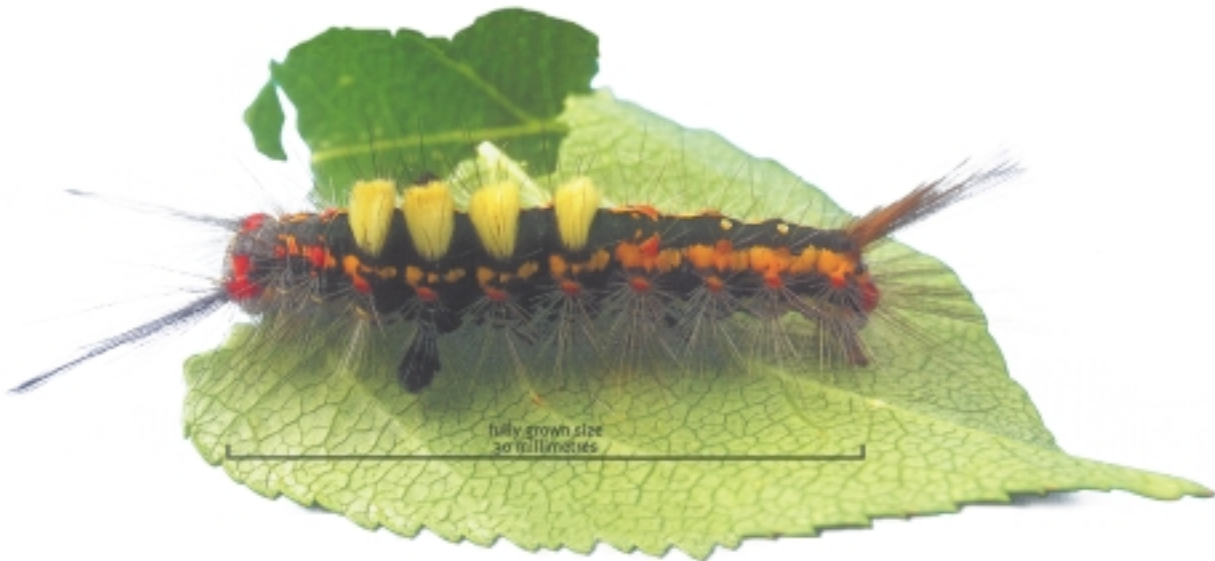


Health Surveillance following Operation Ever Green:

A programme to eradicate the
white-spotted tussock moth
from the eastern suburbs of Auckland



Report to the Ministry of Agriculture and Forestry

May 2001

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Executive summary: Operation Ever Green Health Surveillance

Section 1 Introduction

- The white-spotted tussock moth (*Orgyia thyellina*), was found in Auckland's eastern suburbs in April 1996. A programme to eradicate the pest commenced in October 1996, using aerial and ground application of *Bacillus thuringiensis* var. *kurstaki* (*Btk*).
- The programme, named Operation Ever Green, was implemented by the Ministry of Forestry. Since then a merger on 1 March 1998 led to a combined Ministry of Agriculture and Forestry (MAF). References throughout this report to MAF or to "the Ministry" are to the ministry responsible for Forestry and the Operation Ever Green programme.
- The area included in the aerial eradication with *Btk* was predominately urban residential with a usually resident population of 81,389 at the time of the 1996 census. A smaller "infested" area, with a population of 5,640, underwent a longer duration aerial programme supplemented with ground spraying of 539 residential properties in the immediate vicinity of detected caterpillars, egg cases or moths. Ground spraying was also used at one school and church and unoccupied properties including vegetation collection areas.

Table: Exposure to *Btk*

	DC6	Helicopter	Ground Spraying
Type:	aerial mist - <i>Btk</i>	aerial mist - <i>Btk</i>	ground level mist blower or micronair - <i>Btk</i>
Total litres of <i>Btk</i>	130,000	28,090	See Appendix 5
When:	5 Oct 1996 - 9 Dec 1996	5 Oct 1996 - 17 Apr 1997	2 Oct 1996 - 17 Apr 1997
Where:	Eastern suburbs	Sub-area of Mission Bay, Kohimarama and Meadowbank	Some properties within sub-area
Population	81,389	5,640	Est. 1,269
No. of residential properties	Approx. 30,000	2,395	539

- *Btk* kills caterpillars through a protein substance, which is activated in the specific conditions of the caterpillar gut. The pest control action is limited to caterpillars. For 30 years large quantities of *Btk* have been used throughout North America for the control of gypsy moth (*Lymantria dispar*), a relative of tussock moth. Patterns of *Btk* use differ according to local conditions and moth species.

- A synthetic pheromone (chemical sexual attractant for catching male moths) was developed and used in an extensive pest surveillance programme during 1997/98 - "moth trapping".
- A formal Health Risk Assessment preceded the spraying in 1996/97 and incorporated a plan for risk management and communication. A second Health Risk Assessment in 1997 was preparatory for possible continued control measures. However, no further applications of *Btk* were used in the area and eradication was declared in June 1998.
- At the time of the spraying, self-reporting of health concerns was encouraged through the availability of a "free-phone" number. Callers were referred to an independent medical adviser or to the public health agency and this system continued to operate until June 1999.
- As a response to community concerns expressed about the potential for health risks associated with spray exposure, a comprehensive health surveillance programme was undertaken, to look for any effects on health for a period of two years after commencement of spraying.

Section 2 Background to the health surveillance programme

- The implementation of health surveillance was required by government.
- The health surveillance incorporated:
 - (a) Documentation and investigation of self-reported concerns;
 - (b) Health surveillance using sentinel general medical practitioners;
 - (c) Review of health data from suitable sources;
 - (d) Birth outcomes analysis;
 - (e) A register of individuals exposed to the *Btk* spray.

Section 3 Ethical requirements

- All components of the surveillance received relevant ethical committee approval and complied with requirements under NZ Privacy legislation. Only for the volunteered self-reports was any individually identifiable information available to the surveillance team. In other instances individual information was reviewed by the practitioners involved in the provision of the health care services. They extracted the necessary reports for the surveillance, thus maintaining individual privacy.

Section 4 Self-reported health concerns

- 375 individuals reported varied concerns, between October 1996 and June 1999. These included a few reports to the Medical Officer of Health by medical practitioners (who were repeatedly asked to report any events associated with exposure to the spray, as with reporting for any environmental disease). Clusters of reporting arose after publicity, which

included initial publicity about the "free phone" system to contact Operation Ever Green, requests for public submissions to MAF about the programme, a systematic phone enquiry to all households in the quarantine area asking for their views, membership recruitment by a citizens' group opposing spraying, written material to all households in the quarantine area advising about the Register project and public meetings attended by the independent medical adviser.

- The most frequently reported single concern was "fear of unspecified future disease", followed by headache and respiratory symptoms such as sore throat. Concerns were reported from nearly all organ systems, using the International Classification of Primary Care, but especially Respiratory (183 concerns), General (116), Eye (86), Skin (74), Social (73), Neurological (71) and Psychological (51).
- Reported concerns were followed up through a process of interview, requests to consent to obtaining relevant information from health care practitioners, review by a panel of medical specialists of recorded concerns and any available medical information, and where appropriate additional personal medical assessments. This process did not identify any significant diseases attributable to the spraying.
- For three years from the start of Operation Ever Green, general medical practitioners in the area were asked to inform the Medical Officer of Health about any health problems which they thought might be associated with spraying. There were no systematic problems reported and no further individual reports after mid 1997.
- Many of the 375 individuals reporting health concerns had not consulted a medical practitioner about those concerns. However, their concerns were part of a spectrum of symptoms commonly taken to a family doctor. It was considered that patterns of consultations observable within general medical practices (family doctors) could indicate whether any change in frequency of health conditions was associated with the spraying.

Section 5 Sentinel General Medical Practitioners

- Two general medical practitioners (family doctors/physicians) participated in a review by the practice nurse of written patient notes and computer practice records, to identify consultation frequency for selected health problems. Practice ONE was located in the heart of the infested area with a widespread patient population. Practice TWO was near the perimeter of the spray zone and had nearby patients both exposed and not exposed to spraying. A "before", "during DC6", "during helicopter" and "after" spraying comparison was undertaken within each practice, using period prevalence for consultation rates.
- Each patient was classified according to their street address (at the time of spraying) as either Zone A - residentially exposed to spraying between October 1996 and April 1997 by DC-6 and helicopter; Zone B - residentially exposed to DC-6 spraying between October and December 1996; or Zone C - not residentially exposed to spraying.
- The following numbers of patient records were reviewed:

	Zone A	Zone B	Zone C
Practice ONE	1061	699	724
Practice TWO	22	420	463
Total	1083	1119	1187

The following proportion of patient records were sampled:

	Zone A	Zone B	Zone C
Practice ONE	All	Part 1:2 & 1:4	1:3
Practice TWO	All	All	1:2

Approximately one in five of the total residents exposed to the longer duration programme (Zone A) had their medical records included in the review.

- The health presentations studied were:

Asthma, lower respiratory other than asthma, upper respiratory, rheumatoid arthritis and other autoimmune disorders, chronic fatigue syndrome, headaches, conjunctivitis, dermatitis.
- Based on the two practices, no adverse patterns were found. In particular, there was:
 - no identified new onset of asthma during spraying;
 - no pattern of increased consultation for pre-existing asthma associated with spraying;
 - no identified chronic fatigue syndrome associated with residence in a spray area;
 - no increase in presentations for autoimmune disorders nor any increase in consultation rates by people with pre-existing conditions;
 - no increase in consultation rates for lower respiratory problems, which include serious lung diseases;

- no obvious pattern of problems with headache, eye, skin or upper respiratory symptoms.

Section 6 Review of health data from suitable sources

- The following table summarises health concerns that were examined using various available sources of health data.

Health concern	Source of data	Methods	Results
Accidents, child bicycles & pedestrians	National hospital morbidity data	Time and area comparison for DC-6 spray days	No accidents
Anaphylaxis	GP (family doctors)	Event reporting	No events
Birth defects	National Congenital Anomalies Register	Time & area comparison	No statistical difference for residence in spray area
Birth weight & gestational age	Statistics for births at National Women's Hospital	Time & area comparison	No statistical difference for residence in spray area
Measles	None	Not reviewed	Considered unnecessary
Meningococcal disease	Statutory health notifications	Time & area comparison	No increase seen associated with spraying
Infections with <i>Btk</i>	Community and hospital pathology laboratories	Information request to pathologists	No invasive infections reported

- Socio-economic status patterns within the Operation Ever Green area were examined as part of the review of health data in order to assist, where relevant, with interpretation of findings.
- The 1996 Health Risk Assessment found that there was a potential for child pedestrian or bicycle injury through motor vehicle collision during travel to school because of possible distraction by low flying aircraft. Accordingly the national hospital morbidity database was searched for each spray day to identify any pedestrian or cyclist injury admissions among children resident in the spray area. None were identified.
- In response to community concern about allergy and risk of infection, the occurrence of anaphylaxis was investigated as were patterns of selected infections. No association was found between the spray programme and anaphylaxis, meningococcal disease or *Bacillus* infections.
- Community concern about birth outcomes led to a specific investigation of birth defects (congenital abnormalities), birth weight and prematurity (gestational age).

Section 7 Birth outcomes

- In early 1997 a spray related pregnancy scare was reported in news media - that babies were being born too soon and too small. Consequently, a detailed investigation of birth

outcome data was undertaken, using information from the base maternity hospital where virtually all spray area residents would have given birth.

- Information was available for analysis using actual individual birth weight, actual individual gestational age, and live or still birth outcome. Individual records in the dataset were classified for exposure status according to census code areas, which approximated DC6 and helicopter spray areas.
- There was no consistent difference between birth weights and gestational age among babies born to mothers residentially exposed to *Btk* spray. The magnitude of variation all lay within population trends and chance.
- New Zealand maintains a liveborn National Congenital Anomalies register through case reporting of chromosomal and structural disorders of all severity. Patterns of birth defects were examined using residence by census areas to represent exposure status to the *Btk* spray. A time comparison was also used. Differences between time periods and geographical areas were no greater than natural variation.

Section 8 Register

- There was considerable expressed community concern about potential future diseases not anticipated by current medical knowledge about *Btk*.
- To address this, a voluntary register of individuals exposed to the spray has been compiled and placed in the National Archives. The register can be accessed to assist future scientific health studies, should any be proposed.
- The register project received widespread community support.

Register response at 1 October 1998:

Register area households	2300
Number of registered households	1153
Number of registered individuals	3144

- Household participation:

Household		
Participation rate	1153/2300	50.1%
Refusal rate	112/2300	4.9%
Non-Response rate	1021/2300	44.4%

- Participation rate by eligible individuals - 3144/5640 - 55.7%.

Note: Number of individuals usually resident was 5,640.

Note: The non-participation rate includes people who did not receive the register information. We estimate that 20% of eligible individuals would have moved address between spraying and the register project.

In conclusion:

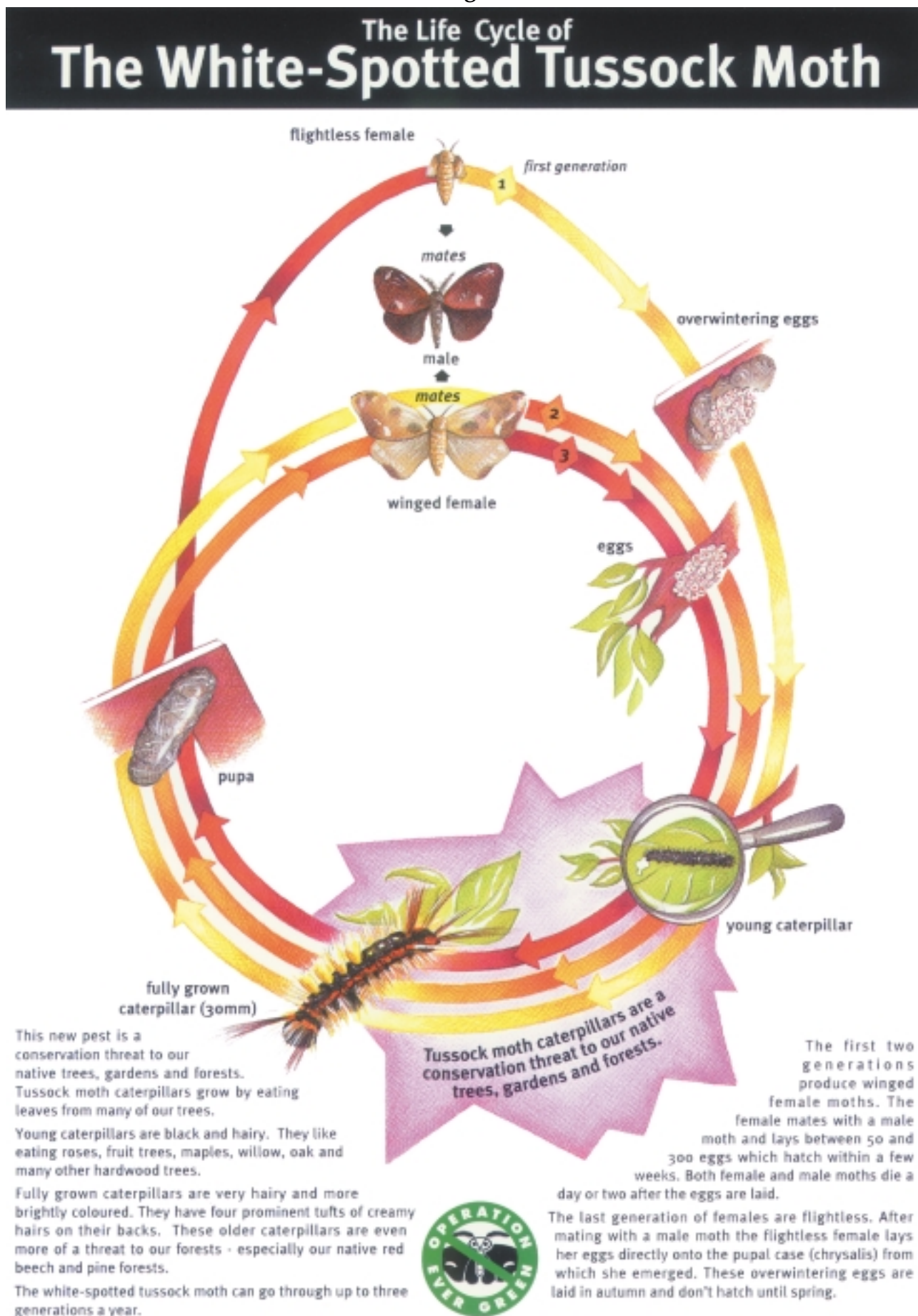
In 1996/97 *Btk* aerial and ground spraying was used in Auckland's eastern suburbs to eradicate white-spotted tussock moth (Operation Ever Green). The area was mainly urban residential with a population of over 80,000, of whom approximately 5,000 lived in the infested area subject to longer duration spraying.

A comprehensive health surveillance programme has examined health outcomes for a period of two years afterwards - using individual, local, regional and national health information. This included investigating residents' self-reported health concerns, consultation rates at sentinel family doctors, and a review of health data sources to establish birth outcomes and other events of community concern.

No adverse health patterns were found, once patterns were examined at a population level. The frequency of occurrence of the following was no different from natural variation: early births; small babies; birth defects; consultation rates with sentinel family doctors for asthma, other respiratory problems, headaches, skin or eye symptoms, and autoimmune disorders.

There was a pattern of self-reports by residents to MAF for irritant respiratory, skin and eye symptoms at the time of spraying and a level of expressed concern about potential future disease. A voluntary register of residents exposed to the longer duration programme was well supported and has been placed in the National Archives (Auckland Regional Office) to assist with any future health studies.

Figure 1:



1.0 Introduction

The tussock moth eradication programme, named Operation Ever Green, was implemented by the Ministry of Forestry. Since then a merger on 1 March 1998 has led to a combined Ministry of Agriculture and Forestry (MAF). References throughout this report to MAF or to "the Ministry" are to the ministry responsible for Forestry and the Operation Ever Green programme.

1.1 Identification of the pest and implementation of Operation Ever Green

The white-spotted tussock moth (*Orgyia thyellina*) was found in Auckland's eastern suburbs in April 1996. The species is native to Japan, Korea, Taiwan, China and the Russian Far East, where it lives in both urban and rural areas.¹ Tussock moth does not occur naturally in New Zealand, and thus presented a threat to native and planted forests, horticultural crops, amenity trees and gardens.

