to a major health risk, depending on the health and physical condition of a person [9]. Other mental and

physical problems caused by noise include decreased performance by school children, various sleep disorders, increased heart rate, and hearing loss [9]. All of these health effects can begin to occur with noise levels as low as sixty-five decibels [10].

2.3.2 Effects in Brent

Noise pollution and its health effects are a potential problem for the residents of the area surrounding the NCR. The people who work, learn, and live in the area surrounding the road are exposed to the noise that the road creates. With the large diversity in the residents along the NCR and the loud volume of the road, it is highly possible that effects from noise pollution may be a health problem for residents living adjacent to the NCR.

2.4. Predictions & Objectives

In the process of collecting the data used for submission in the LIFE-Environment bid proposal, we also discovered data concerning predictions of future levels of particulate matter and nitrogen dioxide levels. These predictions were done by Kings College for use by the Borough of Brent in their stage three report. These predictions are based on past trends and assume that no remedial measures are being taken to reduce the levels of pollution.

2.4.1 NO_2

Levels of Nitrogen Dioxide in the Borough are expected to increase in the near future. Figure 2.5 shows a map of the levels of NO_2 predicted for 2005 based on a Kings College study of traffic levels and increased air pollution. The study was done using current traffic levels, current pollution levels, and predicted traffic increases. The map shows the NCR to have the highest NO_2 levels throughout the Borough. This additionally supports the claim that traffic is causing higher levels of pollution, since the main factor in predicting the values of pollution for this study was traffic levels. The study predicts levels of NO_2 along the area of the NCR that we are concentrating on to be approximately 37 ppb in 2005. This is higher than the annual mean for 2002, which was approximately 34 ppb. This is due to a predicted increase in traffic in the area. Comparatively, Figure 2.6 shows the objective levels of NO_2 in ppb, the objective levels (target levels for the Borough) for the NCR are 21 ppb as an annual mean. These objective levels are set to bring the Borough in adherence with national standards [7].

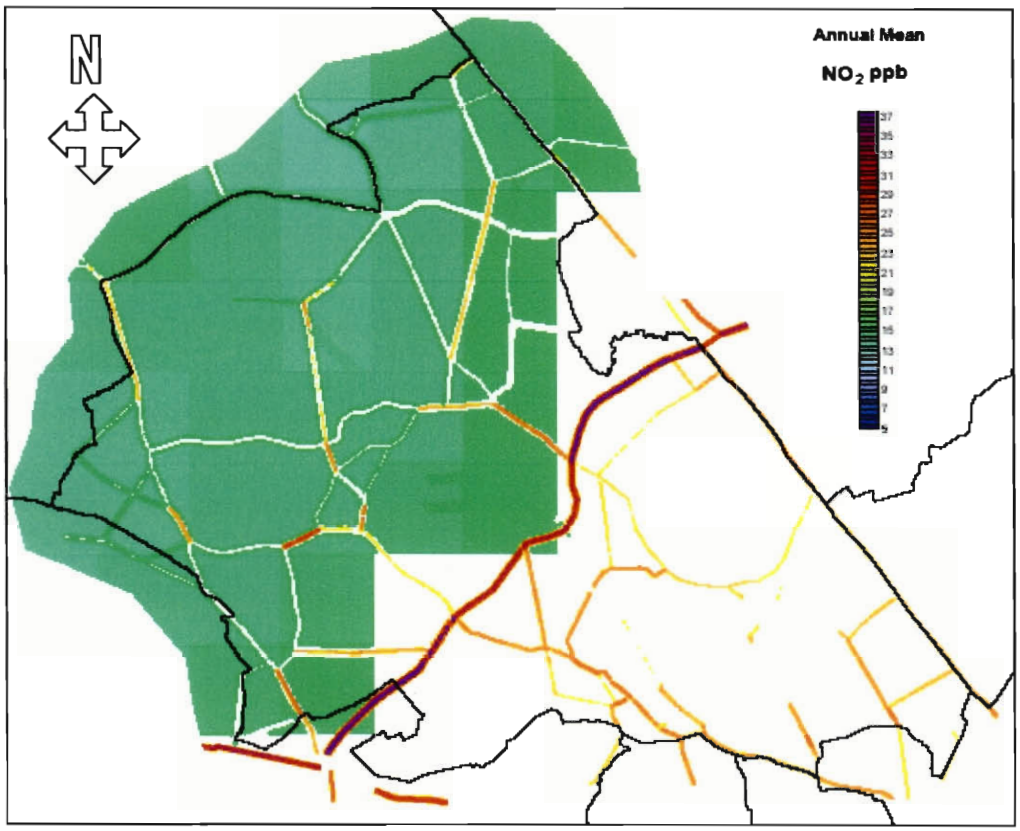


Figure 2.5: Kings College NO2 Prediction for 2005 (1 ug/m3 = 1 ppb / .52) [7]

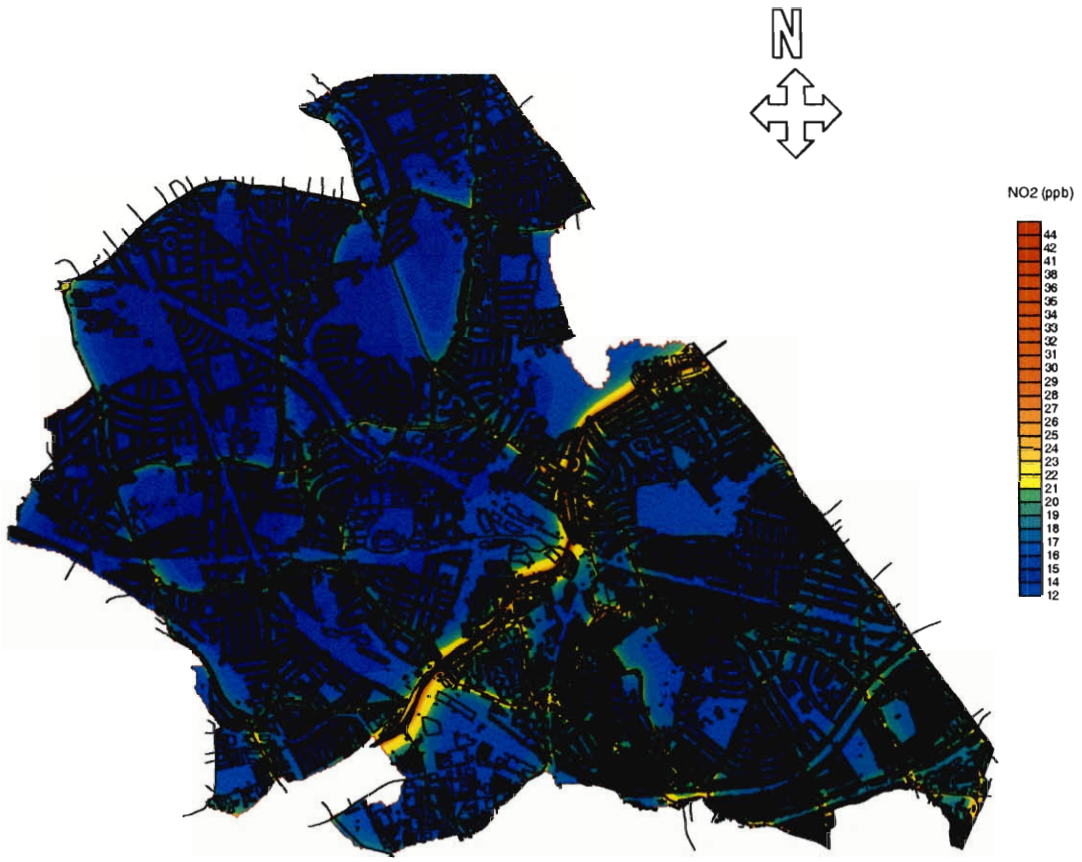


Figure 2.6: Objective Levels of N02 for 2005 – Conversion PPB to Ug/M3 – PPB / .52 [7]

2.4.2 Particulate Matter

Particulate matter is also expected to be at levels exceeding national standards in the future. Figure 2.7 shows a map of the levels of particulate matter predicted for 2004 based on a Kings College study of traffic levels and increased air pollution. This study was done in the same manner as the study in Section 2.4.1. The results of this study were mapped according to the number of predicted days the particulate matter in the air will be greater than 80 ug/m_3. The predicted number of days along the NCR was 60. Comparatively, the objective (target for the Borough of Brent, in order to adhere to

national standards) for 2005 is to achieve active levels less than 80ug/m3 for 40 days or less. Figure 2.8 shows objective levels along the NCR to be less than 50 ug/m_3 for all but 40 days of the year. From this we can conclude that something must be done to meet objective levels. This prediction map shows the NCR region having higher levels than any other road on the map. This supports the claim that particulate matter is caused by motor vehicle usage [7].

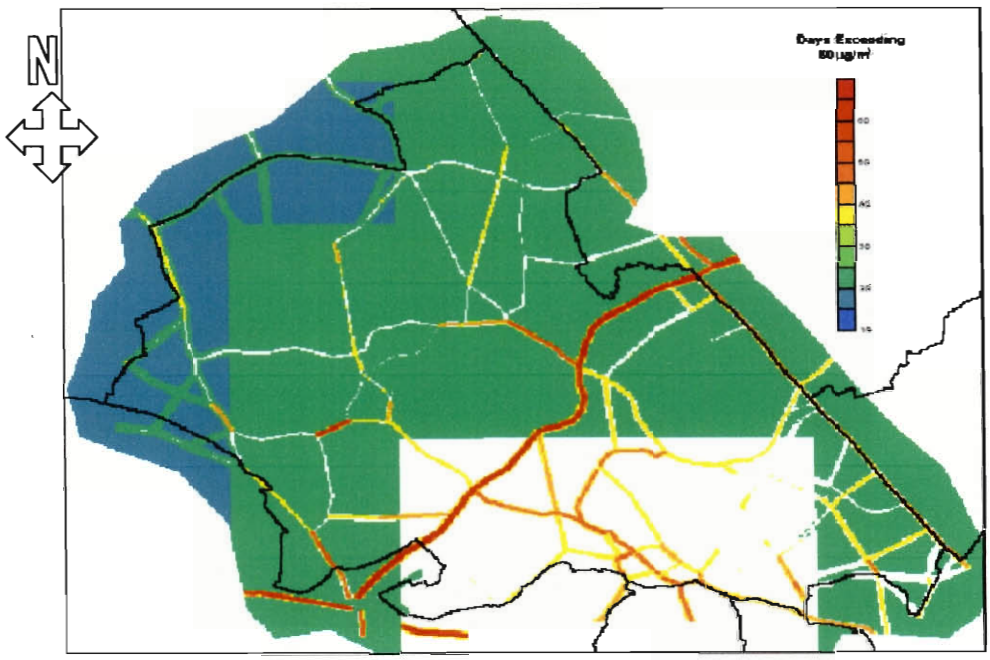


Figure 2.7: Kings College Predection for Particulate Matter Predictions for 2004 [7]

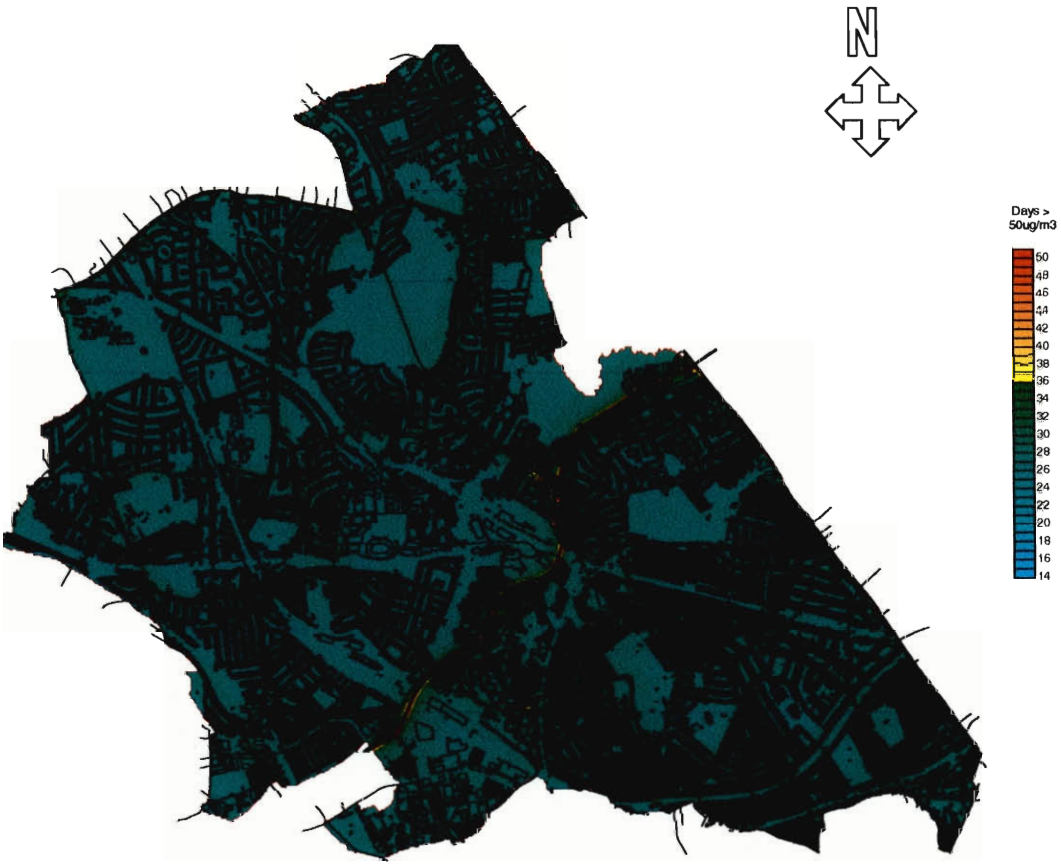


Figure 2.8: Objective Particulate Matter levels for 2005 [7]

2.5. Remedial Measures: General Trends & Case Studies

Although the main goal of this project was to assist, by collection, organization, and presentation of data, the Borough of Brent in submitting a bid proposal to the EU's LIFE Environment fund, the project team also produced a set of best practice recommendations to potentially remedy the problems along the NCR. Some of the problems along the NCR have occurred in past situations in other locations. Information about these situations and the methods of remediation used is referred to as best practice

data. This section describes the key results of our background research into best practices relevant to the NCR.

2.5.1 High Population Density

A similar case to the NCR occurred in San Diego California in 2002. The population of San Diego County had been steadily increasing by approximately 10% each year for ten years [11]. Specific areas in the city were in need of redevelopment to account for the increase in the population. In order to deal with the increasing population and keep the city from seeming overpopulated, they decided redevelopment was the best remedial option. The redevelopment work included increasing the number of multi-family units in high-density areas. Since redevelopment work affected the residents on site, the government redeveloped a mitigation plan to temporarily relocate the residents while redevelopment was in process [11].

2.5.2 Air Pollution

Air pollution from motor vehicles can adversely affect households situated near roadways. There are many methods of controlling air pollution, but not all are feasible for the Borough of Brent. The planting of foliage and other natural air pollution reduction methods work well in certain situations to reduce the amount of air pollution in an area. As determined in one case study, an average mature tree has the ability to absorb as much as or more than 240 pounds of pollution and gases, such as those emitted by traffic [12]. Quality landscaping that is close to the highway or in medians can increase driver

awareness of the immediate environment and alter driver behavior, resulting in slower speeds and a safer main street. Street landscaping, consisting of low-growth plants, is generally acceptable if their maintenance does not create safety concerns on the highway [13]. Trees are an attractive way to cool streets in the summer, block wind in the winter, and absorb pollutants [14]. With the amount of air pollution in Brent, especially around the NCR, the use of landscaping could improve the conditions considerably.

There are other options for the reduction of air pollution, both proactive and reactive. Reactive measures could include nitrogen fixing bacteria [15]. Proactive measures include more strict emission standards and traffic reduction. In the case of the NCR, the Borough of Brent has little control over traffic and emission standards, so reactive measures such as landscaping or nitrogen fixing bacteria will have to be used.

2.5.3 Noise Pollution

Some of the noise pollution problems facing the NCR can be remedied using the some of same methods as reducing air pollution. In order to reduce noise from a roadway, noise barriers are most commonly used and are the most effective. Noise barriers can be constructed with a solid substance (such as concrete) or live foliage (such as living willow). In order to utilize a noise barrier effectively, many steps must be taken to ensure the proper placement, material used when placing, and constructing of noise barriers.