A resident in Kohimarama in Auckland first reported the tussock moth caterpillar on 17 April 1996. The Ministry of Agriculture and Forestry (MAF) immediately surveyed selected sites within an area of around 40 square kilometres. The infestation was considered contained within a seven-square-kilometre area in the suburbs around Kohimarama in east Auckland.

Because of the tussock moth's potential as a pest, the Ministry, in association with various other agencies, conducted an eradication programme - Operation Ever Green. This programme used aerial and ground spraying of the insecticide Foray 48B, a water-based spray that contained a bacterium, *Bacillus thuringiensis var.kurstaki* (*Btk*). Spraying by DC-6 aircraft occurred between 5 October and 9 December 1996 throughout the eastern suburbs of Auckland, followed by continued spraying in a more limited area by helicopter until 17 April 1997. Additionally, some properties in infested locations were ground sprayed with *Btk*.

The *Btk* kills caterpillars through a protein substance, which is activated in the specific conditions of the caterpillar gut. The pest control action is limited to caterpillars as it relies on the alkaline environment of a caterpillar gut, in contrast to the acid barrier of the human stomach.

The use of *Btk* for the control of various types of moths and butterflies is widely recognised. For 30 years large quantities of *Btk* have been used throughout North America for the control of gypsy moth (*Lymantria dispar*), a relative of tussock moth. Patterns of *Btk* use differ according to local conditions and moth species.

¹ Gibbs N. Environmental Impact Assessment of Aerial Spraying Btk in New Zealand to Eradicate Tussock Moth. Wellington: Ministry of Forestry; July 1996.

An intensive pheromone[#] moth trapping programme took place during the summer of 1997/1998 in the infested area together with more widely dispersed pheromone traps throughout the Auckland region. Results from the pheromone surveillance and continued surveillance to detect caterpillars led to no further detection of the pest. The white spotted tussock moth was announced in June 1998 by MAF as eradicated from the known infested area.

Two Health Risk Assessments were conducted: in September 1996 prior to the start of the eradication² and in 1997 as preparation for possible further use of *Btk*, which was not required.³ Refer to these assessments for the composition of the Foray 48B.*

A pheromone is a chemical substance secreted externally by certain animals including moths, and which affects the behaviour of others within the same species. Pheromones tend to be unique and specific to particular insect or animal species. The mating pheromone for white spotted tussock moth was identified chemically in a co-operative research programme and produced synthetically for use in lures (moth traps). The pheromone within the lures imitated the presence of a female moth receptive to mating and would attract male moths to the lures where they would be physically caught for later collection and identification.

² Auckland Healthcare Services Ltd and Jenner Consultants Ltd. Health Risk Assessment of Btk Spraying in Auckland's Eastern Suburbs to Eradicate White-Spotted Tussock Moth. Auckland: 4 September 1996.

³ Public Health Protection Service, Auckland Healthcare Services Limited. Health Risk Assessment of the Proposed 1997-1998 Control Programme for the White-Spotted Tussock Moth in the Eastern Suburbs of Auckland. Auckland: September 1997.

* The *Btk* containing liquid concentrate used in Operation Ever Green was Foray 48B from Abbott laboratories which contained the active biological ingredient *Bacillus thuringiensis* var. *kurstaki*, referred to as *Btk*, in a water-based preparation with minor amounts of a number of additional substances. These include fermenter concentrate solids (residues of the medium on which the *Btk* is grown), preservatives, pH regulators and a sticking agent. All these ingredients used in the Abbott formulation of Foray 48B are approved for use in foods in both the USA and Canada. More extensive information is presented in both Health Risk Assessments.

**Figure 2: Operation Ever Green
Auckland Eastern Suburbs**
Aerial spraying of *Btk* by DC6 aircraft, October - December 1996



1.2 Exposure

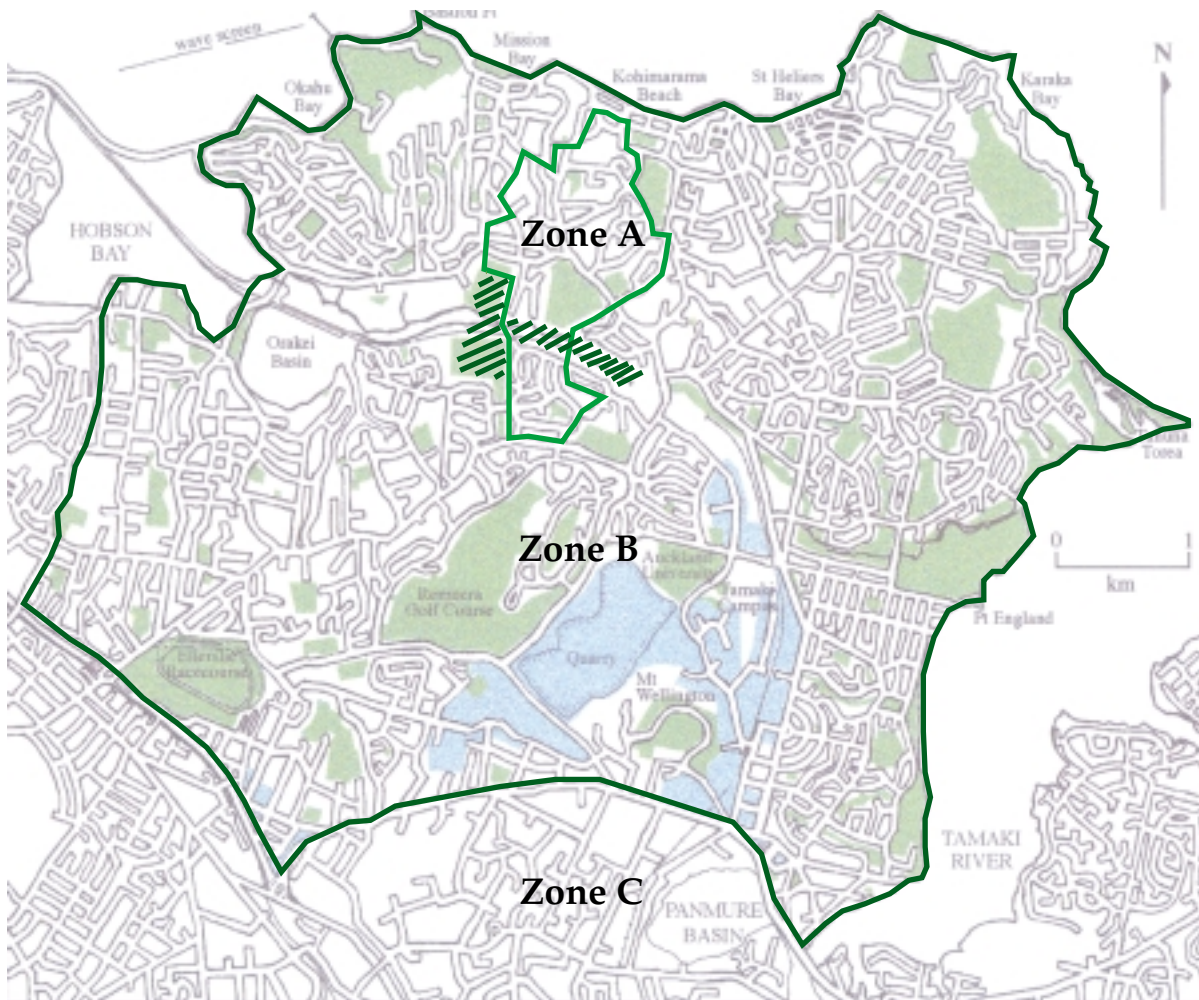
Table 1: Exposure to *Btk*






	DC6	Helicopter	Ground Spraying
Type:	aerial mist - <i>Btk</i>	aerial mist - <i>Btk</i>	ground level mist blower or micronair - <i>Btk</i>
What: Total litres of <i>Btk</i>	130,000	28,090	See Appendix 5
When:	5 Oct 1996 - 9 Dec 1996	5 Oct 1996 - 17 Apr 1997	2 Oct 1996 - 17 Apr 1997
Where:	Eastern suburbs (see Fig 2)	Sub-area of Mission bay, Kohimarama West and Meadowbank North (see Fig 3)	Some properties within Sub-area
Who: Population	81,389	5,640	Est. 1,269
Who: Number of residential properties	Approx. 30,000	2,395	539

NOTE: Population in the DC6 and helicopter areas was derived from Statistics New Zealand Population Counts 1996 (refer to Tables 14 and 15). Estimated population in the ground sprayed properties was derived by assuming that household composition reflected that of the census mesh blocks which covered the same area.

NOTE: Ground spraying occurred through treatment of vegetation anywhere in the immediate vicinity of a pest at any life stage. This affected 539 residential properties, of which 112 were treated on seven separate occasions, 207 on ten, 101 on eleven, 3 on seventeen and 116 on twenty-one. Additionally ground spraying was used to treat vegetation at one school, a church, a cemetery and unoccupied areas such as those used to collect and dispose of vegetation from properties affected by vegetation controls.

**Figure 3: Operation Ever Green
Exposure of population to *Btk* through aerial spraying**



-  Aerial spraying of *Btk* by DC6 aircraft, 5 October 1996 - 9 December 1996
-  Helicopter spraying, 5 October 1996 - 9 December 1996
-  Helicopter spraying, 17 January 1997 - 17 April 1997
-  Industrial areas
-  Parks, schools and reserves

A health surveillance programme from October 1997 to July 1999, to monitor health patterns in the sprayed area, was organised for the Crown. This was in response to expressed desires from residents for greater health monitoring in association with Operation Ever Green.

For the health surveillance three zones were identified in relation to exposure to *Btk* spray. First a zone (B) of spraying by DC-6 from October 5 1996 to December 9 1996, which included the wider eastern suburbs. Second a zone (A) of continued spraying from October 5 1996 to April 17 1997, which included any ground sprayed properties. This area included parts of Kohimarama West, Mission Bay and Meadowbank North, and corresponded to the infested area for quarantine purposes. Third a zone (C) was identified as outside any sprayed area.

2.0 Background to the Health Surveillance Programme

Implementation of health surveillance was required. This followed a decision by the government through a cabinet process. It was also a requirement that appropriate steps with regard to ethics were taken throughout.

2.1 Ministry of Agriculture and Forestry Operation Ever Green: Health Surveillance Programme

This had the following components:

- Self reports by residents of health concerns. These comprised a merged set of information held by MAF and the Medical Officer of Health, who holds statutory responsibility for public health.

Until the end of June 1999 the Operation Ever Green 0800 76 5000 free-phone number was available to residents as a means of access to the MAF Independent Medical Advisor in order to report any health concerns.

Also, doctors with patients in the eastern suburbs were asked to report to the Medical Officer of Health any illnesses in individual patients which they considered to be associated with exposure to the spraying (as with reporting of any environmental exposure to chemicals). This reporting by doctors of Associated Events was from the commencement of spraying in October 1996 until the end of the health surveillance.

- Sentinel general family doctors participated from practices with patients distributed both within and outside the sprayed area, to investigate patterns of selected potential health problems within their practices. The health problems were those featured in self-reports by residents and associated events reported by general practitioners.
- Selected health experiences within the spray zone were checked, from appropriate selected health information systems, to ascertain whether there had been any significant increase in numbers of health events.

The following health information databases were examined:

- ❖ Patterns from the national congenital anomalies register;
 - ❖ Patterns of pregnancy outcomes from National Women's Hospital – birth weight patterns, gestational age patterns and fetal/neonatal death rates;
 - ❖ Reports of laboratory isolations for bacillus thuringiensis;
 - ❖ Geographical distribution of meningococcal disease notifications and trends in the spray area 1995/1998;
 - ❖ Child pedestrian and bicycle accidents on DC6 spray days.
- A voluntary register of individuals with residential exposure to *Btk* was established and lodged in the National Archives (Auckland Regional Office) to enable any future health studies into long term effects. The register area covered those households in the July 1997 zone for ongoing vegetation restrictions - the "infested" zone. Detailed property exposure records were also archived.
 - A presentation of socio-economic and relevant demographic information was planned as background information, to assist in interpretation of findings from components of the surveillance. The NZDep96 was identified as a suitable source of information.

2.2 The Steering Committee

A Steering Committee of experts in population health surveillance was established to advise on the methods and interpretation of the findings from the health surveillance programme.

Individual members of the Steering Committee agreed to contribute directly to the implementation of different aspects of the research, including oversight of analysis, according to their research interests.

Representatives from the Ministries of Agriculture and Forestry and Health attended Steering Committee meetings.

The Steering Committee met 17 October 1997, 28 November 1997, 20 January 1998, 7 October 1998 and 16 December 1998, to formulate the research methods for the Register initiative, Sentinel GP Research and use of national or regional databases. A sentinel GP study methods meeting was conducted on 9 March 1999. A technical meeting of Steering Committee members was held on the 23 April to look at results from the database analyses. Further full Steering Committee meetings were held on 7 May 1999, 12 September 1999 and 12 November 1999.

2.3 Peer review

The methods of the health surveillance programme and the presentation used in this report were peer reviewed by an expert in the field of population health surveillance. The peer

reviewer was from Australia and had not previously participated in the health surveillance programme.

2.4 Composition of the Steering Committee

The Steering Committee comprised:

- Dr Francesca Kelly, Aer'aqua Medicine Ltd, Independent Medical Advisor to MAF (Chair);
- Dr Virginia Hope, Medical Officer of Health, Auckland Healthcare and Senior Lecturer, Department of Community Health, University of Auckland;
- Mr Alistair Stewart, HRC Biostatistician, Department of Community Health, University of Auckland;
- Dr Phil Weinstein, Senior Lecturer, Department of Public Health, Wellington School of Medicine;
- Dr Rae West, General Practitioner and former head of Department of Community Health and General Practice, University of Auckland; and
- Professor Alistair Woodward, Head of Department of Public Health, Wellington School of Medicine.

3.0 Ethical Requirements for the Health Surveillance Services

Ethical approvals were obtained from the appropriate committees, which were those administered by the Health Funding Authority (formerly North Health) for:

The proposal to establish a Register.

(i) MAF Operation Ever Green: A register of individuals exposed to the Btk spray - records for the National Archives. This application covered both resident and possible school roll registration and was approved in a letter dated 1 December 1997 (Ref 97/231).⁴

A Final Report was provided on 10 November 1998, which explained results from completion of the Register enrolment and outlined the documentation that was lodged in the National Archives.⁵

The health monitoring programme using sentinel doctors.

(ii) Ministry of Agriculture and Forestry Operation Ever Green: Health surveillance using Sentinel General Practitioners. This application (Dec 97) covered recruitment of doctors, initial exploration of their databases to establish patient numbers, establishment of disease definitions and feasibility.

(iii) Health surveillance following the use of Btk spray during MAF Operation Ever Green (a programme to attempt eradication of the white-spotted tussock moth): through the recruitment of Sentinel Medical Practices and an analysis of period prevalence of selected health problems. This application covered the finalised methods for the study. The Ethics Committee commented that the study was well conceived, paid particular attention to the privacy of residents and that it was pleasing to see the Crown invest in the follow-up. The study was fully approved in a letter dated 27 November 1998 (Ref 98/11/231).⁶ A Final Report was provided on 1 December 1999.⁷

4 Application 97/231 submitted to Ethics Committee x , meeting of 26 Nov 1997.

5 Study 97/231, acknowledgement of completion of study and report, 13 Nov 1998.

6 Application 98/11/231 submitted to Ethics Committee x, meeting of 25 November 1998.

7 Study 98/231, acknowledgement of completion of study and report, 15 Dec 1999.

4.0 Self-Reported Health Concerns Among People

4.1 Sources of self-reporting of concerns

Operation Ever Green maintained a health concerns database, through the Independent Medical Advisor to MAF. This was scheduled to finish with Operation Ever Green at 30 June 1998. However, occasional reports continued and were included up to 30 June 1999 (375 individuals).

Throughout the self-reporting an 0800 "free-phone" number was answered by Forest Health, a Ministry team, and health concerns were referred to the Independent Medical Advisor.

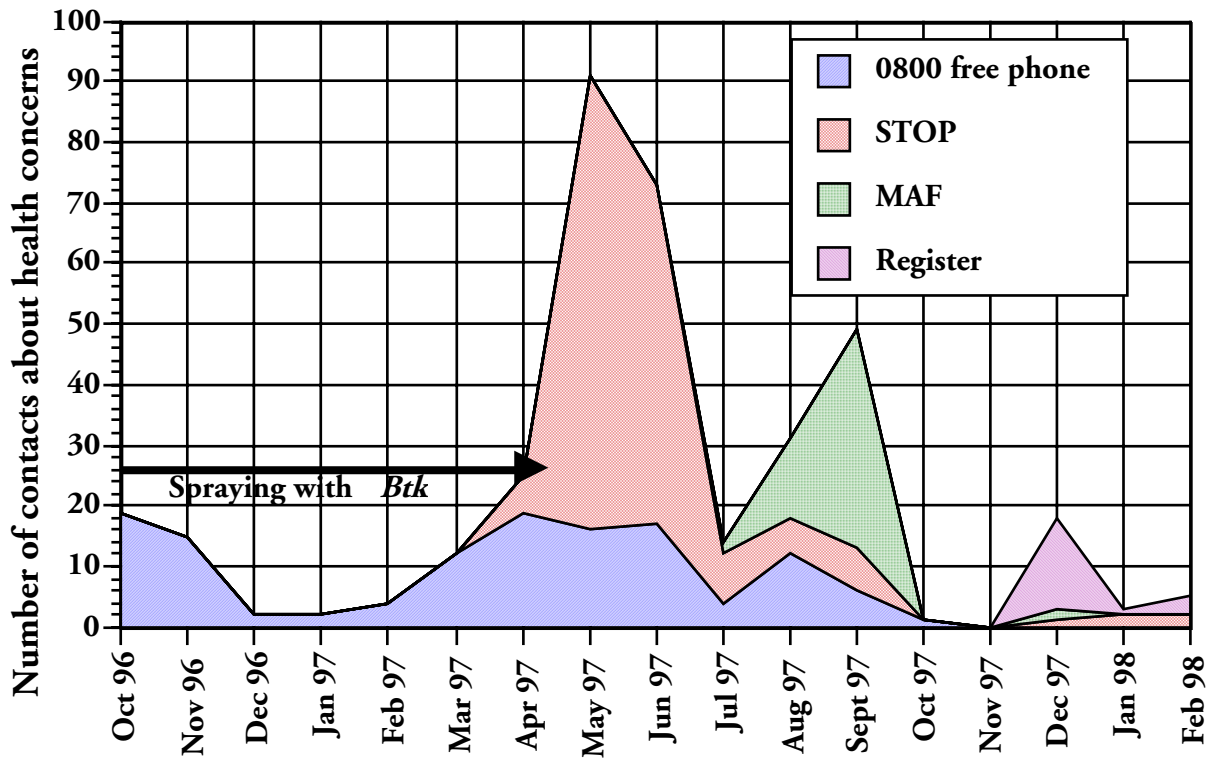
The self-reporting arose from:

- ❖ callers to the 0800 76 5000 Operation Ever Green number;
- ❖ those referred by STOP via their membership forms (Society Targeting Overuse of Pesticides, a local citizens' action group);
- ❖ those people who sent written health comments with their register form;
- ❖ those people who wrote to MAF during a formal submission process;
- ❖ occasional referral from doctors, following a formal request from the Medical Officer of Health, who holds statutory responsibility for Public Health;
- ❖ callers to Auckland Healthcare (Medical Officer of Health);
- ❖ callers who phoned the MAF Independent Medical Advisor directly.

Additional to self-reporting: 35 people had their health concerns recorded after a systematic telephone enquiry to all households in the infested area (Register Area); Also, after public meetings a number of people came forward about their concerns.

The figure on the following page shows the pattern of contacts over health concerns.

Figure 4: Pattern of contacts over health concerns



Some people used more than one form of contact, and each contact is displayed above.

People with health concerns could contact the MAF independent medical adviser via a "free-phone" number which was widely publicised.

A citizens' action group (STOP) referred details of members' health concerns to the Ministry.

Other methods of contact with the Ministry included written public submissions, a systematic phone contact with households in the infested area to ask for their views, public meetings or other direct contact with the independent medical adviser.

The Register project produced additional written concerns.

The Public Health Protection Agency also received contacts about concerns. These are mainly displayed as "0800 free phone" since they included the free-phone contacts prior to the appointment of the independent medical adviser in late February 1997.

4.2 Public communications about health risk

The Health Risk Assessment 1996 (HRA) prior to Operation Ever Green reviewed international literature about experience with *Btk* in other communities. The HRA included recommendations for risk communication and risk management, that identified people with asthma and skin disease as warranting individual advice to maintain usual medications as a means of reducing any risk and to contact their usual doctor or nurse "if you are at all concerned". The other key risk messages in the HRA were general to all households about continuing usual hygiene measures for food preparation, gardening and outdoor pools and playground equipment.

The HRA reports⁸ formed the basis for the public advice released by the Medical Officer of Health and were made available to medical practices, pharmacies and other interested health practices in the spray area. They were also provided to any members of the public on request. An HRA conclusion, from a review of experience in other communities, was that some people might experience short-term eye, skin and upper respiratory irritancy associated with direct exposure to the spray.

Information originating with MAF, the Ministry of Health and Medical Officer of Health (MOH) generally emphasised the relative safety of the *Btk* spray and advised people that they did not need to leave the area during the programme to avoid exposure. However, some advice contained a message that those wishing to take extra individual precautions could stay indoors during actual spraying and close windows and doors to reduce direct exposure. This message was at times associated with mention of asthma, skin disease and allergic disposition as individual situations where people might choose a precautionary approach.

4.3 Operation Ever Green communications to residents

Operation Ever Green incorporated various regular forms of communication to residents. For example public meetings and library displays at the outset of the programme, releases to news media, a newsletter *Inform* which was distributed to households in the infested area. MAF messages were consistent with the health risk assessments, publicised the 0800 phone method for raising individual concerns with the MAF independent medical adviser and publicised the health register once that was initiated. At public meetings others apart from MAF and the MOH had opportunity to express their views.

⁸ Auckland Healthcare Services Ltd and Jenner Consultants Ltd. Health Risk Assessment of Btk Spraying in Auckland's Eastern Suburbs to Eradicate White-Spotted Tussock Moth. Auckland: 4 September 1996. Public Health Protection Service, Auckland Healthcare Services Limited. Health Risk Assessment of the Proposed 1997-1998 Control Programme for the White-Spotted Tussock Moth in the Eastern Suburbs of Auckland. Auckland: September 1997.

4.4 Other communications about health risks

As well as these MAF communications residents received other publicity about the spraying from a citizens' action group, who listed varied symptoms as associated with exposure to the use of *Btk* sprays. Some news stories included accounts of individuals with ill health that were attributed to spraying, including some people leaving their homes to avoid the spray. Also, in 1997, there was reporting of a purported cluster of pregnancy problems among women in the infested area.

4.5 Quarterly newsletters to general practitioners

Quarterly through the surveillance programme, a newsletter was sent to general practitioners in the wider spray area (Zone A and B), identified through the after-hours co-operating service among practices and listings in the telephone directory. Each newsletter included a standard request to advise the Medical Officer of Health (MOH) of associated events. The wording was kept consistent throughout.

There were no further reports by a medical practitioner to the MOH since prior to the first newsletter in December 1997.

4.6 People reporting health concerns associated with Operation Ever Green

Following an opinion from the Privacy Commissioner to the Medical Officer of Health, Auckland Healthcare and MAF exchanged copies of records and collaborated in preparing a merged database which contained information about each concern reported to either. This has been checked thoroughly for duplications of individuals, and provides the basis for the following analysis of 375 individual concerns.

Reports for each individual expressing a health concern or complaint were coded into as many 'reasons for encounter' as necessary, using the International Classification of Primary Care (ICPC)⁹.

Table 2: numbers of specific concerns

The following list shows the number of people reporting specific concerns that were relatively common. It includes the ICPC codes and text words where the codes could not present the detail sought:

Fear of disease, unspecified	A27	68
Headache	N01	64

⁹ This ICPC classification system, developed for the World Health Organisation of National Colleges, Academies and Academic Associations of General Practitioners/Family Physicians (WONCA) is a 'reason for encounter' system which focuses on a complainant's symptoms as well as having facility to code for practitioner diagnosis and treatment. FROM: International Classification of Primary Care Eds Lambert & Wood (Oxford 1987)

Asthma	R96	46
Sneezing/runny nose	R07	43
Throat symptoms	R21	42
Localised rash	S06	31
"other" nose symptoms	R08	21
No concerns about disease	A97	19
Skin itch	S02	19
Irritable/angry	P04	19
Situational stress	P02	18
Hay fever	R97	15
General rash	S07	13
Allergy	A12	12
Confirmed pregnant	W78	12
Sleep disturbance	P06	10
Noise/noisy	text word	10
Miscarriage	W82	8
Query about pregnancy	W01	8
Breast feeding concerns	text word	nil
Social concerns		
"Other" social concerns - pets, disruption to lifestyle, smelly, home gardens	Z29	43
Fear of illness in others including children	Z27	18
Neighbourhood conditions	Z03	15

Eight women self-reported that they had had a miscarriage, eight had a question or concern about a current pregnancy and twelve just wanted to be noted as being pregnant. Most of these concerns were expressed at a similar time to a news story claiming pregnancy and miscarriage dangers associated with Operation Ever Green.

Note about the news story: The Medical Officer of Health used her statutory role to investigate the individual clinical records for women who were reportedly part of a geographically localised increased occurrence of miscarriage/pre-term birth. This review did not confirm the existence of a cluster. (See *Health Risk Assessment, 1997, for this study*).¹⁰

¹⁰ Public Health Protection Service, Auckland Healthcare Services Limited. Health Risk Assessment of the Proposed 1997-1998 Control Programme for the White-Spotted Tussock Moth in the Eastern Suburbs of Auckland. Auckland: September 1997.

4.7 Categories of health concerns

The IPCP categorises concerns in terms of bodily systems such as respiratory, digestive, circulatory, eye, pregnancy, social. Each category contains a list of codes for specific symptoms and concerns.

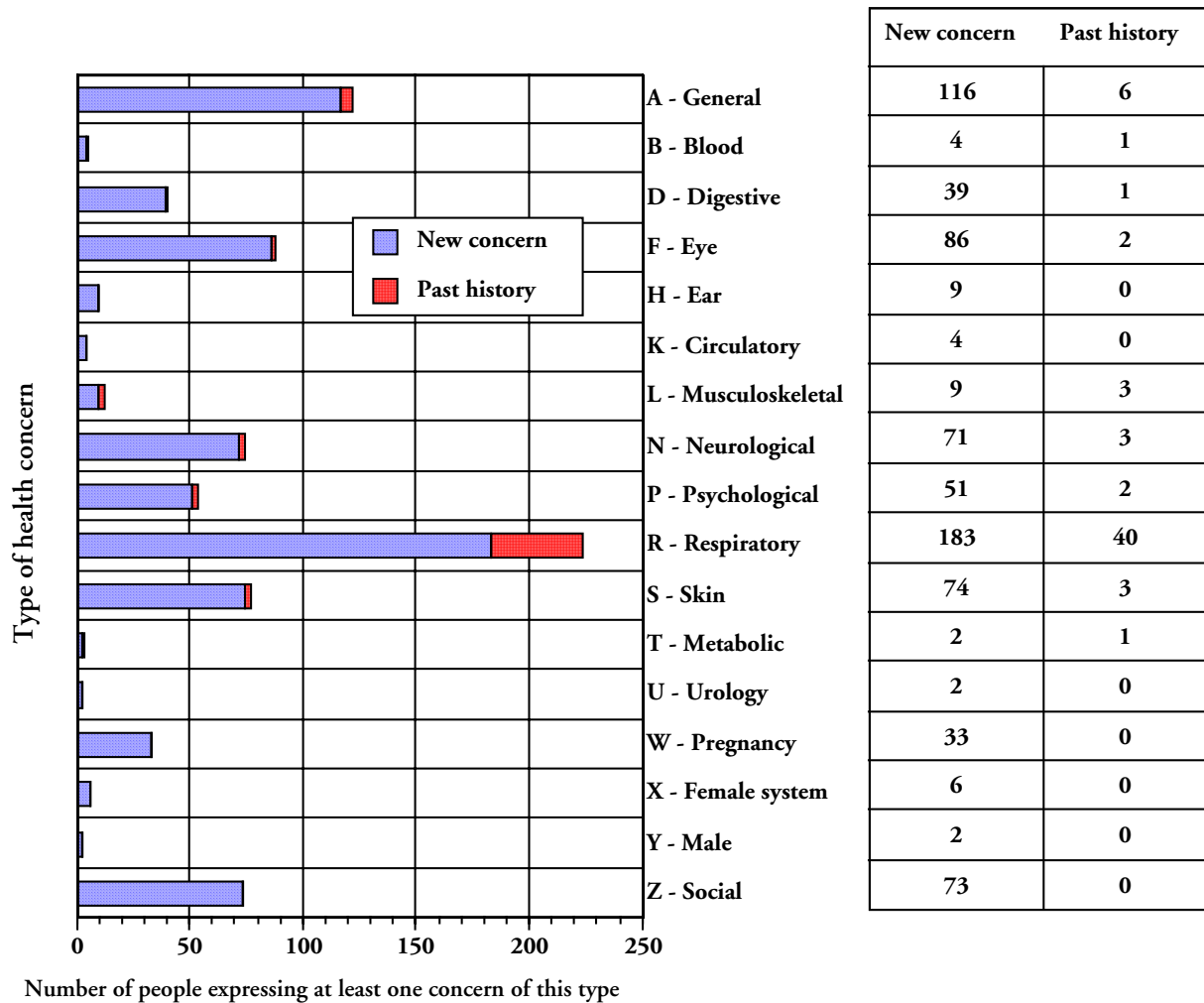
The figure on the following page displays the number of individuals with one or more health concerns arising in each category. Eg someone with asthma and sneezing appears once in Respiratory concerns, but may also be under General if allergy was a specifically mentioned concern. If she also had watery eyes this appears additionally under Eye concerns.

Respiratory concerns were the most frequently reported concerns among the 375 people, with General, Eye, Neurological (headache), Psychological, Skin, Pregnancy and Social also common.

Total number of concerns has not been displayed because number within a category for a person appeared to relate to how expansive they were about the symptoms. Eg red, watery, sore eyes versus red eyes.

Many individuals had not consulted a medical practitioner. An advantage of the ICPC classification is that it reflects concerns as they are experienced and would present to a medical practitioner, if one were consulted. Where appropriate, people were asked to complete a formal written consent so that information about relevant medical problems could be obtained from their doctors.

Figure 5: 375 people reporting health concerns associated with Operation Ever Green



4.8 Medical Advisory Group

A number of consultant medical specialists comprised a medical advisory group, established to advise generally about symptoms reported by residents, to review anonymised documentation of residents' concerns and, in some cases, to accept referrals by the independent medical adviser of individuals for full clinical review.

However, a proportion of people never returned their original requests for written consent to contact their doctor about their health and some could not be contacted further at their original address or phone number. Of those who did agree to further follow-up of records, some did not want this to include further personal medical assessment. Further medical appointments were not relevant for some people because they had already received medical advice appropriate to their health concerns.

Concerns related to respiratory symptoms, immunology/allergy, paediatric illness and dermatology were those most frequently reviewed by the medical advisory group. In particular, there was a follow-up of self-reports of new or aggravated asthma, people with reports of serious respiratory or allergic disease or reports suggestive of immediate hypersensitivity (allergy) reactions at the time of spraying. No medical events were seen at a population level. Also, among those medically reviewed, no individual was identified as having a significant adverse outcome attributable to the *Btk* spraying.

While no community pattern emerged, among the varied symptoms self-reported by residents there were individuals who had problematic personal health experiences at the time of the programme. These included a few people who told us about stress from prior war or plane crash experiences, people with pre-existing severe respiratory disease and individuals with asthma or allergy problems that coincided with spraying.

Some individuals reported that they had individual medical events contemporaneous with spraying. To elucidate this further the General Practice study was instigated to look at patterns, particularly for the medically important or commonly experienced symptoms.

5.0 Health Surveillance **Using Sentinel General Practitioners**

5.1 Introduction

Health surveillance to June 1999 of people exposed to *Btk* spray during Operation Ever Green included the recruitment of Sentinel General Medical Practitioners and an analysis of presentations of selected diseases. [NOTE: Registered General Medical Practitioners are also known as "GP's", family doctors or family physicians and are commonly referred to as being in "general practice".]

One purpose for this component of the health surveillance was to ensure investigation of patterns for diseases of significance, with pathological processes that could span a time period after spraying. This potentially covered a later onset of health problems than the method of reporting at the time of spraying to the Medical Officer of Health or through the 0800 free-phone number.

Health problems examined in this component of the health surveillance were selected to include common and significant self-reported health concerns. Many of the 375 individuals reporting health concerns had not consulted a medical practitioner about those concerns. However, their concerns were part of a spectrum of symptoms commonly taken to a family doctor. It was considered that patterns of consultations observable within general practices (family doctors) could indicate whether any change in frequency of health conditions was associated with the spraying.

5.2 General Practices

Two general medical practitioners located in separate practices contributed their practice information to the study. The investigation was done by existing practice staff, in particular practice nurses who were usually involved as care practitioners for the patients whose information was included in the study. No individual patient data was transferred out of the practice record systems.

Practice ONE was located in the heart of the infested area with a widespread patient population. Practice TWO was near the perimeter of the spray zone and had nearby patients both exposed and not exposed to spraying.

5.3 Zones

Each patient was classified according to their address (at the time of spraying) as either:

- Zone A - residentially exposed to spraying between 5 October 1996 and 17 April 1997 (included any ground sprayed properties);
- Zone B - residentially exposed to spraying between 5 October and 9 December 1996 (however exclude Zone A); or
- Zone C - not residentially exposed to spraying.

Individual patients were assigned to a zone by the practice nurse through comparing the exact street address to a list of household street addresses used for the register (Zone A). Patients were also assigned to zones B and C using lists of suburbs and by reference to maps.

5.4 Analytical approach

The occurrence of health symptoms was studied using frequency of consultations within a time period related to spraying. End dates for spray exposure were taken as the eighth day after any spraying, to allow for manifestation of symptoms and any health consultations.

The periods before, during and after spraying were defined, so the prevalence could be compared to address the question whether there was a change associated with spraying.

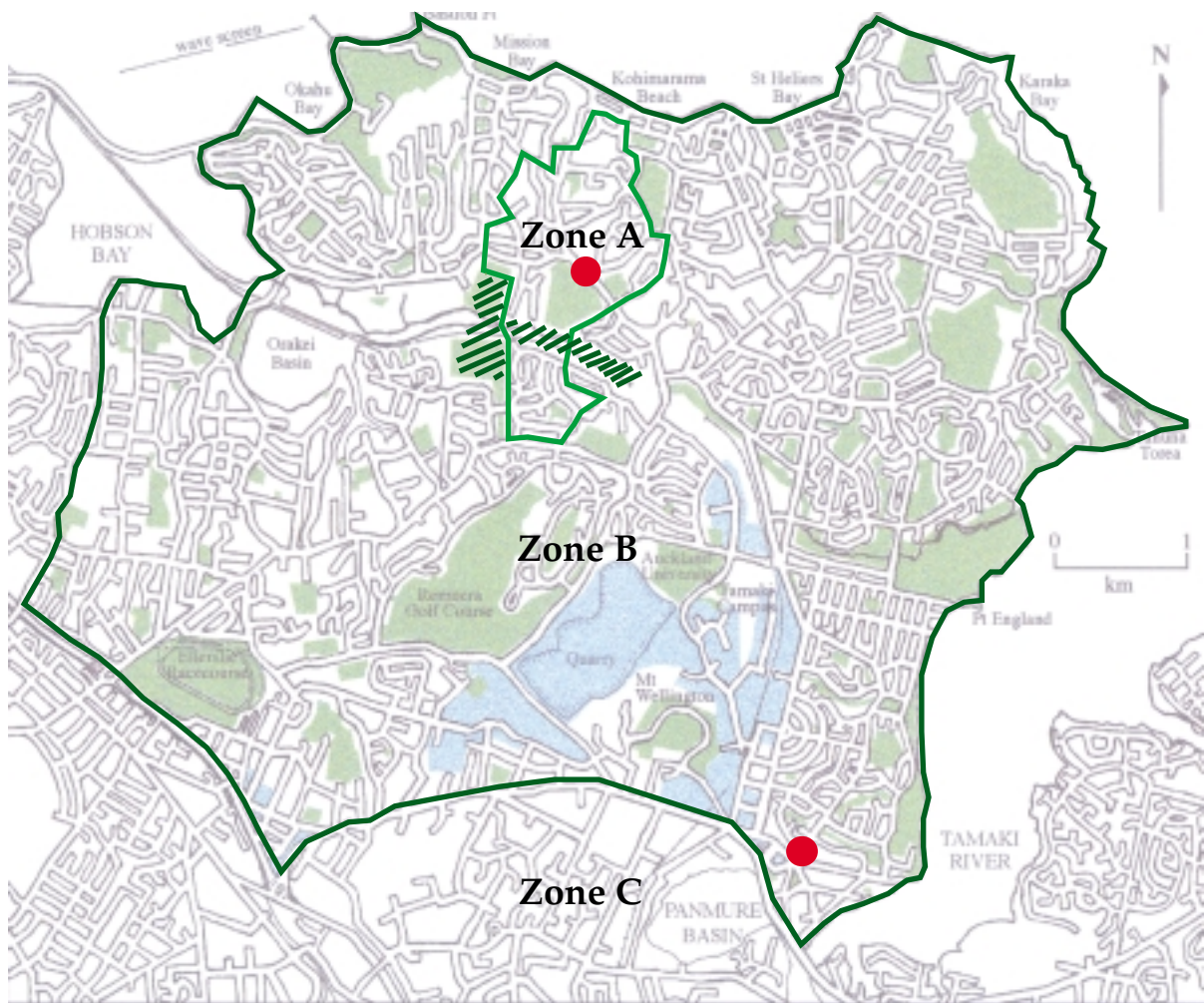
The frequency of certain selected presentations was evaluated for a period of two years from commencement of spraying, to allow for any manifestation of chronic disease ("after" period). The "before" period corresponds in months and seasonality to the "after".