One new and interesting method of noise reduction is the use of willow trees [15]. There are commercial businesses who sell specialized willow trees made for the reduction of noise, in some cases reducing noise levels by 60 dB or more [15], Figure 2.9. One such company that produces this product is ETS, Ltd. Willow trees are more

visually appealing than a typical noise barrier and are rated to reduce noise at approximately the same level, shown in Figure 2.10 [15].

Figure 2.9: Live Barrier [16]

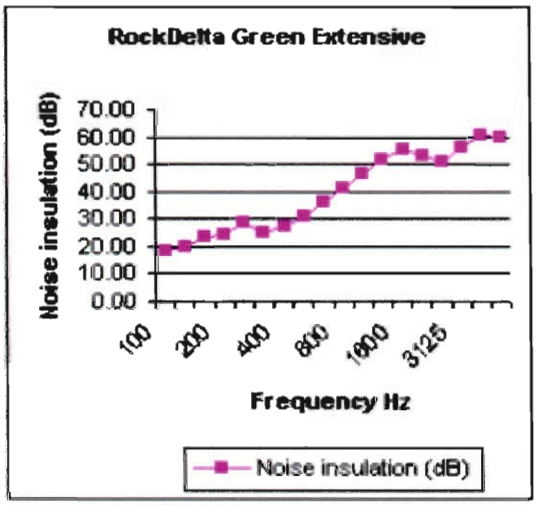


Figure 2.10: Graph of Live Barrier Reductions [16]

Size and placement of noise barriers is important to the reduction of noise and the safety of the area where the barriers are located. The length of a noise barrier needs to be at least 10 meters and should be continuous for long distances to be effective [17]. The height of a barrier also has a very large impact on the amount of noise reduced. A barrier of twenty feet will reduce sound levels by 10 decibels [18]. Additionally, noise barriers

placed as close to the source of noise as possible, will result in the largest reduction of noise [17]. Other than the reduction of noise, noise barriers could also help to improve the safety of the sidewalks along a roadway.

A similar problem to the one facing the NCR took place in Arizona on State Route 51. New sound barriers were built to separate adjacent neighborhoods from the freeways. Figure 2.11 shows where new barriers were constructed or existing barriers built upon. We can see in Appendix A the effects of the addition of these barriers, reducing the noise levels by up to 7dB. Along State Route 51, the problems the residents were experiencing were similar, but lesser in extent that the problems of noise along the NCR.

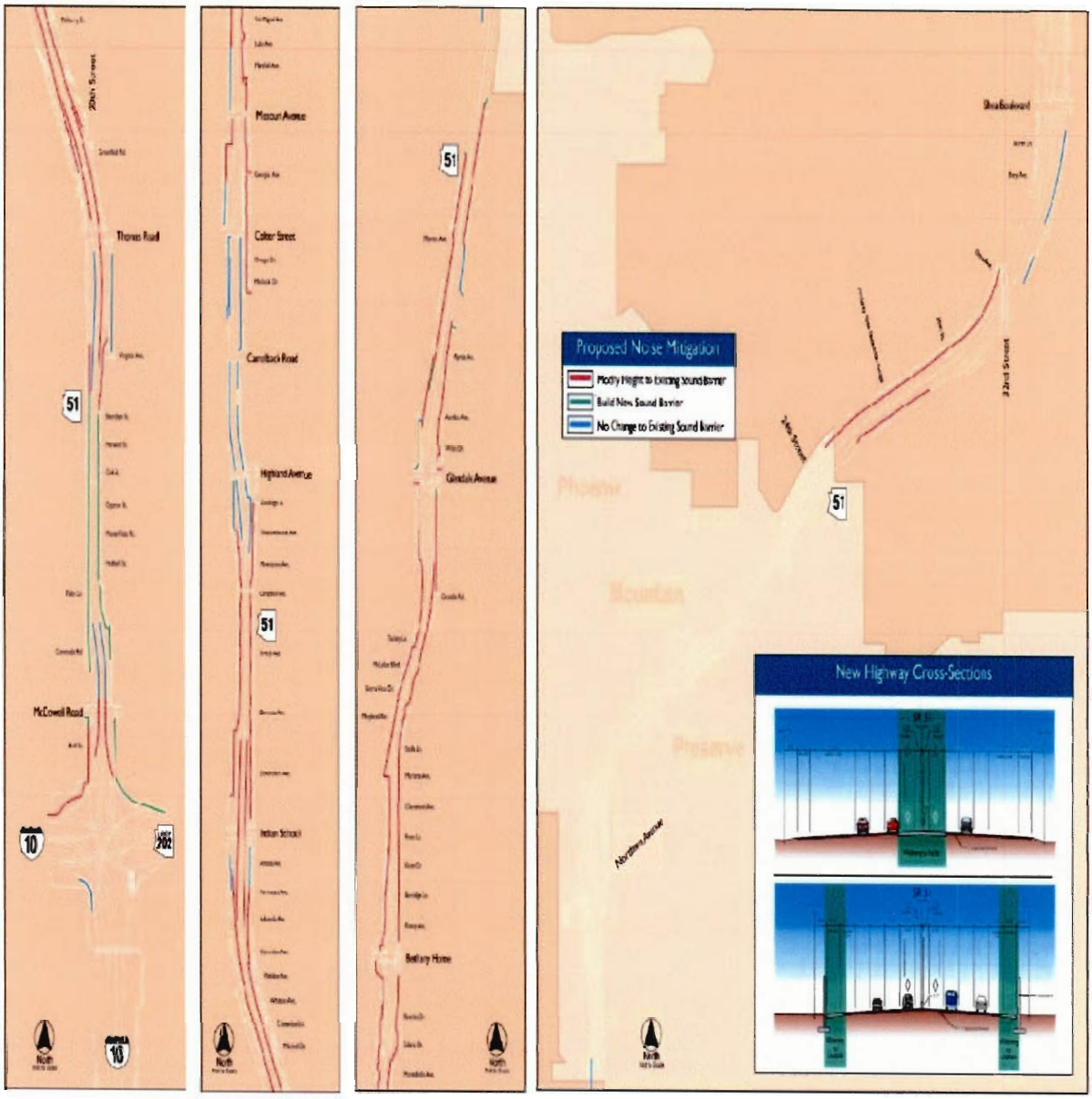


Figure 2.11: Remediation along State Route 51 [18]

2.5.4 Safety

The safety of residents, pedestrians, and travelers of the NCR is a very important issue, and is of great concern to the Borough of Brent. With the proximity of the road to the houses, the options for improvement of the pavements are minimal. This poses many

safety concerns for the residents who regularly use the sidewalks as a means of transportation. The pavements along the NCR lack protection from cars on the road, which creates the possibility of automobiles veering off the road (Figure 2.4). By examining what has been done in similar situations to remedy problems with pavements and reviewing best practice data we may be able to find potential solutions to some of the safety problems along the NCR.

Figure 2.12: Narrow sidewalk along NCR

It is a basic principal that there be well designed safe places for people to walk along all public rights-of-way. The guidance, entitled "Accommodating Bicycle and Pedestrian Travel: A Recommended Approach – A U.S. DOT Policy Statement on

Integrating Bicycling and Walking Into Transportation Infrastructure", says according to U.S. policy, bicycling and walking facilities will be incorporated into all transportation projects unless "exceptional circumstances" exist [20]. Pavements, provided on both sides of a street, are generally the preferred pedestrian method of traveling. They provide the greatest degree of comfort for pedestrians and the presence of pavements has been associated with increased safety for pedestrians.

2.6 Bid Process

The project team was responsible for assisting the Borough of Brent with their bid proposal to the European Union's LIFE-Environment fund. In order to accomplish this, the team first had to understand the application process used. Five different areas exist which LIFE will fund:

- Land use development and planning
- Reduction of the environmental impact of economic activities
- Water management
- Waste management
- Reduction of the environmental impact of products through an integrated product policy

We have identified our project to conform to the first two areas. The first, land use development and planning, will relate to the potential redevelopment of the area surrounding the NCR. This will be extremely relevant since the most effective option to reducing noise pollution and solving the parking problem along the NCR may be to redevelop the area. The next, reduction of environmental impact of economic activities,

will relate to the reduction of air pollution present along the NCR. This portion of the grant money will be useful for both reduction of air pollution and re-development of the area.

The application process for the EU's LIFE-Environment fund can be a complicated process. The sections of the proposal can be viewed in Appendix B. This process involves providing large amounts of information about the roadway and the area surrounding the road. This data is suggested to be in the form of charts, maps, and graphs, to visually aid the EU in determining both the presence and extent of problems which are requesting remedial measures. For the presentation section of the bid proposal, we will be creating maps of air pollution levels, maps of noise pollution levels, graphs showing trends in air pollution levels, and assorted relevant charts of survey results. These will be combined with the plans for remedial measures, and will form part of the bid proposal to the EU's LIFE-Environment fund.

Chapter III: Methodology

The primary goal of our project was to assist the London Borough of Brent with the collection, organization, and presentation of data relevant to the problems experienced by residents living along the NCR. In order to complete this task, we first had to collect an extensive set of relevant data. This included gathering air pollution, noise pollution, and accident data already collected by Brent and collecting new data through the conduction of two surveys. Organizing the data was the next phase of our project. This involved re-formatting data, adding geographical information to it, and interpreting maps. The next step, presentation, involved putting all the data into a form that Brent will be able to use when making a bid proposal to the European Union's LIFE-Environment fund. This included generating maps, charts, tables, and graphs.

In addition to our data collection efforts, we investigated best practice data and provided Brent with applicable case studies showing similar situations to the NCR and how they were remedied. From these case studies, we extracted the best methods used and made specific recommendations to the London Borough of Brent.

3.1. Data Collection

To find a relationship between the health effects discussed in Chapter II and the impact of the road on the lives of the residents, the first step was to collect the appropriate data from several sources. This was done in two different steps, the first step being the collection of specific data about the NCR. The Borough of Brent has collected extensive

data on air pollution, noise pollution, accidents, and health statistics which were used in our project. In addition to using the data already collected by the Borough, we conducted two surveys, a photographic survey of the NCR and a survey of the residents.

3.1.1 Gathering Data Already Collected by Brent

The Borough of Brent and all other Boroughs and cities in the UK are required by law to collect information on the noise and air pollution levels in the area. The United Kingdom requires this in order to ensure that the Boroughs comply with national standards in these areas. In addition to monitoring air and noise pollution, Brent collects information on accidents along the NCR. Health Statistics are also collected in Brent by outside agencies such as The London Health Observatory.

3.1.1.1 Air Pollution

The Environmental Services division of Brent, which contains the Environmental Health unit, is where we obtained data on air pollution. Our specific contact was Yogini Patel, the Service Manager. The Borough monitors five different types of pollutants: lead, sulfur dioxide, nitrogen dioxide, benzene, and carbon dioxide. We specifically examined nitrogen dioxide, carbon dioxide, and sulfur dioxide. We chose these three pollutants because they were the three pollutants which are currently a problem both in Brent as a whole and along the NCR.

Brent has two different ways of monitoring air quality. The first is with a continuous monitoring site located along the NCR. The locations of this site are shown in Figure 3.1. This site, in conjunction with a background site, formed a large part of our data set for air pollution. There is only one continuous monitoring site along the NCR, which makes it difficult to predict the exact levels of pollutants at every point on the road. Thus, the second type of collection method Brent uses is a borough wide nitrogen dioxide diffusion tube survey with 12 locations. There are four of these sites along the entire road, two of them on the road section this project focused on, shown in Figure 3.1. The data we obtained from this was used to supplement the continuous monitoring site data. Due to the small number of monitoring sites along the NCR, as shown in Figure 3.1, there are some limitations on the accuracy of air pollution data available from Brent. In order to reduce the effect of this, we recommended that Brent either add more monitoring sites along the NCR or acquire a program similar to CADNA (software used to simulate noise pollution levels for this project discussed in Section 3.3.2.2) to produce more detailed air pollution data.

Figure 3.1: Locations of Monitoring Sites along the NCR

3.1.1.2 Accidents

Data relating to accidents and road access was obtained from the Brent Transportation Unit. The specific contact within Transportation was Nanji Bhudia, the Principal Engineer of Traffic Analysis for Brent. The accident data came in a few different formats:

- Monthly breakdowns of accidents along the NCR for the last three years
- Breakdown by month of the number of causalities in the past three years
- Table of the severity of accidents: slight, serious, and fatal, broken down by year

- Table of pedestrian accidents, broken down by severity and year

Included with all accident data was the geographical information with the coordinates showing the locations of the accidents, which we used in Arc View to create maps of the area.

3.1.1.3 Health Statistics

While the Borough of Brent conducts a census to obtain health statistics of the residents of Brent, no specific information existed for the residents of the NCR. In order to obtain data of this, we contacted Clementine Mondey, Brent's Health Strategy Manager. Clementine was able to provide us with Brent's contact at the London Health Observatory, Dr. Jenny Mindell, Deputy Director. Brent contracts the London Health Observatory to gather specific health data for regions in the Borough. Because of limitations in time and the current state of the census (the results of which will not be available until June) we were unable to obtain specific health data. The data will become available to Brent before the submission deadline for a bid to the EU's LIFE-Environment fund.

3.1.2 Gathering New Data

Although the Borough of Brent had collected a large amount of data pertaining to our project, we decided that it would be helpful to also collect supplemental data. We did this by conducting surveys. The first survey involved taking photographs of the NCR and

the surrounding area and the other survey was a questionnaire of the residents living along the NCR.

3.1.2.1 Photographic Survey

The photographic survey was conducted using a digital camera by taking pictures of the entire roadway. We used an overhead map of the road to mark the location where each picture was taken Figure 2.1. Pictures were taken on the opposite side of the roadway, with each picture overlapping slightly. We used these pictures to give a strong visual link between the actual conditions along the NCR and the data we collected. These pictures included photographs of areas of the road similar to those in case studies we collected. With these pictures, the relevance of the case studies was more easily demonstrated.

3.1.2.2 Survey of Residents

We conducted a survey of the residents in the area. The specific portion of roadway this project focused on along the NCR contained 153 households. Our selection of the residencies was random and contained 50 households. The purpose of the survey was to help establish what the residents concerns and needs were. Questions were both open ended and specific in nature. The survey and the reasoning for asking each specific question can be viewed in Appendix C. The survey was administered using an interview

style. Two students administered the survey together, one asking the questions and the other recording the answers.

3.2. Organization of Data

Once the data was collected, we organized it so that it could be clearly presented. In order to transform our data into the correct format, we needed to ensure a geographic element was associated with it. In order to complete this, we ensured during the data collection phase of the project that any data collected had or could have found for it the geographical element associating it to a location along the NCR.

Our data was given to us by Brent in an easily organized format. The data for noise pollution, health statistics, and accidents was provided to us in the Microsoft Excel file format, which is easily manipulated and imported into other programs. We used the data in Microsoft Excel format to import it into our Geographical Information System (GIS) software. We did this by saving the excel spreadsheets in dbf4 format. Once in this format we were able to import the tables into ArcView and use them to create maps and graphs.

In contrast, our survey data which was collected by hand with responses being recorded on paper, had to be put into electronic format prior to analysis. In order to organize our survey we first categorized the responses we received into qualitative and quantitative responses. The quantitative responses were organized using Microsoft Excel. The answers were categorized, the totals for each column were totaled, and percentages calculated. The qualitative data was organized using Microsoft Excel, when organizing

this data, similar responses were grouped together so conclusions could more easily be drawn during the conclusions phase of our project.

3.3. Presentation

Once collected and organized, we presented our data using maps, charts, graphs, and tables. We made maps showing the location and severity of noise pollution, air pollution, and accidents. Charts were made showing the average amount of air and noise pollution present along the NCR and a background site. Next, graphs were made of past and current levels of air and noise pollution and numbers of accidents.

3.3.1 Geographical Information System

We needed a powerful and coherent way of organizing our data for all aspects of our project. GIS was our way of displaying data that had a geographical aspect to it. This system enabled us to show visually the data we collected and the relationship between the data and the proximity to the NCR. With this, the locations and severity of various health effects, noise and air pollution data, and accident data was presented on maps of the NCR area. The results of our picture survey were presented using an interactive map, with a point on the map displaying the picture of that area when the point is clicked on.

The specific GIS software package we used was Arc View. Arc View has many options for the visualization of data on a map. Arc View starts with a base layer map of the desired area. A table of data containing geographical information for each data point

is then imported or entered. In a process called geocoding, the address portion of the data is then decoded by Arc View so that it correlates to a point on the map. Once geocoded, the data can then be displayed by creating new layers above the base map.
Air pollution data was partially gathered from a monitoring station present along the location of the NCR we are studying. This data was then used for the simulation of the pollution levels at all points along the road. Accidents were mapped directly from collected data, with no simulation involved.

3.3.2 Presentation of Graphs, Charts, and Maps

Each chart, graph, and map that we made using the data we had collected and organized had a specific process which was used to generate the maps. In order to make maps, we used ArcView to use geographical information and locate the points where data was collected on a map. To make charts and graphs, we used Microsoft Excel to plot points.

3.3.2.1 Air Pollution

A map of the air pollution levels in the Borough was made using ArcView. The specific process which was used was as follows. First the data was imported into ArcView. Once imported this data was used to create a point on the map, showing the location where the measurement was taken. Once this was completed the measurement values were used to create a thematic grid map showing the NO_2 levels in the Borough.

A chart showing the levels of NO_2 along the roadway and the distances from the road was made. This chart was made using the levels of NO_2 and their distances from the roadway. Using this data, a chart was made comparing the distances to their levels.

3.3.2.2 Noise Pollution

Our noise pollution data was simulated using a computer software package called Computer Aided Noise Abatement (CADNA). This software package simulates the amount of noise created by a roadway, and the output is a map visually showing the noise levels using colors for each noise range. This software takes into consideration traffic levels, road surface, size and placement of buildings, and geographical elements when determining the noise sources. Then, the software breaks the map up into 10 meters blocks, calculating the noise level at each block. To calculate these levels, the software takes into account every noise source in a two kilometers radius from the block being calculated. This generated a detailed map with noise levels available for all points along the NCR.

Our noise data had to be simulated because the Borough of Brent does not collect noise pollution data by measuring the levels manually on the road. Brent uses CADNA to simulate the noise levels for the entire Borough. Brent has determined from its stage 4 report that this software package very closely parallels the results that would be obtained from manual measurement of noise levels. Manual measurement of the noise levels on the road was not possible due to time and budgetary constraints. Since no data was

available from Brent or any other known source, this made simulation of noise levels necessary.

3.3.2.3 Survey Results

As discussed in Section 3.1.2.2, we conducted two surveys along the NCR. In the first survey, photographs were taken of the NCR and represented by locations on a map and then linked to the digital photograph of that location. This allows for quick and easy access to pictures showing the current condition of the roadway. Second, the data from our interviews of the residents was organized and responses were separated by categories and imported into Microsoft Excel. Once imported into Microsoft Excel, charts of important responses were made to visually show the importance of the responses. The data will also be very helpful for Brent to use when submitting their bid proposal to the European Union's LIFE Environment fund.

3.4. Bid Process

The process which is used to compile a bid proposal to the fund can be viewed in Appendix A. We have followed the guidelines set forth in the proposal and application documents when collecting, organizing, and presenting data. Our project dealt with sections (a) and (c) of the proposal. Section (a), the summary section contained a summary of the problem at hand and the applicant applying. Section (c), the technical section of the proposal is the most important part of the application. The technical section

of the proposal contains all technical information collected. This section is where Brent will use maps, charts, and graphs we made to prove that a problem exists. This section will also contain Brent's plans to remedy the problems, which will come from the recommendations and analysis section of this IQP report.

We judged our progress during this project against the guidelines set forth by the LIFE-Environment fund. As our project's aim was to collect data for the eventual submission of the bid, we wanted to provide Brent with the data needed for a successful bid. This data was needed to be a visual representation of the problems focused on in this project. This applied mostly to the presentation phase of our project, because the data collected had to be presented in a way recommended by the LIFE-Environment fund. In order to ensure that our data was in a form which could be used when presenting a bid to the EU's LIFE-Environment fund, we compared our data to those in other grants which had been accepted by the EU's LIFE-Environment fund. We saw how much progress we had made during the project by looking at our data and how well it could be presented and used to potentially show a link between health effects and location on the road.

3.5. Best Practice Research

Best practice recommendations were made by researching case studies of similar situations to the NCR. Once collected, the case studies were then analyzed and their suitability determined. After this the case studies were developed into recommendations for remediation of the problems facing the residents of the NCR.

3.5.1 Case Studies

In order to make best practice recommendations, we collected information on how similar situations to the NCR had been remedied. This data came in the form of case studies from other locations in Europe and North America. The selection of these case studies was mainly focused on redevelopment options for air pollution, noise pollution, and safety. The relevant data from these case studies was extracted and presented as best practice recommendations.

The selection of case studies was aimed at selecting the most relevant situations for each of the problems we planned on helping Brent remedy. Many case studies exist similar to the NCR, but many of these studies do not have problems to the same degree as the NCR situation in all three areas: air pollution, noise pollution, and safety. Hence case studies were selected based on their degree of similarity to our situation in the remediation of one or more of the problem areas. This process was completed by using a relevance ranking system. This system was based on input from our survey, our liaison, and our sponsor. Using this input, we were able to find which case studies conformed best to the needs of the residents, while still helping Brent attempt to conform to national standards for air and noise pollution levels.

Our case studies were gathered from various locations. One main source of case studies was the internet. We searched the internet using major web search engines such as Google, Yahoo!, and AltaVista. The appropriate keywords were entered for each of the problems we were researching. We then read through the case studies that appeared and selected based on relevance, as discussed above. Other sources included the Greater London Authority technological library. Here we did a computer search through the titles

contained in the library and selected the titles based on relevance to our project. These selected web pages and library titles became the basis of our best practice recommendations.

3.5.2 Development of Recommendations

Once our relevant case studies were gathered, we then read and analyzed them for methods of remediation that could be used on the NCR. To do this, we read through each case study, extracting the methods of remediation used to address one or more of the problems we are focusing on. These methods were then analyzed for the ability to be implemented on the area surrounding the NCR. This was done by looking at how similar the situation was to the NCR, the cost, and the effectiveness level. The main focus for this part of the process was to find if these remediation methods could be implemented on the NCR. To complete this we used our photo survey and observations of the NCR area, along with our case studies to make comparisons to the NCR and the situations described in the case studies.

Once relevant and potentially feasible methods of remediation were found, we began collating the methods into recommendations for remediation of the problems facing the NCR. Once the most relevant, effective, and feasible methods were determined (using our relevance raking system), we gave the Borough of Brent proposed methods of remediation for the problems along the NCR. These proposed remediation steps covered a large range. The recommendations were separated into low cost and low impact and high cost and high impact. Through this information, Brent is now more informed of the

different prospective uses of potential grant money appropriated for the improvement of the quality of life for the residents of the NCR.

Chapter IV: Results & Analysis

After the collection and organization phase of our project was complete, the team moved on to presenting and analyzing data in order to assist Brent in making a case for the need to remediate the area surrounding the North Circular Road (NCR). This provided us with many visualization options for viewing the presence of environmental and safety factors in relation to the NCR. Our data came in two general forms, data that Brent had already begun to organize, which the team then analyzed, and also data the team both collected and analyzed. The data was received in a raw format in both cases, and transformed into a more usable form for more powerful presentation of the data in the European Union's (EU's) LIFE-Environment fund proposal.

4.1 Presentation and Analysis of Previously Collected Data

A certain amount of data regarding the NCR and the conditions of the environment that surround it had been collected by Brent prior to the conception of this project. We then collated this data, organized it, and presented it visually as described in Chapter III. This data was then analyzed for trends between the road and location of pollution, accidents, and health effects.

We presented and analyzed data that Brent had already collected concerning the NCR. This data was in the form of spreadsheets and also hard copy, which we then turned into maps, to show the visual link between pollution and accidents with the NCR. Once this visual link has been determined, it is possible to surmise that health effects in the area could be caused by the pollution and safety issues. Through this, we saw that the

NCR is a potential safety risk for the residents, and that something should be done to remedy these problems.

4.1.1 Nitrogen Dioxide Air Pollution

Data was contained in Brent's stage three and stage four reports that we applied to the case of the NCR. These stage three and four reports were created by the Brent council to assess the problem of air pollution in the entire Borough, for the evaluation of compliance with national standards. Information on the North Circular Road, being one of the most heavily trafficked roads in the Borough, can be extracted easily from this document.

Nitrogen dioxide levels were determined to be above acceptable levels, borough-wide, with the NCR being the area of highest concern. Figure 4.1 shows NO_2 levels along the NCR by distance away from the road, compared to a location off the NCR where no major roadways are. The graphs shows that as you move further away from the NCR pollution levels decrease significantly. While moving to a site away from a major highway, the level decreases even more significantly. This is shown in Figure 4.1.

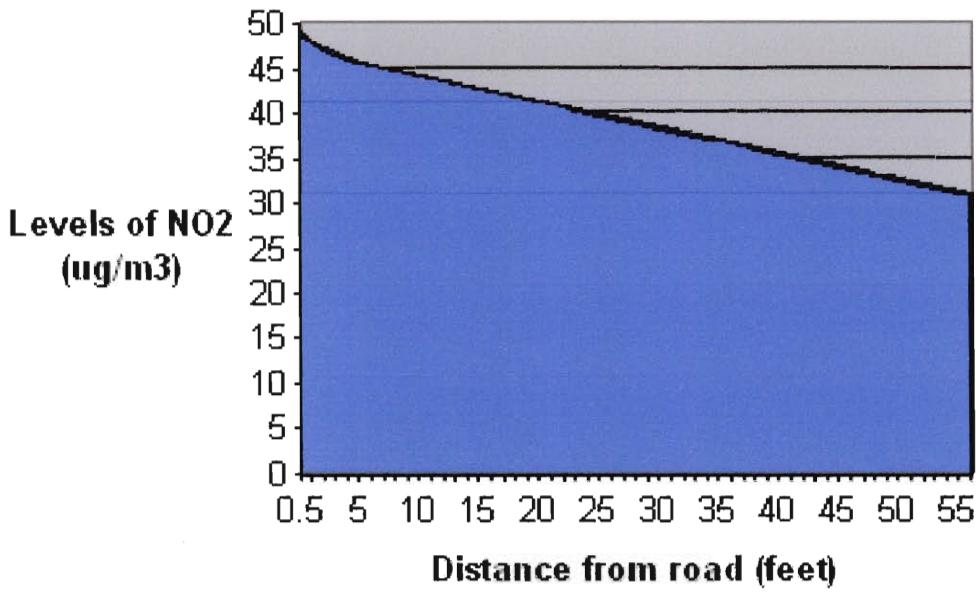


Figure 4.1: NO_2 Levels in 2001 Yearly Means

After Brent measured the levels of NO_2 in the air in these locations, they then decided on objectives for the future. Figure 2.6 in Chapter II is a map of the objective levels Brent would like to achieve by the year 2005. This map shows that the NO_2 objectives along the NCR are extremely higher than for any other area of Brent. This is because of the high levels of traffic and current levels of pollution along the road already. The NCR is the most highly polluted road in the United Kingdom (UK), starting in the south-west, and heading up towards the north-east.

4.1.2 Sulfur Dioxide Air Pollution

Sulfur Dioxide levels on the NCR were found in the stage four report to be higher than current national standards and objective levels for 2005. These objective levels are

the maximum levels that the Borough of Brent would desire the pollutant to be at. The annual mean SO_2 level along the NCR in 2002 was 114.3 ppb and the objective level for 2005 is 100 ppb [7]. This shows that levels of SO_2 along the NCR are not as high as other pollutants. The SO_2 levels also vary greatly by time of the day. The average SO_2 yearly means for 2002 during high traffic periods (6am– 10am weekdays) was 190 ppb, while the average level during low travel times (10pm–2am on weekdays) was 32.5 ppb [7]. The large difference in this can be accounted for by the difference in road traffic during these times. Comparatively, the average SO_2 concentration in the Month of July 2002 along the NCR was 120ppb, while the average SO_2 level during December 2002 was only 60 ppb [7].This could show that the traffic levels are less during the winter months or cold weather lowers the amount of SO_2 in the air.

4.1.3 Particulate Matter Air Pollution

Bent determined that particulate matter levels exceed national standard levels, and from the stage 4 report we determined that the North Circular Road contains the highest levels in the Borough. The average yearly mean for particulate matter along the NCR in 2002 was 61.1 ug/m_3 [7]. In comparison, the average yearly mean at our background site in Kingsbury for 2002 was 23.3 ug/m^3, while the standard set forth for Brent to adhere to is 50 ug/m^3 [7].Figure 2.8 in Chapter II represents a map of the objective levels the Borough has set forth for 2004. The NCR is the most highly polluted road, starting in the south-west, and heading up towards the north-east. While the standard the Borough would like to achieve is 50 ug/m^3, their objective is to keep levels below the standard for

as many days as possible. Looking at the map, one can see that the NCR has higher levels of pollution compared to the rest of the Borough. This is due to higher traffic levels along the NCR.

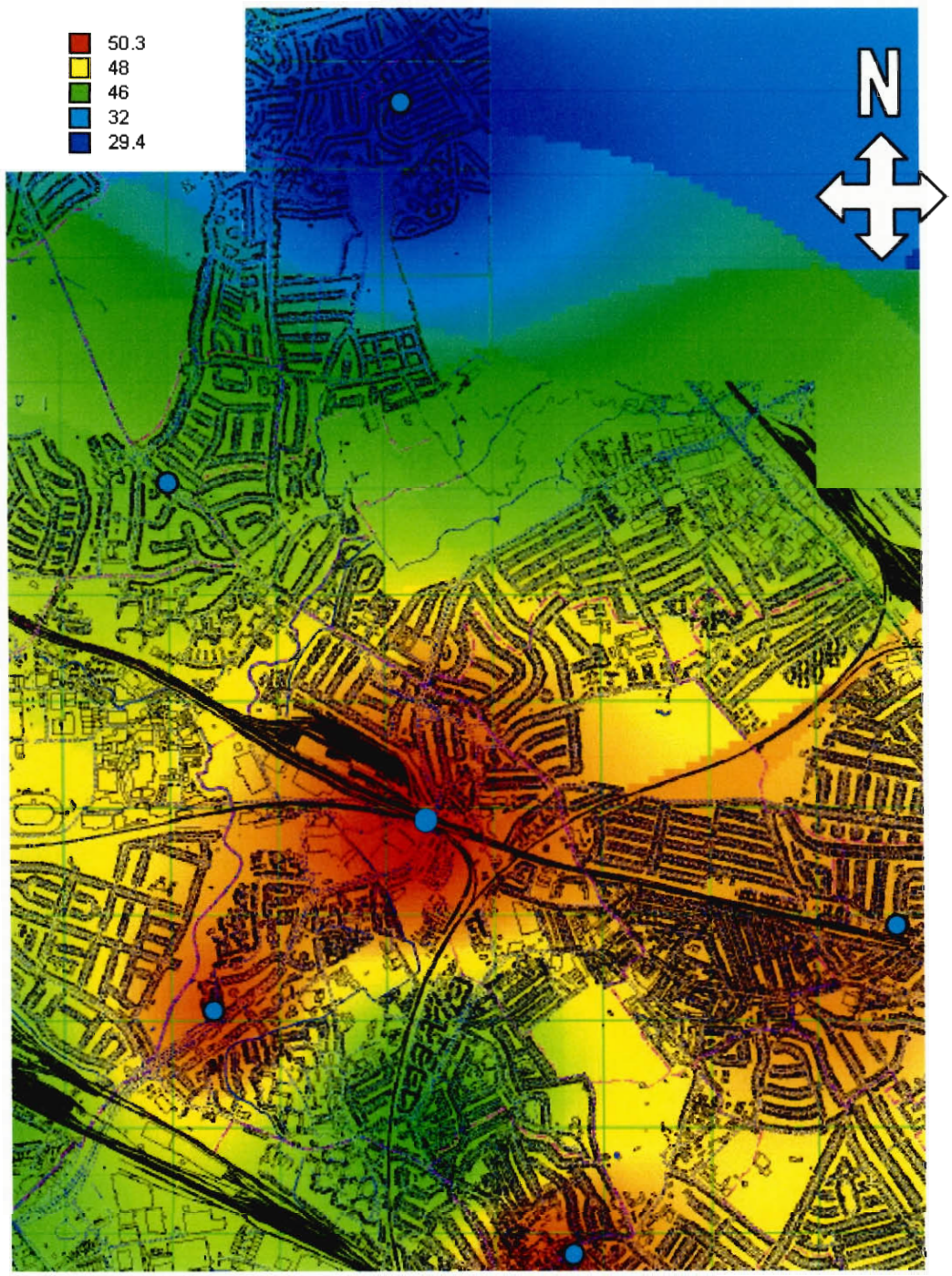
4.1.4 Results & Analysis of Brent's collected data

We collated and presented data that Brent had already collected concerning the NCR. This data was in the form of spreadsheets and also hard copy, which we then turned into maps, to show the visual link between pollution and accidents with the NCR. Once this visual link has been determined, it is possible to surmise that health effects in the area could be linked to the pollution and safety issues. Through this, we saw that the NCR is a potential safety risk for the residents, and that something should be done to remedy these problems.