Periods before, during and after spraying have been defined as:

Before	25 April 1995 to 4 October 1996 (17 months)
During	5 October 1996 to 16 December 1996 (2 months)
During - Helicopter	17 December 1996 to 24 April 1997 (4 months)
After	25 April 1997 to 4 October 1998 (17 months)

NB: The health surveillance periods include an additional 7 days after the end operational dates referred to in 5.3 as exposure periods.

**Figure 6: Operation Ever Green
Study of health outcomes using general practices**



- Aerial spraying of *Btk* by DC6 aircraft, 5 October 1996 - 9 December 1996
- ▨ Helicopter spraying, 5 October 1996 - 9 December 1996
- Helicopter spraying, 17 January 1997 - 17 April 1997
- Industrial areas
- Parks, schools and reserves
- Participating general medical practitioners

5.5 Respiratory Symptoms

These include asthma, sinusitis, chronic respiratory conditions and acute respiratory infection. The rationale for including each:

- (a) Asthma – a common cause of community concern in relation to inhaled sprays.
- (b) Sinusitis – commonly subject to phone reports from residents, especially in the year after spraying where people had experienced new or aggravated onset of nasal allergy or chronic sinusitis.
- (c) Chronic respiratory conditions – to include chronic bronchitis and emphysema because these are major medical diagnoses.
- (d) Acute respiratory infections – in response to expressed community concerns that the spray might somehow reduce normal resistance to these.

Asthma was handled on its own, using the participating doctor's definition of asthma and examining for frequency of presentations. It was hoped that this would address the issue of exacerbation of pre-existing asthma as well as new incidence.

5.6 GP Questionnaire

Apart from asthma, the respiratory presentations were divided into "upper respiratory other than asthma" and "lower respiratory other than asthma". Within these classifications, both allergic and infective symptoms were included, since these often arise in combination or with similar presentations.

- (a) Known past or present history of asthma;
- (b) Severity of asthma;
- (c) Upper respiratory other than asthma – allergic/infective;
- (d) Lower respiratory other than asthma – allergic/infective;
- (e) Rheumatoid arthritis and other autoimmune disorders – known diagnosis (refer to list);
- (f) Rheumatoid arthritis and other autoimmune disorders – current severity;
- (g) Chronic Fatigue Syndrome;
- (h) Headaches;
- (i) Conjunctivitis/corneal ulcer/eye irritation (no injury);
- (j) Eczema/dermatitis.

All except (a) and (e) were measured by frequency of consultations. For asthma (a) and known diagnosis of a listed autoimmune disorder (e), presence or absence was measured as well as consultation rate. Period prevalence was the outcome of interest, not point prevalence

at two years.

5.7 Data collection

The individual patient records were systematically reviewed by the health practitioners usually involved in the care of those patients. A manual method was used for extracting information. The information was obtained from a combination of written consultation notes and computer records of consultation events and prescriptions issued.

A database was set up by the MAF medical adviser to process patient information from the practices. No personally identifiable patient data was transferred out of the practice record systems, only frequencies of presentations. Once an appropriate portion of the records was reviewed and processed, preliminary analysis for patterns among the results was carried out. This assisted the Steering Group in confirmation that the numbers of records to be included remained appropriate, since this depended partly on frequency patterns that were present among the data.

5.8 Results

The following numbers of patient records were reviewed:

Table 3: Number of records

	Zone A	Zone B	Zone C
Practice ONE	1061	699	724
Practice TWO	22	420	463
Total	1083	1119	1187

The following proportion of patient records were sampled:

Table 4: Proportion of patients sampled

	Zone A	Zone B	Zone C
Practice ONE	All	Part 1:2 & 1:4	1:3
Practice TWO	All	All	1:2

Approximately one in five of the residents exposed to the longer duration programme had their medical records included in the review.

5.9 Selected health presentations

The health presentations studied were:

Asthma, lower respiratory other than asthma, upper respiratory, rheumatoid arthritis and other autoimmune disorders, chronic fatigue syndrome, headaches, conjunctivitis, dermatitis.

Patterns of results for all these presentations were examined by a subgroup of the Steering Committee. This included looking at the timing of presentations within individual records where a positive response of interest was showing - Eg new diagnosis of asthma. This also included looking at the frequency patterns within groups of individual records where a positive response of interest was showing - Eg patients with lower respiratory other than asthma or autoimmune disorders because these could include seriously ill people. Cross-checking the information was requested of the nurses where individual patterns seemed unexpected.

Printed records of the frequencies of presentations have been provided to the National Archives (Auckland Regional Office) for retention along with the Register documentation.

Results for headaches, upper respiratory symptoms, eye conditions and asthma are displayed on the following pages. These were selected for specific tabulation because headaches and upper respiratory concerns featured as the most common concerns among self-reports (table 2); eye symptoms were described in *Btk* spray programmes elsewhere; and asthma is of community importance in New Zealand.

Headache Consultations

Table 5: Practice ONE

Mean Consultations per 10,000 patient-days	Time				Number of Patients
	Pre	Plane	Helicopter	After	
Zone A	1.7	1.5	1.3	2.0	1061
Zone B	1.9	2.4	1.6	2.2	699
Zone C	2.1	2.5	1.7	2.0	724

Based on 600 consultations

Headache Consultations

Table 6: Practice TWO

Mean Consultations per 10,000 patient-days	Time				Number of Patients
	Pre	Plane	Helicopter	After	
Zone A & B	1.7	2.5	1.2	1.5	442
Zone C	1.2	0.9	1.8	2.0	463

Based on 181 consultations (There were only 22 patients in Zone A)

Upper Respiratory Consultations Table 7: Practice ONE

Mean Consultations per 10,000 patient-days	Time				Number of Patients
	Pre	Plane	Helicopter	After	
Zone A	6.8	5.7	5.3	6.9	1061
Zone B	8.3	7.4	6.7	9.5	699
Zone C	7.0	8.1	4.2	9.4	724

Based on 2348 consultations

Upper Respiratory Consultations Table 8: Practice TWO

Mean Consultations per 10,000 patient-days	Time				Number of Patients
	Pre	Plane	Helicopter	After	
Zone A & B	12.4	13.9	7.7	14.9	442
Zone C	12.3	14.2	8.0	10.4	463

Based on 1378 consultations (There were only 22 patients in Zone A)

Consultations for Asthma Table 9: Practice ONE

Mean Consultations per 10,000 patient-days	Time				Number of Patients
	Pre	Plane	Helicopter	After	
Zone A	1.2	0.9	1.4	1.0	1061
Zone B	1.8	2.9	2.8	1.5	699
Zone C	1.4	1.1	0.5	1.3	724

Based on 422 consultations

Consultations for Asthma Table 10: Practice TWO

Mean Consultations per 10,000 patient-days	Time				Number of Patients
	Pre	Plane	Helicopter	After	
Zone A & B	1.0	2.8	1.4	1.0	442
Zone C	1.7	1.5	1.5	1.5	463

Based on 157 consultations (There were only 22 patients in Zone A)

Consultations for Conjunctivitis
Table 11: Practice ONE

Mean Consultations per 10,000 patient-days	Time				Number of Patients
	Pre	Plane	Helicopter	After	
Zone A	0.9	1.5	1.0	1.0	1061
Zone B	0.9	1.4	1.4	0.8	699
Zone C	0.7	1.5	0.5	1.1	724

Based on 303 consultations

Consultations for Conjunctivitis
Table 12: Practice TWO

Mean Consultations per 10,000 patient-days	Time				Number of Patients
	Pre	Plane	Helicopter	After	
Zone A & B	1.3	1.9	3.0	1.2	442
Zone C	0.5	1.5	1.5	1.1	463

Based on 133 consultations (There were only 22 patients in Zone A)

5.10 Summary of findings from sentinel General Practitioner study

No adverse patterns were found.

In particular, there was:

- no identified new onset of asthma during spraying;
- no pattern of increased consultation for pre-existing asthma associated with spraying;
- no identified chronic fatigue syndrome associated with residence in a spray area;
- no increase in presentations for autoimmune disorders nor any increase in consultation rates by people with pre-existing conditions;
- no increase in consultation rates for lower respiratory problems, which include serious lung diseases;
- no obvious pattern of problems with headache, eye, skin or upper respiratory symptoms.

6.0 Review of Health Data from Suitable Sources

6.1 Introduction

Health surveillance to June 1999 of people exposed to *Btk* spray during Operation Ever Green included the review of health data from suitable sources and an analysis of presentations of selected health outcomes.

A systematic analysis of outcomes examined whether or not there was a statistical association of patterns of symptoms with the spraying.

Small numbers of some events were expected in the exposure zones; this low frequency is anticipated because of small population numbers.

It was decided to include analysis at a level of detail appropriate to the information in each component of the investigations. Problems that might have arisen through lack of confidence in results among small groups, or with the presence of uncommon outcomes, were to be addressed through explanation and interpretation. In this way the surveillance did not fail to look fully at the information sources selected for inclusion.

6.2 Table 13: Summary of Health Data Review

Health concern	Source of data	Methods	Results
Accidents, child bicycles & pedestrians	National hospital morbidity data	Time and area comparison for DC-6 spray days	No accidents
Anaphylaxis	GP (family doctors)	Event reporting	No events
Birth defects	National Congenital Anomalies Register	Time & area comparison	No statistical difference for residence in spray area
Birth weight & gestational age	Statistics for births at National Women's Hospital	Time & area comparison	No statistical difference for residence in spray area
Measles	None	Not reviewed	Considered unnecessary
Meningococcal disease	Statutory health notifications	Time & area comparison	No increase seen associated with spraying
Infections with <i>Btk</i>	Community and hospital pathology laboratories	Information request to pathologists	No invasive infections reported

**Figure 7: Operation Ever Green
Location of census area units**



- Aerial spraying of *Btk* by DC6 aircraft, 5 October 1996 - 9 December 1996
- Helicopter spraying, 17 January 1997 - 17 April 1997
- Industrial areas
- Parks, schools and reserves
- Census area unit boundaries

Usually resident population (1996) in the spray area by census area unit
Table 14: DC6 spraying, 5 October 1996 to 9 December 1996

Census area unit	Total usually resident population in census area units	% usually resident population in DC6 spray area	Usually resident population in DC6 spray area	Usually resident population out of DC6 spray area
Kohimarama W	3016	100	3016	0
Mission Bay	4850	100	4850	0
Meadowbank N	5609	100	5609	0
Orakei N	4668	100	4668	0
Kohimarama E	3315	100	3315	0
St Heliers	4477	100	4477	0
Glendowie	3669	100	3669	0
Glen Innes N	4824	100	4824	0
Glen Innes West	4051	100	4051	0
Glen Innes East	2791	100	2791	0
St Johns	2709	100	2709	0
Point England	3816	100	3816	0
Mt Wellington N	5547	53.2	2952	2595
Tamaki	4229	100	4229	0
Panmure Basin	2036	59.7	1215	821
Ellerslie North	5416	100	5416	0
Meadowbank S	4419	100	4419	0
Abbotts Park	3779	86.2	3257	522
Waiata	3937	100	3937	0
Remuera South	3390	87.9	2978	412
Orakei South	3177	100	3177	0
Waitaramoa	3892	42.0	2014	1878
Total	87,617	92.9%	81,389	6,228

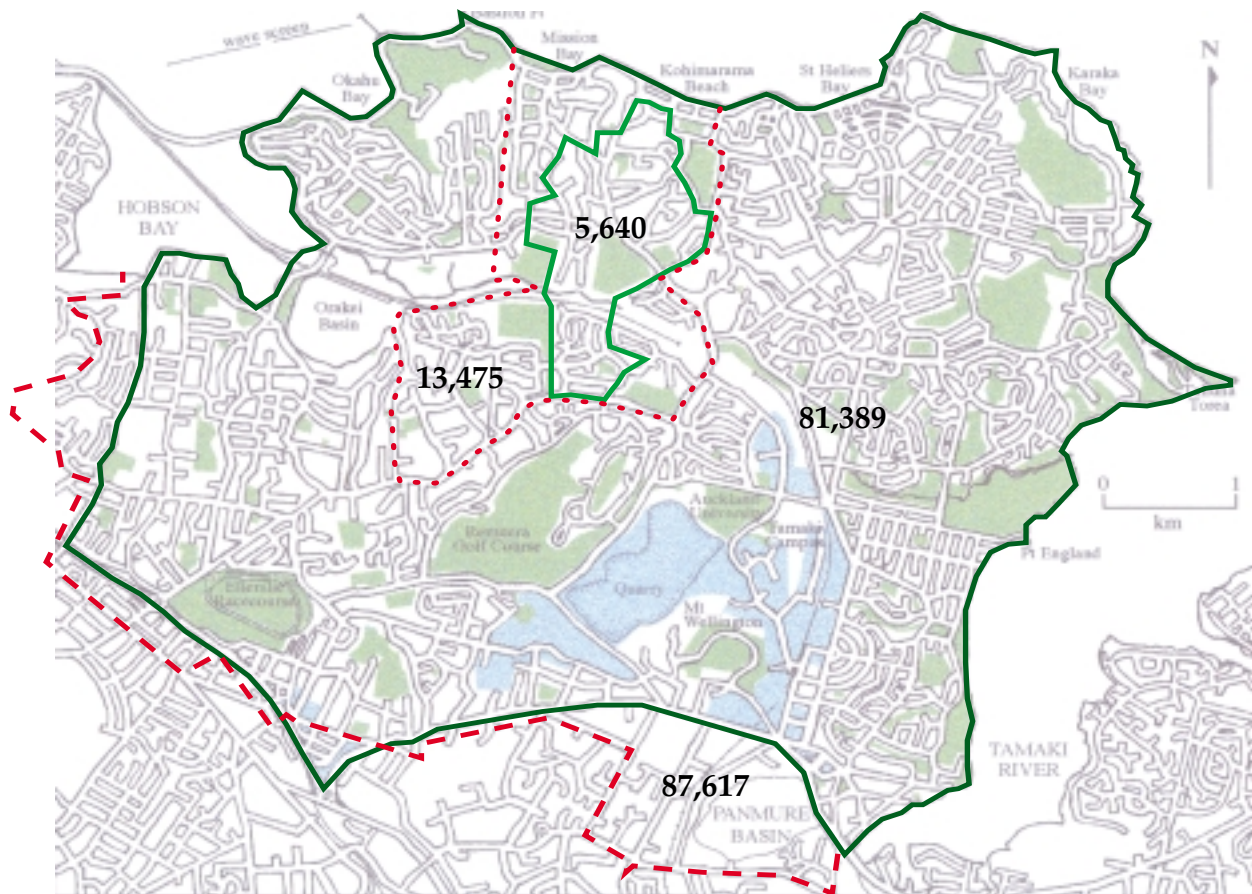
NOTE: Ellerslie South has a total usually resident population of 1,476, and a usually resident population in the DC6 spray area of 288, which is 19.5% of the total population usually resident.

Table 15: Helicopter and ground spraying, 2 October 1996 to 17 April 1997

Census area unit	Total usually resident population in census area units	% usually resident population	Usually resident population in the helicopter and ground spray area	Usually resident population out of helicopter and ground spray area
Kohimarama W	3016	77.2	2327	689
Mission Bay	4850	41.2	1916	2934
Meadowbank N	5609	24.9	1397	4212
Total	13,475	41.9%	5,640	7,835

Source: Statistics New Zealand, Population Counts, NZ census 1996.

**Figure 8: Operation Ever Green
Boundaries Defined Using Census Area Units**



- Aerial spraying of *Btk* by DC6 aircraft, 5 October 1996 - 9 December 1996
- Helicopter spraying, 17 January 1997 - 17 April 1997
- - - Census area units included as a study zone to represent aerial spraying of *Btk* by DC6 aircraft, 5 October 1996 - 9 December 1996
- Census area units included as a study zone to represent helicopter spraying, 17 January 1997 - 17 April 1997

6.4 Accidents

At its December 1998 meeting, the Steering Group decided to investigate frequency of pedestrian or bicycle accidents among children associated with spraying by the DC-6. The 1996 health risk assessment identified a possibility of risk through distraction of children while they travel to school.

This study was developed in conjunction with the NHIS at the Ministry of Health, who access the national hospital morbidity database. A time comparison was the planned analysis.

There were no such accidents recorded on any spray day. One accident arose in each of the "before" and "after" periods. *See appendix two for details of study design and analysis.*

6.5 Anaphylaxis

At its December 1998 meeting, the Steering Group decided to investigate frequency of anaphylaxis associated with spraying. It was agreed that it is too rare to study in the sentinel GP practices. As a first analytical approach, all doctors in the area were asked to report occurrences during 1996, 1997 and 1998 to contribute events to a time trend analysis.

The number of general practitioners included in the request was about 53, generally all were principals in their practice so that further doctors would have been involved as assistants or locums. Also, some practices had one of a group of principals as their contact person. The number of practices was about 34.

At 30 April 1999 there were no such reports by general practitioners.

Subsequently, a newsletter to general practitioners provided feedback about the lack of reports. At 30 June 1999 there were still no such reports by general practitioners.

6.6 Birth weight and gestational age statistics

At the time of spraying there arose considerable community concern about effects on pregnancy, and a scare about premature birth. The Steering Committee recommended the analysis of National Women's Hospital data to determine birth weight and gestational age patterns in the spray area. At that time, virtually all births among residents in the spray area would take place at National Women's.[#]

[#] At the time of spraying access to maternity hospital facilities was determined by area of residence. A private birthing centre predominately provided post-natal stays (following births at National Women's) and home births were a small proportion of births in Auckland.

Access to the data was arranged, as Official Information. Data provided included all the desired outcome measures, including stillbirths, foetal and neonatal deaths. However, birth weights and gestational age were both already categorised, which reduces the accuracy of the classification of data and hence may affect the accuracy of the analysis. A further request was made for specific birth weight and gestational age data.

Residential location in the National Women's Hospital data was described using census area units (consistent with health domiciliary codes), hence the exposure zones only approximate the actual Zones A and B. See *figures 6 & 7 and tables 14 & 15 for study zone information.*

In consultation with the Information Services Manager and Privacy Manager at National Women's, a formal request was made in terms of the Privacy Code rather than as Official Information. The Privacy Code request has cited the parts of Rule 10 and Rule 11 that refer to statistical purposes and has also stated that the statistics are being compiled for the Crown. There was not a request using the part of the Privacy Code that enables disclosure to protect public health from a serious and imminent threat.

Also, specific date of birth information was requested rather than birth month as this would allow more accurate classification of each pregnancy as being in a time association or otherwise with the spraying. The request was approved and access was obtained in August 1999 to calculated statistics derived from a sufficiently comprehensive data set, which included specific date of birth, birth weight and gestational age. Analysis is presented in Section 7, Birth Outcomes.

6.7 Measles

At the time of the original health risk assessments and the instigation of the present monitoring both meningococcal disease and measles were noted as specific infectious diseases of community concern.

A nation-wide epidemic of measles occurred in 1997, as anticipated. However practices in the spray area contacted by the MAF independent medical adviser said they had not experienced cases because their patients were immunised.

The Steering Group members, at the October 1998 meeting, expressed their opinion that patterns of measles only tell us about immunisation rates. It was also recommended to remove measles from the list of proposed diseases for monitoring through general practitioners.

The Ministry of Health wrote (8 December 1998, Ref DS20-17-6) to agree with the conclusions of the Steering Group. Hence a study of patterns of measles and their association with spraying did not proceed.

6.8 Meningococcal disease

As mentioned in 6.7, at the time of the original health risk assessments and the instigation of the present monitoring, meningococcal disease was noted as specific infectious diseases of community concern.

It was decided to analyse notifications in terms of time association to spraying. Numbers of cases of probable and confirmed cases of meningococcal disease notified to Public Health Protection, Auckland Healthcare for the three years beginning 5 October 1995 are reported in the table below. *Details are in Appendix three.*

Table 16: Notified cases of meningococcal disease (numbers)

Time period	Eastern Suburbs	Central Auckland	Auckland Region
5 Oct 1995 - 4 Oct 1996	22	72	230
5 Oct 1996 - 4 Oct 1997	23	80	301
5 Oct 1997 - 4 Oct 1998	21	82	244

Table 17: Notified cases of meningococcal disease (rate per 100,000)

Time period	Eastern Suburbs	Central Auckland	Auckland Region
5 Oct 1995 - 4 Oct 1996	25.1	18.3	21.3
5 Oct 1996 - 4 Oct 1997	26.3	20.3	27.8
5 Oct 1997 - 4 Oct 1998	24.0	20.8	22.6

NOTE: Central Auckland Health District corresponds to Auckland City, which includes the eastern suburbs area where *Btk* spraying took place. A population of 87,617 (all census area units in spray zone) was used as a denominator for the eastern suburbs cases.

There has been no demonstrable change in the number of cases of meningococcal disease reported in the Eastern Suburbs and therefore no identifiable trend associated with the spraying of Foray 48B. The number of cases within Central Auckland has also been relatively stable in contrast with the marked increase in cases reported for the Auckland region as a whole in 1996/97. The cases which contributed to this regional rise in the number of cases occurred mainly in specific areas of South Auckland which were not exposed to Foray 48B.

Most of the Eastern Suburbs cases occurred in Glen Innes and this is to be expected based on past experience. There is no indication of an increase in cases in this suburb. Case numbers are broken down into probable and confirmed cases for each individual suburb and each health district in the tables in Appendix 3.

The usual seasonal variation characterised by a peak in the number of cases in Winter/Spring is unchanged over the three-year period, and shows no variation which could be associated with the timing of spray programmes.

6.9 National Congenital Anomalies Register

At the time of spraying the greatest expressions of community concern related to potential effects on pregnancy and young children. Possible birth defects were included among these concerns.

A national compilation of reported congenital anomalies among live born is available. This includes all types ICD codes 740 - 759; all severity, but generally those requiring treatment will be fully reported; chromosomal and structural disorders are included; not metabolic disorders.

An initial extraction of data for all reported anomalies, which covers all months relevant to spraying, was received. Actual individual diagnostic information including severity and treatment course was provided for cases from the spray area, without personal identifying information. The detailed information was viewed by the Steering Committee, prior to deciding an analytical approach. Preliminary statistical analysis using the available denominator showed no significant difference between the spray area and the rest of NZ for total cases.

Definitive analysis required the use of the specific birth rate information for census area units in the spray area. This became available in July 1999 and results of the final analysis are presented in Section 7, Birth Outcomes.

The Steering Committee advised that the congenital anomalies data should be "pooled" over a combined time period to ensure the most reliable analysis of rates (the numbers of anomalies are small among a population of 80,000). And that a two-way comparison be conducted between any spray exposure and none, rather than a third exposure category to separately examine the area where there was continuation of spraying using the helicopter. There was a concern not to report single events that identify individual families.

Also that conditions be analysed in combination, rather than singling out rarer events. Apart from leading to greatest reliability of rates among a small population, there is no prior hypothesis in relation to *Btk* exposure and types of congenital anomalies.

6.10 Infections with *Bacillus* species during spraying

The community laboratories serving the areas affected by spraying were asked, as part of this health surveillance, if they could provide information about the community occurrence of *Bacillus* species.

Microbiologists at Auckland Healthcare, Medlab and Diagnostic Laboratory collaborated in this reporting. Together, they included all clinical pathology collection for the study area, unless a resident received hospital care in another city.

At the time of the spraying the pathologists concerned said they had been very aware of the issue of the presence of *Btk* within the community environment. They continued using their standard culture media and methods, which they considered effective for isolation of

all types of *Bacillus* species, including *Btk*. Where relevant, after growth of a *Bacillus*, they used an additional staining technique appropriate for identification of *Bacillus thuringiensis*.

In total they report two isolates of *Btk*, associated time-wise with spraying, one from a person with conjunctivitis and one from a blood culture sample. The isolate from a blood culture was considered by the clinicians and pathologists to be a contaminant and of no clinical significance. No further clinical information was available about the person with an isolate from the eye. However, viable dormant forms of *Btk* are commonly recoverable from an eye swab and this in no way indicates that the *Btk* was a cause of the person's conjunctivitis.¹¹

There was no person identified with invasive infection from *Btk* during the eradication programme.

¹¹ Siegel JP and Shaddock JA. Safety of microbial insecticides to vertebrates - humans. Pages 104-105. In Eds: Laird M, Lacey LA, Davidson EW. Safety of Microbial Insecticides. CRC Press, Florida 1990.

6.11 Socio-economic Indicators

It was decided to examine patterns of socio-economic status within the study areas, to provide general information that might assist interpretation of patterns of health outcomes if differences were found.

Some of the health patterns and outcomes included in this health surveillance may vary in association with socio-economic status.

A suitable method was identified, the *NZDep96* 10-point ordinal scale which separates the country into approximate deciles where 1 is least deprived and 10 is most deprived.

Table 18 presents socio-economic indicators derived using the *NZDep96* method. It can be seen that there is a complete variation within the spray area, from census areas that are predominately decile 1 to those that are predominately decile 10.

The distribution within each census area unit of deciles among mesh blocks is displayed as pie charts in Figure 10. These are proportional in size. Hence they display the overall distribution of the values among the affected mesh blocks.

Figure 9 displays the distribution within the helicopter and ground spray area of deciles among mesh blocks. Note that these pies only include the actual exposure area (Zone A), with a population of 5,640.

Figure 10 includes the pies for the entire population (13,475) of the three census area units that included Zone A.

To locate each pie chart within the overall area refer to Figure 7.

The DC-6 spray area comprises a complete range of socio-economic status, as seen in Table 18 and Figure 10. The smaller area exposed to longer duration spraying by helicopter is predominately high socio-economic status, and for this characteristic does not represent the NZ community as a whole.

After examining the results, the Steering Committee has considered that the distribution of socio-economic status in the sprayed area has not affected the conclusions from the health surveillance.

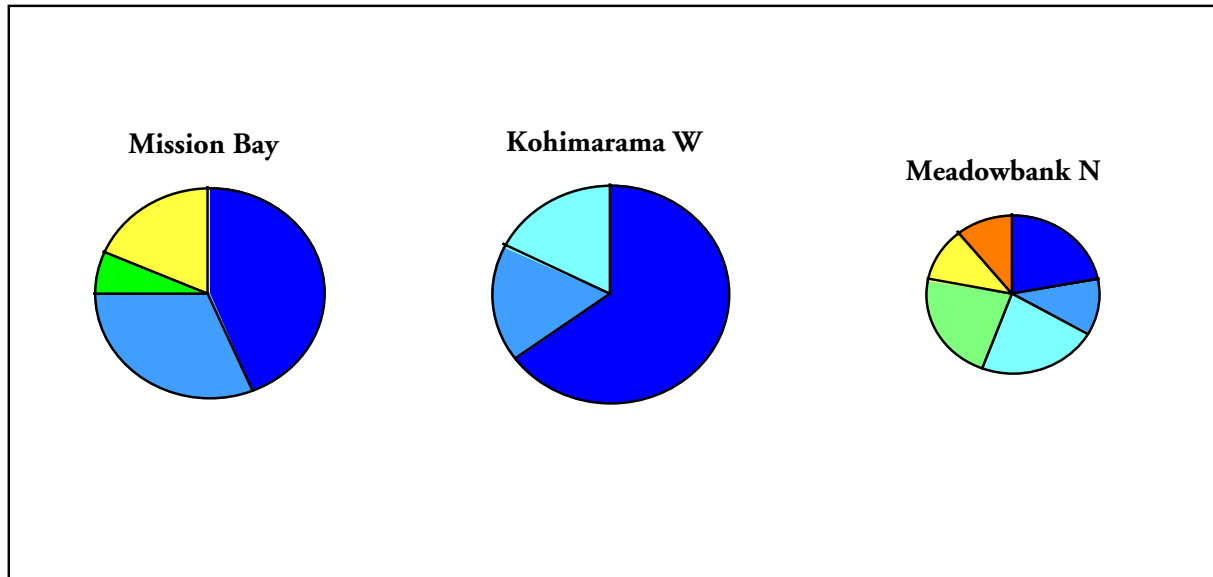
Table 18: NZDep96 Socio-economic indicators

NZDep96 SCALE VALUE AVERAGE	NZDep96 SCALE VALUE MEDIAN	CENSUS AREA UNITS	USUALLY RESIDENT POPULATION IN SPRAY AREA
DC6 spraying 5 October 1996 - 9 December 1996			
1.5	1	St Heliers	4477
1.5	1	Kohimarama E	3315
1.5	1	Waiata	3937
1.7	2	Glendowie	3669
1.8	1	Orakei South	3177
1.9	1	Kohimarama W	3016
2.1	1	Waitaramoa	2014
2.2	2	Meadowbank S	4419
2.6	3	Abbotts Park	3257
2.6	2	Mission Bay	4850
3.0	3	Remuera South	2978
3.7	3	Ellerslie North	5416
3.9	3	Meadowbank N	5609
4.4	3	Glen Innes N	4824
5.6	6	Orakei North	4668
6.6	7	St Johns	2709
7.3	8	Panmure Basin	1215
7.1	7	Mt Wellington N	2952
8.9	10	Glen Innes West	4051
9.5	10	Glen Innes East	2791
9.7	10	Tamaki	4229
9.8	10	Point England	3816
Total 4.8	3		81,389
Helicopter & ground spraying 5 October 1996 - 17 April 1997			
1.5	1	Kohimarama W	2327
2.4	2	Mission Bay	1916
3.7	3	Meadowbank N	1397
2.3	2		5,640

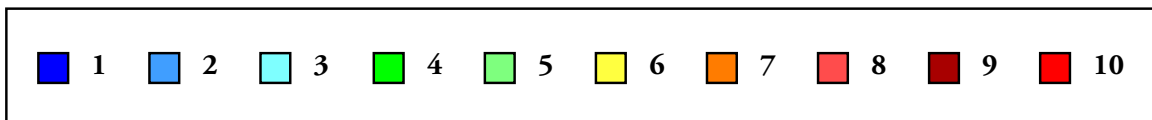
The scale values from the mesh block units in the spray area were totalled and an average was calculated for each census area unit. All mesh block units within the DC6 spray zone were totalled and a weighted average was calculated. Similarly, a weighted average was calculated for the zone for continued spraying by helicopter and ground.

Source: Clare Salmond, Peter Crampton and Frances Sutton. *NZDep96 Index of Deprivation Look Up Directory*, Health Services Research Centre, Victoria University of Wellington, June 1998.

**Figure 9: Operation Ever Green, helicopter and ground spray area
Distribution within census area units of NZDep96 scores for meshblocks**



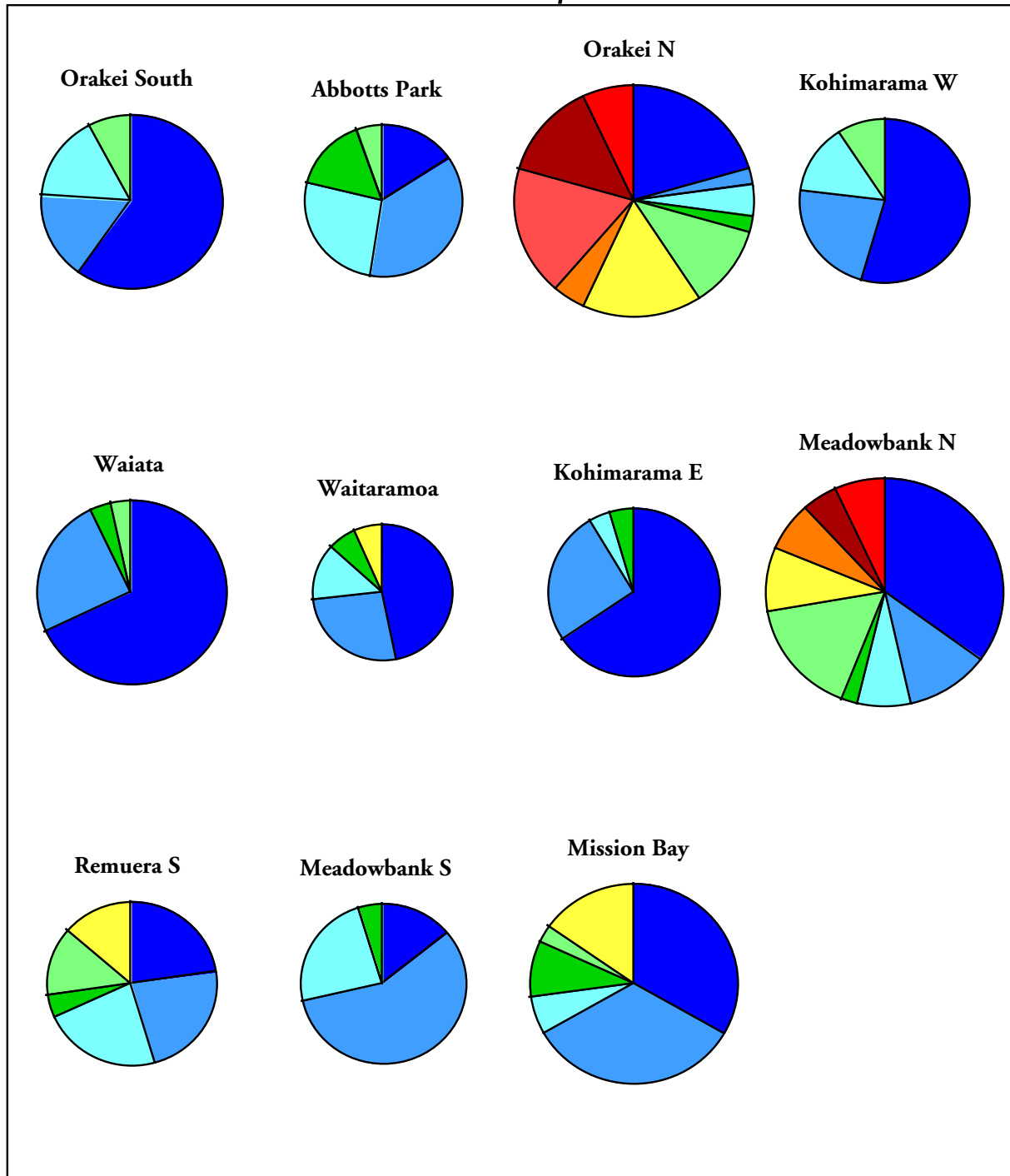
NZDep96 Scale Values 1-10



NOTE: The NZDep96 10-point ordinal scale separates the country into approximate deciles where 1 is the least deprived and 10 the most.

Source: NZDep96 Index of deprivation look-up directory, Health Services Research Centre, June 1998.