4.1.4.1 Air Pollution

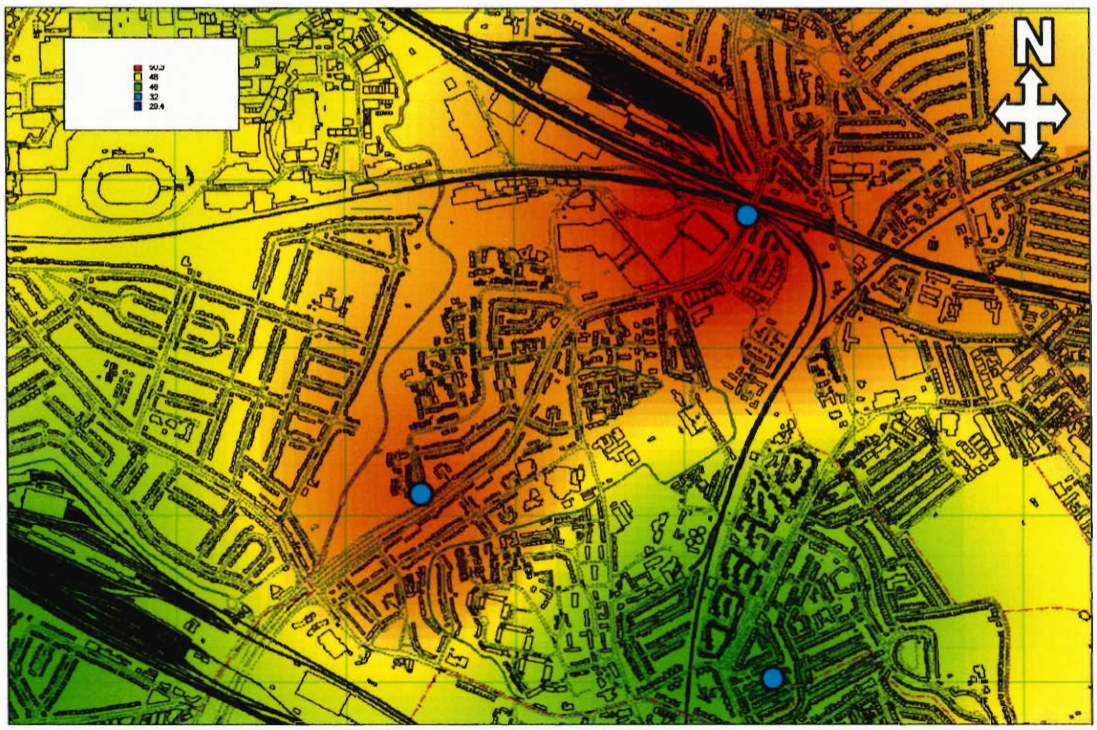
By analyzing collected air pollution data (NO_2 data can be seen in Appendix D) we can see that the volume of traffic traveling on the NCR directly relates to the levels of pollution along the roadway. Looking at the map in Figure 4.2, we can see the dark red region of the map showing the NCR area, while the blue region showing a background site away from any major highways. The red colored region contains the highest levels of NO_2, while the blue colors represent the lowest values of NO_2. Additionally Figure 4.3 shows a zoomed in picture of the NCR. This supports the claim made above that high volumes of traffic on the NCR are causing air pollution in the area. Table 2.1 helps to

supports this claim, showing that one must be 100 meters from the NCR in order to reach all objective air pollution levels.



- Nitrogen diffusion monitoring locations

Figure 4.2: NO_2 map of Brent Borough - Ug/M^3 Yearly Means



- Nitrogen diffusion monitoring locations

Figure 4.3: NO_2 map of Brent Borough - Ug/M^3 Yearly Means

4.1.4.1.1 Limitations of data

Our air pollution data was very reliable, but our only limitation was the number of monitoring sites along the roadway. The process which Brent uses to collect data on air pollution, which is regulated by the national government, is described about in detail in Section 3.1.1.1. Since Brent has only a few locations where data is collected along the road, this limited the amount of data we had available when creating NO_2 grid maps. This limitation was overcome by using other monitoring locations within Brent to make a borough wide map. ArcView then used the twelve data points to make a thematic grid map.

The rest of the air pollution data which was collected was all collected from one site along the NCR and one background site. The way in which this data is collected left it unable to be mapped. This limited the amount of analysis which could be done to creating graphs and predicting cause and effect.

4.1.4.2 Noise Pollution

Through the noise pollution maps that were generated, the survey of the residents, and background research, the team was able to find that noise from the motor vehicles traveling on the NCR creates an unhealthy environment for the residents. As discussed in Chapter II, noise has been proven to affect the health of those regularly subjected to it. When subjected to high levels of noise, symptoms such as high blood pressure and sleeping disorders can potentially result. We found, through our survey, that many of the residents were experiencing these health problems, one reason potentially being the high noise levels around the NCR.

Through our map of noise levels (Figure 4.4), seeing where noise exists in relation to the road enabled us to show some links between the road and pollution. Referring to Section 2.3.1 shows that noise levels at or above 65 dB are when health effects begin to occur. As would be expected, the noise is very high nearest the road, and highest nearest traffic intersections. Road traffic creates a high amount of noise and we can see that the noise created by the road is still at harmful levels at the front of the residences directly on the road.

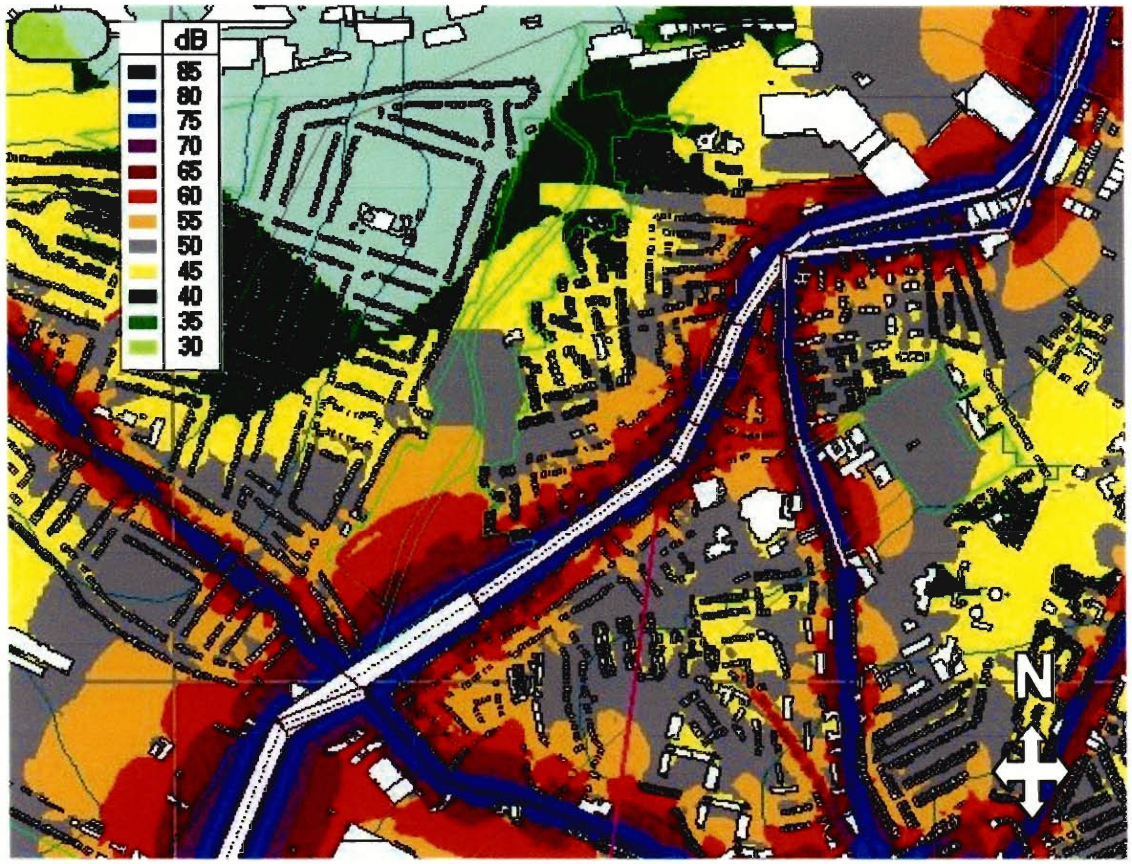


Figure 4.4: Noise pollution levels on the NCR in dB

4.1.4.2.1 Limitations of data

Our noise pollution data was not available as data in the form of measurements from the road locations itself, so we overcame the limitation through the use of modeling software. We used the modeling software program CADNA discussed in Section 3.3.1.2 to take traffic levels and the position of buildings along the road to approximate data levels for points all along the roadway. When synthesizing the data, for every 10 meters block on the map, the software takes into consideration every noise source within a two kilometers radius. This creates a very accurate approximation of the noise levels, and

thereby overcomes most of the limitation associated with the lack of monitoring sites along the NCR. This is the method that Brent uses for mapping noise pollution levels throughout the Borough.

4.1.4.3 Accidents

Accident data that we collected from the Transportation department at the Borough of Brent was important for use when understanding the safety concerns for the residents surrounding the NCR. The analysis of our accident data focused on the potential causes of the accidents and proving a connection between pedestrian accidents and the lack of overpasses and barriers, and the parking situation and the lack of safe locations for the residents to park their vehicles.

Pedestrian related accidents comprised 18% of all accidents occurring along the NCR between the Harrow Rd. and IKEA. Figure 4.5 shows a map of the locations of all the accidents occurring in the area of the NCR we focused on during the past three years. By looking at the map one can see that the intersection near the top of the map (near the IKEA site) had many accidents occurring. Ten out of 51 of the accidents occurring in the past three years were pedestrian related. Other than these pedestrian related accidents, the other area of concern was accidents related to residents reversing onto the street from their driveways. As we can see by looking at our survey results (69.76 % of the households were aware of accidents occurring around their residence), and by looking at Figure 4.5, we can see that accidents occurred along the roadway at locations mostly before and after the bend in the roadway. By analyzing this, and using the results from our survey telling us that residents are very concerned with the parking situation and

accidents in general, we can infer that a possible cause of some of these accidents is residents reversing out of their driveways onto the NCR.

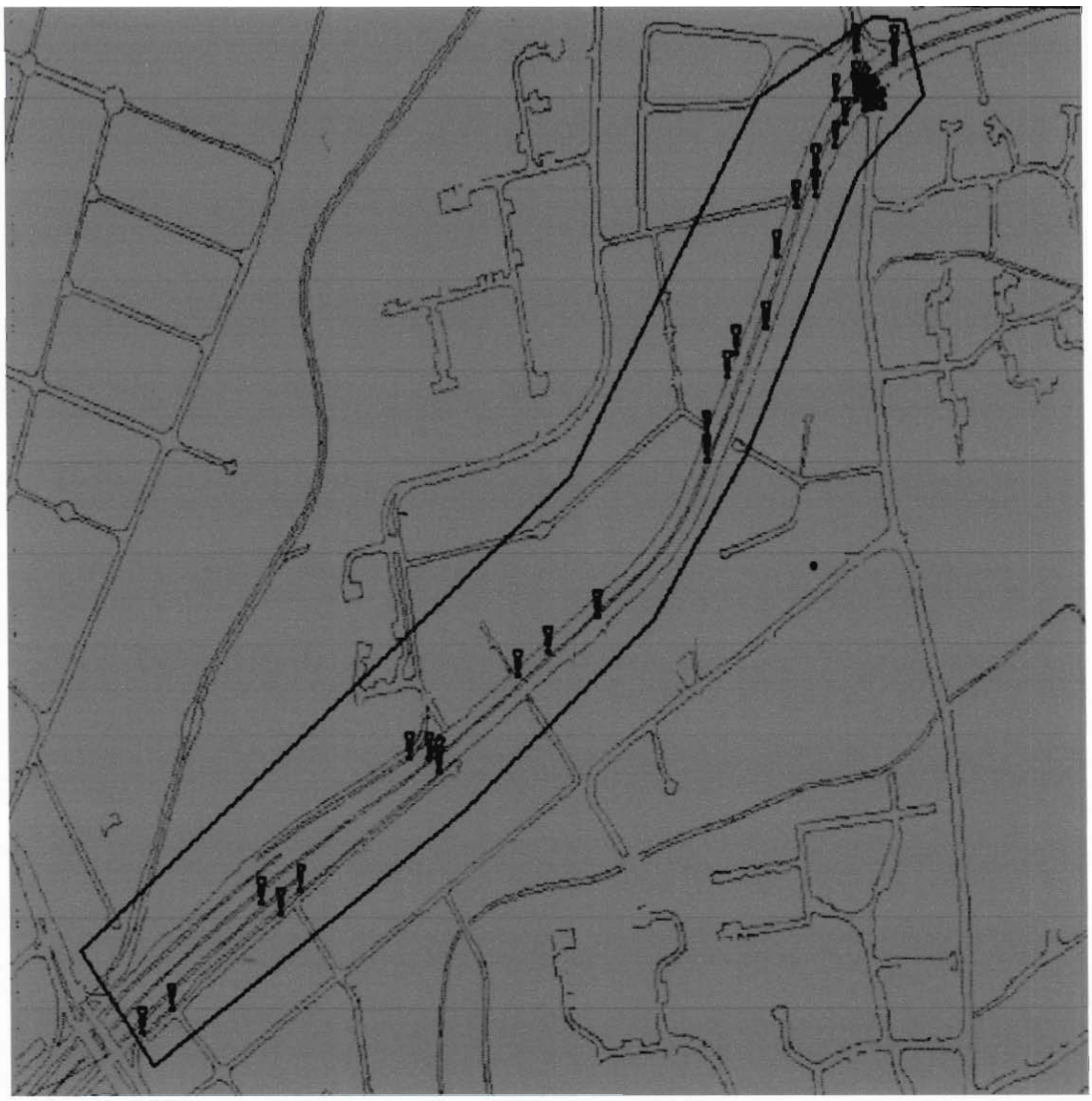


Figure 4.5: Locations of Accidents along NCR

From the accident data we collected (Appendix E), we can see some interesting statistics about the NCR from the past three years:

- 38% of all accidents occurred during September and October

- 44% of all accidents occurred during night hours
- 20% of all accidents involved pedestrians

The first bulleted point may be related to the placement of the roadway and the glare of the sun during September and October. The second bullet could be related to a lack of road lighting along the NCR. While the final bullet, accidents involving pedestrians, could be related to the lack of an overpass at the intersection near IKEA.

4.1.4.3.1 Limitations of data

The limitations of our data pertaining to accidents dealt with the method in which accidents are reported by the police. Only accidents which include an injury of some sort are reported to the Borough. These accidents are then reported only in the form of three categories: fatal, serious, and slight. Because of this limitation, the cause of the accidents is not known, but can be inferred by the location, the type of vehicle, and if a pedestrian was involved.