Figure 10: Operation Ever Green, DC6 spray area
Distribution within census area units of NZDep96 scores for meshblocks



NZ Dep96 Scale Values 1-10

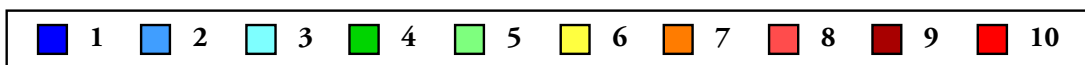
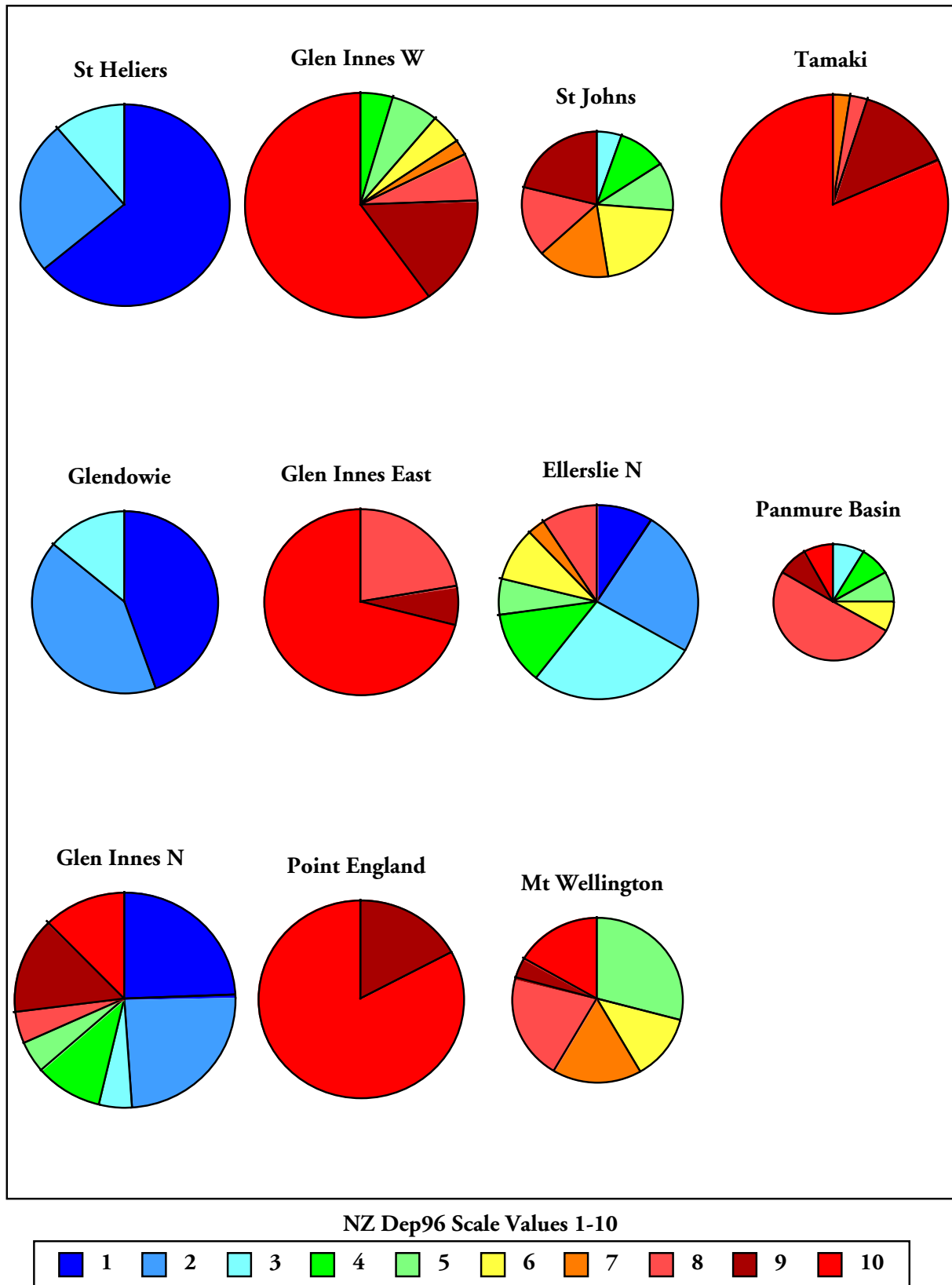


Figure 10 continued: Operation Ever Green, DC6 spray area



7.0 Birth Outcomes

7.1 Introduction

Birth outcomes received special attention in this health surveillance because of community interest and expressed concerns about potential effects on pregnancy and babies.

Outcomes for which health information was available were:

- Birth defects (congenital anomalies)
- Birth weight
- Gestational age

7.2 Definition of an "exposed" pregnancy

"Exposed" for this health surveillance simply means exposed at any stage through pregnancy to the day of birth.

Exposure has not been subdivided into:

- periconception,
- embryogenic, or
- fetal.

There is no known "insult" associated with the use of *Btk*, apart from the entirety of the spray intervention, hence no specific reason to extract any part of the developmental period.

For birth weight and gestational age, any pregnancy was included as an exposed pregnancy if any day from day 1 of week 1 (by LMP) to birth, arose at some time during spraying and for one week afterwards. Note that the defined exposure spans the two weeks prior to conception (the first two weeks since LMP). These times were calculated using individual recorded gestational age and actual date of birth.

7.3 Definition of time of exposure

From the first day of spraying, up to and including seven days after last day of spraying; consistent with definition for the GP study.

Zone A - October 5th 1996 to 24th April 1997

Zone B - October 5th 1996 to 16th December 1996

For congenital anomalies (birth defects), relevant quarters of information had to be used because of the available format of the denominator data.

7.4 Birth outcomes study zones, see Figures 6 & 7:

Birth outcomes data from National Women's Hospital and the National Congenital Anomalies Register included domiciliary codes as a means of identifying geographical residential location of the individuals concerned. Domiciliary codes are for the same areas as census area units.

- **Exposure Zone A - greatest exposure**

This was taken as the following census area units (domiciliary codes): Mission Bay, Kohimarama West, Meadowbank North.

- **Exposure Zone B - DC-6 exposure**

This was taken as the census area units comprising the wider eastern suburbs, see Figures 6 & 7.

- **Exposure Zone C - not exposed**

For birth weight and gestational age analyses:

Zone C was defined as a selection of comparison census area units within Auckland, outside the spray area, and where women were likely to give birth at National Women's Hospital rather than alternative hospitals in West and South Auckland.

For congenital anomalies (birth defects):

The comparison population was taken as the whole of NZ. Exposed residential areas were based on domiciliary codes, as for other birth outcomes, see Figures 6 & 7.

7.5 Socio-economic status of study areas

The tables below show the socio-economic status of the population within the actual spray area for helicopter and ground spraying (table 14) compared with that in the total census area units taken as a study zone to represent that spray zone (table 15).

There was no important difference in socio-economic status between the two.

Table 19: Socio-economic indicators for helicopter and ground spray area

Helicopter & ground spraying Oct 1996 - 17 Apr 1997			
NZDep96 scale value average	NZDep96 scale value median	Spray area mesh blocks from census area units	Usually resident population in spray area
1.5	1	Kohimarama W	2327
2.4	2	Mission Bay	1916
3.7	3	Meadowbank N	1397
2.3	2		5,640

Table 20: Socio-economic indicators for census area units included as a study zone for birth outcomes

NZDep96 scale value average	NZDep96 scale value median	Census area units	Usually resident population in census area units
1.9	1	Kohimarama W	3016
2.6	2	Mission Bay	4850
3.9	3	Meadowbank N	5609
3.0	2		13,475

The scale values from the mesh block units in the spray area were totalled and an average was calculated for each census area unit. All mesh block units within the zone for continued spraying by helicopter and ground were totalled and a weighted average was calculated. Similarly, a weighted average was calculated for the study zone.

Source: Clare Salmond, Peter Crampton and Frances Sutton. *NZDep96* Index of Deprivation Look Up Directory, Health Services Research Centre, Victoria University of Wellington, June 1998.

7.6 Results

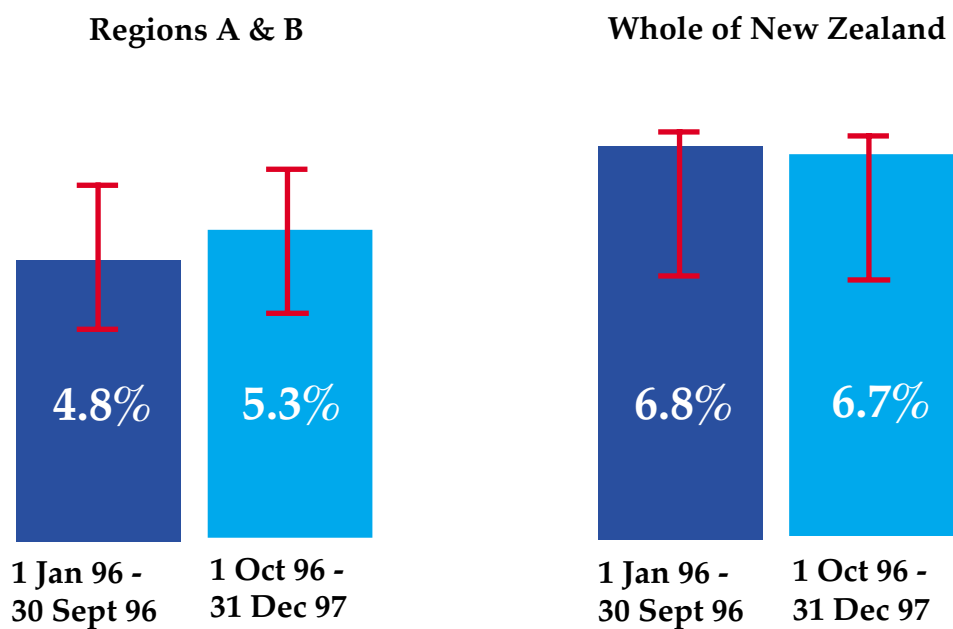
The following diagrams show results for birth defects (congenital anomalies) and birth weight and gestational age.

See Figures 11, 12 and 13.

There were no differences between the pregnancies exposed to spray and those not, once statistical significance was taken into account.

Also presented (as Figure 14) is a time trend for birth weights at National Women's Hospital over a five year period. This shows that natural variation exceeded any variability contained within the health surveillance analysis.

Figure 11: Congenital abnormalities by region in two time periods



I 95% Confidence Interval - implies that there is only a 5% chance that the percentage of the outcome lies outside the 95% Confidence Interval

To compare the percentage results from the two time periods it is necessary to compare the position of the Confidence Interval bars.

Figure 12: birth weight patterns

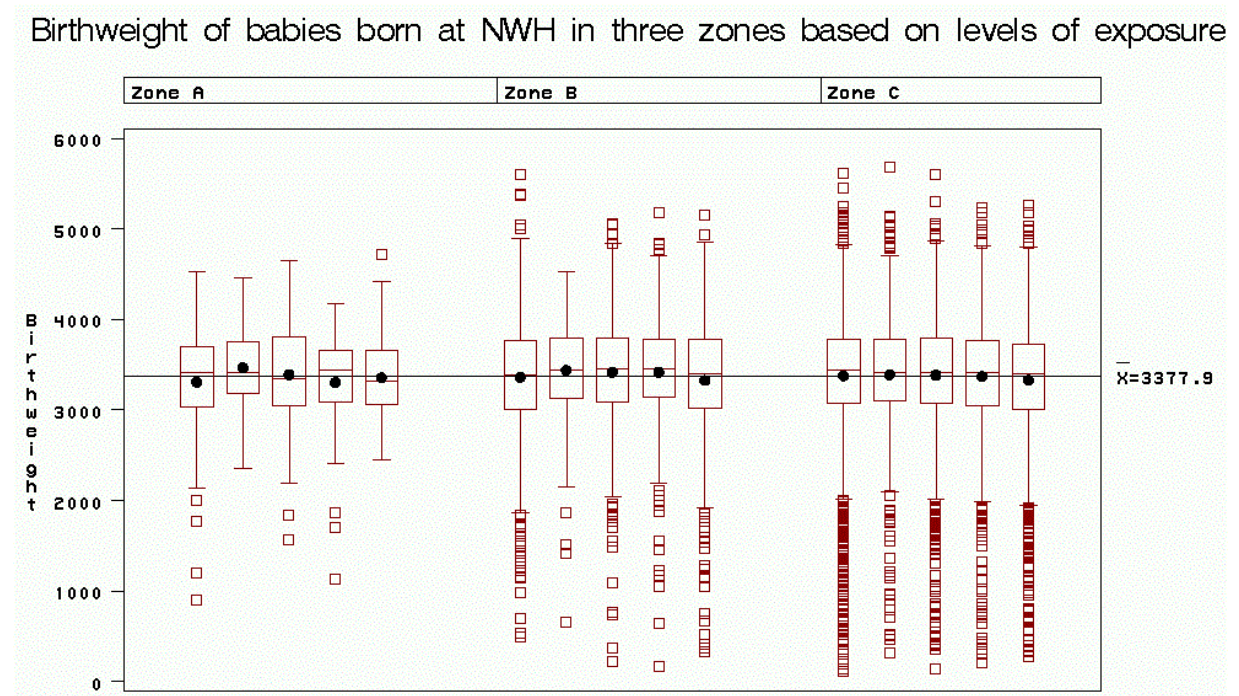
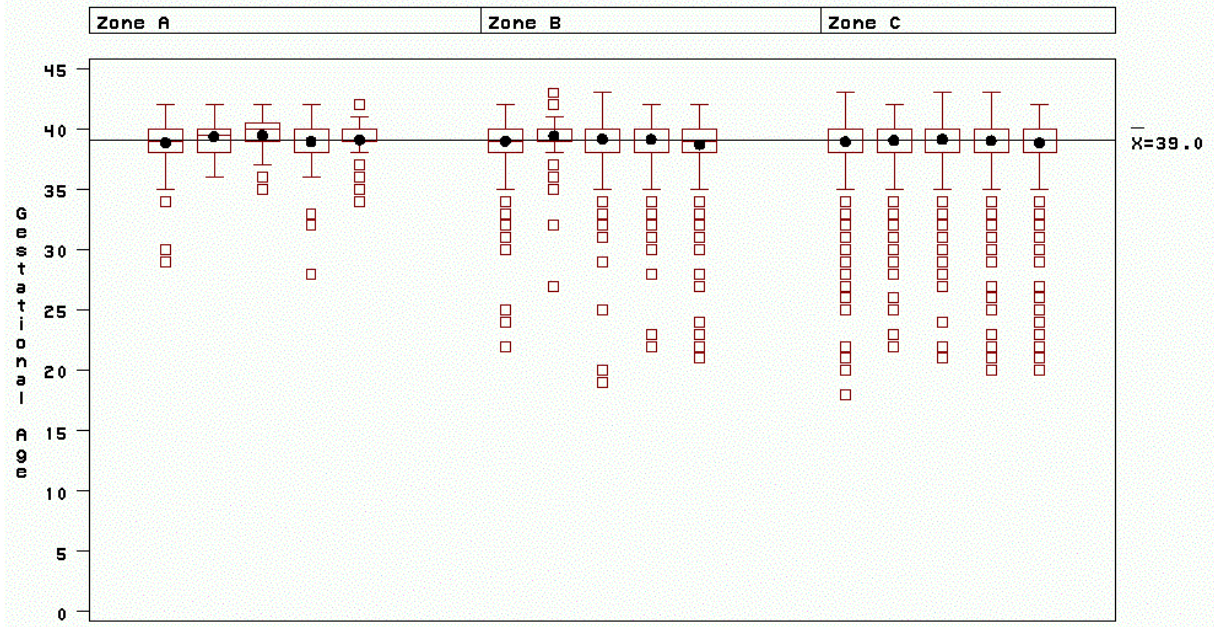
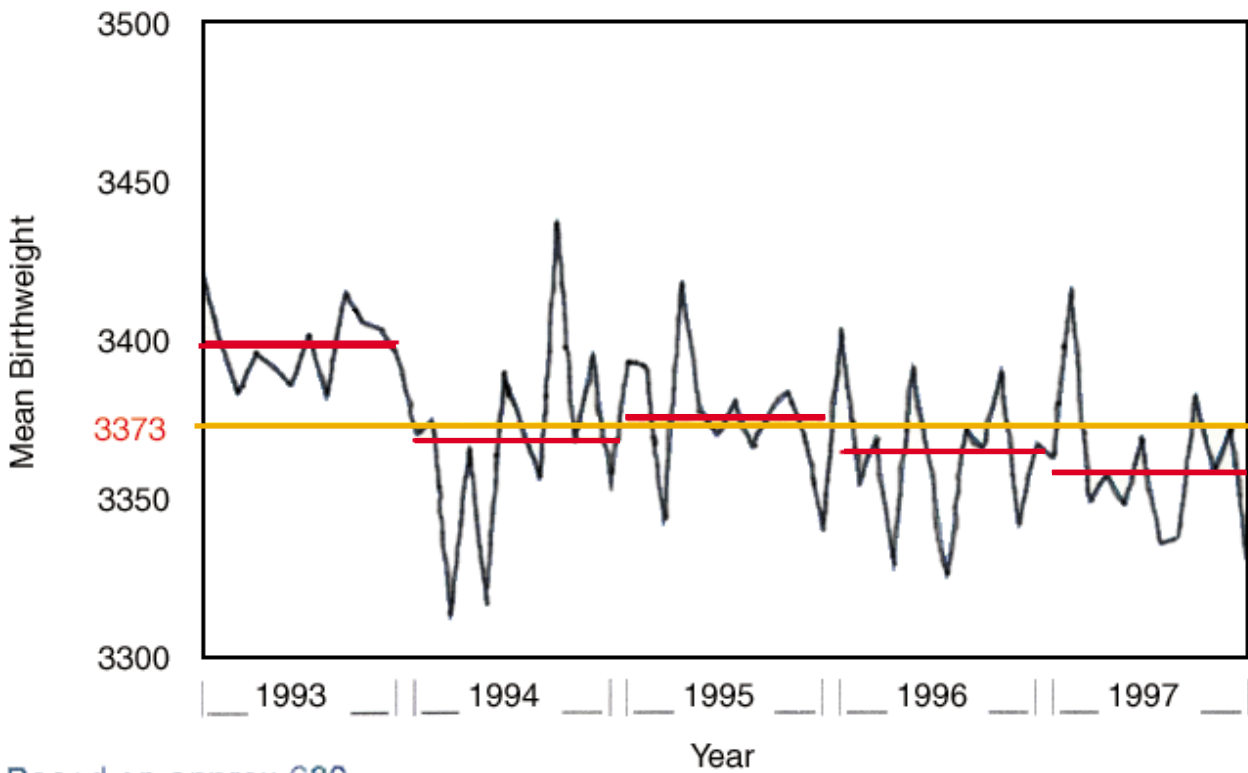


Figure 13: gestational age patterns

Gestational Age of babies born at NWH in three zones based on levels of exposure



**Figure 14: Birth weight trends 1993 - 1997
for all births at National Women's Hospital**



Based on approx 680
births/month

- Average between 1993 - 1997
- Average each year

7.7 Summary of findings from birth outcomes

Congenital anomalies (birth defects): Between 1 January and 30 September 1996, 4.8% of babies born resident in the wider spray area were reported to have a birth defect compared to 6.8% for the whole of New Zealand. Between 1 October 1996 and 31 December 1997, regarded as "exposed" pregnancies, this was 5.3% compared to 6.7% for New Zealand. When 95% confidence intervals are derived, the results show no difference associated with spraying.