4.1.4.4 Health Effects and Proximity to the Road

By the analysis of our background research and health data we collected, we were able to see a possible link between health problems to road traffic. Based on our background research, we were able to find that air and noise pollution levels similar to the levels present in Brent are harmful. Brent conducted a ward level survey (a survey of all the members living in the ward adjacent to the NCR – approximately 1000 households). One question on this survey was "Which of these things do you think has

the most negative impact on your health?" 31% of the residents said air pollution was having the largest negative impact on their lives. The results of the survey are in Figure 4.6. This combined with our survey results, shows that the residents believe that air pollution has the largest effect on their own health and safety.

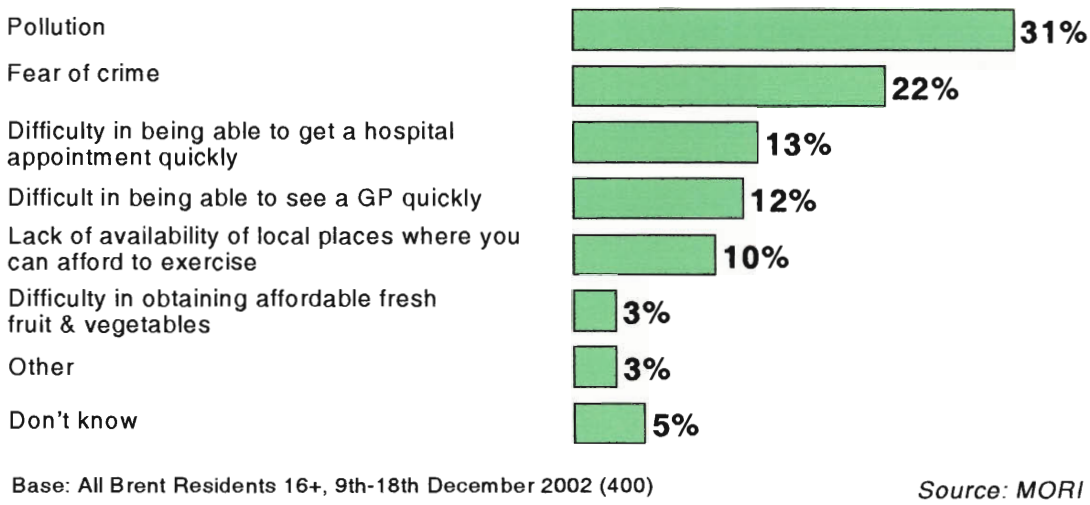


Figure 4.6: Negative Impacts on Health for Borough Residents

4.1.4.4.1 Limitations of data

The greatest limitation we faced during our project was that of health statistics for residents living directly adjacent to the NCR. Since the area of the NCR we were focusing on contained only one hundred fifty houses, a direct correlation of health problems to the residents' proximity to the road would be quite difficult. Additionally, the Borough only had Borough-wide health statistics. In order to combat this limitation, we conducted our survey of the residents, asking some health questions, and we used

background research to show that the levels of pollution present in Brent have been known to cause problems in other areas.

4.2. Presentation & Analysis of New Data

We collected our own data about the road in the form of a survey of the residents directly abutting the road, and a photographic survey of the road (results in Appendix E). These two surveys helped us to understand the conditions facing the residents. The photographic survey showed us in a visual manner the nature and orientation of the road and the conditions of the properties along the roadway. The survey of the residents showed us the residents' attitudes and opinions on how the road affects them and their daily lives.

4.2.1 Survey Results & Analysis

By surveying the residents, we obtained the opinions the residents had about the NCR, how it affects them, and possible redevelopment ideas. The survey consisted of thirty questions aimed at understanding the life of a resident on the North Circular Road and how living directly on such a highly traveled roadway affects them. We determined, as expected, that the residents were very concerned about the various health related aspects of living in close proximity of a road, which might stem from the large number of motor vehicles traveling the NCR every day. Complete survey results can be viewed in Appendix F.

Figure 4.7 shows the different health problems that the residents are experiencing which are also commonly caused by air and noise pollution. We can see that asthma is the biggest health problem the residents are experiencing from air pollution. 42 % of the residents interviewed reported that they had at least one member of their household that had asthma. The next big issue is heart disease, with up to 14% of the households had at least one member of their household experiencing heart disease. Other health problems such as recurring Bronchitis had a percentage of 6 %. Noise pollution caused by the motor vehicle traffic on the NCR was found to be a major concern and health risk for the residents. We found that 42% of the residents we interviewed were having problems sleeping caused by the noise, shown in Figure 4.7. Up to 26% of the interviewees households had at least one member experience high blood pressure, which has been thought to be related to noise pollution in certain cases. This shows that the residents on the NCR are being affected by noise by such a high degree that it is a major concern for them.

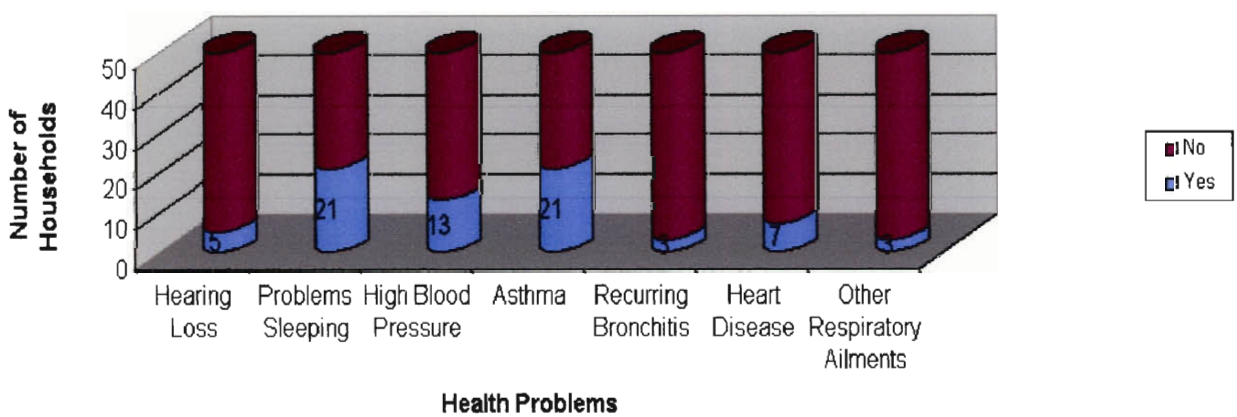


Figure 4.7: The effects of pollution on the NCR residents

Perception of noise levels that the residents are experiencing during the day and night are shown in Figure 4.8. We can note that most of the residents are really not comfortable with noise levels at any time of day, but many are especially concerned with the levels during the nighttime hours.

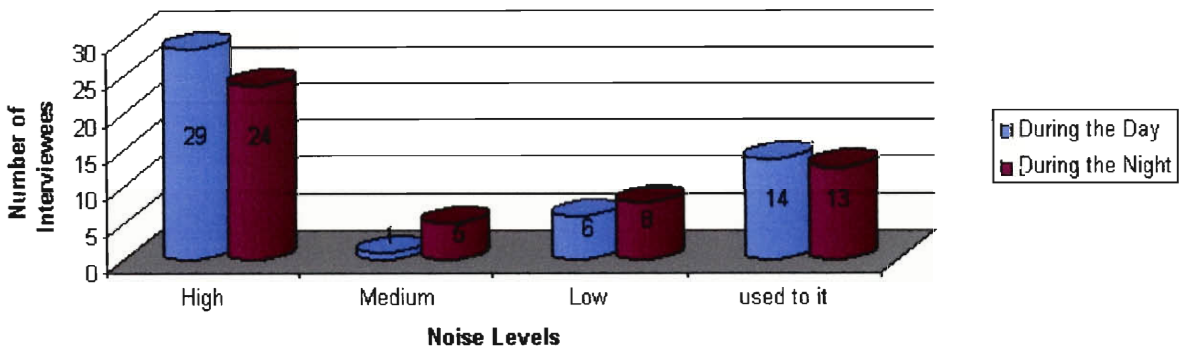


Figure 4.8: Perception of noise levels around residences

To understand the issues that the residents feel most strongly about, we posed an open ended question asking what areas of their lives they felt the road was affecting. Figure 4.9 shows the effects of the North Circular Road on the residents. Noise was the problem that the residents felt was affecting their lives the most, 66% of the residents we interviewed felt noise was the largest problem facing the residents. The next commonly reported problem or effect was health and safety, up to 50% of the interviewees said that the NCR affect their health and their children's health in a negative way.

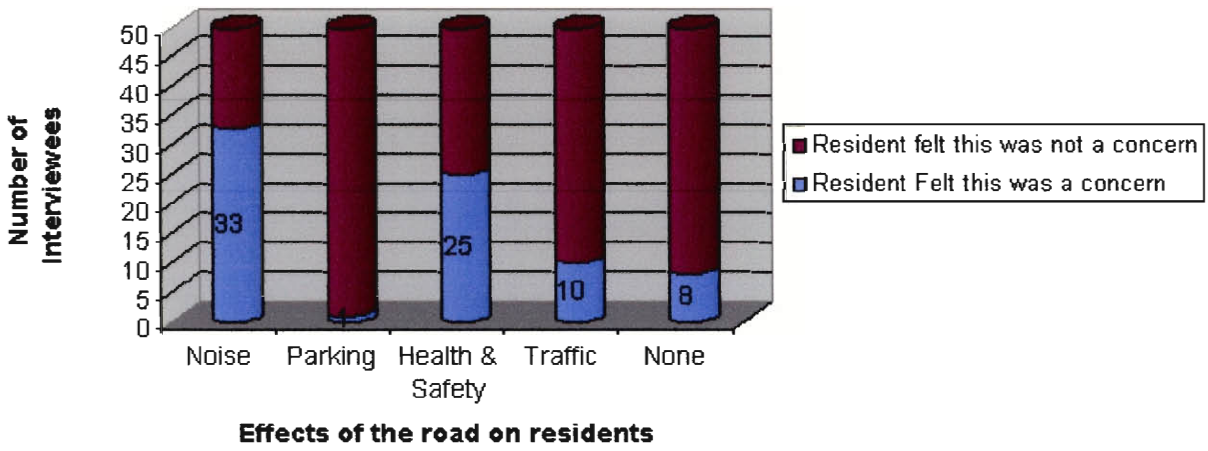


Figure 4.9: Residents concerns about the NCR

Understanding the residents' feelings about the parking situation along the NCR was a very important part of our survey. Figure 4.10 describes the parking situation residents currently have. 24% of the residents interviewed park their car on a driveway facing the NCR, which is where the biggest problems with parking exist. Parked cars are 3.5 meters away from the cars traveling on the NCR, which greatly affects the safety of the roadway. Another statistic that applied to the parking situation is that 62% of the residents we interviewed own a car. Also, 83.3% of the interviewees that owned a car could not get along without a car and it was reported this was because there is a "poor transportation system" in that area or because their "work requires a car". This problem is such a concern for the residents, that 73.3% of the residents interviewed who owned a car wanted a new way of parking their vehicle.

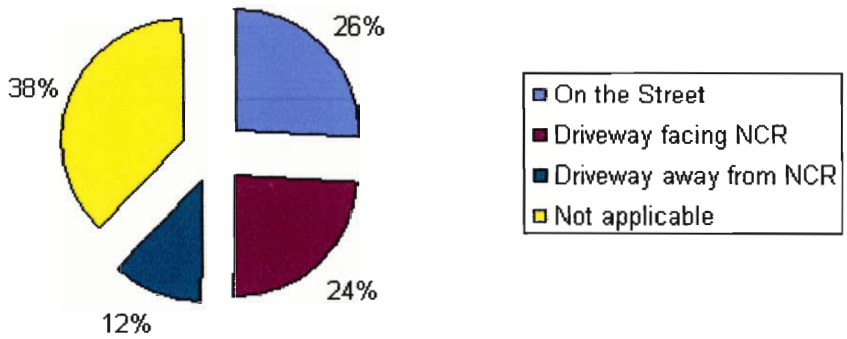


Figure 4.10: Common parking locations

One survey question asked the residents to describe the improvements that they would like to see implemented in their area, the results of which are shown in Figure 4.11. As we can see, the addition of barriers and a safer environment were the most desired improvements. 54% of the interviewees wanted to see barriers of some sort to increase the safety of the area and potentially reduce the noise levels around their homes. 50% of residents asked for increased safety precautions in the area, such as more police officers and better sidewalks. One common complaint was that the cars could be damaged or stolen due to the lack of safety in the area. Another safety precaution the residents desired was the addition of more closed circuit video cameras installed in the area, in order to better control speeding cars and increase the general safety for pedestrians walking along the road. The conditions of pavements were a large concern, 62% of the residents interviewed confirmed that the pavements along the road are too narrow, dangerous and dirty and that their general health and safety was being affected by the sidewalks.

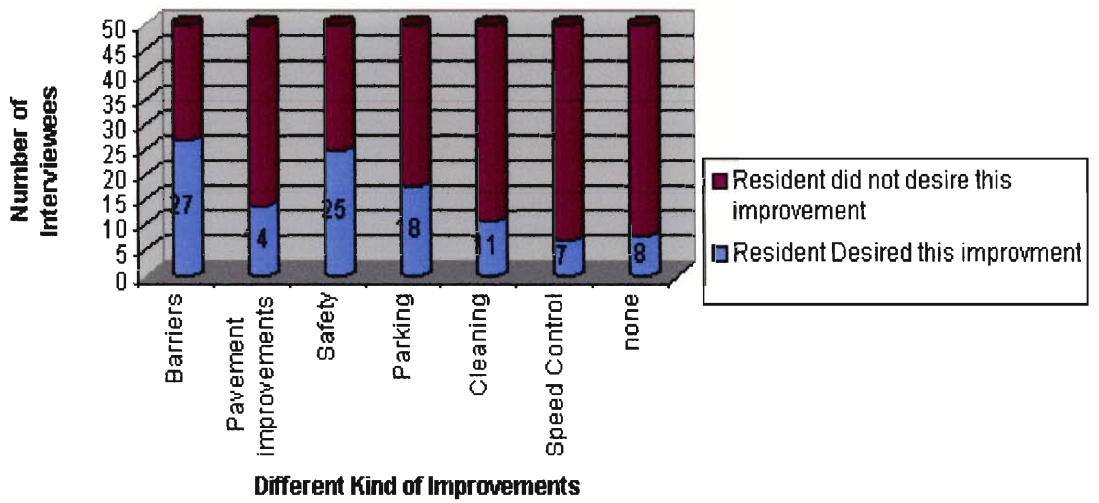


Figure 4.11: Improvements of the NCR area that residents desire

If remedial measures to correct the pollution, parking, or safety problems were taken, residents might lose some of their rear garden. A question asking their feelings about this was asked, and statistics extracted from it. Figure 4.12 shows that 77% of the residents with whom this question applied were concerned about the problems to the extent that they are willing to give up part of their rear garden to see improvements done by the council to reduce the impact of the road on their life. This is an important finding, because the addition of roads to provide access to the rear of houses is one of our proposed remediation options, discussed in Section 4.3.2.1.

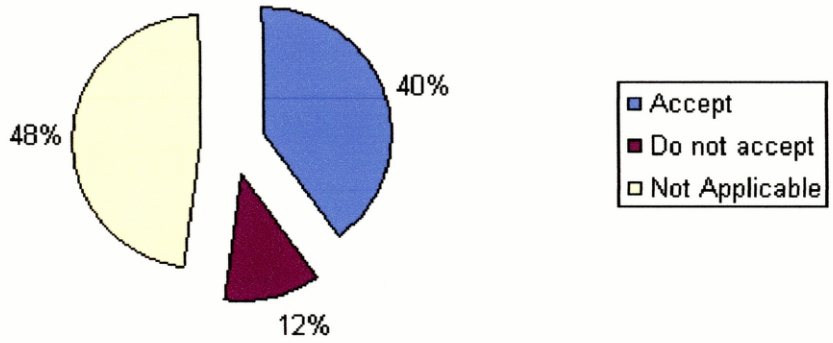


Figure 4.12: Residents response on loss of rear garden for remedial action

4.2.1.1 Limitations of data

When conducting our survey, there were a few factors that may have skewed our results. The two most prominent factors are biased or inaccurate responses from residents and bias introduced from the lack of diversity in interviewees that responded. Residents may have been hesitant to answer questions correctly because of the fact the team was working on the behalf of the Brent Council, and could have answered the questions in a way they feel the Council would want to hear. To overcome a potential lack of diversity in interviewees, we interviewed residents at different time ranges during the day. This enabled us to survey different groups of people who where home at different times during the day, such as the elderly and those who work.