Birth weight: Patterns of birth weight showed no differences between the pregnancies exposed to the spray and those not, once statistical significance was taken into account. A five-year time trend for birth weights at National Women's Hospital shows that natural variation exceeded any variability among spray area birth weights.

Gestational age (early babies or born when due): Patterns of gestational age showed no differences between the pregnancies exposed to the spray and those not, once statistical significance was taken into account.

8.0 A Register of Individuals Exposed to the Btk Spray

The Register comprises voluntary information about households present at any time between October 1996 and April 1997 in a defined area. The full register materials are in the National Archives, Auckland Regional Office.

The Register area is the area that was regarded as infested for quarantine purposes, and was subject to vegetation removal restrictions at July 1997. This infested area contains the properties that were exposed to the longer duration of Btk application (by helicopter), and also any properties that were exposed to ground spray applications because of pest presence. See figures 12 and 13.

Table 21 summarises the population exposure to *Btk*.
Refer to the Appendices five and six for more detailed summaries of the spray exposures.

8.1 Register response at 1 October 1998

Table 22: Household participation in register

Register area households	2300
Number of registered households	1153
Number of registered individuals	3144

Note: Number of individuals usually resident was 5,640.#

Table 23: Household participation rate

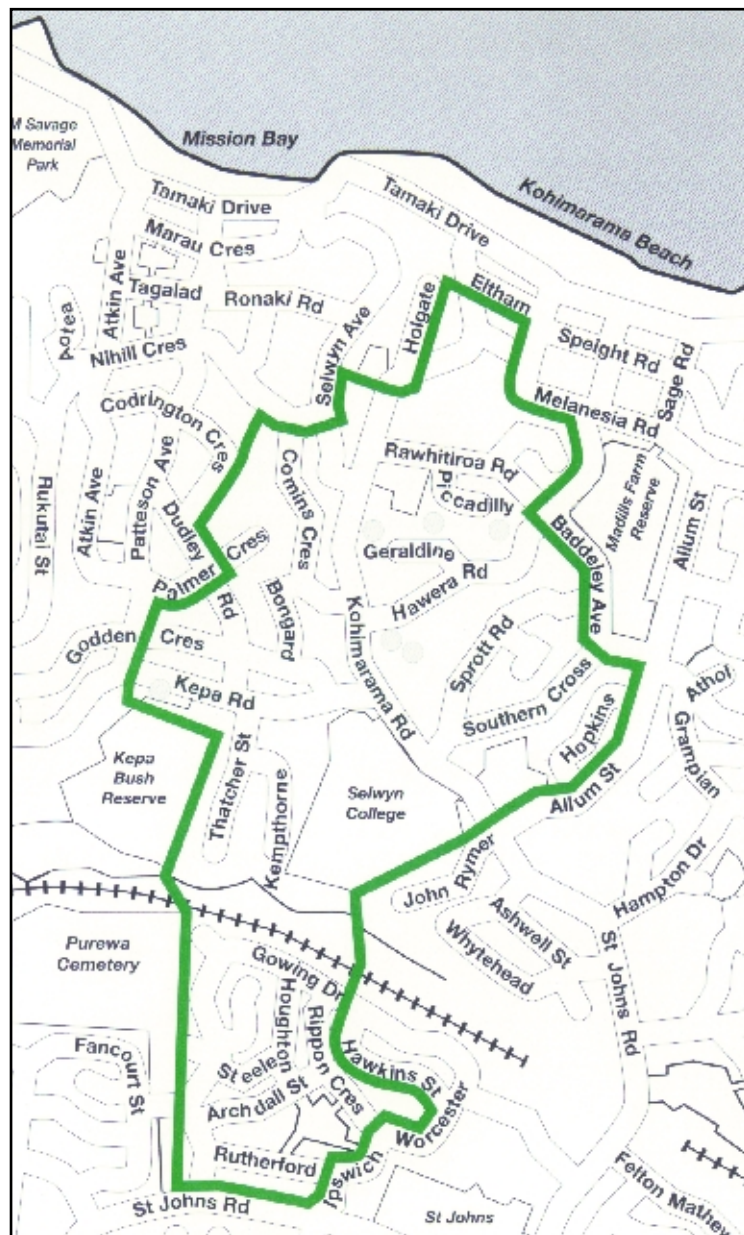
Household		
Participation rate	1153/2300	50.1%
Refusal rate	112/2300	4.9%
Non-Response rate	1021/2300	44.4%

Participation rate by eligible individuals - 3144/5640 - 55.7%.

Note: The non-participation rate includes people who did not receive the register information. In 8.11 we estimate that 20% of eligible individuals would have moved address between spraying and the register project.

Census data for mesh blocks as displayed in Tables 14 & 15, page 25

Figure 15: Operation Ever Green - Register Area



This 2.5 square kilometre area was designated at July 1997 for quarantine of vegetation and includes properties which had ground spraying (2 Oct 96 to 17 April 97) because caterpillars or moths were detected near those properties.

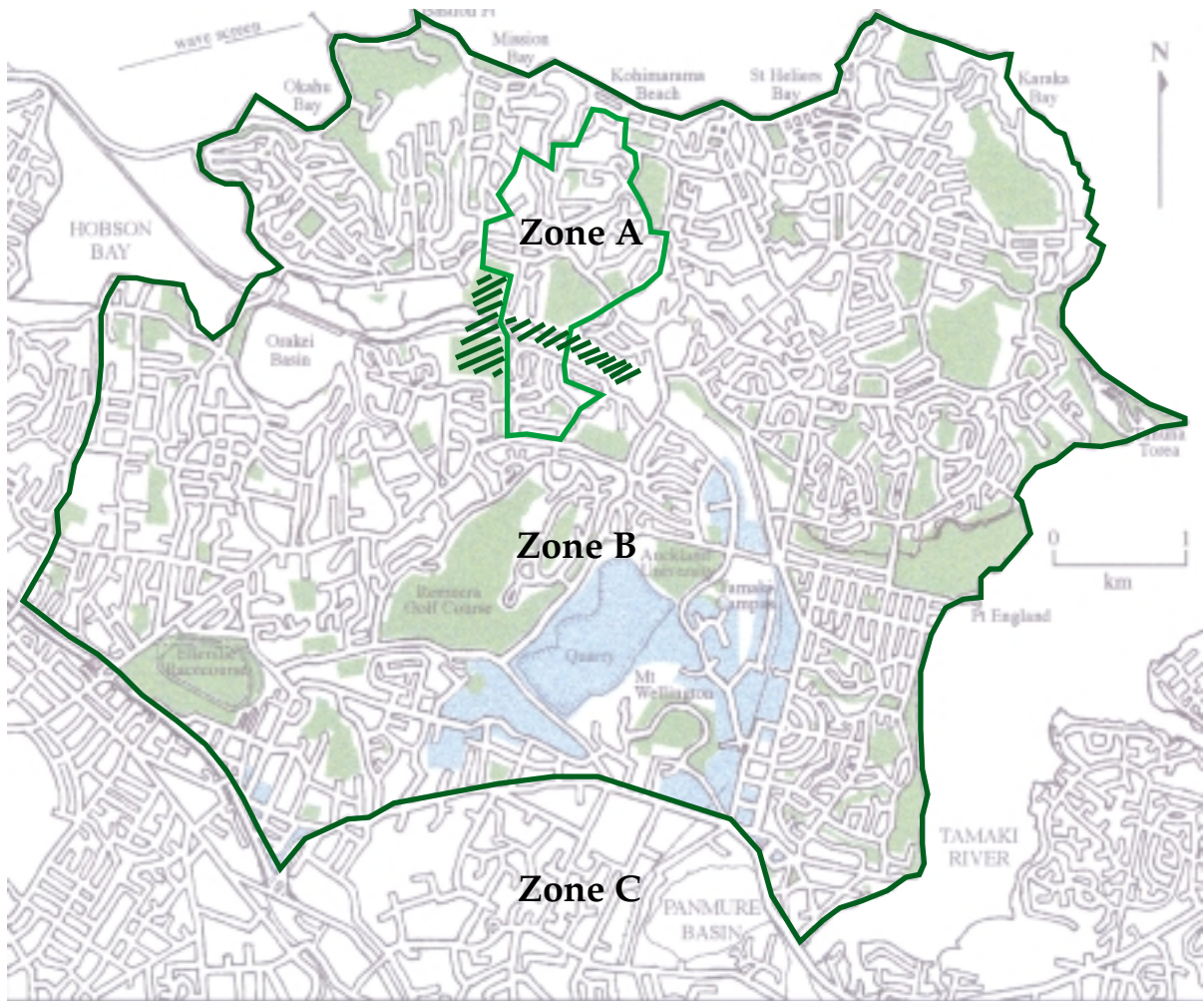
Table 21: Exposure






	DC6	Helicopter	Ground Spraying
Type:	aerial mist - <i>Btk</i>	aerial mist - <i>Btk</i>	ground level mist blower or micronair - <i>Btk</i>
What: Total litres of <i>Btk</i>	130,000	28,090	See Appendix 5
When:	5 Oct 1996 - 9 Dec 1996	5 Oct 1996 - 17 Apr 1997	2 Oct 1996 - 17 Apr 1997
Where:	Eastern suburbs (see Figure 13)	Sub-area of Mission bay, Kohimarama West and Meadowbank North (see Figs 12 & 13)	Some properties within Sub-area
Who: Population	81,389	5,640	Est. 1,269
Who: Number of residential properties	Approx. 30,000	2,395	539

NOTE: Population in the DC6 and helicopter areas was derived from Statistics New Zealand Population Counts 1996 (refer to Tables 10 and 11). Estimated population in the ground sprayed properties was derived by assuming that household composition reflected that of the census mesh blocks which covered the same area.

NOTE: Ground spraying occurred through treatment of vegetation anywhere in the immediate vicinity of a pest at any life stage. This affected 539 residential properties, of which 112 were treated on seven separate occasions, 207 on ten, 101 on eleven, 3 on seventeen and 116 on twenty-one. Additionally ground spraying was used to treat vegetation at one school, a church, a cemetery and unoccupied areas such as those used to collect and dispose of vegetation from properties affected by vegetation controls.

**Figure 16: Operation Ever Green
Exposure of population to *Btk* through aerial spraying**



-  Aerial spraying of *Btk* by DC6 aircraft, 5 October 1996 - 9 December 1996
-  Helicopter spraying, 5 October 1996 - 9 December 1996
-  Helicopter spraying, 17 January 1997 - 17 April 1997
-  Industrial areas
-  Parks, schools and reserves

**Table 24: STATUS A register of individuals exposed to the Btk Spray
- records for the National Archives, [1 October 1998]**

Category	Number of households
Number of addresses in the register area	2395
Known to be no occupied dwelling	12
Known to be new occupiers - with previous household not traceable	83
Register area households	2300
Take part	1153
Refused to take part (eligible)	112
Other – e.g. decline due to age, deceased, participation status response not clear	14
Total responses	1279
No response (will include some unidentified new occupiers = ineligible)	1021

Those 1153 households who want to take part include two households with two eligible addresses during the time period and four without adequate address details.

For 1149 registered households, their personal details will be able to be linked to specific property environmental data in any future research projects.

8.2 Personal Information

The personal information contained in the Register includes the following identifiers: duration of personal exposure, full names, former names, gender, date and place of birth and residential address (plus current address at time of completion of the form).

To classify duration of personal exposure, each individual registrant within a household indicated whether they were resident at that address at any time during each month between October 1996 and April 1997.

8.3 Environmental data

The Ministry has retained detailed records of spray delivery. These cover the dose and application method for each spray, whether by ground or air, and the geographical areas sprayed. Records of this environmental data were obtained to lodge in the National Archives with the household register in order to provide future access to property exposure information.

Maps and physical lists of street number and names included in spray areas and receiving ground spray were produced. It is anticipated that these are in a format that will be

understandable and usable in future decades. They include a sorted printed listing of eligible addresses with information as to household participation status and a contact householder name for respondent households. A separate sorted listing gives addresses exposed to ground spray.

8.4 Eligible households - Register Denominator

A list of eligible household addresses forms the denominator for the register. This was initially obtained from the local city council rating roll. In addition to the exercise of recruiting households, we worked at the accuracy of the list. For example, twelve properties on the rating roll, and hence listed in the register area, had no dwelling constructed at the time and hence no eligible household.

8.5 Resident registration

Register area households were approached in December through a direct non-personalised "letter box drop." Approximately 2,450 packages were delivered with information, registration forms and return FREEPOST envelopes.

At 12 February 1998, 978 responses had been received. It was suspected that some people overlooked returning their response at the busy pre-Christmas time, since they were received as a "circular". In mid-February 1998, 1450 "non respondent" households were posted personalised letters using the Operation Ever Green householder name file. A further good response followed.

The householder name file was a list of property address and a contact person originally obtained from the local city council rating roll. This was corrected in response to feedback each time it was used to contact households. Contact with households was through regular newsletters known as *Inform*, used to provide updates of quarantine and other insect control requirements. This listing was also used to identify properties for the pheromone surveillance ('moth trapping'). Copies of *Inform* and other communications with households have been lodged in the Archives.

Between December and April individual responses that were not clear in any respect were followed up by a combination of phone calls and personal letters. Residents were asked to assist with forwarding register information to households who have moved since the spraying and this has contributed to the numbers registered.

The toll free 0800 765000 number was publicised locally as a contact point for the Register. The 0800 number was included in all newspaper advertisements to inform residents about quarantine and rubbish collection, and was also prominent in all printed materials distributed in household letterboxes and through local library displays.

A press release was timed for the February mail-out, to provide general publicity. As a result of the news reports a few enquiries were received from households who had moved.

8.6 Households outside register area who have registered (supplementary)

A small number of enquiries and registration forms were received from people living outside the register area, but within the wider eastern suburbs where DC-6 spraying with Btk took place. Also, some new occupiers in the register area wanted to participate, especially if they had lived in nearby (non-register) areas during the aerial spraying.

The households who were not living at an eligible address between October 1996 and April 1997 have been kept as a supplement to the Register, and have been lodged in the Archives in accordance with those householders' request. However they do not form part of the Epidemiological Register and do not feature in the summary of register response presented in Section 8.1.

They form an additional group, numbered in the table below:

Table 25: Supplementary register information

Number of registered households (supplementary)	26
Number of registered individuals (supplementary)	65

8.7 Workforce registration

Workplaces within the target zone such as retail premises, doctors' surgeries and home businesses have been included through their property address. There are no large workplaces in the target area, apart from schools (see below).

People who entered the area for occasional work at properties have not been included (E.g. gardeners, builders and other tradesmen).

A special form was distributed to all people known to have been occupationally exposed as a direct part of the delivery of the Operation Ever Green Programme. They provided the same personal identifier information as that for residents retained in the Register. Additionally, they each classified their occupational exposures according to activity and duration.

Thirty-two people chose to respond out of an estimated 63 Operation Ever Green programme staff/contractors (estimated response rate 50.8%). It is estimated that 23 out of the non-returns related to operational contractors.

Table 26: Operation Ever Green workforce

Number of registered individuals Operation Ever Green workforce	32
--	-----------

8.8 Schools

Three schools were located in the register area.

- Kohimarama Primary School, 112 Kohimarama Rd
- St Thomas's Primary School, corner of Allum & Kohimarama Rd
- Selwyn College, Kohimarama Rd

The schools were offered the opportunity for both teachers, and records of pupils (school rolls) present during the spray period to participate in the health register. There was no initiation of pupil questionnaires.

Table 27: Participation by schools

Number of registered school rolls	nil
Number of registered teachers	22

8.9 Participation by households with communication barriers

The materials distributed to households have been in written English. We have been concerned to ensure that participation is possible for people who have another native language, or who have a physical disability such as blindness.

Our concern has been for two reasons. Firstly, out of consideration for human rights, to ensure an opportunity is available to everybody to choose to participate or otherwise. Secondly, out of scientific consideration for the issue of bias among those who do choose to register. As explained below, we believe that there are no significant numbers of households that have been precluded from participation because of communication barriers.

Eligible properties for the register were within the "infested area" for quarantine purposes where pheromone surveillance ("moth trapping") has been conducted, associated with regular household contact.

The Operation Ever Green contractors who were visiting register properties were asked to identify any household where language or cultural factors had been an obstacle to communication. They reported that where this was the case there was always at least one family member who could communicate. Likewise they were asked if any households comprised a sole person with significant physical disability and they reported that this was not the case. They were asked in April 1998 to mention the Register wherever appropriate during trap inspection, as a further reminder to people that there still was an opportunity to participate.

A specific Press release about the Register was made to the Chinese and other Asian language news organisations as another effort to publicise the project.

8.10 Community Liaison

Dr Francesca Kelly, the independent medical adviser to MAF, attended meetings of the Auckland City Council Eastern Bays Community Board in late 1997 and again on 16 March 1998. An update was provided as to the Register Project. Councillors asked questions and commented on community concerns, especially related to pregnancy outcomes. At the March 1998 meeting, the Community Board expressed no further health concerns nor health-related queries.

8.11 Estimated non-contact rate with eligible households

In March 1998 Auckland City provided information about household movements. This came from a 1996 census question as to length of individual residence at the census address. This showed that, for the eastern bays ward, 24% of individuals were resident within the ward for less than one year. A further 9% were resident between one and two years.

These figures suggest that at the time of Register requests to households (December 1997 and February 1998) about 20% of residents may have moved to their current address since spraying stopped. The general response rate from new households (who were asked to respond indicating this) has been substantially less than the response rate from eligible households - see summary table.

A precise adjustment cannot be made for this factor, to estimate the outstanding response from eligible households, because the size distribution of new and non-respondent households is not known.

8.12 National Archive Records

The Register itself, together with comprehensive supporting documentation has been lodged in the National Archives, Auckland Regional Office. Access to the material is arranged by the Archivist, with authorisation for access referred to the Chief Executive Officer of MAF, or whoever succeeds that organisation in the future. The National Archives have a system for updating access agreements to account for changes to the structure of government.