4.3 Recommendations for Improvements to the NCR

Once we found all our case studies and extracted the methods used in them we broke our recommendations into two sub-sections. Those that were low cost and most

easily applicable, these also had the least impact on the area, and those that were highest cost and highest impact.

4.3.1 Low Impact / Low Cost

The low impact and low cost recommendations spanned a broad range of suggestions. These suggestions came from similar situations, as well as remediation methods found when the team conducted background research.

4.3.1.1 Planting Foliage

One method that we found worked well to reduce both air and noise pollution and increase the beauty of an area is the addition of live foliage such as trees to the area. The addition of trees along the roadway in the median and along the sides of the pavements will add beauty to the area. We recommend the addition of a belt of trees either along the median or the pavements on the NCR, to increase the beautification of the area and lower air and noise pollution levels [22][23].

4.3.1.2 Noise Barriers

The addition of noise barriers to the NCR could be a very efficient way of combating both the levels of noise pollution in the area, and the safety factors the residents associate with walking along the roadway. We suggested two types of noise barriers be considered, concrete barriers and living willow barriers.

4.3.1.2.1 Concrete Barriers

Concrete noise barriers have been around for years and have been used to reduce noise in many different environments. In the case of the NCR, concrete noise barriers could be used along side the roadway sheltering the households and the pavements from the noise and danger from the roadway. These barriers would provide reduction in noise levels for households directly abutting the NCR of approximately 10db with the instillation of a 20ft. wall. Figure 2.11 shows how noise barriers were added in a similar situation and Table 2.1 shows the size of a noise barrier and the amount of noise it reduced [24].

4.3.1.2.2 Living Barriers

A new and interesting method of reducing noise levels along a roadway is the construction of living willow barriers. The process used in the construction and reduction of levels of air and noise pollution is discussed in Section 2.6.3. Using living willow barriers instead of concrete barriers poses two positive aspects. The first is these barriers also absorb a comparable amount of air pollution, and the second being for beatification purposes. By constructing living willow barriers in the area of the NCR, residents will be able to use their front yards as areas for their children to play without concern of the roadway. Figure 2.9 shows a living barrier [16].

4.3.1.5 Street Lighting

Another major concern for the residents we surveyed was the safety of the pavements along the NCR. This combined with the high percentage of accidents occurring during the night hours lead us to the conclusion that the addition of street lighting would be a helpful addition to the NCR. Street lighting would provide the residents with more peace of mind while walking along the NCR at night and at the same time would provide better conditions for cars traveling the NCR during the night hours. FCO street lights similar to the ones shown in Figure 4.13 would be a viable option for the NCR. They are cost effective and help to reduce glare, which could potentially interfere with drivers.

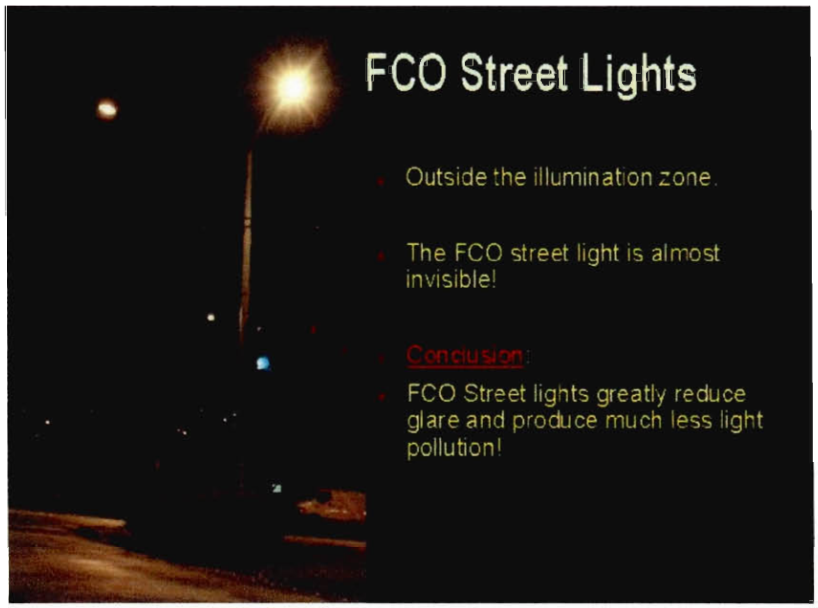


Figure 4.13: FCO Street lights [23]

4.3.1.6 Addition to Sidewalks

Although the NCR has the presence of sidewalks, these sidewalks lack paving in some areas, and are extremely narrow. The narrowness of these sidewalks in places makes it impossible to walk any other way than single file. Because of this, a mother with a child must walk in back of their child, and worry that the child is at harm from the roadway. Widening the sidewalks would not be a viable solution because of the nature of the roadway and the closeness of households to the roadway. A viable solution to part of the problems associated with safety would be adding pavements in a similar manner to those the manner discussed in standards [20].

4.3.1.7 Re-Pavement

A method found to help decrease road noise and reduce the number of accidents is the use of new "modern noise reducing asphalts". These new types of asphalt have been proven to reduce noise levels by 5db and reduce the number of accidents due to the negative texture and skid resistance provided with gaps in what is otherwise an even surface. In the situation of the NCR, the road was last paved in 1991, meaning re-paving the road is not only necessary for regular maintenance, but would also be helpful for the reduction of noise levels and accidents [25].

4.3.2 High Impact / High Cost

While the improvements suggested above would help to reduce the effects of the NCR on its residents, they will not remove them completely. The following section will talk about large scale improvements dealing with re-developing the area to result in significant impacts on the residents and the effects of the roadway.

4.3.2.1 Parking

The nature of the current parking situation along the NCR is a large problem for residents and is thought to be the results of a large number of accidents. Because of the nature of the NCR and the current state of the parking situation, the team proposes the following remediation method which was obtained through the suggestion of our liaison. The addition of new roadways in the rear of the residencies providing an alternate access to the houses and an alternative location to park their cars would be a very viable solution An example of this can be seen as a before (Figure 4.14) and after picture (Figure 4.15). This would mean the residents would have to give up part of their rear gardens in order to be able to park their cars and have a street added. In order to make this desirable, the addition of living barriers could be added to the front of the residents' houses along the NCR, in turn reversing their front yard and their back yards. Since not all areas of the NCR have the ability to have a road added, the addition of a parking lot in close proximity to their household would be another viable solution.

Figure 4.14: NCR before remediation

Figure 4.15: NCR after remediation

4.3.2.2 Pedestrian Overpass

Since the NCR is a high speed highway, it is impossible for residents to walk from one side of the road to another. To combat this, two overpasses are present in the area of the NCR this project focused on. These overpasses are placed evenly along the roadway and provide a good way for residents to cross the road. Unfortunately there is no overpass near the only major intersection on the roadway where many pedestrian accidents have occurred. A viable method to reduce the number of pedestrian related accidents would be the addition of an overpass near the intersection of IKEA, in a similar manner to the overpasses already constructed along the NCR.

4.3.2.3 Underpass

A very high impact, high cost solution to the problems facing the NCR would be the addition of an underpass, creating a completely underground roadway from Harrow road, surfacing again at the IKEA location. This road would be developed similar in strategy to tunnels built during the Center Artery Tunnel Project in Boston Massachusetts, USA, but in smaller scale. Where the road previously was above ground, green space could be produced, parks for children built, and local streets made for residents to travel to and from there homes. Although a very high cost solution, redeveloping the area in such a manner would significantly reduce the effects of noise pollution. As well, methods suggested in Section 4.3.1.1 and Section 4.3.1.4 for reducing air pollution would be used to lower the levels of air pollution escaping from the tunnel [26].

Chapter V: Conclusions & Recommendations

The objective of this project was to collect, organize, and present data relevant to the problems facing the residents of the North Circular Road (NCR), and present the Borough of Brent with recommendations for the improvement of the area. From the analysis of our collected data, the team was able to come to certain conclusions. The analysis of our data provided us with a strong visual representation of the problems facing the NCR. One main conclusion is that air and noise pollution are at unsafe levels on and near the NCR, which may be affecting the health and safety of the residents. Also, accidents cause a large safety issue for the residents of the road, and are a large concern to the residents according to our survey results.

We found from our data collection and background research that currently levels of air pollution along the NCR are at unsafe and potentially harmful levels. Trends show that air pollution levels have been rising in the past three years and are likely to continue to rise in the future if no remedial action is undertaken. Nitrogen dioxide, sulfur dioxide, and particulate matter are at extremely high levels along the NCR, with all three of these pollutants are at levels above the national standards. From our survey data and our background research, we can suggest that there is a link between health problems and living in the proximity of the NCR, as asthma is very common in the residences directly abutting the road.

Noise pollution is also a harmful effect that is caused by a high traffic roadway such as the NCR. Noise levels were found to be above 65db in certain locations along the NCR which is higher than healthy levels because of the closeness of the residences to the road. Noise levels from road traffic are very high on the road and continue at harmful

levels past houses bordering those abutting the road. Noise levels this high have caused residents to have problems sleeping and decrease the overall quality of life around the NCR. Measures have been taken to reduce the amount of noise inside some of the residences by installing double glazing (multiple layers of glass) on the windows, even triple glazing sometimes. This solution does not completely reduce the effects of noise on the residents.

The NCR affects the safety of residents because of motor vehicle traffic and the lack of precautions taken to protect the residents from it. Driveways are situated so the only access points are along the NCR, causing accidents because of cars reversing into the flow of traffic or slowing down to pull into their driveways. Also, many accidents occur because of the intersection at Brentfield Rd, directly across from the IKEA site. As well, of all the accidents occurring along the NCR in the past three years, 44% of these occurred during the night. All these accidents directly affect the safety of the residents and in some cases when pedestrian injury occurs, also their health.

From our survey, we arrived at the general conclusion that the residents are unsatisfied with their quality of life because of the proximity of their residences to the NCR. Air pollution, noise pollution, the parking situation, and accidents were all main concerns for the surveyed residents. The residents expressed the need for immediate remedial action to be undertaken in the near future. When asked if the residents would consider losing a portion of their rear garden to provide road access from the rears of their houses so that remedial action could be taken in the front, a majority of the residents responded that they would be interested in that improvement. This showed us that the

residents were concerned enough about their health and safety that they would be willing to give up a part of their land to remediate the problems.

For the Borough of Brent to have an even more reliable and powerful set of data, we recommend the acquisition of more data points for air pollution or another valid method of synthesizing more data points. Our air pollution map was not as detailed as we would have desired, and this is from the lack of data points both along the roadway and throughout the entire Borough. A program to synthesize this, or more measured data points, would reduce any misleading areas of our map, and give a more powerful and clear representation of where pollution is present on the NCR. The improvement of the maps will make the bid to the LIFE-Environment fund more effective, and improve the chances of getting grant funding.

The results of our data collection, organization, and presentation will be used to create the principal sections of the bid proposal to the LIFE-Environment fund, and will make the case to redevelop the land for the improvement of the area neighboring the NCR. The Borough of Brent will be collecting a small amount of data which was not available to the project team during the span of this project. Health data concerning the NCR was not available to us during our project. Because of the completion data of the latest census this data will not be available until May. Once this data becomes available, Brent will be using it to complete the bid proposal to the EU. Because of the small number of households along the NCR (153) it was very difficult to obtain statistically significant figures about the health of residents. To deal with this, Brent will be using a program to simulate health statistics along the NCR. Our air pollution, noise pollution, and accident maps, and our survey results, will be included in the bid proposal. These

will visually show the problems on the NCR in order to make a more successful bid application.

Some of the problems associated with the NCR are unable to be dealt with by the Borough of Brent. Since Brent does not have control over the NCR itself, reducing traffic or moving houses away from the NCR are not viable solutions. To reduce the effects of air pollution on the residents, our research has shown that the planting of foliage is a low cost and easily maintainable way of reducing the amount of air pollution in the area. The trees remove pollution from the area by absorbing fine particulate matter and other pollutants such as carbon monoxide. This will reduce the amount of air pollution that the residents have to breathe, and also increases the attractiveness of the region. This solution will not be viable winter months. Since we have found that most pollutant levels are lower in the winter than the summer, this may not pose a large problem.

Noise pollution is a larger problem, and several case studies have shown that noise barriers have been installed to reduce the levels. Noise barriers, which would be situated directly between the houses and the road, block and reduce the sound heard by the residents in and around their residences. Through our background research we found that the most attractive variety of noise barrier to be the living willow barrier, which is rated to reduce noise levels in a comparable manner as standard noise barriers. The living willow barrier also has the added benefit of being living foliage, which continues to grow after planting. This method, unlike planting live foliage, will continue to reduce noise during the winter months, since the barrier is not only a willow plant, but a sound barrier covered by living willow.

Redevelopment of the parking situation would be necessary if remedial actions were taken to reduce the effects of air and noise pollution on the residents. Since the noise barriers would be positioned so that they were between the houses and the road, it would be impractical to have driveways directly on the NCR. This would mean alternative parking access must be provided to the residents. Our recommendation is to, where possible, create roadways in the rear of the houses so that access could be gained from the back. This will solve the problem of accidents occurring from residents pulling in or out of their driveways directly onto or off of the NCR. Where this is not possible (approximately half of the households affected by a parking problem), we recommend parking lots be constructed nearby the houses with no access directly onto the NCR. These could be created on side streets along the NCR.

Through the reduction of air pollution, noise pollution, accidents, and relieving the parking situation along the NCR, the residents will lead happier, more productive lives. The key to this outcome, will be receiving grant funding from the LIFE-Environment fund for use when remedying the problems concerning both the residents and the London Borough of Brent. Depending on the amount of grant funding allocated, the Borough will be able to introduce remedial measures to resolve one or more of the areas of distress along the road.

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Appendix A: Planned sound barrier predictions

Receiver Type	Location	2002 Noise Levels	Planned Mitigation	Predicted 2022 Noise Levels
Residence	1749 E. Medlock Dr	66	Add 4 feet to existing wall	62
Apartments	1701 E. Colter St	73	New 8 to 15 foot wall	66
Residence	1750 E. Orange Dr	65	Add 4 feet to existing wall	61
Residence	1749 E. Oregon Ave	66	Add 4 feet to existing wall	63
Residence	1749 E. Georgia Ave	64	Add 4 feet to existing wall	61
Park	Desert Storm Park	60	-	60
Residence	5302 N. 18th St	65	Add 4 feet to existing wall	61
Apartments	1650 E. Georgia Ave	65	Add 2 feet to existing wall	63
Residence	5332 N. 18th St	66	Add 4 feet to existing wall	62
Residence	1745 E. Marshall Ave	67	Add 4 feet to existing wall	64
Residence	1739 E. Luke Ave	66	Add 4 feet to existing wall	63
School	Madison No. 1 Middle School	67	-	66
Residence	1739 E. San Juan Ave	66	Add 4 feet to existing wall	64
Residence	1739 E. San Miguel Ave	67	Add 4 feet to existing wall	64
Apartments	5605 N. 17th St	68	Add 4 feet to existing wall	65
Residence	1839 E. Montibello Ave	67	Add 4 feet to existing wall	65
Residence	1712 E. Montibello Ave	66	Add 4 feet to existing wall	64
Residence	1716 E. Solano Dr	66	Add 4 feet to existing wall	64
Residence	5735 N. 18th St	66	Add 4 feet to existing wall	64
Residence	5801 N. 18th St	65	Add 4 feet to existing wall	63
Residence	1719 E. Palo Verde Dr	66	Add 4 feet to existing wall	64
Residence	5829 N. 18th St	65	Add 4 feet to existing wall	64

Table A.1: Locations of Improvments

Appendix B: Sections of the LIFE proposal

The following sections introduce briefly the summary, administrative and technical section of the proposal while elaborating up to a greater level of detail the financial proposal. In particularly, an explanation will be given on the rate of Community co-funding a project may request to receive as well as an overview of those items and types of expenditure that are considered eligible/ineligible for funding under LIFE-Environment.

(1) A proposal to LIFE environment entails:

(a) A summary section

(b) An administrative section

(c) A technical section

(d) A financial section

Plus : Declaration(s) of technical and financial commitment by the partner(s)

Declaration(s) of financial commitment by the co-financer/(s).