Some documents are available now for public inspection, such as the Health Risk Assessments, ethical application and Manual summarising the project. Viewing must take place on site. Personal information and street listings with participants' names are, however, subject to a ten year restriction for privacy reasons. The Ministry can authorise earlier access to the information.

The purpose of the Register has been specified in the documentation, and this is reproduced below:

"This voluntary register of residents exposed to Btk spraying from October 1996 to April 1997 was created for possible future health studies. It is anticipated that any

such studies would relate to serious, long-term illnesses and these would only be initiated if there was reason in the future to address specific questions.

"It is anticipated that any research use of the Register will meet statutory, ethical, scientific and cultural requirements at the time of the research, through whatever processes are current for the approval of medical research.

"The purpose of the Register was explained to Cabinet, who approved the formation of the Register as an activity for the Ministry of Agriculture and Forestry - and that it include names, addresses and spray exposure information."

In the ethical application, the reason for the Register was explained as:

"Register of exposure to Btk spray during Operation Ever Green, a programme to attempt eradication of the white spotted tussock moth, including all those resident in the infested zone, to be retained in the National Archives.

"The Operation Ever Green programme to attempt eradication of the white spotted tussock moth used aerial Btk spray between October and December 1996 throughout the eastern suburbs of Auckland, followed by continued spraying in a more limited area until April 1997. Additionally, some properties in infested locations were ground sprayed with Btk.

"The Register is being compiled in response to expressed desires from residents for greater health research in association with Operation Ever Green. The concerns about future, as yet unrecognised, health effects and requests for health research have been expressed with greatest frequency by those resident in the infested zone, delineated by vegetation restrictions after July 1997.

"To facilitate any future long term health studies, 2,300 households and three schools will be approached for voluntary inclusion in a Register to be kept in the National Archives. The Register is planned to include people who were resident at any time between October 1996 and April 1997, in the area delineated by vegetation restrictions after July 1997. This will include people who might have had the greatest residential exposure to the spray. Associated with the Register, detailed information about spray exposure for each property will be retained for future reference."

Further, the significance was explained as:

"To ensure that any future studies into questions about health effects from Operation Ever Green (the nature of such studies being unknown at present) will be based on accurate exposure information for the individuals most exposed, through their residence in the infested zone.

"Some residents have asked for such a register and anxiety about future disease (type unspecified) has been a frequent concern of people self reporting health events to Operation Ever Green."

The list of archived Register documents is included as Appendix seven.

9.0 Appendices

9.1 Appendix one - Sentinel General Practice results

Notes for the Study Nurse

Moved between zones during a period – assign to the lowest zone (highest exposure) (a), then (b) then (c).

Incomplete patient records – where there is evidence that the patient first became a patient at sometime during the before period OR where there is evidence that the patient ceased to attend at sometime during the after – DO NOT INCLUDE a questionnaire based on these records. Please make a note on your patient list so that we can explain non-inclusion.

Include infants where the pregnancy was exposed (birth may have been after April 1997).

Sampling is for individual patients NOT families. Where members of a household are in a grouped file the coin needs to be tossed for each person among the group.

1. ***Asthma*** is handled as its own condition using your practice definition for recognising this.
2. ***Upper respiratory other than asthma*** - This symptom complex will include either manifestations of allergy or presence of upper respiratory infection or combination of both.

The following types of symptoms may be present:

- ***throat*** - sore throat; scratchy, irritated throat; throat inflamed on examination, tonsillitis.
- ***voice*** – laryngeal irritation; croaky voice or lost voice.
- ***nose*** - blocked or stuffy nose; sneezing; watery discharge from nose.
- ***sinus*** - purulent discharge from nose; sinus pain or tenderness.
- ***ear*** - ear symptoms where these are part of an acute respiratory condition.
- BUT EXCLUDE chronic otitis media or secretory otitis media, and EXCLUDE any repeated consultations for unresolved prolonged ear infection episode in childhood.

3. ***Lower respiratory other than asthma*** - This symptom complex will include either manifestations of allergy or presence of lower respiratory infection or combination of both.

The following types of symptoms may be present:

- ***cough*** - cough; dry or productive.

- **breathing** - breathlessness
- wheeze in the presence of URTI, "post viral wheeze" where the person does not otherwise have asthma.
- **pain** - complaints of pain with breathing where these may be pleuritic rather than from the chest muscles.
- **examination** - signs of bronchitis or pneumonia on examination.
- **flu** - "influenza" or influenza-like illness.
- **chronic disease** - INCLUDE acute exacerbation of chronic bronchitis or emphysema, also repeat consultations for these chronic conditions.

4. **Conjunctivitis/Corneal Ulcer** - It was agreed to include eye irritation during spraying, or conjunctivitis or corneal ulcer of any sort excluding an unrelated injury event. We will need to not overlook injuries from direct contact with the spray operations, but it was decided to confine this to people who are not the spray operators themselves.

5. **Rheumatoid arthritis and autoimmune diseases** - Where you come across such a patient, you need to keep a note yourself on the patient list so that we can follow-up and clarify whether the disorder was due to an autoimmune process. We plan to ask you to do this with the general practitioner and with reference to any correspondence with the specialists concerned. You will not identify these patients to us.

Systemic Autoimmune Disease (Probable) = Connective tissue diseases

- Systemic Lupus Erythematosus
- Scleroderma
- Polymyositis – dermatomyositis
- Sjögren's syndrome
- Mixed connective tissue disease
- Rheumatoid arthritis
- Polyarteritis nodosa plus variants

Systemic Autoimmune Disease (Possible)

- Amyloidosis - Amyloid deposition between cells in various tissues and organs of the body.

Probable Organ Specific Autoimmune Disease

DISEASES	PROBABLE ANTIGENS
Blood Autoimmune haemolytic anemia Idiopathic thrombocytopenic purpura Neutropenia Lymphopenia	Erythrocyte antigens Platelet surface antigens Leukocyte surface antigens Leukocyte surface antigens

<p>Thyroid Hashimoto's thyroiditis Thyrotoxicosis</p>	<p>Thyroglobulin + microsomal antigens Cell surface TSH receptors</p>
<p>Kidney Goodpasture's syndrome</p>	<p>Kidney and lung basement membranes</p>
<p>Gut Pernicious anemia Primary cirrhosis Chronic active hepatitis Ulcerative colitis IDDM Type I</p>	<p>Parietal cell antigens Mitochondria/bile duct cells Liver cells (virally infected) Colonic mycosal cells Islet cell antigens</p>
<p>Adrenals Autoimmune adrenalitis</p>	<p>Adrenal cell</p>
<p>Skin Pemphigus vulgaris</p>	<p>Intercellular substance of mucosa and skin</p>
<p>Nerves Acute idiopathic polyneuritis</p>	<p>Peripheral nerve myelin</p>
<p>Eyes Sympathetic ophthalmia</p>	<p>Urea</p>
<p>Blood Vessels Temporal arteritis</p>	<p>Blood vessel antigens</p>
<p>Muscle Myasthenia gravis</p>	<p>Acetylcholine receptors</p>

9.2 Appendix two: Child pedestrian and bicycle accidents, details of study design and analysis

Public hospital discharge data was supplied.

The selected health events were:

- where a cycle accident or pedestrian versus car accident is found,
- the patient is aged 0-14,
- and the health event contains one of the following domicile codes:
0433-0434 inclusive Remuera South + Abbots Park
0436-0451 inclusive Waitaramoa - St Johns
0489 Ellerslie North
0491 Mt Wellington North
0495-0496 inclusive Tamaki + Panmure Basin
- and an admission date of:
5th October 1996
17th October 1996
23rd October 1996
31st October 1996
6th November 1996
17th November 1996
22nd November 1996
29th November 1996
6-9th December 1996 inclusive
(i.e. days when the DC6 sprayed aerial *Btk* over the spray zone)

The following variables were supplied for these health events:

Encrypted NHI
Age
Gender
Admission date
Event end date
Admission type
Event end type
Domicile code
Diag 01-05
Accident/Ecode 01-05
Accident date
Accident/Ecode description

Control data:

The identical data was also supplied for 1995 and 1997.

Results:

Year	Age	Accident date	Description of accident
1995 Comparison year	5 years	29/11/1995	MVTA - motor vehicle transport accident - involving collision with pedestrian, injuring pedestrian
1996 Spray year	0	0	0
1997 Comparison year	11 years	07/12/1997	Pedal cyclist fell over front of bike, Not Otherwise Specified

9.3 Appendix three: Meningococcal disease notifications

Meningococcal cases - by Health District

5/10/95 - 4/10/96

Health District	Probable	Confirmed	Grand Total	Population
CA	30	42	72	394197
NW	16	37	53	345747
SA	40	65	105	341712
Total Auckland Region	86	144	230	1081656

5/10/96 - 4/10/97

Health District	Probable	Confirmed	Grand Total	Population
CA	35	45	80	394197
NW	7	32	39	345747
SA	83	99	182	341712
Total Auckland Region	125	176	301	1081656

5/10/97 - 4/10/98

Health District	Probable	Confirmed	Grand Total	Population
CA	34	48	82	394197
NW	25	27	52	345747
SA	48	62	110	341712
Total Auckland Region	107	137	244	1081656

Meningococcal cases - by suburbs

Suburb 5/10/95 - 4/10/96	Probable	Confirmed	Grand Total
Ellerslie	1	1	2
Glen Innes	2	5	7
Glendowie	0	2	2
Meadowbank	0	1	1
Orakei	1	1	2
Panmure	1	5	6
Pt England	1	0	2
Grand Total	6	15	22

Suburb 5/10/96 - 4/10/97	Probable	Confirmed	Grand Total
Ellerslie	0	1	1
Glen Innes	2	7	9
Glendowie	1	0	1
Meadowbank	0	2	2
Mission Bay	1	0	1
Panmure	3	4	7
Pt England	0	1	1
Remuera	0	1	1
Grand Total	7	16	23

Suburb 5/10/97 - 4/10/98	Probable	Confirmed	Grand Total
Ellerslie	1	2	3
Glen Innes	2	4	6
Glendowie	0	1	1
Kohimarama	0	1	1
Meadowbank	1	0	1
Orakei	0	2	2
Panmure	2	1	3
Remuera	1	2	3
St Johns	0	1	1
Grand Total	7	14	21

9.4 Appendix four - Area sprayed with *Btk* , population and census codes

AREA	DOMICILE CODE	CENSUS AREA UNIT CODE	USUALLY RESIDENT POPULATION
Remuera South	0433	516002	3390
Abbotts Park	0434	516003	3779
Waitaramoa	0436	516102	3892
Orakei South	0437	516201	3177
Waiata	0438	516202	3937
Meadowbank N (<i>Zone A</i>)	0439	516301	5609
Meadowbank S	0440	516302	4419
Orakei North	0441	516400	4668
Mission Bay (<i>Zone A</i>)	0442	516500	4850
Kohimarama W (<i>Zone A</i>)	0443	516601	3016
Kohimarama East	0444	516602	3315
St Heliers	0445	516700	4477
Glendowie	0446	516800	3669
Glen Innes North	0447	516900	4824
Glen Innes West	0448	517001	4051
Glen Innes East	0449	517002	2791
Point England	0450	517100	3816
St Johns	0451	517200	2709
Ellerslie North	0489	520201	5416
Mt Wellington North	0491	520300	5547
Tamaki	0495	520601	4229
Panmure Basin	0496	520602	2036

Weather and time of day:

Aerial spraying needed to take place during calm and dry weather to facilitate deposition of the spray on the vegetation below. In practice this meant from first daylight for three or four hours on suitable days. Hence spray delivery coincided with peak times of travel from homes to school or work. Efforts were made to cover school premises at early times, prior to children arriving. Aircraft needed to operate at heights lower than usual over residential areas, to maximise effective deposition of spray. The Civil Aviation Authority, responsible for safety, took this into account when approving aircraft types for Operation Ever Green (refer HRA).

9.5 Appendix five - Details of Ground Sprays with *Btk*

SPRAY No.	DATE	DILUTION	BAFFLE SETTING	RATE/HA# (ESTIMATES)
1	2-5/10/96	50:1	2 (mist blower)	3-5
	8-10/10/96	50:1	3 (mist blower)	3-5
2	15-17/10/96	50:1	3 (mist blower)	3-5
3	23-25/10/96	20:1	3 (mist blower)	7
4	30-31/10/96	20:1	3 (mist blower)	7
5	5-7/11/96	20:1	3 (mist blower)	7
6	14-15/11/96	20:1	3 (mist blower)	7
7	20-22/11/96	20:1	3 (mist blower)	7
8	2-6/12/96	20:1	3 (mist blower)	7
9	11-12/11/96	Undiluted	1 (mist blower)	10-15
10	17-19/12/96	Undiluted	1 (mist blower)	10-15
11	14-15/1/97	4:1	2 (mist blower)	7-10
12	20-21/1/97	4:1	2 (mist blower)	7-10
13	28-29/1/97	4:1	2 (mist blower)	7-10
14	10-11/2/97	4:1	2 (mist blower)	7-10
15	20, 25/2/97	4:1	2 (mist blower)	7-10
16	4-7/3/97	4:1	2 (mist blower)	7-10
17	12-14/3/97	4:1	2 (mist blower)	7-10
18	19/3/97	Undiluted	Micronair	5
20	2/4/97	Undiluted	Micronair	5
21	17/4/97	Undiluted	Micronair	5

Rate per hectare is of litres of the *Btk* liquid concentrate before dilution

The following equipment was tested to determine droplet sizes:

- Stihl mist blower (model SR400) which uses specified flow (baffle) settings from a low of 1 to a high of 6. Setting 2 corresponds to an emission rate of 1.7 litres/minute and setting 3 to 3.8 litres/minute. Droplet spectra for flow settings 1 and 2 respectively are volume median diameters of 75 and 108 microns.
- Micronair AU8000 sprayer, a modified mist blower which can generate the optimal droplet size spectrum for application of *Btk* even at very low flow (application) rates. When run at full throttle the droplet spectrum will have a volume median diameter of 125 microns.

9.6 Appendix six - Aerial sprays with undiluted *Btk* at 5 litres per hectare

SPRAY No.	DATE	AIRCRAFT 1 DC6 (HECTARES)	LITRES OF BTK USED	AIRCRAFT 2 HELICOPTER (HECTARES)	LITRES OF BTK USED	TOTAL BTK USED #
1	5/10/96	4000	20000	200	1000	21000
2	17/10/96	4000	20000	200	1000	21000
3	23/10/96	4000	20000	200	1000	21000
4	31/10/96	4000	20000	200	1000	21000
5	6/11/96	4000	20000	200	1000	21000
6	17/11/96	2000	10000	174	870	10870
7	22/11/96	2000	10000	174	870	10870
8	29/11/96	1000	5000	174	870	5870
9	6-9/12/96	1000	5000	174	870	5870
10	17/1/97			140	700	700
11	22/1/97			190	950	950
12	30/1/97			220	1100	1100
13	9/2/97			308	1540	1540
14	13/2/97			308	1540	1540
15	21/2/97			308	1540	1540
16	27/2/97			308	1540	1540
17	6/3/97			308	1540	1540
18	14/3/97			308	1540	1540
19	19/3/97			308	1540	1540
20	26/3/97			308	1540	1540
21	2/4/97			308	1540	1540
22	12/4/97			300	1500	1500
23	17/4/97			300	1500	1500
	Total	26000	130000	5618	28090	158090
NB: The first 9 helicopter sprays were carried out over uninhabited areas.						

Total *Btk* used is litres of the *Btk* liquid concentrate before dilution.

The concentrate used was Abbott Foray 48B, which is water-based. More extensive information about the composition of Foray 48B is presented in both HRA - Health Risk Assessments. (Section 1, refs. 2 & 3).

9.7 Appendix seven: Register documents held in the National Archives

ENVELOPE NUMBER:	DOCUMENT/PARTICIPATION CATEGORY	NOTES/ RECORDS FOR STREETS
1	REGISTER MANUAL	GUIDE TO THE REGISTER
2	TAKE PART	ALLUM ST ARCHDALL ST
3	TAKE PART	BADDELEY AVE BEERE PL. BONGARD RD
4	TAKE PART	CODRINGTON CRES COLENZO PL COMINS CRES CRUICKSHANK CRES
5	TAKE PART	DORCHESTER ST DUDLEY RD ELTHAM RD GERALDINE PL
6	TAKE PART	GODDEN CRES GODFREY PL GOWING DR GRAMPION RD
7	TAKE PART	HAWERA RD HAWKINS ST
8	TAKE PART	HOBDAV PL HOLGATE RD HOPKINS CRES
9	TAKE PART	HOUGHTON ST KEMPTHORNE CRES KEPA RD
10	TAKE PART	KOHIMARAMA RD (23-132)
11	TAKE PART	KOHIMARAMA RD (133-251)
12	TAKE PART	MELANESIA RD NIHILL CRES PALMER CRES PAORA ST PATTESON AVE PICCADILLY PREBBLE PL
13	TAKE PART	RAWHITIROA RD RIPON CRES

ENVELOPE NUMBER:	DOCUMENT/ PARTICIPATION CATEGORY	NOTES/ RECORDS FOR STREETS
14	TAKE PART	RUTHERFORD TCE ST JOHNS RD SELWYN AVE
15	TAKE PART	SIOTA CRES SOUTHERN CROSS RD
16	TAKE PART	SPROTT RD STEELE ST
17	TAKE PART	TAKITIMU ST TAMAKI DR TARANAKI RD THATCHER ST TIPENE PL TULAGI PL WEST TAMAKI RD WORCESTER RD
18	REFUSE	ALLUM ST TO KEPA RD
19	REFUSE	KEMPTHORNE CRES TO WORCESTER RD
20	PREVIOUS OCCUPIERS NOT TRACEABLE	ALLUM ST TO KEPA RD
21	PREVIOUS OCCUPIERS NOT TRACEABLE	KOHIMARAMA RD TO TULAGI PL
22	PREVIOUS OCCUPIERS NO RESPONSE	
23	NO OCCUPIED DWELLING	
24	OTHER	
25	OCCUPATIONAL REGISTER	
26	OUTSIDE TARGET AREA	
27	SPRAY TECHNICAL DATA	
28	HEALTH RISK ASSESSMENT INFORMATION	
29	EXPOSURE REGISTER PROPERTY ADDRESS DATABASE	
30	HEALTH REGISTER FOR SCHOOLS	
31	ETHICS COMMITTEE APPLICATION	

Supplementary record: Ordered listing of street addresses with participation status and householder names.