(2) In order to allow efficient processing, proposals must be structured according to predefined proposal submission forms.

(3) Part III of the application file consists of the proposal forms and guidelines for the preparation of these proposal forms.

(a) The summary section of the proposal

(1) The summary section consists of a general overview of the project, containing general data, and a project summary

(2) The applicant is required to present a short, concise summary of the project outlining its objectives, a description of the work and the expected results in English and native or other official EC language (i.e 2 language versions are required).

(b)The administrative section of the proposal

(1) The first part of the administrative section consists of a formal declaration of the applicant. This form needs to be present, signed and dated. .

(2) The second part of the administrative section provides detailed information on the applicant/beneficiary and the eventual partners and co-financiers. This information will be used by the Commission to examine the legal and financial standing of the participants and to eventually contact the participants.

(c)The technical section of the proposal

(1) The technical section of the proposal consists of a series of predefined forms used to collect information on the technical aspects of the project and profiles of the beneficiary and eventual partner(s).

(2) The technical proposal should allow the Commission to assess the adherence of the project to the general and specific objectives of LIFE-Environment.

(3) The applicant is required to present a summary of the different project tasks.

This summary is followed by a detailed description of every task including:

(4) An overview of who is involved in the particular task and a description of his role within the task,

(5) A description of the tasks' goals, actions and assumptions made.

(6) A timeline of the task and progress indicators

(7) A description of the deliverables which will be developed, and their time schedule.

(8) An identification of the most important milestones, and their time schedule.

Further, information to be provided:

(9) a description of the state-of-the-art in the field of activity of the project and the anticipated level of innovation,

(10) an elaboration of the demonstration character of the project with the emphasis on the dissemination of results the project plans to undertake,

(11) an assessment of the potential for reproducing the projects in other geographical areas and/or sectors and the possibilities, and eventually planning, for transferring the techniques or methods developed,

(12) an evaluation of the value for money the project aims to achieve and an assessment of the environmental benefits in relation to the costs of the project,

(13) an assessment of the implications on employment, such as the creation of jobs during the project and/or as a consequence of the results achieved,

(14) the added value of establishing an international partnership, should it be envisaged by the project.

It is important to note that the technical section of the proposal may be presented in the national language of the applicant. The Commission nevertheless strongly recommends to submit the technical part of the proposal also or only in English. Several internal Commission, and eventually, external experts participate in the evaluation of the proposals. Experience shows that having an English version available generally leads to a more efficient and accurate evaluation of the proposals.

Appendix C: Survey Questions

Address_____

Interview Start: We are students doing a research project on behalf of Brent council; we will be conducting a study of the North Circular Road. We are collecting information to help the council deal with some of the environmental problems present in the area. We would like to ask you a few questions regarding your experiences with the road.

Background

1. How long have you been living at your current residence?
   0 – 2 years 2 – 10 years 10 – 100 years

Reason for asking: To make certain residents have been living there long enough to correctly answer questions

2. How would you describe the condition of your property?
   Poor Mediocre Good Excellent

Reason for asking: To attain the residents' perception of their own property

3. What areas of your life, if any do you feel the North Circular Road has had an effect on?

Reason for asking: To establish residents concerns

4. Have you taken any measures to reduce/remove these issues? Yes No
What:

Reason for asking: To see what residents are doing about the problems?

Noise

5. What is your perception of the noise levels around your residence during the day?

Reason for asking: To see if the residents feel noise is a problem

6. at night?

Reason for asking: To see if residents feel differently about day and night

7. How does this affect / disturb you or your family?

Reason for asking: To see if residents feel the road disturbs them, to understand their viewpoints

8. Is anyone in your household experiencing

   Hearing Loss Problems sleeping High Blood Pressure

Reason for asking: To hone in our data search on specific people

Air Quality

9. Is anyone in your family suffering from any of the following?
Asthma Recurring Bronchitis Heart Disease Other Respiratory Ailments_____

Reason for asking: To see if anyone is suffering from disease associated with air pollution

Access

10. Do you own your own car? Yes No

Reason for asking: To begin to assess parking situation

11. Where do you park your car?
On the street Garage Driveway facing NCR Driveway away from NCR

Reason for asking: To learn how / where residents park there cars

12. What feelings do you have about the parking situation?

Reason for asking: To identify what the residents think of the parking situation

13. Could you get along without a car? Yes No

Reason for asking: To see if public transportation is acceptable / viable for residents

14. If not, why not?

Safety

15. What are your feelings about the condition of pavements along the NCR?

Reason for asking: Identify concerns with sidewalks

16. What type of concerns do you associate with walking along the NCR?

Reason for asking: To identify safety concerns residents have

17. Are you aware of any accidents near your residence? Yes No

Reason for asking question 17, 18, and 19: To see if residents feel accidents are a big problem

18. How often?

19. (If yes) Does this concern you? Yes No

Improvements

20. What types of improvements would you like to see around your home, to tackle the problems you've mentioned?

Reason for asking: To identify what the residents want

21. If the council was able to undertake measures to reduce the impact of the road on your life, but this meant giving up part of your rear garden (say 15ft) to provide an alternative access of the rear, would this be acceptable to you?

Yes No

Reason for asking: To see what the residents think of re-development

22. What do you think could be done to better the landscaping around your residence?

Reason for asking: To get suggestions from the residents

23. Would you be interested in an alternative method / place to park your car?

Yes No

Reason for asking: To see how residents feel about parking situation / if they want another way to park

Personal Information (Optional)

Reason for asking all: For organizing purposes

24. Male Female

25. Does any in your household have a disability of any sort? Yes No

26. How many members are in your family _____

27. Number of Family members per age group?

Under 18 _____
18 – 60 _____
Over 60 _____

28. Is there someone in the household regularly home during the day? Yes No

29. What is your type of work?

30. Do you have any other comments or suggestions for the Brent council?

Thank you for helping with this questionnaire. All information will be treated anonymously.

Appendix D: NO2 Concentrations in Ug/M^3 Monthly Means

Borough	Site Code	X_coord	Y_coord
Brent	BR31	521117	185325
Brent	BR41	518461	184110
Brent	BR42	521134	183996
Brent	BR43	520242	184541
Brent	BR51	521051	188792
Brent	BR52	520583	189858
Brent	BR53	518305	185182
Brent	BR54	518728	185238
Brent	BR55	521750	183365
Brent	BR56	523634	183151
Brent	BR57	525453	183562
Brent	BR58	523009	184653

Client ID	Month	Date On	Date Off	ug/m^3
BRT 31	January	1/2/2002	1/31/2002	69.82
BRT 42	January	1/3/2002	1/31/2002	50.96
BRT 43	January	1/3/2002	1/31/2002	62.00
BRT 41	January	1/2/2002	1/31/2002	39.49
BRT 51	January	1/2/2002	1/31/2002	21.16
BRT 51	January	1/2/2002	1/31/2002	41.77
BRT 51	January	1/2/2002	1/31/2002	43.44
BRT 52	January	1/2/2002	1/31/2002	49.08
BRT 53	January	1/2/2002	2/1/2002	64.07
BRT 54	January	1/3/2002	1/31/2002	53.89
BRT 55	January	1/3/2002	1/31/2002	59.33
BRT 56	January	1/3/2002	1/31/2002	60.57
BRT 57	January	1/3/2002	1/31/2002	53.57
BRT 58	January	1/3/2002	1/31/2002	55.38
BRT 31	February	1/31/2002	3/1/2002	34.45
BRT 42	February	1/31/2002	3/1/2002	24.87
BRT 43	February	1/31/2002	3/1/2002	40.95
BRT 51	February	1/31/2002	2/26/2002	10.82
BRT 51	February	1/31/2002	2/26/2002	10.21
BRT 51	February	1/31/2002	2/26/2002	13.82
BRT 52	February	1/31/2002	2/26/2002	12.61
BRT 53	February	2/1/2002	2/26/2002	25.02

BRT 54	February	1/31/2002	3/1/2002	25.22
BRT 55	February	1/31/2002	2/28/2002	94.57
BRT 56	February	1/31/2002	2/28/2002	18.25
BRT 57	February	1/31/2002	3/1/2002	27.60
BRT 58	February	1/31/2002	3/1/2002	38.47
BRT 31	March	3/1/2002	4/3/2002	35.43
BRT 42	March	3/1/2002	4/2/2002	22.07
BRT 43	March	3/1/2002	4/2/2002	56.07
BRT 41	March	2/26/2002	4/3/2002	16.87
BRT 51	March	2/26/2002	4/3/2002	25.49
BRT 51	March	2/26/2002	4/3/2002	21.91
BRT 51	March	2/26/2002	4/3/2002	20.57
BRT 52	March	2/26/2002	4/3/2002	22.81
BRT 53	March	2/26/2002	4/3/2002	62.15
BRT 54	March	3/1/2002	4/3/2002	29.68
BRT 55	March	2/28/2002	4/3/2002	65.31
BRT 56	March	2/28/2002	4/3/2002	21.45
BRT 57	March	3/1/2002	4/3/2002	30.61
BRT 58	March	3/1/2002	4/3/2002	16.01
BRT 42	April	4/2/2002	5/1/2002	40.53
BRT 43	April	4/2/2002	5/1/2002	40.09
BRT 41	April	4/3/2002	4/30/2002	19.09
BRT 51	April	4/3/2002	4/30/2002	16.74
BRT 51	April	4/3/2002	4/30/2002	12.70
BRT 51	April	4/3/2002	4/30/2002	16.16
BRT 52	April	4/3/2002	4/30/2002	18.44
BRT 53	April	4/3/2002	5/1/2002	58.34
BRT 55	April	4/3/2002	5/1/2002	39.09
BRT 56	April	4/3/2002	5/1/2002	28.48
BRT 57	April	4/3/2002	5/1/2002	22.32
BRT 58	April	4/3/2002	5/1/2002	25.68
Sample 43 or 34		4/3/2002	5/1/2002	47.61

Sample arrived labeled 43 but written on tube with 34. Both were missing. Times taken as the highest of these two

BRT 31	May	5/1/2002	6/6/2002	32.56
BRT 43	May	5/1/2002	6/6/2002	55.56
BRT 41	May	4/30/2002	6/5/2002	17.04
BRT 51	May	4/30/2002	6/5/2002	19.12

BRT 51	May	4/30/2002	6/5/2002	23.04
BRT 51	May	4/30/2002	6/5/2002	14.34
BRT 52	May	4/30/2002	6/5/2002	33.50
BRT 53	May	5/1/2002	6/5/2002	74.75
BRT 54	May	5/1/2002	6/6/2002	29.61
BRT 55	May	5/1/2002	6/5/2002	57.97
BRT 56	May	5/1/2002	6/6/2002	20.47
BRT 57	May	5/1/2002	6/5/2002	-
BRT 58	May	5/1/2002	6/5/2002	26.76
BRT 31	June	6/6/2002	7/3/2002	65.27
BRT 42	June	6/5/2002	7/2/2002	17.12
BRT 43	June	6/6/2002	7/2/2002	25.30
BRT 52	June	6/5/2002	7/2/2002	18.36
BRT 53	June	6/5/2002	7/2/2002	45.30
BRT 54	June	6/6/2002	7/3/2002	31.15
BRT 56	June	6/6/2002	7/2/2002	17.76
BRT 57	June	6/5/2002	7/3/2002	20.71
BRT 58	June	6/5/2002	7/3/2002	26.09
BRT 31	July	7/3/2002	8/1/2002	19.80
BRT 42	July	7/2/2002	8/1/2002	26.13
BRT 43	July	7/2/2002	8/1/2002	52.01
BRT 41	July	7/2/2002	7/31/2002	23.69
BRT 51	July	7/2/2002	8/1/2002	20.15
BRT 51	July	7/2/2002	8/1/2002	15.90
BRT 51	July	7/2/2002	8/1/2002	15.58
BRT 52	July	7/2/2002	8/1/2002	15.85
BRT 53	July	7/2/2002	7/31/2002	51.03
BRT 54	July	7/3/2002	8/1/2002	26.51
BRT 56	July	7/2/2002	8/1/2002	34.02
BRT 57	July	7/3/2002	8/1/2002	31.95
BRT 58	July	7/3/2002	8/1/2002	28.08
BRT 31	August	8/1/2002	9/3/2002	7.39
BRT 42	August	8/1/2002	9/3/2002	7.99
BRT 43	August	8/1/2002	9/3/2002	8.07
BRT 41	August	7/31/2002	9/3/2002	6.05
BRT 51	August	8/1/2002	9/3/2002	5.68
BRT 51	August	8/1/2002	9/3/2002	20.40
BRT 51	August	8/1/2002	9/3/2002	33.04

BRT 52	August	8/1/2002	9/3/2002	22.35
BRT 53	August	7/31/2002	9/3/2002	10.95
BRT 54	August	8/1/2002	9/3/2002	30.23
BRT 56	August	8/1/2002	9/3/2002	7.26
BRT 57	August	8/1/2002	9/3/2002	20.21
BRT 58	August	8/1/2002	9/3/2002	5.40
BRT 31	September	9/3/2002	10/2/2002	32.48
BRT 42	September	9/3/2002	10/4/2002	66.35
BRT 43	September	9/3/2002	10/2/2002	23.18
BRT 41	September	9/3/2002	10/4/2002	39.11
BRT 51	September	9/3/2002	10/2/2002	25.40
BRT 51	September	9/3/2002	10/2/2002	23.92
BRT 51	September	9/3/2002	10/2/2002	29.15
BRT 52	September	9/3/2002	10/4/2002	22.53
BRT 53	September	9/3/2002	10/2/2002	51.83
BRT 55	September	9/3/2002	10/4/2002	57.39
BRT 56	September	9/3/2002	10/4/2002	43.31
BRT 57	September	9/3/2002	10/4/2002	46.27
BRT 58	September	9/3/2002	10/4/2002	42.71
BRT 31	October	10/2/2002	10/29/2002	41.61
BRT 42	October	10/4/2002	10/29/2002	35.66
BRT 43	October	10/2/2002	10/29/2002	42.22
BRT 41	October	10/4/2002	10/29/2002	30.31
BRT 51	October	10/2/2002	10/29/2002	23.85
BRT 51	October	10/2/2002	10/29/2002	26.91
BRT 51	October	10/2/2002	10/29/2002	26.30
BRT 52	October	10/4/2002	10/29/2002	34.89
BRT 53	October	10/2/2002	10/29/2002	39.06
BRT 54	October	10/4/2002	10/29/2002	48.17
BRT 55	October	10/4/2002	10/29/2002	50.05
BRT 56	October	10/4/2002	10/29/2002	27.16
BRT 57	October	10/4/2002	10/29/2002	53.62
BRT 58	October	10/4/2002	10/29/2002	49.66
BRT 31	November	10/29/2002	12/3/2002	54.20
BRT 42	November	10/29/2002	12/3/2002	45.01
BRT 43	November	10/29/2002	12/3/2002	58.60
BRT 41	November	10/29/2002	12/3/2002	29.37
BRT 51	November	10/29/2002	12/3/2002	29.75

BRT 52	November	10/29/2002	12/3/2002	37.52
BRT 53	November	10/29/2002	12/3/2002	42.14
BRT 54	November	10/29/2002	12/3/2002	46.01
BRT 55	November	10/29/2002	12/3/2002	57.93
BRT 56	November	10/29/2002	12/3/2002	71.57
BRT 57	November	10/29/2002	12/3/2002	91.94
BRT 58	November	10/29/2002	12/3/2002	67.97
BRT 31	December	12/3/2002	1/6/2003	54.88
BRT 42	December	12/3/2002	1/6/2003	48.26
BRT 43	December	12/3/2002	1/6/2003	60.79
BRT 41	December	12/3/2002	1/6/2003	38.79
BRT 51	December	12/3/2002	1/6/2003	42.75
BRT 51	December	12/3/2002	1/6/2003	39.42
BRT 51	December	12/3/2002	1/6/2003	42.27
BRT 52	December	12/3/2002	1/6/2003	45.13
BRT 54	December	12/3/2002	1/6/2003	20.34
BRT 55	December	12/3/2002	1/6/2003	76.53
BRT 56	December	12/3/2002	1/6/2003	55.84
BRT 57	December	12/3/2002	1/6/2003	73.82
BRT 58	December	12/3/2002	1/6/2003	54.87

NO2 Levels in Brent in Ug/M3 Based on yearly means

Borough	Site Code	X_coord	Y_coord	Distance_road	Class	Jan	Feb	Mar
Brent	BR31	521117	185325	26	I	47.57	57.76	35.78
Brent	BR41	518461	184110	56	B	38.18	33.88	37.80
Brent	BR42	521134	183996	2	R	49.79	43.87	Unav
Brent	BR43	520242	184541	2	R	40.38	47.21	43.34
Brent	BR51	521051	188792	2	B	28.90	32.58	26.85
Brent	BR52	520583	189858	2	R	27.79	32.26	25.67
Brent	BR53	518305	185182	1	R	52.00	46.10	39.76
Brent	BR54	518728	185238	4	R	53.35	52.20	45.30
Brent	BR55	521750	183365	0.5	R	53.12	60.54	37.30
Brent	BR56	523634	183151	1.9	R	46.50	44.43	51.41
Brent	BR57	525453	183562	2	R	40.96	46.10	46.87
Brent	BR58	523009	184653	1	R	45.39	46.10	32.76

Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
59.09	41.73	43.12	44.96	87.55	43.57	66.46	36.91	38.93
20.65	21.15	16.55	18.31	14.60	37.00	55.14	38.85	35.04
33.85	34.87	28.08	19.96	29.62	60.88	42.12	42.50	40.48
44.75	32.58	39.61	63.41	31.64	18.88	45.26	56.35	45.48
26.35	30.74	23.07	19.37	25.54	24.79	39.55	35.30	35.78
41.37	36.01	26.68	27.87	27.72	35.13	56.79	42.09	45.61
49.98	43.51	51.15	74.83	37.20	46.19	38.38	60.54	52.84
41.25	55.53	38.51	34.90	57.44	28.90	49.34	57.21	39.43
42.45	39.44	46.64	30.17	45.14	68.71	56.88	58.20	51.02
66.55	27.44	62.18	34.96	37.80	43.57	37.62	48.44	49.98
40.16	30.30	38.56	24.58	23.28	45.45	44.56	56.88	45.48
43.03	55.45	29.51	51.70	65.71	41.11	68.29	54.90	41.04

NO_2 Concentrations – Yearly Means 2000 – Ug/M^3

Site Code	background	intermediate	roadside
BR41	30.3		
BR51	28.2		
BR31		46.6	
BR54			34.3
BR42			37.3
BR43			49.0
BR52			43.3
BR53			46.3
BR55			51.9
BR56			41.2
BR57			41.6
BR58			46.9

Appendix E: Accident Data

Accidents between dates 01/01/2000 and 31/12/2002--36 months

Percentages

Pedestrian	18
Wet	15
Dark	44

Yearly figures

Year	Slight	Serious	Fatal	Total
2000	12	1	0	13
2001	11	1	1	13
2002	10	3	0	13
Total	33	5	1	39

Accidents involving

	Fatal	Serious	Slight	Total
Motor vehicles only (excluding 2-wheels)	1	4	30	35
2-Wheeled motor vehicles	0	1	2	3
Pedal cycles	0	0	1	1
Horses & other	0	0	0	0
Total	1	5	33	39

	Fatal	Serious	Slight	Total
Vehicle driver	1	3	21	25
Passenger	1	1	13	15
Motorcycle ride	0	1	2	3
Cyclist	0	0	1	1
Pedestrian	0	1	6	7
Other	0	0	0	0
Total	2	6	43	51

	2000	2001	2002	Total
January	1	0	1	2
February	0	1	1	2
March	1	0	1	2
April	0	2	1	3
May	1	1	1	3
June	0	0	2	2
July	2	1	0	3
August	2	0	1	3
September	2	3	4	9
October	1	4	1	6
November	1	0	0	1
December	2	1	....	3
Total	13	13	13	39

	2000	2001	2002	Total
January	1	0	1	2
February	0	1	1	2
March	1	0	1	2
April	0	4	1	5
May	1	3	1	5
June	0	0	3	3
July	4	2	0	6
August	2	0	1	3
September	2	3	6	11
October	2	4	1	7
November	1	0	0	1
December	3	1	0	4
Total	17	18	16	51

	2000	2001	2002	Total
Fatal	0	1	0	1
Serious	1	1	3	5
Slight	12	11	10	33
Total	13	13	13	39

	2000	2001	2002	Total
Fatal	0	0	0	0
Serious	0	0	1	1
Slight	4	1	1	6
Total	4	1	2	7

	2000	2001	2002	Total
Fatal	0	0	0	0
Serious	0	0	0	0
Slight	0	1	0	1
Total	0	1	0	1

	2000	2001	2002	Total
Fatal	0	1	0	1
Serious	1	1	2	4
Slight	8	9	9	26
Total	9	11	11	31

	2000	2001	2002	Total
Fatal	0	0	0	0
Serious	1	0	1	2
Slight	0	0	0	0
Total	1	0	1	2

	2000	2001	2002	Total
Fatal	0	0	0	0
Serious	1	0	1	2
Slight	1	2	0	3
Total	2	2	1	5

Appendix F: Picture Survey of the North Circular Road

Appendix G: Survey Results

Questions	1			2				3					4					5				6				7		8				9				
Address	0 - 2	2-10	10-100	Poor	Mediocre	Good	Excellent	Noise	Parking	Health & Safety	Traffic	None	Yes	Triple glazing	double Glazing	Medication	No	High	Medium	Low	used to it	at night: High	at night: Medium	at night: Low	at night: used to it	can't sleep	none	Hearing Loss	Problems Sleeping	High Blood Pressure	None	Asthma	Recurring Bronchitis	Heart Disease	Other Respiratory Ailments	None
17			1		1			1		1			1			1		1				1				1			1	1						
19			1			1		1		1							1			1				1			1				1	1				
23			1			1				1			1					1				1				1									1
27		1				1		1		1	1		1		1			1				1				1		1	1	1	1					
31			1		1					1	1						1				1				1	1					1	1			1	
41		1					1					1					1				1				1	1					1					1
43	1					1		1		1	1						1	1				1				1				1		1				
45			1	1						1							1				1				1	1					1					1
49			1			1		1					1	1							1	1				1				1						1
55			1			1		1			1						1	1				1				1			1			1	1			
57			1			1				1	1						1	1					1			1			1				1			
59		1		1				1		1							1	1				1				1			1	1			1			
65			1	1				1									1	1				1				1			1							1
67			1		1			1	1				1		1			1				1				1			1		1				1	
69		1		1				1		1			1		1			1				1				1			1							1
71			1			1		1					1		1						1				1	1		1					1			
83		1			1			1					1		1			1				1				1			1		1					
86	1			1				1		1			1		1	1		1				1				1			1	1	1					
91		1			1			1		1			1		1			1				1				1					1					
93			1		1			1									1	1						1			1				1	1				
94	1					1		1					1		1						1				1		1				1					1
99			1		1			1					1		1			1				1				1			1			1		1		
104			1		1			1									1				1				1		1							1	
106		1				1		1									1	1				1					1				1					1
108	1			1				1		1							1	1				1				1			1			1				
110			1			1				1	1						1	1						1			1		1				1			
111			1			1		1		1							1	1					1				1	1			1	1				
115	1					1				1							1			1			1				1				1					1
119			1		1							1	1		1				1				1				1				1					
120			1		1							1			1						1				1		1				1					
128			1				1					1					1			1				1		1				1		1				
132			1			1		1					1		1						1				1					1	1					
138		1				1						1			1					1				1		1				1						1
148			1		1					1	1						1	1						1		1			1		1					
150		1		1				1		1							1	1				1				1			1		1					
152			1			1		1		1	1		1		1			1					1			1			1	1	1					
154			1			1						1					1				1				1		1				1					1
156		1		1						1			1		1						1				1		1				1					1
160			1			1		1									1				1				1		1	1			1		1			
162		1				1		1		1			1					1				1	1			1		1	1							1
166			1			1		1		1	1		1		1					1				1		1				1						1
172		1		1				1									1	1				1				1				1						1
174	1			1				1		1			1		1			1				1				1			1		1					
206		1			1							1					1				1				1				1							1
250			1			1		1				1					1	1				1				1			1	1						1
262			1			1						1					1			1			1				1			1						
270		1				1		1					1				1	1				1				1			1							1
276		1				1		1					1		1			1				1				1			1							1
278			1			1		1		1			1		1			1				1				1			1							1
286		1				1				1			1		1						1				1	1				1						1

Questions	10		11				12			13 & 14				
Address	yes	No	On the Street	Driveway facing NCR	Driveway away from NCR	Not applicable	Good	Bad	not applicable	Not Applicable	Yes	No	work	no buses
17	1				1		1					1	1	
19	1		1					1				1		1
23	1				1			1				1	1	
27	1				1			1				1	1	1
31	1			1				1				1	1	
41	1			1				1				1	1	
43	1			1				1				1		1
45	1			1			1				1			
49	1			1				1				1	1	
55	1			1				1				1		1
57		1				1			1	1				
59		1				1		1		1				
65		1				1			1	1				
67	1		1					1				1	1	
69		1				1			1	1				
71		1				1			1	1				
83	1		1					1				1	1	
86	1		1					1				1	1	
91	1		1					1				1	1	
93	1			1				1				1	1	
94		1				1			1	1				
99		1				1			1	1				
104	1			1				1			1			
106	1			1			1					1	1	
108	1		1					1				1		1
110	1		1					1				1	1	
111		1				1			1	1				
115	1		1				1							
119	1				1		1					1		1
120	1				1		1					1	1	
128		1				1			1	1				
132		1				1			1	1				
138		1				1			1	1				
148		1				1		1		1				
150	1		1					1				1	1	
152		1				1		1		1				
154		1				1			1	1				
156		1				1			1	1				
160		1				1		1		1				
162		1				1			1	1				
166	1		1					1				1		1
172		1				1			1	1				
174	1		1					1			1			
206	1		1					1				1	1	
250	1				1			1				1		1
262	1		1					1			1			
270	1			1				1			1			
276	1			1			1					1	1	
278		1				1		1		1				
286	1			1				1				1		1

Question	15			16		17		18		19		20					
Address	Good	bad	dusty	safety	none	Aware	Not aware	Very often	Not very often	Concerned	Not Concerned	Barriers	Pavement improvements	Safety	Parking	Cleaning	Speed Control
17	1		1	1		1		1		1		1		1			
19		1	1		1	1		1		1			1		1		
23		1	1	1		1			1	1		1		1			
27		1	1	1		1		1		1		1	1		1	1	
31	1				1	1			1		1						
41		1		1		1		1			1	1			1	1	
43	1				1		1				1				1		
45		1		1		1		1			1	1					
49	1			1		1		1		1				1	1		
55	1				1	1		1		1		1		1	1		
57	1				1	1		1			1						
59		1		1		1		1		1		1					
65		1	1	1		1		1		1			1			1	
67		1	1	1		1		1		1					1		
69		1		1		1		1		1		1	1	1			
71	1				1	1			1		1	1					
83		1	1	1			1				1	1			1	1	
86		1	1		1	1		1		1		1				1	
91		1	1	1		1		1			1	1				1	
93		1		1		1		1			1	1	1	1	1		
94	1			1			1				1	1		1			
99	1			1			1				1	1					
104	1			1		1			1		1				1	1	
106	1				1	1			1		1			1			1
108		1		1		1		1		1		1		1			1
110	1			1		1		1		1		1		1	1		1
111		1		1			1				1	1	1				
115		1		1		1			1		1	1	1	1			
119	1			1			1				1			1			1
120	1			1			1				1			1			1
126		1		1			1				1	1	1	1			
132		1	1		1	1			1		1						
136	1				1		1				1						
148	1			1		1		1		1		1		1	1		
150		1		1		1		1		1		1	1	1	1		
152		1	1	1		1		1		1		1	1	1			
154		1		1			1				1						
156		1		1		1		1		1		1					
160		1	1	1		1			1	1							
162	1			1			1			1							
166		1	1	1		1		1		1		1	1	1		1	1
172		1	1	1		1		1		1							
174		1	1	1		1		1		1		1		1			
206		1	1	1		1			1	1			1		1		
250		1		1		1		1		1				1			1
262	1			1			1			1		1		1	1		
270		1		1		1			1	1				1	1	1	
276	1			1			1			1				1		1	
278		1		1		1		1		1			1	1	1	1	
286		1		1		1			1	1			1	1	1		

Questions	20							21			22		23			24	
Address	Barriers	Pavement improvements	Safety	Parking	Cleaning	Speed Control	none	Accept	Do not accept	Not Applicable	Fatigue	nothing could be done	Interested	Not Interested	Not Applicable	Male	Female
17	1		1					1			1			1			1
19		1		1					1		1		1			1	
23	1		1							1	1				1	1	
27	1	1		1	1			1			1		1				1
31							1	1				1	1			1	
41	1			1	1			1				1	1				1
43				1				1				1	1			1	
45	1							1			1		1			1	
49			1	1				1				1	1			1	
55	1		1	1					1			1	1				1
57										1	1				1	1	
59	1									1		1			1		1
65		1			1			1			1				1		1
67				1				1				1	1				1
69	1	1	1							1		1			1		1
71	1						1			1		1			1	1	
83	1			1	1			1			1		1				1
86	1				1			1			1		1				1
91	1				1					1	1		1			1	
93	1	1	1	1				1				1	1			1	
94	1		1							1	1				1	1	
99	1									1	1				1		1
104				1	1			1			1		1			1	
106			1			1		1			1			1			1
108	1		1			1				1	1			1			1
110	1		1	1		1		1				1	1			1	
111	1	1							1			1			1		1
115	1	1	1					1			1			1			1
118			1			1				1	1			1			1
120			1			1				1		1			1		1
126	1	1	1							1	1				1	1	
132							1			1	1				1		
138							1			1		1			1	1	
148	1		1	1						1		1			1	1	
150	1	1	1	1				1			1		1				1
152	1	1	1					1			1				1		1
154							1			1		1			1		1
156	1									1		1			1		1
160							1		1		1				1	1	
162							1			1		1			1	1	
166	1	1	1		1	1				1	1			1			1
172							1			1		1			1		1
174	1		1					1			1		1				1
206		1		1				1				1	1			1	
250			1			1				1	1			1		1	
252	1		1	1						1	1		1				1
270			1	1	1				1		1		1				1
276			1		1				1			1	1			1	
278		1	1	1	1					1	1		1				1
286		1	1	1						1	1			1		1	

Questions	25		26						27			28		29			
Address	Yes	No	1 member	2 members	3 members	4 members	5 members	6 members	Under 18	18-60	Over 60	Yes	No	Manager	Chef	Other	Doesn't work
17		1		1						1	1	1					1
19		1				1				3	1		1			1	
23		1						1	3	3		1				1	
27		1					1		1	4			1			1	
31	1			1						1	1	1				1	
41		1			1					2	1	1					1
43		1						1		6		1			1		
45		1		1						2		1				1	
49		1						1		5	1		1			1	
55		1				1			1	2	1		1			1	
57		1	1								1		1				1
59		1		1					1	1		1					1
65		1	1								1		1				1
67		1						1	2	3	1		1			1	
69		1						1	2	4			1				1
71		1	1								1	1					1
83		1					1		3	2		1				1	
86		1				1			2	2			1				1
91	1					1			2	2			1			1	
93		1		1							2	1					1
94		1				1			2	2		1				1	
99		1	1								1	1					1
104	1						1			5			1		1		
106																	
108		1				1			3	1		1				1	
110		1					1			4	1	1				1	
111	1		1								1	1					1
115																	
119		1			1					3			1			1	
120		1			1					3			1			1	
128	1		1								1	1					1
132																	
136		1			1					3		1		1			
148	1						1		2	3		1					1
150	1						1		4	1		1					1
152	1		1								1	1					1
154		1	1								1	1					1
156		1				1			3	1		1					1
160	1					1				2	2	1					1
162	1							1	4	2		1					1
166		1	1								1	1				1	
172		1				1			2	2		1					1
174	1					1			2	2		1		1			
206		1			1					2	1	1					1
250		1						1	4	2		1		1			
262																	
270																	
276		1						1	2	4		1			1		
278		1					1			3	2	1					1
286		1			1				1	2			1	1			